APPENDIX 2.7 (A)

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FIRST AQUIFER TEST — PAGE

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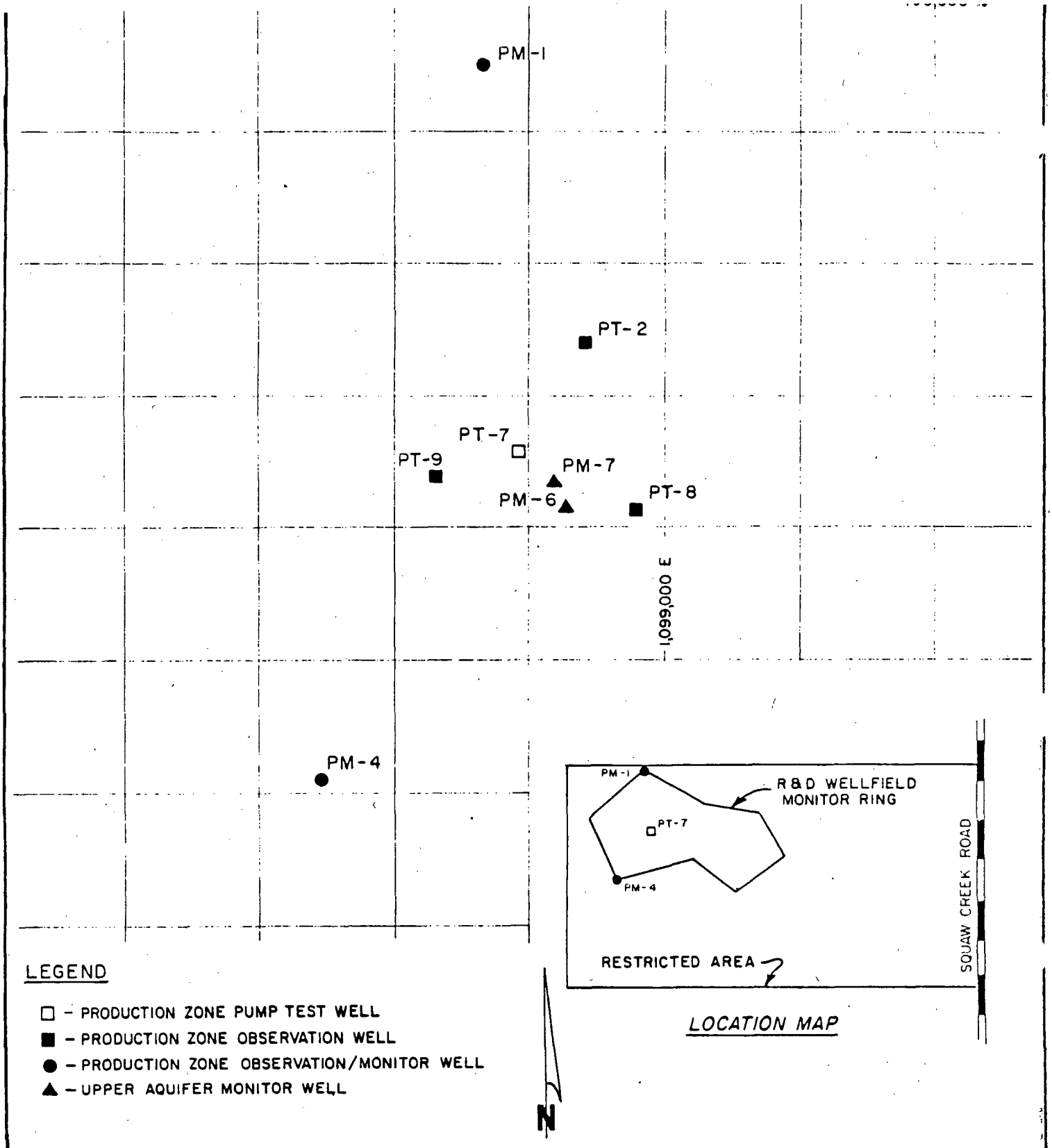
First Aquifer Test

The first aquifer test was conducted in the R&D wellfield during November, 1982. The pumping period was 50.75 hours and the recovery was monitored subsequently for 27.6 hours. Water levels in four production zone observation wells and two shallow Brule monitor wells were monitored. The following sections describe the results of that test and the methods of analysis used. Figure 2.7A-1 shows the relative locations of the wells used in the aquifer test.

Aquifer Test Well Pattern. The wells used for the aquifer test were located so that they could be incorporated into the pilot wellfield. Four of the R&D pattern wells were drilled and completed in the lower 15 to 20 feet (4.5 to 6.0 m) of the Basal Chadron Sandstone. They are numbered PT-2, PT-7, PT-8 and PT-9. Two of the production zone monitor wells were also drilled and completed in the same horizon. These two production zone monitor wells are designated PM-1 and PM-4. In addition to the production zone wells, two shallow aquifer monitor wells were installed into saturated upper sands of the outcropping Brule Formation. The deeper of the two is PM-6 and the other is assigned the number PM-7.

The original completion method used for the wells was the integral screen and cement basket completion. Some difficulties with the original 4 inch (10 cm) screen made it necessary to install 2 inch (5 cm) telescoping liners inside the 4 inch (10 cm) to control sand production.

Table 2.7A-1 lists the completion details for the pump test wells along with their distances from the pumping well, PT-7. The Chadron wells are completed only in the lower 15 to 20 feet (4.5 to 6.0 m) of the Basal Sandstone which has a total thickness of 30 to 45 feet (9 to 14 m). The effects of spherical flow as a result of partial penetration of the aquifer by the well screen are most apparent in the vicinity of the pumping well. As a general rule, horizontal flow conditions are assumed to exist at distances from the pumping well greater than 2 times the total aquifer thickness. For this situation, the drawdown data from wells at a distance of more than 60 to 90 feet (18 to 27 m) should be free from the influence



REV	BY	DATE	FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT Dawes County, Nebraska
			AQUIFER TEST WELLS
			PREPARED BY:
			DWN BY: DALewis | DATE: 1/25/83 | FIGURE 2.7A-1

TABLE 2.7A-A1

PUMP TEST WELL COMPLETION DATA
R & D PROJECT AREA

Well No.	Total Depth (ft)	Centralizer Depths (ft)	Basket Depth (ft)	Screen Interval (ft)	Distance To Pumping Well (ft)
PM-1	674.5	640,540,440,320,240, 160,120,60,Top	645	649.5-669.5	294
PM-4	674.5	10,40,80,115,215 315,415,515,615	637	641.5-646.5 654.5-669.5	289
PM-6	217.5	0, 60, 140, 180	193	196.0-211.0	56
PM-7	129.5	0, 40, 80	85	89.5 - 94.5 99.5 -104.5 109.0-114.0 119.5-124.5	35
PT-2	665.6	10,60,80,119,219, 319,419,519,619	641	641.0-656.0	93
PT-7	672.5	20,80,120,230,330, 430,530,630	648	649.0-664.0	0
PT-8	674.5	630,530,430,330, 230,130,70,30,8	650	653.0-668.0	94
PT-9	680.5	10,50,90,140,240, 340,440,540,640	656	659.0-674.0	66

of partial penetration. Well number PT-9 is the only production zone well closer than 93 feet (28 m) and PT-9 was not monitored during the aquifer test because of screen plugging.

The static water levels for the test area are given in Table 2.7A-2. As can be seen, the piezometric surface is essentially flat across the test pattern.

Pump Test. The center well of the pattern, PT-7, was equipped with a 7-1/2 HP submersible pump which was set at a depth of 620 feet (189 m). The pump discharge line was 1-1/4 inch iron pipe. Power was supplied by a 20 KVA diesel driven generator which ran continuously for the duration of the test. A one inch (2.5 cm) diaphragm valve was used as a flow control valve and two Badger flow totalizers were installed in the discharge line to meter the flow. Only one flow meter was used at any one time, keeping the second in reserve. The discharge line from the flow meters extended 500 feet (152 m) from the well head to insure that leakage down into the shallow aquifers did not occur.

TABLE 2.7A-2

STATIC WATER LEVEL IN THE CROW BUTTE R & D PROJECT AREA

Well No.	Aquifer	Water Level Elevation * (feet-msl)
PM-1	Chadron	3754.3
PM-4	Chadron	3754.4
PM-6	Brule	3843.5
PM-7	Brule	3845.9
PT-2	Chadron	3754.6
PT-7	Chadron	3754.2
PT-8	Chadron	3754.4
PT-9	Chadron	3754.6

* Measured January 10, 1983.

A recording barometer was set up near the test area to monitor fluctuations in atmospheric pressure during the test. Measurements of the water levels in the pilot area wells were also made for a period of 8 days after the aquifer test wells had returned to static conditions. These data were compared with the variations in atmospheric pressure to determine the degree of correlation between atmospheric pressure and hydrostatic head in the aquifer. The barometric efficiency of the aquifer can be estimated by dividing the changes in water level by the concurrent changes in barometric pressure.

Each of the observation wells was equipped with an electric water level indicator and most measurements in each well were made with the same instrument. During the early stages of the test, a person was stationed at each well to take the measurements in rapid succession. Pumping began at 7:15 AM on 11/16/82 and was discontinued at 10:00 AM of 11/18/82; a period of 50.75 hours. A discharge rate of 24 gpm (91 l/min) was chosen for the test. The overall average flow rate was 23.8 gpm (90 l/min) and the fluctuations were generally less than 0.3 gpm (1.1 l/min) or 1.3 percent. Water level measurements were taken at 1, 2 and 5 minutes, then at 5 minute intervals for the first 30 minutes of the test with regularly increasing intervals to 4 hours after 24 hours of elapsed time. Drawdowns were generally smooth and symmetrical and there were no equipment failures or interruptions in the test.

Methods of Data Analysis

Five different approaches have been used to analyze the data from the pump test. The original permit application included analyses based on Theis' Nonequilibrium Method, the Modified Jacob Nonequilibrium Method, and Theis' Recovery method. These analysis techniques, all assuming no leakage, were chosen based on the geology of the site.

Implicit to the application of these types of analyses are a series of assumptions that must be considered of the results. The assumptions underlying the methods used herein are listed below.

- The aquifer has seemingly infinite areal extent,
- The aquifer is homogeneous, isotropic and of uniform thickness over the area influenced by the pumping test,
- Prior to pumping, the piezometric surface is nearly horizontal over the area influenced by the pump test,
- The aquifer is pumped at a constant discharge rate,
- The pumped well penetrated the entire aquifer and thus received water from the entire thickness of the aquifer by horizontal flow,
- The water removed from storage is discharged instantaneously with decline in head,
- The aquifer is fully confined (no leakage or deviation from storage),
- The flow to the well is in unsteady state,
- Storage in the well can be neglected,
- The argument (u) of the well function is less than 0.01 (Modified Jacob and Theis Recovery methods only).

The first three assumptions are seldom entirely satisfied in nature, although small deviations are not prohibitive. The fourth assumption is more easily satisfied by careful control of the pump discharge rate. The next qualification, of full aquifer penetration by the pumping well, is not practical if the wells are to be used in an in situ mining wellfield; but by using observation wells at sufficient distances (greater than twice the aquifer thickness), the effects of spherical flow are eliminated. Emperical evidence from aquifer tests has justified the last assumption (constant storage coefficient).

Based on significant deviation of the pump test data from the Theis type curve in the original analysis, the USNRC questioned the use of a non-leaky analysis method on the data. In response to those concerns, the data were analyzed using a two-stage fit to the Theis type curve. This two-stage analysis was based on changes in aquifer thickness and permeability. In addition, an analysis of leakage was performed based on laboratory testing of core samples.

After further discussions with the USNRC, the data were analyzed again using the Modified Hantush method. This analysis method takes into account fluid derived from storage in the confining bed(s). Since all confining beds exhibit some leakage or loss from storage, however small, and since the Theis equation is a special case of the Modified Hantush equations, use of the Modified Hantush analysis was considered proper for the data available.

The water level in well PT-9 did not respond during the pump test. After the test, the screen was removed from PT-9 and found to be completely plugged with silt and clay sized material. This material is thought to have accumulated due to the use of pumping as the only well development technique. The screen was replaced and the well is now functioning properly.

Water levels in the two shallow monitor wells showed no drawdown during the period of the pump test. Figure 2.7A-2 shows the water level fluctuations in the shallow wells during the period of the test. It is therefore concluded that the confining layers between the production zone and upper water bearing zones do not permit leakage. (Note: Well PM-7 shows a water level change at the beginning of the test. It was determined that a faulty probe was being used during the first two hours of the test. Once this was discovered, the water levels for the remainder of the test were measured with the proper probe).

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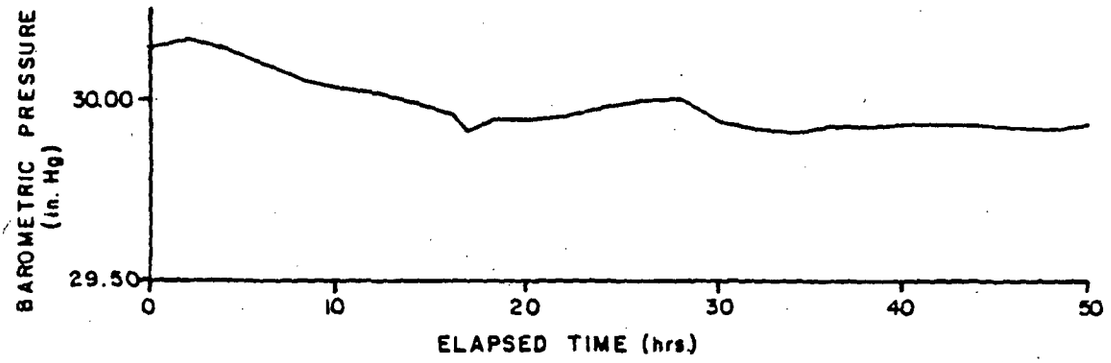
CROW BUTTE PROJECT

Dawes County, Nebraska

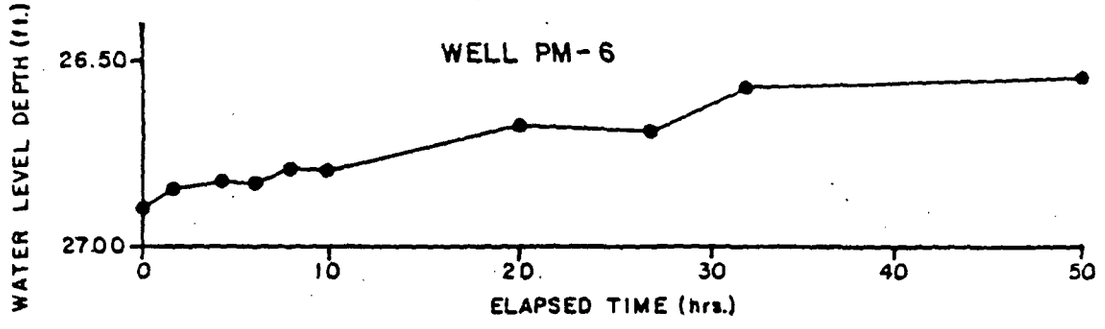
BAROMETRIC PRESSURE vs. ELAPSED TIME OF PUMPING TEST

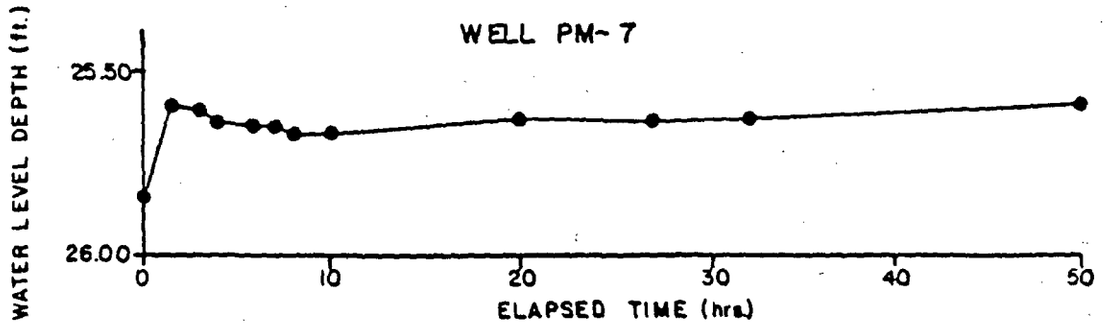
11/16/82 – 11/18/82



(A)

SHALLOW AQUIFIER WATER LEVELS vs. ELAPSED TIME OF PUMPING TEST





(B)

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FIGURE 2.7A-2

FISHER, HARDEN & FISHER

The fluctuations in water levels in the wellfield were measured after the test from 12/6/82 to 12/13/82. Those data were compared with the barometric pressure changes for the same period. An estimate of the barometric efficiency of the aquifer can be obtained from that comparison. Barometric efficiency is defined as the ratio of the water level changes in a well and the concurrent fluctuations in atmospheric pressure. Both values are usually expressed in meters of water as calculated from the data for the 8 day period of measurement. The barometric efficiency of the Basal Chadron Sandstone was 0.40. A graphical comparison of those data is included as Figure 2.7A-3. The effects of barometric pressure changes are not noticeable during the early part of a pump test but are often responsible for the minor fluctuations in drawdown during the latter portion of the test when the rate of change in drawdown is very small. The following sections summarize the hydrologic analyses performed..

Theis' Nonequilibrium Method. Water levels in the observation wells continued to decline for the duration of the test indicating a continuously expanding cone of depression. Under those circumstances, the unsteady state methods of analysis are generally employed. One of the most common of these methods is the Theis nonequilibrium curve matching technique.

The drawdown data "s" for each well are plotted on log-log coordinate paper versus r^2/t: where r is the distance from pumping well to the observation well and t is the time in minutes since the pumping started. The curves are then compared to a standard non-leaky artesian type curve which is a log-log plot of the "well function" W(u) and its argument u.

The results of the Theis curve matching method produce an average value for transmissivity, T, of 3,724 gal/day-ft ($5.36 \times 10^{-4} m^2/sec$) and an average storage coefficient S, of 9.66×10^{-5}. The variation in the four estimated values of T was less than 4 percent. The results of the Theis analysis are given in Table 2.7A-3.

The results of the analysis of the recovery data are also presented in Table 2.7A-3. The average value of T is 3,936 gal/day-ft ($5.66 \times 10^{-4} m^2/sec$) for this method which is slightly higher than the values from the previous

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CROW BUTTE PROJECT

Dawes County, Nebraska

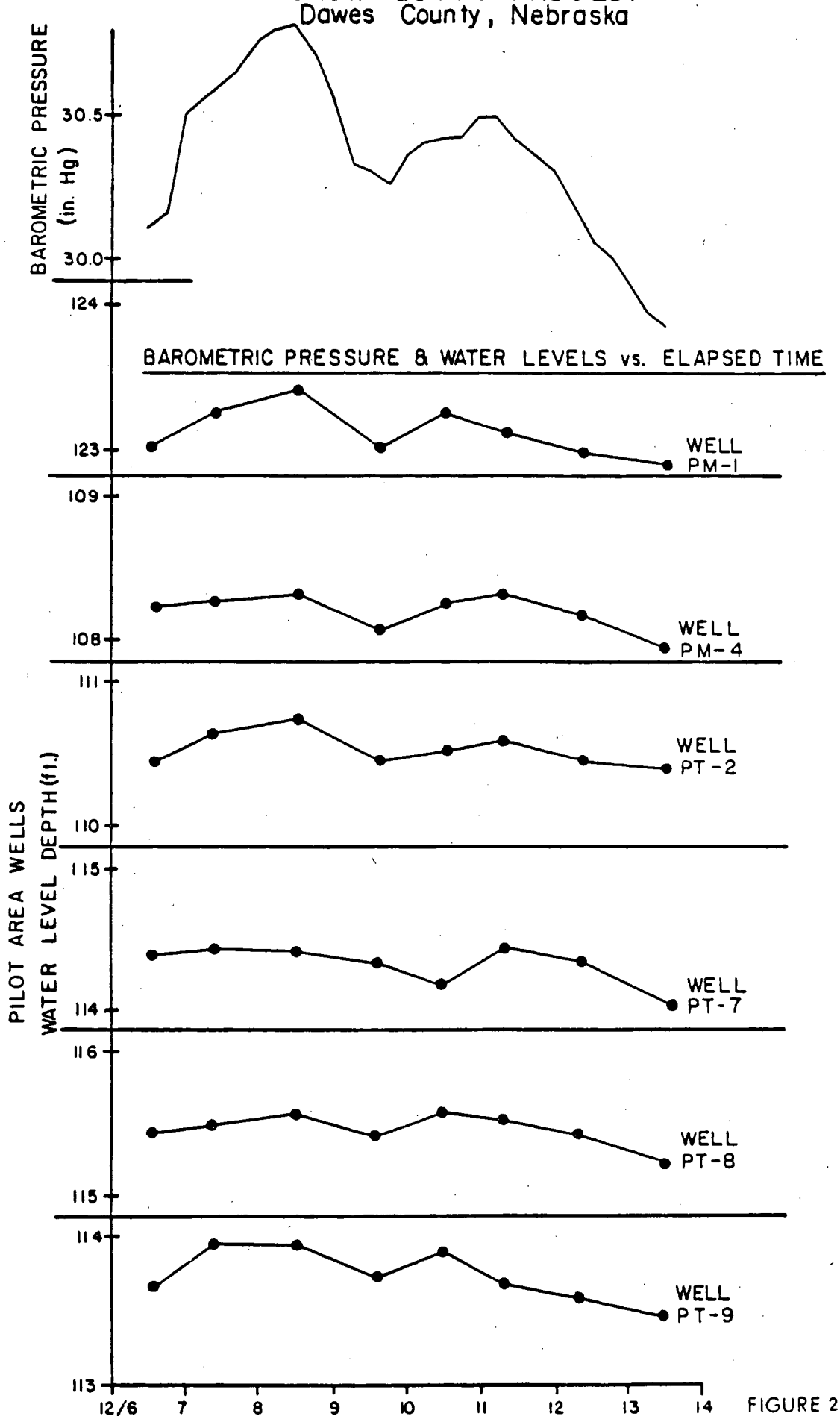

FIGURE 2.7A-3

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TABLE 2.7A-3

ESTIMATED AQUIFER PARAMETERS

Well No.	Theis' Method T (gpd/ft)	Theis' Method T (m^2/sec)	Theis' Method S	Jacob's Method T (gpd/ft)	Jacob's Method T (m^2 sec)	Jacob's Method S	Theis' Recovery Method T (gpd/ft)	Theis' Recovery Method T (m^2/sec)	Theis' Recovery Method S
PT-2	3767	5.42×10^{-4}	1.24×10^{-4}	3727	5.36×10^{-4}	1.34×10^{-4}	3662	5.27×10^{-4}	-------
PT-8	3793	5.45×1^{-4}	1.20×10^{-4}	3840	5.52×10^{-4}	1.23×1^{-4}	4010	5.77×10^{-4}	-------
PM-1	3595	5.17×10^{-4}	6.51×10^{-5}	3899	5.61×10^{-4}	5.85×10^{-5}	3984	5.73×10^{-4}	-------
PM-4	3742	5.38×10^{-4}	7.72×10^{-5}	3984	5.73×10^{-4}	7.28×10^{-5}	4087	5.88×10^{-4}	-------
MEAN	3724	5.36×10^{-4}	9.66×10^{-5}	3863	5.56×10^{-4}	9.71×10^{-5}	3936	5.66×10^{-4}	-------

analyses. Here again, conditions appear to be horizontally isotropic. The fact that the recovery curves do not go precisely through s"=0 and intersect the drawdown axis at a value <0 suggests a slight variation in the value of S for the drawdown and S" for the recovery. This can be expected as no aquifer is perfectly elastic and the rate of rebound often shows some hysteresis.

Two-Stage Theis Nonequilibrium Analysis. The value of transmissivity T, is the product of hydraulic conductivity k, and the aquifer thickness (b). It was assumed that both of these quantities were virtually constant throughout the area of the aquifer that was affected by the aquifer-test pumping. The thickness of the aquifer at the pumping well PT-7, is 41 feet (12.5 m). At a distance of 93 feet (28.3 m) to the north at well PT-2, the aquifer thickness is 32 feet (9.7 m). Core logs of both holes reveal a marked change in the grain size and sorting of the material comprising the aquifer. Grain size and sorting are controlling factors of formation permeability. Further examination of the geology of the pump test area shows a change in aquifer thickness from 32 to 49 feet (9.7 to 14.9 m) or 53%. If the value of k remains constant, the value of T would then vary 53%. Values for k however, vary widely in braided stream deposits like the Basal Chadron Sand.

This variation in both hydraulic conductivity and aquifer thickness does not strictly follow the assumptions implicit in the methods of data analysis and therefore must be taken into consideration. Variations in aquifer thickness of 30 to 50 percent cannot be ignored. Changes in thickness can be treated by matching the Theis curve to the early and the late data independently, calculating a T value for each segment of the curve. The results of this analysis are given in Table 2.7A-4. The average T for the early part of the curve is 2,450 gal/day-ft and for the later part of the curve is 3,760 gal/day-ft. This represents an increase in transmissivity of approximately 53%, which is comparable to the changes in aquifer thickness.

TABLE 2.7A-4

ESTIMATED AQUIFER PARAMETERS
TWO-STAGE THEIS ANALYSIS

WELL	Early T(gpd/ft)	Early S	Late T(gpd/ft)	Late S
PT-8	2116	3.0×10^{-4}	3667	1.7×10^{-4}
PT-2	2500	2.6×10^{-4}	3618	1.5×10^{-4}
PM-1	2806	7.2×10^{-5}	3767	6.6×10^{-5}
PM-4	2391	1.0×10^{-4}	3986	8.0×10^{-5}
MEAN	**2453**	$\mathbf{1.8 \times 10^{-4}}$	**3759**	$\mathbf{1.2 \times 10^{-4}}$

Modified Hantush Analysis. In this analysis the following techniques were used to determine the aquifer/aquitard characteristics:

- Modified Hantush (1965) method for analyzing pumping test data for aquifers influenced by storage from leaky confining beds.
- Hantush (1966) method for defining the major and minor axes of transmissivity in an aquifer.
- Theory of consolidation (Scott, R.F. 1963).

The following analysis is based on ***Aquifer/Aquitard Analysis, Crow Butte ISL Uranium Project*** by D'Appolonia Consulting Engineers, October, 1983.

1. **Transmissivity and Storage Coefficient of the Basal Chadron Aquifer.** The Modified Hantush method was applied to calculate the transmissivities and storage coefficients for the Basal Chadron aquifer. The method is appropriate for the situation when part of the flow from the pumped aquifer comes as a contribution from confining beds. The drawdown versus time curves, Figures 2.7A-4 to 2.7A-7 give the apparent indication of leakage, especially noticeable at the late times. The observation wells completed in the overlying sands of the Brule Formation do not show response to the pumping in the Basal Chadron.

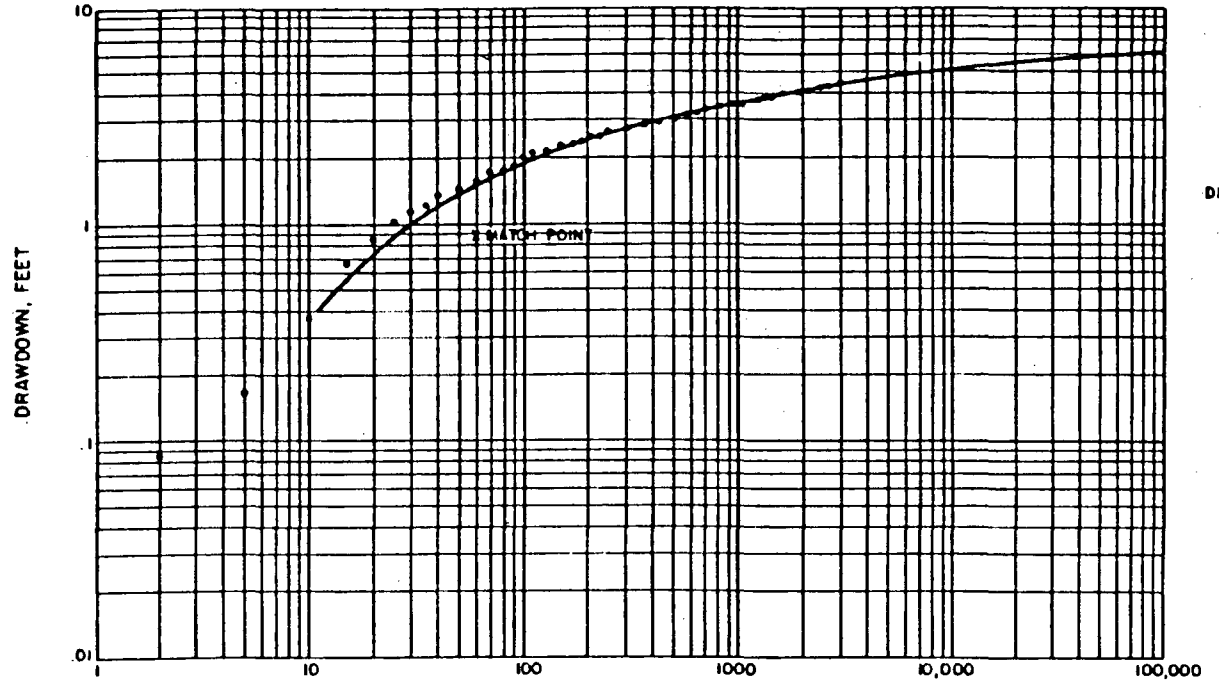
The curve matching technique was used to analyze the data from the observation wells. A log-log plot of drawdown versus elapsed time was laid over the family of type curves which characterize the various possible degrees of leakage from the aquitard to the pumped aquifer. The curve which best fit the data by keeping the axes parallel was determined (Figures 2.7A-4 to 2.7A-7). The designation of the type curve best fitting the drawdown values was recorded and an arbitrary point common to both graphs was selected. The coordinates of the matching point were recorded. The following equations were applied to define the aquifer properties, using match point coordinates:

(Eq. 1)

$$T = \frac{Q}{4\pi s} H(u,\beta)$$

and

(Eq. 2) $S = 4Ttu/r^2$



$\beta = 0.02$

$H(u, \beta) = 1.0$

$\frac{r}{B} = 10,\ u = 0.1$

$s = .92$ ft

$t = 78$ min

DISTANCE FROM THE PUMPING WELL

$r = 294$ ft

$$T = \frac{Q}{4\pi s} H(u, \beta)$$

$$T = \frac{24}{4\pi(92)} \times 1.0 \times 1440 = 399 \text{ ft}^2/\text{day}$$

$$S = \frac{4Tiu}{r^2}$$

$$S = \frac{4 \times 399 \times 78 \times 0.1}{(294)^2 \times 1440} = 1.0 \times 10^{-4}$$

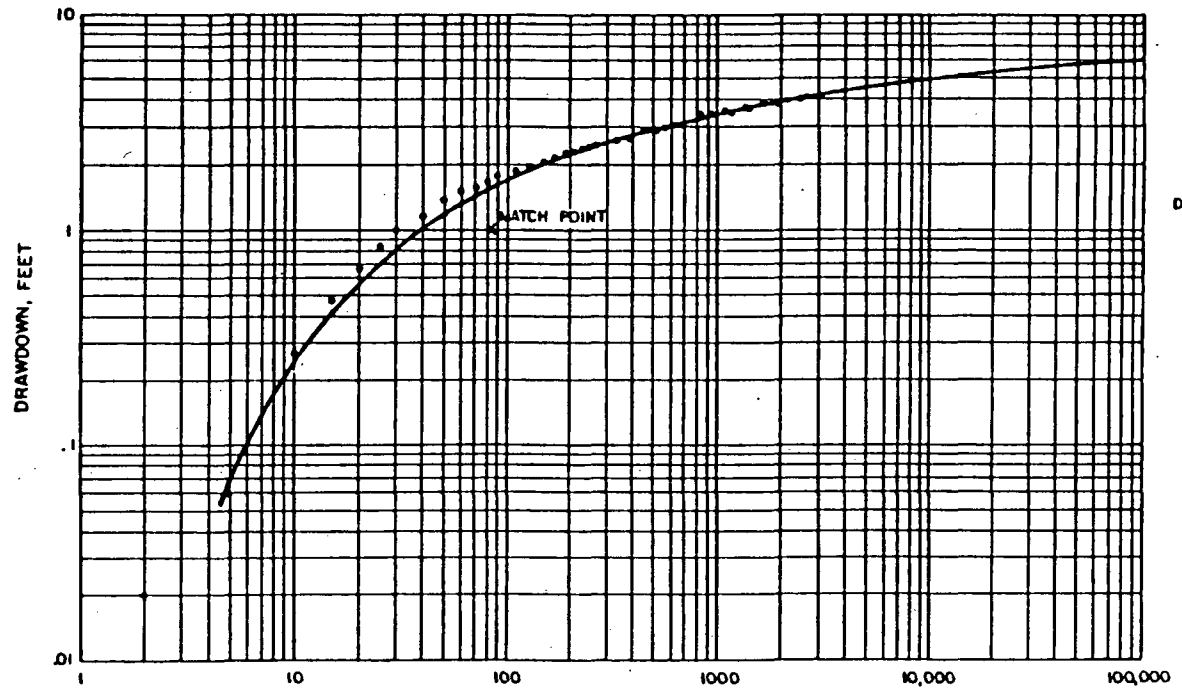
AQUIFER ANALYSIS BY
MODIFIED HANTUSH METHOD
OBSERVATION WELL PM-1

PREPARED FOR

WYOMING FUEL COMPANY
LAKEWOOD, COLORADO

DAMES & MOORE

FIGURE 2.7A-4



$\beta = 0.05$

$H(u, \beta) = 1.0$

$\frac{1}{u} = 10,\ u = 0.1$

$s = 1.0$ ft

$t = 83$ min

DISTANCE FROM THE PUMPING WELL:

$r = 288.75$ ft

$$T = \frac{Q}{4\pi s} H(u, \beta)$$

$$T = \frac{24}{4\pi (1.0)} \times 1.0 \times 1440 = 367 \text{ ft}^2/\text{day}$$

$$S = \frac{4Ttu}{r^2}$$

$$S = \frac{4 \times 367 \times 83 \times 0.1}{(288.75)^2 \times 1440} = 1.0 \times 10^{-4}$$

AQUIFER ANALYSIS BY
MODIFIED HANTUSH METHOD
OBSERVATION WELL PM-4

PREPARED FOR

WYOMING FUEL COMPANY
LAKEWOOD, COLORADO

DAMTOLONA

FIGURE 2.7A-5

DRAWN BY DJ Rodgers 10-27-83 | CHECKED BY R.V.Y. 10/31/83 | APPROVED BY J.T.C. 10/31/83 | DRAWING NUMBER PM83-1721-B1

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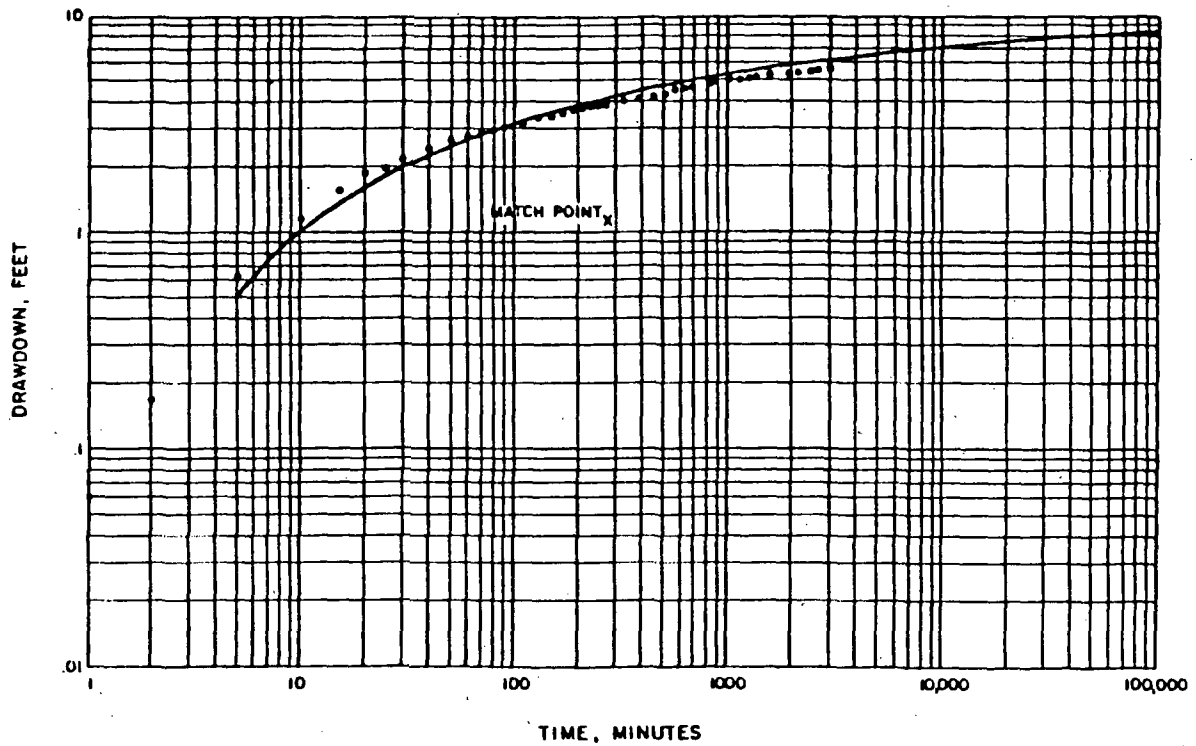


$\beta = 0.02$

$H(u, \beta) = 1.0$

$\frac{1}{u} = 100, \; u = .01$

$s = 1.0$ ft

$t = 200$ min

DISTANCE FROM THE PUMPING WELL

$r = 93.49$ ft

$$T = \frac{Q}{4\pi s} H(u, \beta)$$

$$T = \frac{24}{4\pi(1.0)} \times 1.0 \times 1440 = 367 \text{ ft}^2/\text{day}$$

$$S = \frac{4Ttu}{r^2}$$

$$S = \frac{4(367)200(0.01)}{(93.49)^2 \times 1440} = 2.3 \times 10^{-4}$$

AQUIFER ANALYSIS P-
MODIFIED HANTUSH METHOD
OBSERVATION WELL PT-2

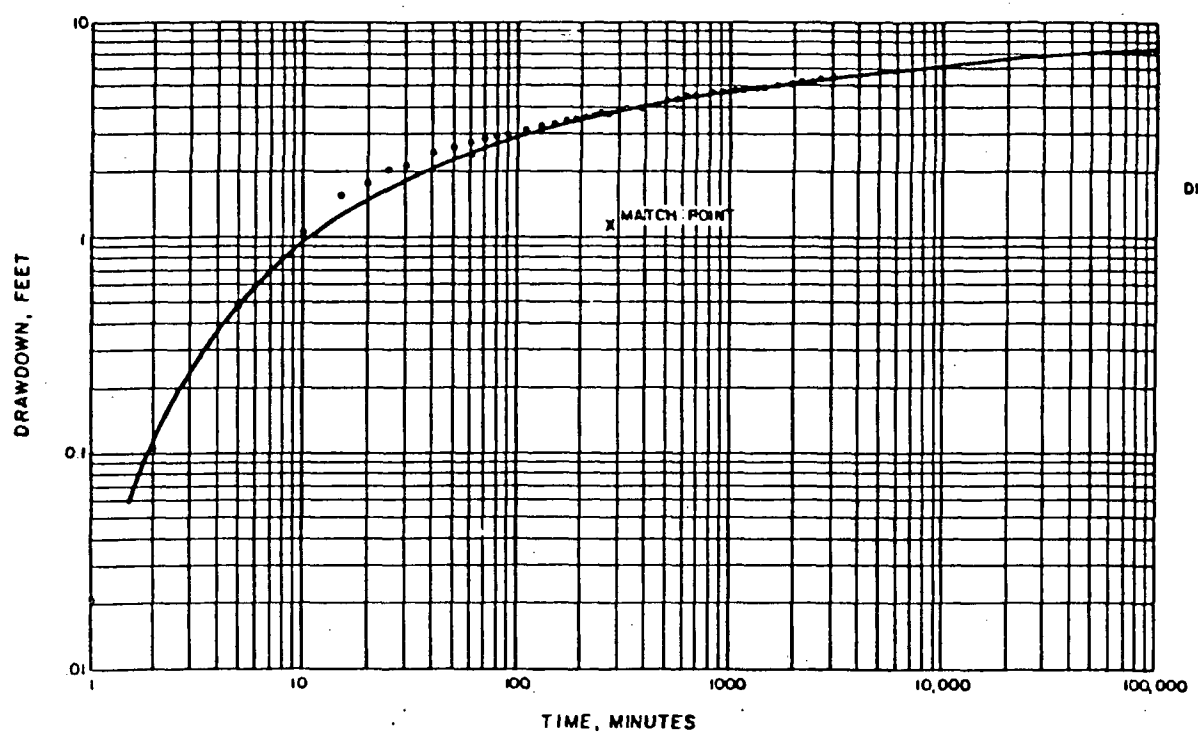
PREPARED FOR

WYOMING FUEL COMPANY
LAKEWOOD, COLORADO

D'APPOLONIA

FIGURE 2.7A-6

2.7A(18) 07/29/87



$\beta = 0.05$

$H(u, \beta) = 1.0$

$\frac{1}{u} = 100, \; u = 0.01$

$s = 1.2$ ft

$t = 275$ min

DISTANCE FROM THE PUMPING WELL:

$r = 93.69$ ft

$T = \frac{Q}{4\pi s} H(u, \beta)$

$T = \frac{24}{4\pi(1.2)} \times 1.0 \times 1440 = 3061 \text{ ft}^2/\text{day}$

$S = \frac{4Ttu}{r^2}$

$S = \frac{4(306)\,275\,(0.01)}{(93.69)^2 \times 1440} = 2.7 \times 10^{-4}$

AQUIFER ANALYSIS BY
MODIFIED HANTUSH METHOD
OBSERVATION WELL PT-8

PREPARED FOR

WYOMING FUEL COMPANY
LAKEWOOD, COLORADO

DAMES & MOORE

FIGURE 2.7A-7

2.7A(19) 07/29/87

Where:

T = transmissivity
Q = pumping rate
H (u,ß) = Hantush's leaky aquifer function
s = drawdown
S = storage coefficient
t = pumping time
u = well function
r = distance from pumping well

The transmissivity measured at four observation wells (PM-1, PT-2, PT-8, and PM-4 ranged from 306 ft^2/day to 399 ft^2/day (2289-2985 gpd/ft) during the pumping period. The storage coefficients ranges from $9.9x10^{-5}$ to $2.7x10^{-4}$ (Table 2.7A-5).

The drawdown data as shown in Figures 2.7A-4 to 2.7A-7 do not appear affected by partial penetration of the production well, which is in agreement with the theory (Hantush, 1961) that vertical flow to a partially penetrating well is not significant at the observation well location when the distance between the pumping and observation well exceeds two thicknesses of the aquifer.

2. **Directional Transmissivity of the Basal Chadron Aquifer.** Most aquifers do not exhibit the same transmissivity in all directions in the horizontal plane, but rather show some horizontal anistropy. Typically, this anistropy can be described by an ellipse of transmissivity with major and minor axes corresponding to the directions of maximum and minimum transmissivities. Hantush (1966) presented a method for defining these axes. The method requires transmissivity values derived from observation wells located along three different radial lines from the pumping well, and is a trigonometric solution for an ellipse, given three points along its perimeter.

TABLE 2.7A-5

AQUIFER PROPERTIES CALCULATED BY THE HANTUSH METHOD

OBSERVATION WELL	TRANSMISSIVITY (feet²/day)	TRANSMISSIVITY (gpd/ft)	STORAGE COEFFICIENT S
PM-1	399	2985	$9.9X10^{-5}$
PM-4	367	2746	$1.0x10^{-4}$
PT-2	367	2746	$2.3x10^{-4}$
PT-8	306	2289	$2.7x10^{-4}$
Mean	360	2692	$1.75x10^{-4}$

In addition to the orientation and magnitude of the major and minor axes, the method also provides a value for the effective (or geometric mean) transmissivity, and permits the calculation of transmissivity in the direction of flow. If the saturated thickness of the aquifer is generally uniform, the directional hydraulic conductivity of the aquifer will correspond more or less with the directional transmissivity.

The directional transmissivity for the Basal Chadron aquifer was determined from four observation wells. The major axis of transmissivity lies along an azimuth of 2 degrees and has the magnitude of 401 ft^2/day (3000 gpd/ft). The minor axis of transmissivity has an azimuth of 92 degrees with a magnitude of 290 ft^2/day (2169 gpd/ft). The geometric mean of transmissivities is 341 ft^2/day (2551 gpd/ft). The major and minor axes of hydraulic conductivity coincide with the transmissivity axes and have magnitude of 10 ft/day and 7.25 ft/day respectively based on a Basal Chadron Sandstone nominal thickness of 40 feet over the area tested (Table 2.7A-7). The geometric mean hydraulic conductivity is 8.52 ft/day.

3. **Properties of the Aquitards.** The results of the laboratory testing performed on core samples from the core hole C6C, the only such samples available, were utilized in the following section of this report. Since no monitoring wells were installed in the Middle Chadron Formation, no aquitard permeability data are available from the pump test.

Information from the laboratory tests used in this report include:

- for Pierre Shale
  - vertical hydraulic conductivity - $K_v = 9.6 \times 10^{-9}$ ft/day
  - coefficient of consolidation - $C_v = 6.3 \times 10^{-3}$ cm^2/sec
- for Red Clay
  - vertical hydraulic conductivity - $K_v = 7.8 \times 10^{-7}$ ft/day
  - coefficient of consolidation - $C_v = 1.9 \times 10^{-3}$ cm^2/sec
- for Sandy Claystone
  - vertical hydraulic conductivity - $K_v = 8.2 \times 10^{-7}$ ft/day
  - coefficient of consolidation - not available

The laboratory test data are summarized in Table 2.7A-6.

4. **Analysis of the Aquifer/Aquitard Interaction.** Examination of the drawdown/time curves plotted for observation wells indicated that some leakage from confining beds occurred during the pumping test. To quantify

TABLE 2.7A-6

SUMMARY OF THE AQUITARD PROPERTIES

	Vertical Hydraulic Conductivity[1], K (feet/day)	(cm-sec)	Coeffecient of Consolidation[2] C_v (cm^2/sec)
Red Clay	7.8×10^{-7}	2.8×10^{-10}	1.9×10^{-3}
Sandy Claystone	8.2×10^{-7}	2.9×10^{-10}	Not Available
Pierre Shale	9.6×10^{-8}	3.4×10^{-11}	6.3×10^{-3}

(1) From laboratory testing on core samples from C6C corehole by Core Laboratories.

(2) From laboratory testing on core samples from C6C corehole by Woodward-Clyde Consultants.

the aquifer/aquitard interaction which resulted in release of the water from the confining beds when the drawdown in Basal Chadron aquifer occurred, the following analysis of aquifer/aquitard interactions were performed.

To estimate the drawdown as a function of distance from the pumping wells, a drawdown-distance curve was simulated for the aquifer properties presented in Table 2.7A-5. The drawdown equation used to develop the drawdown-distance curve was based on the modified Hantush theory for a leaky aquifer:

(Eq. 3)

$$s = \frac{Q}{4\pi T} H(u,\beta)$$

(Eq. 4)

$$u = r^2 S/4tT$$

Where:

s = drawdown
Q = pumping rate
T = transmissivity (isotropic)
S = storage coefficient
t = pumping time
r = distance of observation from pump well
H(u,ß) = Hantush leaky well function
u = well function
ß = type curve parameter for leaky aquifer analysis.

The simulated distance-drawdown curve for Basal Chadron Aquifer is presented in Figure 2.7A-8. The observed drawdowns are also shown in this figure; they are in reasonable agreement with the simulated drawdown.

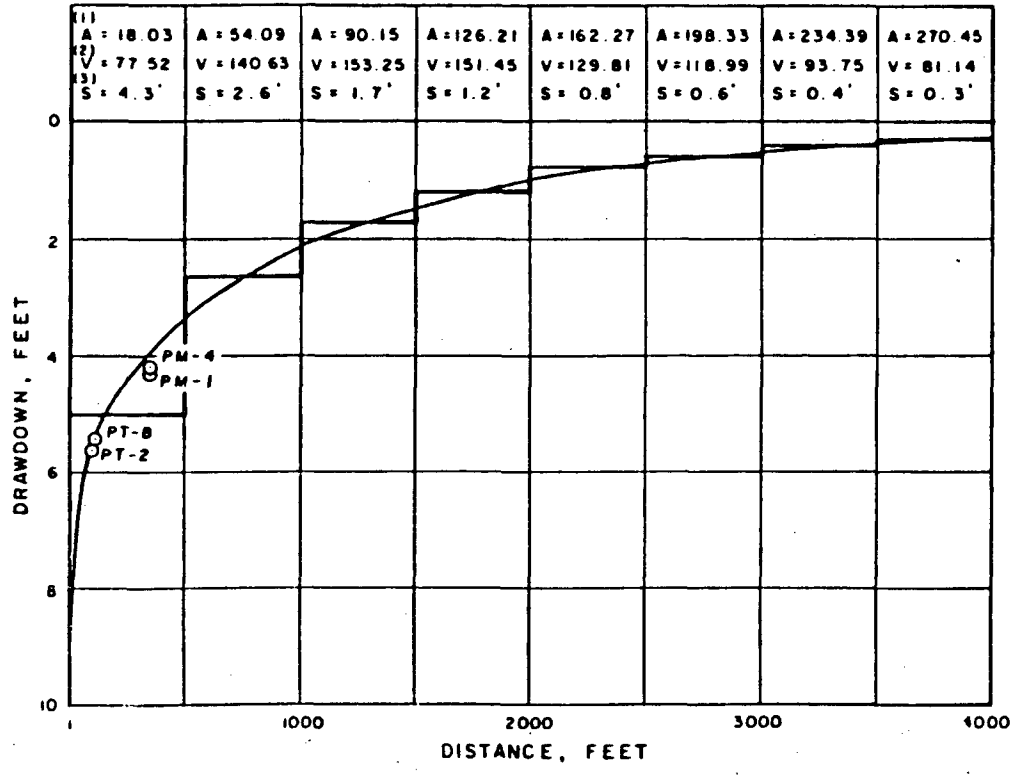
In the process of estimating the magnitude of leakage from the upper confinement both the Red Clay and Sandy Claystone, i.e., two strata immediately overlying the Basal Chadron aquifer, were examined. Initially the permeability of the system comprised of the Red Clay and Sandy Claystone was calculated from the relationship:

(Eq. 5)

$$K_{Av} = \frac{b'}{\frac{b'_1}{K'_{z(1)}} + \frac{b'_2}{K'_{z(2)}}}$$

Where:

K_{Av} = average vertical hydraulic conductivity of the system
b' = thickness of the system
b'_1, b'_2 = thickness of the different strata comprising the system
$K'_z(1), K'_z(2)$ = vertical hydraulic conductivities of strata comprising the system.



AREA AFFECTED BY PUMPING

A_t = 1154 ACRES

TOTAL LEAKAGE FROM UPPER CONFINEMENT

V_t = 947 GALLONS

(1) ACRES

(2) GALLONS

(3) FEET

SIMULATED DISTANCE DRAWDOWN CURVE AND INFLOWS FROM UPPER AQUITARD

PREPARED FOR

WYOMING FUEL COMPANY
LAKEWOOD, COLORADO

DAMES & MOORE

FIGURE 2.7A-8

2.7A(25) 07/29/87

DRAWN BY R.D.B. 10/5/87
CHECKED BY R.S.P. 10/5/87
APPROVED BY J.T.G. 10/5/87
DRAWING NUMBER RMB3.1721-B5

The average hydraulic conductivity of the entire system was found to be almost the same as the hydraulic conductivity of the Red Clay. Furthermore, from the analysis of the aquifer/aquitard interaction from the formation consolidation standpoint, it is apparent that during the period of the pumping test, the water released from the upper aquitard is entirely from the Red Clay. Pore pressure changes at the bottom of the Red Clay did not propagate through the clay into the overlying sandy claystone over the pumping test period. Applying the theory of consolidation (Scott, 1963), the volume of water which could be liberated from the Red Clay under induced drawdown was calculated from the relationship:

(Eq. 6)

$$Q_T = \frac{2 K_v U_i}{\gamma_w \sqrt{\pi C_v}} \sqrt{t}$$

Where:

Q_T = volume of water released from the confining bed during the time t
K_v = vertical hydraulic conductivity of the confining bed
γ_w = unit weight of water
U_i = induced change in effective overburden pressure, proportional to drawdown ($s = U_i / \gamma_w$)
C_v = coefficient of consolidation
t = time since drawdown occurred
s = drawdown

The analysis showed that Red Clay could release one gallon of water per one foot of drawdown per acre during the 2.09 days (i.e., during the entire pumping test). Using the values of drawdown for a given distance from the pumping well presented in Figure 2.7A-8 and the volumes of water which could be released from confinement, the overall contribution from aquifer upper confinement to the flow produced during the pumping test was calculated. The results of calculations are also illustrated in Figure 2.7A-9. The volume of water released from the Red Clay during the pumping test was thus computed to be about 1,000 gallons. This constitutes

The contribution from the Pierre Shale owing to its lower hydraulic conductivity (approximately one order of magnitude less than the upper confinement)(Table 2.7A-6) would be significantly smaller - about 0.06 gallon of water per foot of drawdown per acre - during the entire pumping test. Figure 2.7A-9 illustrates the relationship between volume of inflow

DRAWN BY	CHECKED BY		DRAWING NUMBER
D.J. Rodriguez 10 31 83	APPROVED BY	RSP 10/31/83	RM83-1721-A2

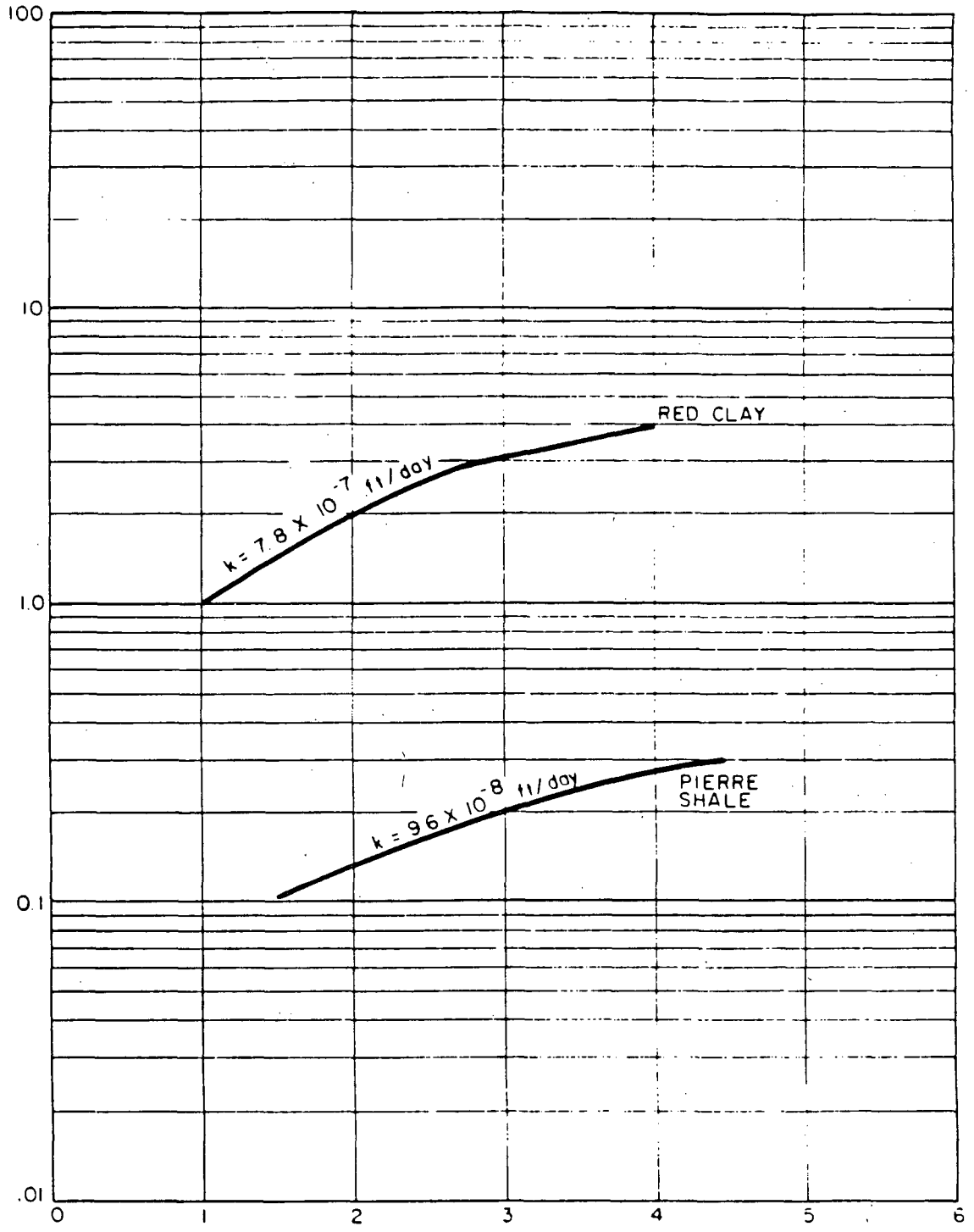


Figure 2.7A-9
LEAKAGE FROM
AQUITARD VS DRAWDOWN
PREPARED FOR
WYOMING FUEL COMPANY
LAKEWOOD, COLORADO

DAMPIERRE

from the confining Red Clay and Pierre Shale versus drop in the hydraulic head at the aquifer/aquitard contact.

In the above analysis, the transient nature of drawdown versus time was not considered in the analysis. In other words, the maximum drawdowns as observed or simulated for the final phase of the pumping test were assumed to persist for the duration of the pumping test. This is conservative in that it overpredicts the volume of water released.

For time periods extending well beyond the pumping test period, the rate of water released from the aquitard will be less than indicated above, assuming equal drawdown conditions. Quantification of this rate involves an analysis different from that represented in Equation 6.

Two factors which were used to further characterize the degree of confinement are the leakage factor (B) and the hydraulic resistance (c). The leakage factor was defined by Hantush (1964) as:

(Eq. 7) $B = [Kb/(K_z'/b')]\ 1/2$

Where:

B = leakage factor
K = hydraulic conductivity of aquifer
b = thickness of aquifer
K_z' = vertical hydraulic conductivity of aquitard
b' = thickness of aquitard

The leakage factor has units of length. The greater the value of B, the less the contribution of leakage to the water pumped from the aquifer. For the 15 feet of immediate upper confinement comprised of the Red Clay, B has a value of about 8.1×10^4 feet, which is very large. The hydraulic resistance was defined by Kruseman and DeRidder (1970) as:

(Eq. 8) $c = b'/K_z'$

and has units of time. When multiplied by the porosity of the aquitard, the time that a molecule of water would take to pass through the given thickness of the aquitard under a unit gradient could be computed. The hydraulic resistance for the 15 foot thick section of the Red Clay immediately overlying the Basal Chadron sandstone is 53,000 years. To

calculate travel time through the confinement, an effective porosity value of 22 percent was used. This value is based on a measurement of effective porosity performed on a core sample of Red Clay. Only the Red Clay was considered in the analysis, due to its very low permeability and the short time of pumping. Assuming an effective porosity of 22%, the travel time through the 15 foot thick section of the aquitard under unit gradient would be 12,000 years.

5. **Ground Water Movement Within the Investigated Area.** The examination of the average ground water levels in the eight wells in Figure 2.7A-4 completed in the Chadron aquifer shows that the direction of the flow is toward the north and the dip of the potentiometric surface is 0.04 percent.

Using a directional hydraulic conductivity of 10 ft/day and an assumed effective porosity of 29 percent, the average pore velocity across the R&D site was computed to be about 5.0 ft/yr. The ground water flux across the site was computed to be 0.16 ft^3/day per unit width of the aquifer.

SECTION 2.8
ECOLOGY

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TABLE OF CONTENTS (Continued)

SUMMARY

Beginning in March, 1981, plans were initiated to undertake ecological studies for Ferret Nebraska's Crow Butte Uranium Project near Crawford, Nebraska. At that time, all appropriate state and federal regulations pertaining to uranium solution mining were reviewed, and studies were designed which were deemed appropriate to comply with legislative precedents in the region.

Information deemed necessary for completion of a suitable permit application was outlined in a detailed task analysis, which identified the following objectives:

1. Describe the flora and the fauna in the vicinity of the site, their habitats and distributions.
2. Identify "Important Species" - species which are:
   a. commercially or recreationally valuable
   b. threatened or endangered
   c. likely to affect the well-being of species in the above categories
   d. critical to the structure and function of the ecological system
   e. biological indicators of radionuclides or chemical pollutants in the environment.
3. Identify and provide information on the relative abundance of the majority of terrestrial and aquatic organisms.
4. Provide count data on domestic animals and important game animals.
5. Provide a map of the principal plant communities.
6. Discuss species-environmental relationships, diversity measurements, and predator-prey relationships of "important" species.
7. For "important" species, discuss:
   a. life histories
   b. seasonal populations fluctuations
   c. habitat requirements
   d. food chains and interspecies relationships.
8. Identify any pre-existing environmental stresses.
9. Describe the status of ecological succession within each plant community type.

10. Discuss histories of any infestations, epidemics or catastrophes.
11. Present the information in two separate subsections, "Terrestrial Ecology" and "Aquatic Ecology".
12. Identify sources of information and list pertinent published information dealing with the ecology of the region.
13. Reference and describe all ecological and biological studies of the site or its environs currently in process of planned.
14. Update and verify baseline data for expansion to a commercial facility.

Methods of investigation were chosen which would address the above objectives. A review of literature was completed, and discussions were held with local representatives of the state and federal agencies, and with faculty of Chadron State College.

A detailed work plan was developed that would provide sufficient data to satisfy local, state, and federal requirements for a uranium in situ leach Research and Development (R&D) and, with updating, satisfy requirements for expansion to a Commercial facility. Baseline studies were undertaken in January 1982 and continued through December 1982 in order to provide a full year's data. These studies have been updated in 1987 through literature searches, recontacting critical personnel, and field verification.

Stated in its simplest terms, the ecological study entailed, 1) the identification and documentation of plant communities and wildlife habitat types, 2) the systematic documentation of wildlife species within each type, and 3) updating the baseline data and assessing impacts to the ecology of the area caused by development and operation of the R & D facility as well as the upgrading to the commercial scale.

In the attached report, emphasis is placed on the relationships of plants and animals to particular habitat types. This "habitat affinity" approach allows one to address potential impacts in a systematic matter. If a particular habitat type is disturbed, it can be anticipated that the representative plant and animal species will be affected in direct proportion to the

level of disturbance. Conversely, undisturbed habitat types, and their representative species, should not be adversely affected. On the site in question, for example, if only mixed grass habitat is disturbed, one should not expect such species as fox, squirrels and white-tailed deer, which reside in streambank forest, to be adversely affected.

The baseline information presented in the attached report is intended not only as a basis for assessing anticipated impacts, but as a basis for reference against which to measure impacts as they occur. It should be understood that such studies are considered important not only in terms of the public welfare, but also to protect the interests of the company. If, for example, years hence a "decline" in the fishery of Squaw Creek were to be suggested and attributed to mining activities, it would be appropriate to note from the baseline study that there was no significant fishery at the outset of mining activities.

Intensive investigations were conducted throughout the 13 section "Commercial Study Area (CSA). The Commercial Permit Area is contained within the CSA. Equivalent studies were conducted within a 5 mile (8-km) "Adjacent Area" (AA). Finally, extensive studies were conducted within a 50 mile (80-km) "Outer Area" (OA). Hence it is possible to compare conditions within the proposed area of development to conditions in the general vicinity and to a much larger area. It is subsequently possible to make statements concerning the relative importance of the permit area on a local and regional basis.

In the course of the study, no phenomena were discovered which would preclude issuance of permits for development of the property in the current legal and socioeconomic environment. Although the Pine Ridge area contains a wealth of plant and animal species and is regarded as an important hunting and fishing unit, environmental conditions within the CSA proper are relatively degraded due to widespread deleterious land practices.

Of threatened, endangered and rare species, bald eagles and peregrine falcons are winter residents and migrants of the region. The CSA is within the range of the swift fox, but no sightings have been recorded in the CSA.

From a purely ecological point of view, perhaps the most significant aspect of the study was the diversity of raptors (birds-of-prey) with 21 species documented within the study area from January through July, 1982. No adverse impacts, however, are anticipated since no reduction in the prey base is expected to result from project activities. Quite to the contrary, there is considerable opportunity to enhance conditions for raptors, if attention is given to improving habitat conditions in the reclamation phase.

2.8-1 TERRESTRIAL ECOLOGY

Introduction

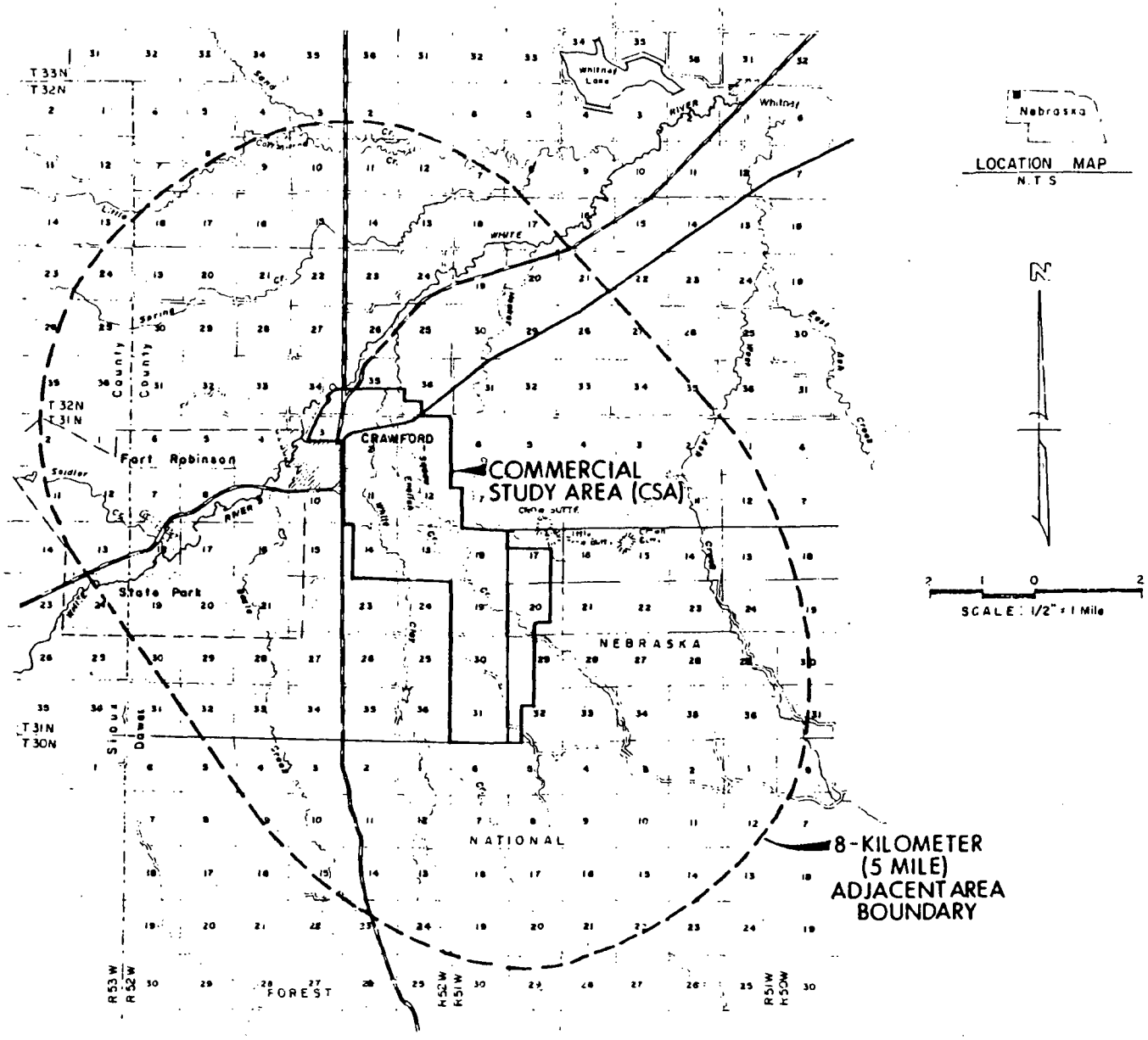
A one-year ecological baseline study was initiated in January, 1982, in conjunction with the Crow Butte Uranium Project, Dawes County, Nebraska.

The principal study area is shown in Figure 2.8-1. Intensive studies were conducted on the proposed CSA. Comparable investigations were conducted within an 8-km (5 mi) AA, in order to assess the ecological importance of the CSA in relation to the immediate environs. Extensive investigations were conducted within an 80-km (50 mi) OA centered on Section 19, drawing primarily upon published sources of information.

The information presented in this section includes findings of the baseline studies conducted in 1982 and updated in 1987. The data base will prove sufficient to comply with federal and state requirements for commercial license applications and sufficient to assess the probable impacts of the the project.

Description of the Study Area. The project area lies within Dawes County in northwestern Nebraska. The 8-km AA includes portions of Sioux County on the west. The 80-km OA includes portions of South Dakota on the north and Wyoming to the west.

The climate is dry continental. The normal annual amount of precipitation is about 19 in (48 cm). Seventy percent of that amount falls during the growing season.



LOCATION MAP
N.T.S

2.8(5) 07/29/87

REV DATE	FERRET OF NEBRASKA, INC.
	CROW BUTTE PROJECT Dawes County, Nebraska
	ECOLOGICAL STUDY AREA
	PREPARED BY: F.E.N.
	DWN BY: JC DATE: 8/87 FIGURE 2.8-1

The winters are cold, with January having a low mean temperature of about -5°C. Warmest temperatures occur during late July, when mean highs range from 35-38°C. The growing season averages about 130 days. The latest killing frost occurs during mid-May, and the earliest in fall occurs during late September (Visher 1954; Urbatsch and Eddy 1969). Violent thunderstorms accompanied by high winds, torrential rains, and hail, can be expected to occur each spring and summer.

The study area lies in two physiographic provinces. The Pine Ridge Escarpment, the region's most prominent geological feature, marks the northern boundary of the Northern High Plains and the southern boundary of the unglaciated Missouri Plateau. The Pine Ridge, which lies along the southern boundary of the CSA, is characterized by buttes, ridges, vertical slopes and deep canyons. The Missouri Plateau, which represents the northern portion of the study area is distinguished from the High Plains by deep erosion and has badlands developed at some sites (Fenneman 1931). The White and Niobrara Rivers are the two major streams which drain the region, the former traversing the study area (Figure 2.8-1).

The soils of the study area have a tremendous range, from clays in the north, to sands in the south, with an intermittence of badlands and relatively fertile soils. The clays (Pierre series) developed from shales in the northern part of Dawes County, where badland outcrops of Tertiary sandstone, and alkaline flats occur. Soils of the CSA are predominantly of a siltstone and sandstone origin.

Elevations within the primary study area (CSA and AA) range from 3,400 ft (1,100m) to 4,600 ft (1,480m). The CSA lies primarily in a foothill and valley bottom situation, surrounded by buttes and escarpments to the east, south and west, and expansive plains to the north.

Methods

Methods of investigation were chosen, taking into account the principal floral and faunal species of the area, and following discussions with agency biologists (J. Peterson, H. Suetsuga, Nebraska Game and Parks

Commission). Whenever possible, methods were employed which would provide continuity and compatibility with ongoing investigations in the state and the region.

Plant Collections were conducted throughout the growing season in order to prepare a comprehensive voucher of plant species within the study area.

Vegetation Mapping was completed at a scale of 1:12,000 for the CSA, and at a scale of 1:24,000 for the AA. Vegetation/Habitat types were chosen in compliance with the system developed by the Montana Agriculture Experiment Station (Coenenberg et al. 1977), modified to conform to the ecological characteristics of the Crow Butte area. The system was deemed appropriate to describe floristic characteristics and to describe wildlife habitat affinities.

General Observation was utilized to generate a species list for the study area and to obtain information on faunal distribution. In addition to routine sightings, observation time was programmed specifically for 1) raptor nest surveys, 2) big game surveys, 3) movement and migration route delineation, 4) game bird winter concentrations, 5) game bird brood counts, 6) grouse strutting ground "lek" surveys, 7) waterfowl breeding pair counts, 8) waterfowl brood surveys and production counts, 9) prairie dog colony surveys, 10) carnivore dens, and 11) reptile and amphibian surveys.

Indirect Evidence of wildlife was recorded to supplement visual documentation. Such evidence included tracks, scat, hair or quills, feathers, vocalization, and evidence of forage utilization. Fresh snowfall afforded special documentation opportunities, e.g., radius of action and behavioral phenomena.

Aerial Observation was the primary means of documenting big game use within the study area. Nesting activity of raptors was monitored by aircraft, and an aerial search was made for grouse leks. Flight lines for big game were oriented north-south and spaced at 1/2 mile intervals within the CSA and AA.

Transects were used to determine relative utilization of the major habitat types by wildlife and to document seasonal songbird activity. One 1,000m transect was placed in each major habitat type. Transects were sampled at 2-week intervals from sunrise to no later than 3 hours after sunrise. Perpendicular distance of each observation was used to compute density by species (Emlen 1977).

Time-area Counts were incorporated to provide consistency in sampling wildlife use within special habitat types, e.g., ponds and impoundments.

Rodent Trapping was conducted over a 3-day period in spring, to provide an index of abundance by habitat type. Fifty traps were placed parallel to each flush transect (above) for 3 consecutive days and nights (150 trap-nights per habitat type).

Spotlight Routes were employed to document the status of carnivores, and to provide herd structure data for ungulates. Four routes, each about 80-km long, were run monthly.

Data Reduction and Analysis. All field data were recorded on prepared forms or on cassette recorder. Raw data were reduced onto Fortran coding forms for permanent storage and analysis. Locations of the major wildlife species were recorded to within 50m, and for certain phenomena, e.g., raptor nests to within 10m with reference to the Universal Transverse Mercator (UTM) system and encoded on mylar overlays at a scale of 1:24,000.

Further details of methodologies are discussed in association with specific taxa.

Vegetation

The Pine Ridge area of Nebraska, as in the case of the adjacent Black Hills of South Dakota, is represented by two principal vegetation regions (Van Bruggen 1977). These are outlined briefly below:

1. Plains and Prairie Flora. This vegetation region is comprised of two subregions - the True Prairie Flora and the Great Plains Grassland Flora. The transition from True Prairie in the eastern part of the state to Great Plains Grassland westward is primarily a factor of reduced effective precipitation. Many species are common to both subregions. There is a general conformity in the composition of the plant cover. A dominance of grasses, absence of trees, rolling topography, and a characteristic xerophytic flora are the main features. Species occurring on the study area which tend to represent the True Prairie (Tall Grass) subregion are Andropogon gerardi, Andropogon scoparius, Elymus canadensis, Poa pratensis, Amorpha canescens, Artemisia ludoviciana, Astragalus crassicarpus, Echinacea angustifolia, Onosmodium molle, Psoralea esculenta, Solidago missouriensis and related species. Species typical of the Great Plains Grassland (Short-Grass, Mid-grass) include Bouteloua gracilis, Agropyron smithii, Buchloe dactyloides, Koeleria pyramidata, Allium textile, Artemisia frigida, Carex filifolia, C. eleocharis, Oxytropis lambertii, Penstemon albidus and Rosa arkansana.

2. Rocky Mountain Forest Flora (Black Hills Montane Element). Although geographically separated from the Rocky Mountains, the Pine Ridge and Black Hills have affinities to this region, which lies principally 200-km to the west. Floral species suggest that the two areas were contiguous during Pleistocene times. Species on the study area typical of this region include Berberis repens, Juniperus scopulorum, Pinus ponderosa, and Calochortus nuttallii.

In addition to the above vegetation regions, there are several other plant communities which are noteworthy. Wooded Bottomlands display certain characteristics of the Eastern Deciduous Flora. Representative species include Populus deltoides, Fraxinus pennsylvanica, Acer negundo, Salix amygdaloides, Salix exigua, Toxicodendron rydbergii, Ulmus americana, and Vitis riparia.

Lakes, Ponds and Prairie Potholes display a characteristic vegetation, including Cicuta maculata, Equisetum hyemale, Scirpus validus, S. americanus, S. maritimus, Eleocharis erythropoda, Typha latifolia, Carex nebraskensis, Polygonum coccinium and Potamogeton pectinatis.

The Great Basin Flora is sparsely represented in the northern portion of the study area, where saline conditions exist. Typical species include Sarcobatus vermiculatus, Artemisia cana, and several species of halophytic forbs.

The Circumpolar and Circumboreal Alpine Groups, well represented in the Black Hills, are poorly represented in the Pine Ridge Area, due to the lower elevations and warmer summer temperatures, but species which occur include Arnica rydbergii, Juniperus communis, and Epilobium angustifolium.

A large number of Exotic Species occurs, representative of Europe, Asia and elsewhere in North America. Indeed, as a result of cultivation and range rehabilitation, perhaps 30 percent of species and more than 50 percent of plant cover is comprised of exotics. Species which are conspicuously successful include Bromus inermis, B. japonicus, B. tectorum, Melilotus officianalis, M. alba, and a large number of Brassicaceae, including the genera Sisymbrium, Descrurainia, Thlaspi, Brassica, and Capsella. Cultivated species include wheat, oats, rye, corn, milo and alfalfa.

VanBruggen (1977) points out that the Black Hills/Pine Ridge region is not an area where endemics occur. If one assumes a less than conservative taxomic interpretation of the species present, it is doubtful that any endemics are present in the Pine Ridge area.

Study Area Vegetation/Habitat Types. A vegetation classification system (Table 2.8-1) was derived from the study area, sufficient to include the flora within the 80-km OA, taking into account regional precedents - terrestrial flora (Coenenberg et al. 1977), and wetlands (Stewart and Kantrud 1971), with particular reference to generating a system useful in identifying faunal habitat affinities. Table 2.8-2 summarizes the habitat types and amounts of each that comprise the CSA. Individual habitat types are described briefly below:

Wetlands (000-009). These types correspond directly to those of Steward and Kantrud (1971), with the addition of 008 (Dugouts) and 009 (Excavated Wetlands, usually abandoned gravel pits). All wetland types are represented

TABLE 2.8-1

HABITAT CLASSIFICATION SYSTEM

000 - Wetlands (Closed Basin Features)

- 001 - Class I Wetland (Mixed Grass Prairie)
- 002 - Class II Wetland (Wet Meadow)
- 003 - Class III Wetland (Shallow Marsh Flora)
- 004 - Class IV Wetland (Deep Marsh Flora)
- 005 - Class V Wetland (Permanent Marsh)
- 006 - Class VI Wetland (Alkaline Lake)
- 007 - Class VII Wetland (Fen/Bog)
- 008 - Dugout
- 009 - Excavated Wetland

010 - Special Features

- 011 - Cliff
- 012 - Talus Slope, Scree
- 013 - Caves
- 014 - Marl Formation ("Badlands")

050 - Riverine Habitats (Open Basin and Drainage Features)

- 050 - Complex Riparian
- 051 - Mixed Grass Prairie Riparian
- 052 - Wet Meadow Riparian
- 053 - Shallow Marsh Riparian
- 054 - Deep Marsh Riparian
- 055 - Permanent Water - Streams and Rivers
- 056 - Alkaline Streambank
- 057 - Streamside Bog
- 058 - Stream Dugout
- 059 - Impoundments - Lakes and Ponds

100 - Woodlands

- 110 - Deciduous Streambank Forest
- 111 - Deciduous Basin Forest
- 120 - Deciduous "Wooded Draw" - Intermittent Drainages
- 130 - Tree Plantings - Orchards, Shelterbelts, Plantations
- 140 - Ponderosa Pine Forest
  - 141 - Ponderosa Pine / Juniper
  - 142 - Ponderosa Pine / Deciduous Woodland
  - 143 - Ponderosa Pine / Grassland
  - 144 - Ponderosa Pine / Shrubland
- 150 - Juniper
- 160 - Aspen

TABLE 2.8-1 (Continued)

HABITAT CLASSIFICATION SYSTEM

200 - Xerophytic Shrublands

- 211 - Big Sagebrush
- 212 - Big Sagebrush / Grassland
- 221 - Sand Sagebrush
- 222 - Sand Sagebrush / Grassland
- 231 - Sumac / Grassland
- 240 - Mixed Shrub / Half Shrub

300 - Mesophytic Shrublands

- 311 - Upland Drainage Seep
- 320 - Chionophilous Copse
- 330 - Flood Plain / Mud Flat Shrubland

400 - Grasslands

- 405 - Shortgrass Prairie
- 410 - Mixed Grass Prairie
- 420 - Range Rehabilitation

500 - Cultivated

- 510 - Grains
- 520 - Hay
- 530 - Root Crops
- 540 - Vegetables
- 550 - Fallow
  - 551 - Bare Ground / Summer Fallow
  - 552 - Annual Weed Complex

600 - Structure Biotopes

- 610 - Surface Disturbance Unreclaimed
- 611 - Surface Disturbance Reclaimed
- 630 - Human Biotopes - Towns, Buildings, Farmyards
- 640 - Cemeteries, Parks
- 650 - Roads and Roadside/Fencerow Complex

TABLE 2.8-2

COMMERCIAL STUDY AREA HABITAT TYPES

Habitat Classification		Acreage	Hectares	Percent
002	(Wet meadow)	4.07	1.65	0.05
051	(Mixed Prairie - Riparian)	119.65	48.42	1.38
052	(Wet Meadow - Riparian)	47.27	19.13	0.55
054	(Deep Marsh - Riparian)	23.50	9.51	0.27
055	(Riverine)	32.86	13.34	0.38
059	(Impoundment)	46.57	18.84	0.54
110	(Deciduous Streambank Forest)	510.43	206.56	5.89
130	(Shelterbelts, Tree Plantings)	27.27	11.04	0.31
140	(Ponderosa Pine)	325.85	131.86	3.76
410	(Mixed Grass Prairie)	2840.18	1149.42	32.74
420	(Range Rehabilitation)	1370.77	554.74	15.80
500	(Cultivated)	2856.08	1155.86	32.92
610	(Surface Disturbance)	2.58	1.04	0.03
630	(Human Biotopes)	105.05	42.51	1.21
640	(Cemeteries)	5.02	2.03	0.06
650	(Roads and Roadside Complex)	356.55	144.30	4.11
	Totals	**8673.70**	**3510.25**	**100.00**

within the 80-km OA, but are poorly represented on the study area (CSA and AA). A few prairie potholes exist in the northern portion of the study area. Those are Temporary and Seasonal wetlands (Class II and III, resp.) representing wet meadow and shallow marsh vegetation types.

Special Features (010-014). Cliffs, rock outcrops and escarpments are common in the south, west and east portions of the study area. Badlands, typical of outcroppings of the Pierre and Brule Formations are encountered within the northeast portion of the study area. By definition, these are areas almost devoid of vegetation, except for a few representatives of the Mixed Grass element.

Riverine Habitats (050-059). These types directly correspond, floristically, to wetland types, and are discussed further in the Aquatic Ecology Section.

Woodlands (100-160). The Deciduous Streambank Forest occupies streamside sites adjacent to all perennial streams and rivers of the study area, except where it has been destroyed by cultivation and/or grazing. Populus deltoides dominates throughout. Other species present include Fraxinus pennsylvanica, Acer negundo, Ulmus americana, Salix amygdaloides, S. Exigua, S. lucida, Prunus americana, and P. virginiana. Understory vegetation varies greatly, depending primarily upon the amount of grazing which occurs. Where reasonable protection is afforded, such species as Clematis ligusticifolia, Parthenocissus vitacea, Vitis riparia, and Bromus inermis tend to predominate. Where heavy grazing has been conducted, the understory is characterized by Urtica dioica, Toxicodendron rydbergii, Apocynum cannabinum, Euphorbia podperae, Croton texendis, Chorispora tenella, Bromus tectorum, Conium maculatum, and other poisonous plants and noxious weeds.

Floristic characteristics of the Deciduous Basin Forest are identical to the above, but with floral zones representing moisture gradients and periods of shoreline inundation. This type is not represented within the study area proper, owing to the absence of sizeable wetland/lake basins.

The Deciduous Wooded Draw is similar to the Deciduous Streambank type, but occupying as it does intermittent upland drainages, is characterized by species with a greater tolerance to aridity. Acer negundo, for example, may predominate over Populus deltoides, and mesophytic shrubland species (below), such as Shepherdia argentea, are closely associated.

Tree plantings are common on the study area, including the CSA. Species most commonly selected for shelterbelts and farmyards are Ulmus pumila, U. americana, Populus deltoides, Juniperus virginiana, and to a much lesser extent, Cornus stolonifera, Pinus ponderosa, and Salix spp. Many shelter-shelterbelts are comprised exclusively of Ulmus spp., and are rapidly disappearing as a result of widespread disease.

The Ponderosa Pine (Pinus ponderosa) Complex dominates the highlands of the study area, but is not well represented at the lower elevations which characterize the CSA. Ponderosa-Juniper (P. ponderosa-Juniperus scopulorum) is found on the more dissected terrain, growing on calcareous lithosols. Very few understory species are present. The type is not represented on the CSA. Ponderosa Pine-Deciduous Woodland Type is the most complex on the study area, where the Deciduous Streambank flora penetrates the Ponderosa Pine Woodland flora at the middle to upper elevations. The Ponderosa Pine Grassland occupies foothills and the plateaus at the higher elevations, above the level of the escarpments. Typical Mixed Grass meadows (below) are interspersed with the stands of pine. Understory species found in association with Ponderosa Pine throughout include Thermopsis rhombifolia, Anemone patens, Galium boreale, Potentilla spp., Penstemon glaber, and related species common to the Rocky Mountain element. Ponderosa Pine-Shrubland occurs sporadically on ridge-tops and southern exposures. Associated shrubs are few-predominantly Rhus aromatica var. trilobata, and Ribes odorata. The absence of well developed shrublands within the Ponderosa Type is not understood, but the role of fire in the past is probably responsible in large measure.

The Juniper Type (Juniperus scopulorum) is not represented on the primary study area, but pure stands, usually with few associated understory species, are found on lithosols to the north and west.

The Aspen Type (Populus tremuloides) is the rarest community on the study area, and is not found on the CSA. A typical stand, consisting of about 20 trees, exists on a steep, shaded, northern exposure in West Ash Creek, about 4-km east of the CSA. No regeneration is evident. The species probably constitutes a Pleistocene relic in the area, is at the extremity of its range, and will probably disappear over the next few decades.

Xerophytic Shrublands (200-240) are poorly represented on the CSA, but are common in the northern portion of the OA. Big Sagebrush (Artemisia tridentata) and Big Sagebrush-Grassland form expansive communities about 30-km northwest of the CSA.

Sand Sagebrush (Artemisia filifolia) and associated psammophytic flora are found on sandy soils throughout the study area, but expansive stands are absent from the CSA. Rarely are stands of this species more than 1 ha in extent. Most often, the species is found along roadways in sandy areas.

Mesophytic Shrublands (300-330). The Upland Drainage Seep Type is comprised primarily of Prunus americana, P. virginiana, and Shepherdia argentea. These copses are found along intermittent water courses and upland plains sites with temporarily high water tables. The type is represented on the CSA, but with stands usually less than 0.5 ha in extent. The Chionophilous Copse Type is comprised almost exclusively of Symphoricarpos occidentalis. The species typically occupies snow-accumulation sites on the downwind side of hills and escarpments, and reaches it's greatest expansion on the plateaus at the higher elevations. It is poorly represented on the CSA.

Grasslands (400-420). Characteristics of the grassland types were described earlier. Within the study area, the differentiation between the Shortgrass Type and Mixed Grass Type could be made only on a subjective basis. The Shortgrass Type tends to be dominated by Bouteloua gracilis and Buchloe dactyloides, whereas the Mixed Grass Type exhibits a more diverse grass component. In practice, differentiation was based on the presence or absence of Tall Grass species, e.g., Andropogon scoparius. Classification

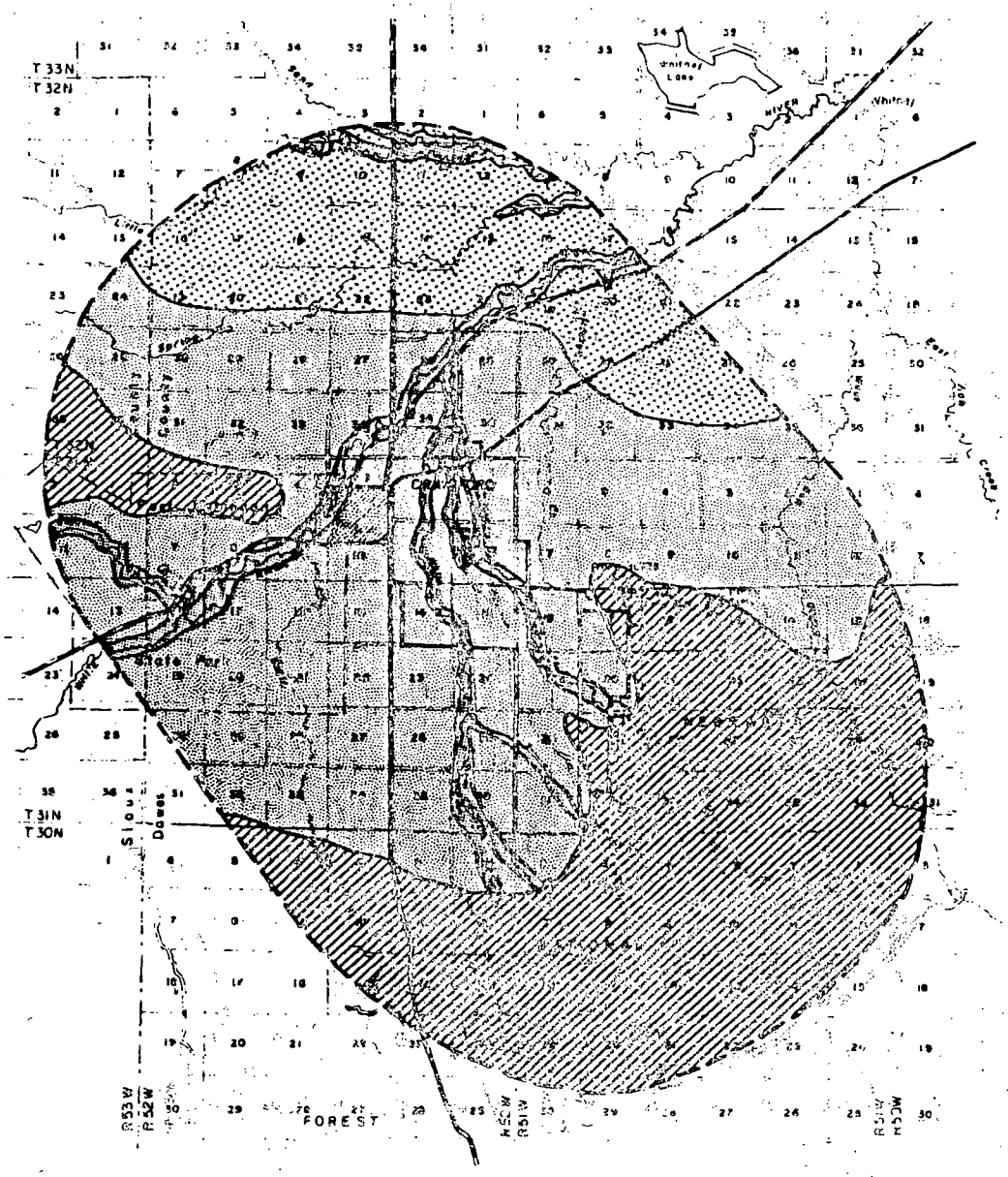
is complicated by the over-grazed nature of the range, whereby much of the Mixed Grass Type has been degraded and now takes on a Shortgrass aspect. Figures 2.8-2 and 2.8-3 represent our estimation of potential grassland vegetation.

Range rehabilitation areas are increasing in size, as lands within the CSA are subjected to increasingly intensive management. Species most commonly selected for seeding are Bromus inermis, Poa pratensis, Agropyron cristatum, A. pectiniforme, A. smithii, A. intermedium, A. elongatum, and Elymus spp. The quality and composition of the type varies greatly, depending upon the interval between seeding and grazing, and the intensity of the grazing. The aspect varies from pure to sparse grass stands, to annual weed complex or bare ground.

Cultivated (500-552). This type comprises about one-third of the CSA. Winter wheat cultivation is the most common practice, typically with a 50 percent rotation (summer-fallow) pattern. Other crops include oats, barley, milo, rye, corn, alfalfa, and small vegetable gardens.

Structure Biotopes (600-650). Man-made features other than cultivation include gravel pits, buildings and farmyards, parks, cemeteries, roads, highways and roadside rights-of-way. These comprise about 5 percent of the CSA.

Commercial Facility Location. The permanent structures that will be constructed for the development of the commercial facility will comprise a maximum of 80 acres located in Section 19. The northeast 1/4 of Section 19 is under wheat cultivation. The Burlington Northern Railroad traverses the southwest 1/4. The area southwest of the railroad is under alfalfa cultivation. An abandoned farmstead is located in the eastcentral portion of the section. The Old Crow Butte cemetery lies along the western boundary of the section. The remainder is in a natural, albeit degraded state of Deciduous Streambank Forest and Mixed Grass Prairie types (Figure 2.8-3). About 30 cattle graze the area from 1 May to 1 November.



2.8(18) 07/29/87

REV	BY	DATE	FERRET OF NEBRASKA, INC
			CROW BUTTE PROJECT Dawes County, Nebraska
			MAJOR VEGETATION TYPES - BIOMES (Potential Vegetation)
			PREPARED BY F. Harrington & Assoc.
			DWN BY OBO Graphics DATE 8-1-82 FIG. 2.8-2

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: FIGURE NO.: 2.8-3, "COMMERCIAL STUD AREA HABITAT TYPES"

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT FIGURE NO.: 2.8-3

D-01

Squaw Creek, which passes through Section 19, is characterized by steep, eroded banks, due to livestock trampling. The riparian forest is comprised of Populus deltoides, with a few specimens of Fraxinus pennsylvenica and Acer negundo. Copses of Prunus virginiana and P. americana occur along the watercourse as well. The bottomland vegetation is comprised principally of indicators of over-grazing - noxious weeds and poisonous plants - Croton texensis, Euphorbia podperae, Urtica dioica, Galium aparine, Toxicodendron rydbergii, and several members of the Brassicaceae.

The Mixed Grass community, which comprises about 65 percent of the section is in poor condition, but with a moderate to high plant cover. The most evident indicator of over-grazing is Yucca glauca, which is the aspect dominant over much of the site. Other indicators of disclimax conditions include high percentages of Bromus tectorum, B. japonicus, Festuca octoflora, Cryptantia fragilis, Carex filifolia, C. rossii, Oxytropis lambertii, and various cushion plants - Arenaria hookeri, Paronychia jamesii, and Phlox andicola.

A preliminary estimate of grazing capacity of the range, in its present condition, based on experience elsewhere in the region, would suggest a proper stocking rate from 5-15 acres per animal-unit-month. 1982 stocking rates were about 1.7 acres per animal-unit-month, or about 3-8 times in excess of proper stocking rates, not uncommon for the area. Since 1982, domestic livestock numbers in the area have declined by 12-20% (Raymer 1987), reducing but not eliminating, overuse of the range.

Plant Species List. According to the Great Plains Flora Association (1977) about 1,020 species of plants should be expected to occur within 80-km of the CSA. The Chadron State College herbarium (Urbatsch and Eddy 1969) contains 463 species from Dawes County.

In the course of the baseline study, between March and Mid-July, 1982, more than 400 species of plants were collected within the study are (CSA, AA). Of that number, 163 species were recorded within Section 19 (Table 2.8-3)

TABLE 2.8-3

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
EQUISETACEAE	
Equisetum laevigatum	Smooth Horsetail
PINACEAE	
Pinus ponderosa	Ponderosa Pine
RANUNCULACEAE	
Anemone patens	Pasque-flower
Clematis ligusticifolia	Western Clematis
Ranunculus abortivus	Early Wood Buttercup
Thalictrum dasycarpum	Purple Meadowrue
PAPAVERACEAE	
Argemone polyanthemos	Prickle Poppy
FUMARIACEAE	
Corydalis aurea	Golden Corydalis
ULMACEAE	
Ulmus americana	American Elm
Ulmus pumila	Siberian Elm
CANNABACEAE	
Humulus lupulus	Common Hop
URTICACEAE	
Urtica dioica	Stinging Nettle
CACTACEAE	
Coryphantha vivipara	Pincushion Cactus
Opuntia fragilis	Brittle Prickly Pear

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
CARYOPHYLLACEAE	
Arenaria hookeri	Hooker Sandwort
Cerastium arvense	Prairie Chickweed
Paronychia jamesii	James Nailwort
Stellaria media	Common chickweed
CHENOPODIACEAE	
Chenopodium album	Lamb's-quarters
Chenopodium fremontii	Fremont Goosefoot
Chenopodium leptophyllum	Maple-leaved Goosefoot
CHENOPODIACEAE	
Kochia scoparia	Kochia
Salsola iberica	Russian Thistle
AMARANTHACEAE	
Amaranthus graecizans	Tumbleweed
Amaranthus retroflexus	Rough Pigweed
POLYGONACEAE	
Polygonum convolvulus	Wild Buckwheat
Polygonum ramosissimum	Bushy Knotweed
MALVACEAE	
Malva rotundifolia	Common Mallow
Sphaeralcea coccinea	Red False Mallow
VIOLACEAE	
Viola canadensis	Canada Violet
Viola nuttallii	Yellow Prairie Violet

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
SALICACEAE	
Populus deltoides	Plains Cottonwood
Salix exigua	Coyote Willow
CAPPARACEAE	
Cleome serrulata	Rocky Mountain Beeplant
BRASSICACEAE	
Arabis holboellii	Rockcress
Brassica kaber	Charlock
Capsella bursa-pastoris	Shepherd's Purse
Chorispora tenella	Blue Mustard
Descurainia pinnata	Tansy Mustard
Descurainia sophia	Flixweed
Draba reptans	White Whitlowwort
Erysimum asperum	Western Wallflower
Erysimum repandum	Bushy Wallflower
Lesquerella ludoviciana	Bladderpod
Sisymbrium altissimum	Tumbling Mustard
Thlaspi arvense	Penny Cress
PRIMULACEAE	
Androsace occidentalis	Western Rocky Jasmine
SAXIFRAGACEAE	
Ribes odoratum	Buffalo Currant
ROSACEAE	
Prunus americana	Wild Plum
Prunus virginiana	Chokecherry
Rosa acicularis	Prickly Wild Rose
Rosa arkansana	Prairie Wild Rose
Rosa woodsii	Western Wild Rose

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
FABACEAE	
Astragalus gracilis	Slender Milkvetch
Astragalus missouriensis	Missouri Milkvetch
Lupinus argenteus	Silvery Lupine
Medicago falcata	Yellow Lucerne
Medicago sativa	Alfalfa
Melilotus alba	White Sweetclover
Melilotus officinalis	Yellow Sweetclover
Oxytropis lambertii	Purple Locoweed
Psoralea argophylla	Silver-leaf Scurf Pea
Psoralea esculenta	Breadroot Scurf Pea
Psoralea lanceolata	Lemon Scurf Pea
Vicia americana	American Vetch
ONAGRACEAE	
Gaura coccinea	Velvety Gaura
Oenothera caespitosa	Gumbo Lily
Oenothera nuttallii	White-stemmed Evening Primrose
CORNACEAE	
Comandra umbellata	Bastard Toadflax
EUPHORBIACEAE	
Croton texensis	Texas Croton
Euphorbia podperae	Leafy Spurge
VITACEAE	
Parthenocissus vitacea	Woodbine
ACERACEAE	
Acer negundo	Box Elder

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
ANACARDIACEAE	
Rhus aromatica	Aromatic Sumac
Toxicodendron rydbergii	Poison Ivy
ZYGOPHYLLACEAE	
Tribulus terrestris	Puncture Vine
LINACEAE	
Linum perenne	Blue Flax
Linum rigidum	Stiffstem Flax
POLYGALACEAE	
Polygala alba	White Milkwort
APIACEAE	
Lomatium nuttallii	Wild Parsley
APOCYNACEAE	
Apocynum cannabinum	Hemp Dogbane
ASCLEPIADACEAE	
Asclepias speciosa	Showy Milkweed
SOLANACEAE	
Solanum rostratum	Buffalo Bur
CONVOLVULACEAE	
Convolvulus arvensis	Field Bindweed
Convolvulus sepium	Hedge Bindweed

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
POLEMONIACEAE	
Phlox andicola	Moss Phlox
BORAGINACEAE	
Cryptantha jamesii	James' Cryptantha
Lappula redowskii	Low Stickseed
Lithospermum incisum	Narrow-leaved Puccoon
LAMIACEAE	
Mentha arvensis	Field Mint
Monarda pectinata	Spotted Beebalm
PLANTAGINACEAE	
Plantago patagonica	Buckhorn
OLEACEAE	
Fraxinus pennsylvanica	Green Ash
SCROPHULARIACEAE	
Penstemon albidus	White Beardtongue
Penstemon angustifolius	Narrow Beardtongue
Penstemon glaber	Smooth Beardtongue
Penstemon grandiflorus	Large Beardtongue
Verbascum thapsus	Common Mullein
CAMPANULACEAE	
Campanula rotundifolia	Harebell
RUBIACEAE	
Galium aparine	Catchweed Bedstraw

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
CAPRIFOLIACEAE	
Symphoricarpos occidentalis	Western Snowberry
ASTERACEAE	
Achillea millefolium	Yarrow
Agoseris glauca	False Dandelion
Antennaria rosea	Rose Pussytoes
Artemisia campestris	Western Sagebrush
Artemisia frigida	Fringed Sagebrush
Artemisia ludoviciana	White Sage
Chrysopsis villosa	Golden Aster
Cirsium undulatum	Wavyleaf Thistle
Cirsium vulgare	Bull Thistle
Crepis runcinata	Hawk's-beard
Erchinacea angustifolia	Purple Coneflower
Erigeron pumilus	Low Fleabane
Grindelia squarrosa	Curly-top Gumweed
Gutierrezia sarothrae	Broom Snakeweed
Helianthus annuus	Common Sunflower
Helianthus petiolaris	Plains Sunflower
Lygodesmia juncea	Skeleton-weed
Ratibida columnifera	Prairie Coneflower
Rudbeckia hirta	Black-eyed Susan
Senecio plattensis	Prairie Ragwort
Taraxacum officinale	Dandelion
Townsendia exscapa	Easter Daisy
Tragopogon dubius	Goatsbeard
COMMELINACEAE	
Tradescantia occidentalis	Prairie Spiderwort
JUNCACEAE	
Juncus balticus	Baltic Rush

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
CYPERACEAE	
Carex filifolia	Thread-leaved Sedge
Carex hystericina	Bottlebrush Sedge
Carex lanuginosa	Wooly-headed Sedge
Carex nebraskensis	Nebraska Sedge
Carex rossii	Ross' Sedge
POACEAE	
Agropyron cristatum	Crested Wheatgrass
Agropyron intermedium	Intermediate Wheatgrass
Agropyron pectiniforme	Smooth Crested Wheatgrass
Wheatgrass	
Agropyron smithii	Western Wheatgrass
Andropogon scoparius	Little Bluestem
Aristida longiseta	Red Threeawn
Bouteloua gracilis	Blue Grama
Bromus inermis	Smooth Brome
Bromus japonicus	Japanese Brome
Bromus tectorum	Cheatgrass
Buchloe dactyloides	Buffalo-grass
Cenchrus longispinus	Field Sandbur
Elymus canadensis	Canada Wild Rye
Festuca octoflora	Six-weeks Fescue
Hordeum jubatum	Foxtail Barley
Hordeum pusillum	Little Barley
Koeleria pyramidata	Junegrass
Oryzopsis hymenoides	Indian Ricegrass
Panicum capillare	Witchgrass
Poa compressa	Canada Bluegrass
Poa pratensis	Kentucky Bluegrass
Poa sandbergii (=P. secunda)	Sandberg Bluegrass
Setaria glauca	Yellow Foxtail
Setaria viridis	Green Foxtail
Sitanion hystrix	Squirreltail
Stipa comata	Needle-and-Thread
Stipa viridula	Green Needlegrass
Triticum aestivum	Wheat

TABLE 2.8-3 (Continued)

PLANT SPECIES LIST - SECTION 19

Scientific Name	Common Name
LILIACEAE	
Allium textile	White Wild Onion
Calochortus nuttallii	Mariposa Lily
Leucocrinum montanum	Mountain Lily
Smilacina stellata	Spikenard
Yucca glauca	Yucca
Zigadenus venenosus	Death Camass
IRIDACEAE	
Sisyrinchium montanum	Blue-eyed Grass

No species of state or federal concern has been found on the study area. The species considered "most rare" was Townsendia exscapa (Easter-Daisy). About 20 specimens were observed on the site. The species, traditionally collected by pioneers during the Easter season, enjoys a wide distribution in the region, but is evidently nowhere abundant. The species does not merit consideration as endangered or threatened. Hayden penstemon (Penstemon haydenii) is a state endangered species that is found in the region near the study area. However, no individuals have been found on the CSA nor are any expected, as the species is restricted to blow-outs and no blow-outs exist within the CSA (Weedon 1987). All other species are generally considered common to abundant in the region.

Mammals

Domestic ungulates on the CSA include cattle, horses, and swine (Table 2.8-4). Cattle management includes cow-calf operations on native range and range rehabilitation areas, winter pasturing and feedlots. Cattle numbers on the CSA range from about 600 to 900 seasonally. In addition, 30 horses and 80 swine are pastured and fed year-round. Livestock numbers have declined since 1982 by 12-20%.

Wild Mammals. Thirty six species of mammals have been documented on the study area, and another 28 species, mostly bats, insectivores and small rodents, are deemed likely to occur (Table 2.8-5, 5A).

Big Game Mammals

Mule Deer* are distributed primarily along the foothills and escarpments, ranging outward into cultivated land, and are occasionally found along watercourses at the lower elevations (Figure 2.8-4). During the period 1 January - 15 July, 1982, 853 observations of the species were recorded within the study area (Table 2.8-6).

* Scientific names are included in the fauna species list.

TABLE 2.8-4

DOMESTIC LIVESTOCK NUMBERS, COMMERCIAL STUDY AREA*
(1982)

Landowner	Cattle	Horses	Swine
Moore	160 (Year-round)	10 (Year-round)	
Taggert	34 (1May-1Nov)		
Franey	59 (1May-1Nov) 80 (1Nov-1May)		
McDowell	69 (1May-1Nov) 180 (1Nov-1May)		
Brott	70 (Year-round)		
Stetson	106 (1May-1Nov)		
Dodd	190 (1Nov-1May)		
Roby	30 (1May-1Sep) 100 (Year-round)		
Lux	130 (1Feb-1May)		
Gibbons(1)	100 (Year-round)		
Ehlers(2)		30 (Year-round)	80 (Year-round)
Totals	**~910 (Winter)** **~598 (Summer)**	**40 (Year-round)**	**80 (Year-round)**

* Since 1982, domestic livestock numbers have declined by 12-20%.

(1) As of 1987 this landowner had approximately 35 swine.

(2) As of 1987 this landowner had zero swine.

TABLE 2.8-5

MAMMAL SPECIES LIST

Common Name	Scientific Name	Status
INSECTIVORA		
Masked Shrew	*Sorex cinereus*	E-CA-U
Dwarf Shrew	*Sorex nanus*	E-CA-U
Merriam Shrew	*Sorex merriami*	E-AA-U
Least Shrew	*Cryptotis parva*	E-CA-U
Eastern Mole	*Scalopus aquaticus*	D-CA-U
CHIROPTERA		
Keen Myotis	*Myotis keeni*	E-CA-U
Little Brown Myotis	*Myotis lucifugus*	E-CA-C
Fringed Myotis	*Myotis thysanodes*	E-CA-U
Long-eared Myotis	*Myotis evotis*	E-CA-U
Long-legged Myotis	*Myotis volans*	E-CA-U
Small-footed Myotis	*Myotis subulatus*	E-CA-U
Silver-haired Bat	*Lasionycteris noctivagans*	E-CA-U
Red Bat	*Lasiurus borealis*	E-AA-U
Big Brown Bat	*Eptesicus fuscus*	E-CA-C
Hoary Bat	*Lasiurus cinereus*	E-CA-U
Western Big-eared Bat	*Plecotus townsendi*	E-AA-U
CARNIVORA		
Raccoon	*Procyon lotor*	D-CA-C
Long-tailed Weasel	*Mustela frenata*	D-CA-U
Mink	*Mustela vison*	D-AA-U
Black-footed Ferret	*Mustela nigripes*	?E-OA-F?
Badger	*Taxidea taxus*	D-AA-U
Spotted Skunk	*Spilogale putorius*	E-AA-U
Striped Skunk	*Mephitis mephitis*	D-CA-C
Coyote	*Canis latrans*	D-CA-U
Swift Fox	*Vulpes velox*	R-AA-S
Red Fox	*Vulpes fulva*	D-CA-U
Bobcat	*Lynx rufus*	D-AA-U
Mountain Lion	*Felis concolor*	R-OA-U
RODENTIA		
Black-tailed Prairie Dog	*Cynomys ludovicianus*	D-CA-U
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*	D-CA-C
Spotted Ground Squirrel	*Citellus spilosoma*	D-OA-U
Least Chipmunk	*Eutamias minimus*	D-AA-U

TABLE 2.8-5 (Continued)
MAMMAL SPECIES LIST

Common Name	Scientific Name	Status
RODENTIA		
Eastern Fox Squirrel	*Sciurus niger*	D-CA-C
Northern Pocket Gopher	*Thomomys talpoides*	D-CA-C
Plains Pocket Gopher	*Geomys bursarius*	E-CA-U
Wyoming Pocket Mouse	*Perognathus fasciatus*	E-CA-U
Plains Pocket Mouse	*Perognathus flavescens*	E-CA-U
Silky Pocket Mouse	*Perognathus flavus*	E-CA-U
Hispid Pocket Mouse	*Perognathus hispidus*	E-CA-U
Ord Kangaroo Rat	*Dipodomys ordii*	D-CA-C
Beaver	*Castor canadensis*	D-AA-U
Plains Harvest Mouse	*Reithrodontomys montanus*	E-CA-U
Western Harvest Mouse	*Reithrodontomys megalotis*	E-CA-U
White-footed Mouse	*Peromyscus leucopus*	D-CA-C
Deer Mouse	*Peromyscus maniculatus*	D-CA-A
Northern Grasshopper Mouse	*Onychomys leucogaster*	E-CA-U
Eastern Woodrat	*Neotoma floridana*	E-AA-U
Bushy-tailed Woodrat	*Neotoma cinerea*	E-AA-U
Brown Rat	*Rattus norvegicus*	E-CA-U
House Mouse	*Mus musculus*	D-CA-C
Meadow Vole	*Microtus pennsylvanicus*	D-CA-C
Prairie Vole	*Microtus ochrogaster*	D-CA-U
Muskrat	*Ondatra zibethicus*	D-CA-C
Meadow Jumping Mouse	*Zapus hudsonicus*	D-CA-U
Porcupine	*Erethizon dorsatum*	D-CA-C
LAGOMORPHA		
White-tailed Jackrabbit	*Lepus townsendi*	D-CA-C
Black-tailed Jackrabbit	*Lepus californicus*	D-CA-U
Eastern Cottontail	*Sylvilagus floridanus*	D-CA-C
Desert Cottontail	*Sylvilagus auduboni*	?D-AA-U?
ARTIODACTYLA		
Mule Deer	*Odocoileus hemionus*	D-CA-C
White-tailed Deer	*Odocoileus virginianus*	D-CA-C
Pronghorn	*Antilocapra americana*	D-AA-C
Wapiti (Elk)	*Cervus elaphus*	D-AA-U
Bighorn Sheep	*Ovis canadensis*	D-AA-U
Bison	*Bison bison*	D-AA-C
Moose	*Alces alces*	R-OA-U
Mule Deer/White-tailed Deer Hybrid	*O. hemionus x virginianus*	D-AA-U

(See Table 2.9-5A for Status Codes)

TABLE 2.8-5A

FAUNAL SPECIES LIST - STATUS CODES

Column 1 **Documentation**

D - Documented in the course of the present study
R - Reported by knowledgeable individual(s)
E - Expected to occur - historical or recent evidence

Column 2,3 **Distribution**

CA - Within the Commerical Study Area Boundary
AA - Within the 8-km Adjacent Area Boundary
OA - Within the 80-km Outer Area Boundary

Column 4 **Abundance**

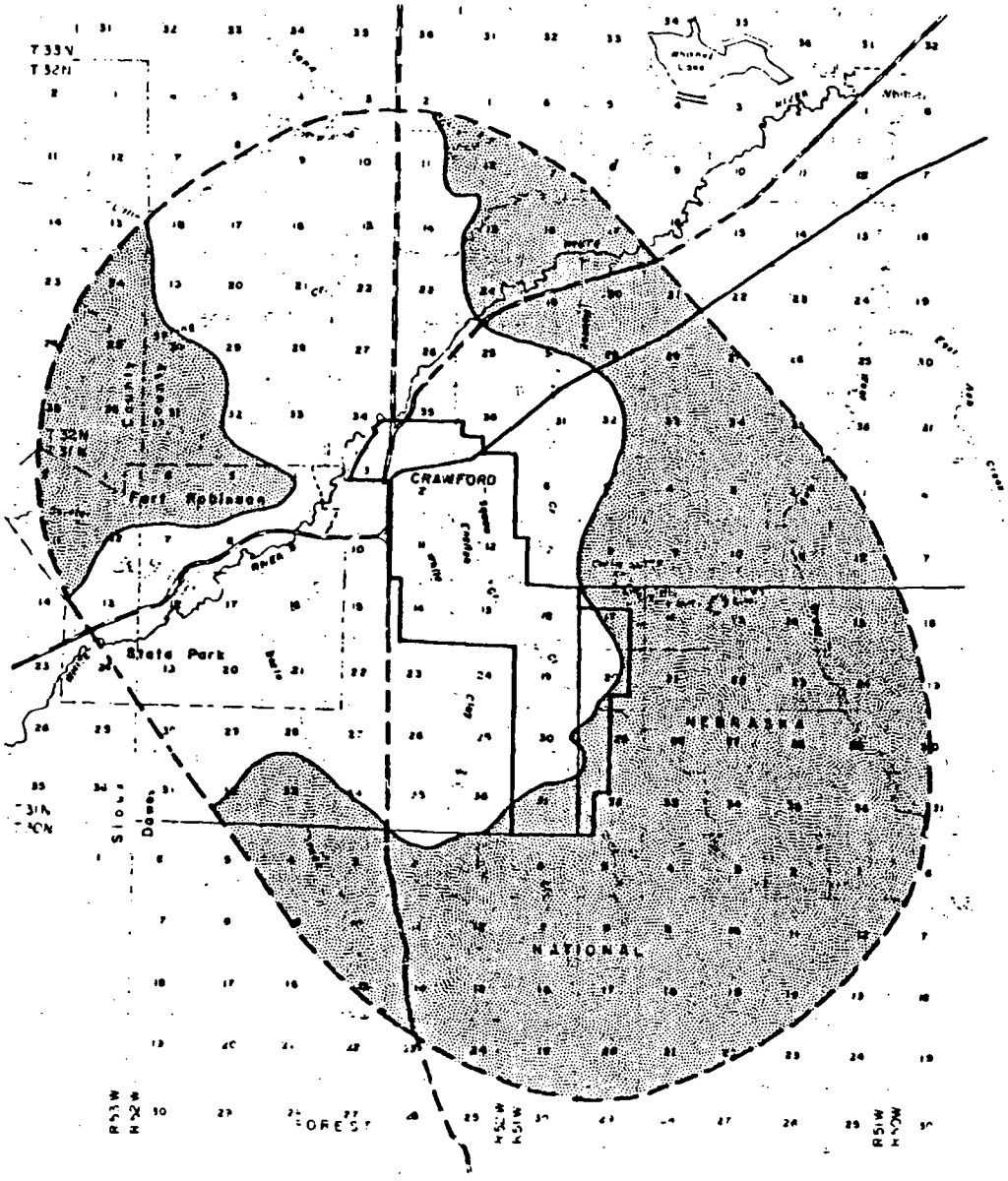
A - Abundant
C - Common
U - Uncommon
O - Occasional, Accidental, or Rare in the study area
F - Federally-listed Rare, Threatened, or Endangered
S - State-listed Rare, Threatened, or Endangered

Column 5,6 **Migratory Status (Birds Only)**

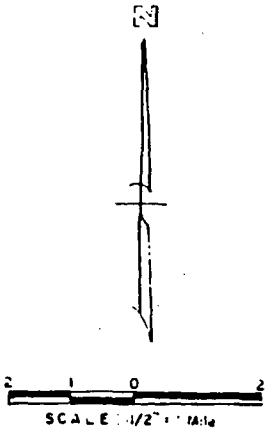
pr - permanent resident
sr - summer resident
sv - summer visitor
wv - winter visitor
m - migrant

Column 7,8 **Breeding Status (Birds Only)**

* - confirmed breeder
** - suspected breeder



LOCATION MAP
N T S



LEGEND

PRIMARY MULE DEER RANGE

NO.	BY	DATE	FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT Dawes County, Nebraska
			MULE DEER DISTRIBUTION
			PREPARED BY F. Harrington & Assoc.
			DRAWN BY D&D Graphics DATE 8-1-82

FIG. 2.8-4

2.8(35) 07/29/87

TABLE 2.8-6

BIG GAME MAMMAL HABITAT AFFINITIES

Species	Deciduous Woodlands Obs	(%)	Coniferous Woodlands Obs	(%)	Mesophytic Shrublands Obs	(%)	Shortgrass Prairie Obs	(%)	Mixed Grass Prairie Obs	(%)	Range Rehab. Obs	(%)	Cultivated Obs	(%)	Structure Biotopes Obs	(%)	Totals Obs	(%)
Mule Deer																		
CSA*	18	(75.0)							2	(8.3)			4	(16.7)			24	(100)
Total Area	132	(15.4)	53	(6.2)					106	(12.4)	57	(6.7)	492	(57.7)	13	(1.5)	853	(100)
White-tailed Deer																		
CSA	39	(37.9)							4	(3.8)	6	(5.8)	54	(52.4)			103	(100)
Total Area	480	(55.8)	23	(2.6)	14	(1.6)			160	(18.6)	31	(3.6)	141	(16.3)	10	(1.1)	860	(100)
Pronghorn																		
CSA	(NOT PRESENT ON COMMERCIAL STUDY AREA)																	
Total Area							109	(22.1)	242	(49.1)	126	(25.6)	13	(2.6)	3	(0.4)	493	(100)

*CSA (Commercial Study Area)

The preferred habitat type during the observation period was Cultivation, with about 58 percent of deer recorded in the type. This reflects a high proportion of mule deer occurring in winter wheat fields during the period January-April. Indeed, it was determined that mule deer on the study area rely very heavily, and in some cases exclusively, on winter wheat during the late winter period. This is doubtlessly due to the relative absence of well developed shrub communities - typical winter range for the species elsewhere in the region.

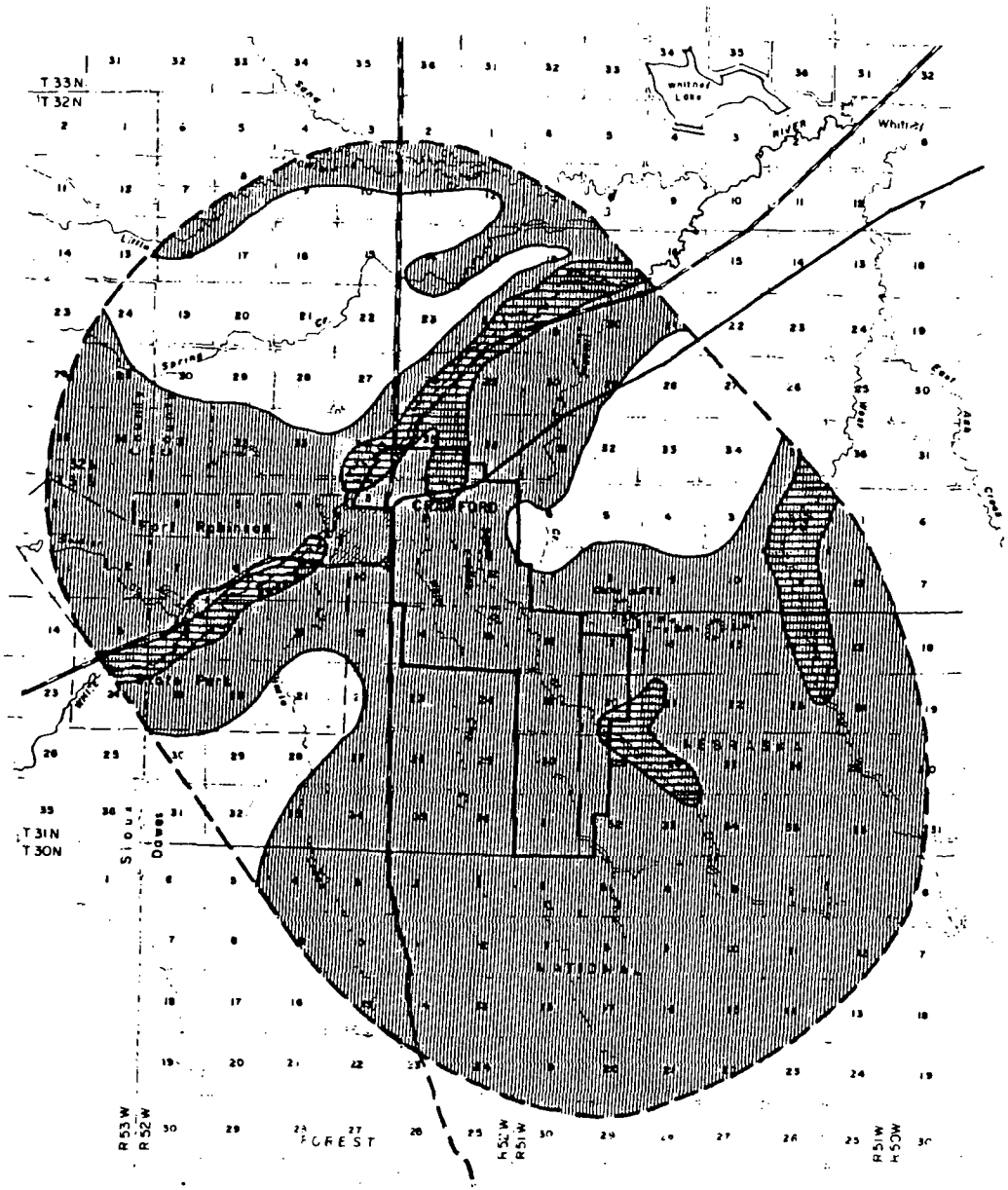
Utilization of winter wheat, and the tendency to utilize haystacks in some areas, has been noted by area farmers and ranchers, who commonly voice complaints about deer damage - complaints which are reported in the local press, e.g., *"Plague of hay-eating deer herds costs area ranchers plenty"* (Page 1, The Crawford Tribune, 17 February 1982).

Group size during the period ranged from 1-39, with largest aggregations observed in March, in winter wheat fields. In May there was a general dispersal of deer into the upper elevations and away from cultivated types. Smallest group size (x=1.7) was observed in June. First fawns were seen in early July.

Distribution of mule deer within the CSA was slight, with only 3 percent of observations recorded there. In contrast to the study area proper, most mule deer on the CSA (75%) were documented in Deciduous Streambank habitat-primarily along Squaw Creek in the southeast portion of the CSA and adjacent to the Ponderosa Wildlife Area.

White-tailed deer were distributed more widely than mule deer (Figure 2.8-5) and were recorded in a greater range of habitat types (Table 2.8-6). Most commonly utilized habitats, however, were the Deciduous Woodland Types.

Herd size ranged from 1-42, with largest aggregations seen in February. During the late winter months, the deer displayed a "yarding" tendency, typical for the species, with concentrations occurring in wooded bottom-



LOCATION MAP
N.T.S.

N

SCALE: 1/2" = 1 Mile

LEGEND

PRIMARY DISTRIBUTION

WINTER CONCENTRATION AREAS

REV.	BY	DATE	FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT Dawes County, Nebraska
			WHITE-TAILED DEER DISTRIBUTION
			PREPARED BY F. Harrington & Assoc.
			DRAWN D&D Graphics DATE 8-1-82 FIG. 2.8-5

2.8(38) 07/29/87

lands. Like mule deer, whitetails made considerable use of winter wheat fields, but about equal use was made of winter annual forbs within the Deciduous Streambank Forest type and adjoining meadows.

In May a general dispersal was observed, with deer moving into upland drainages, although a large percentage remained along the lower watercourses. First fawns were seen in late June.

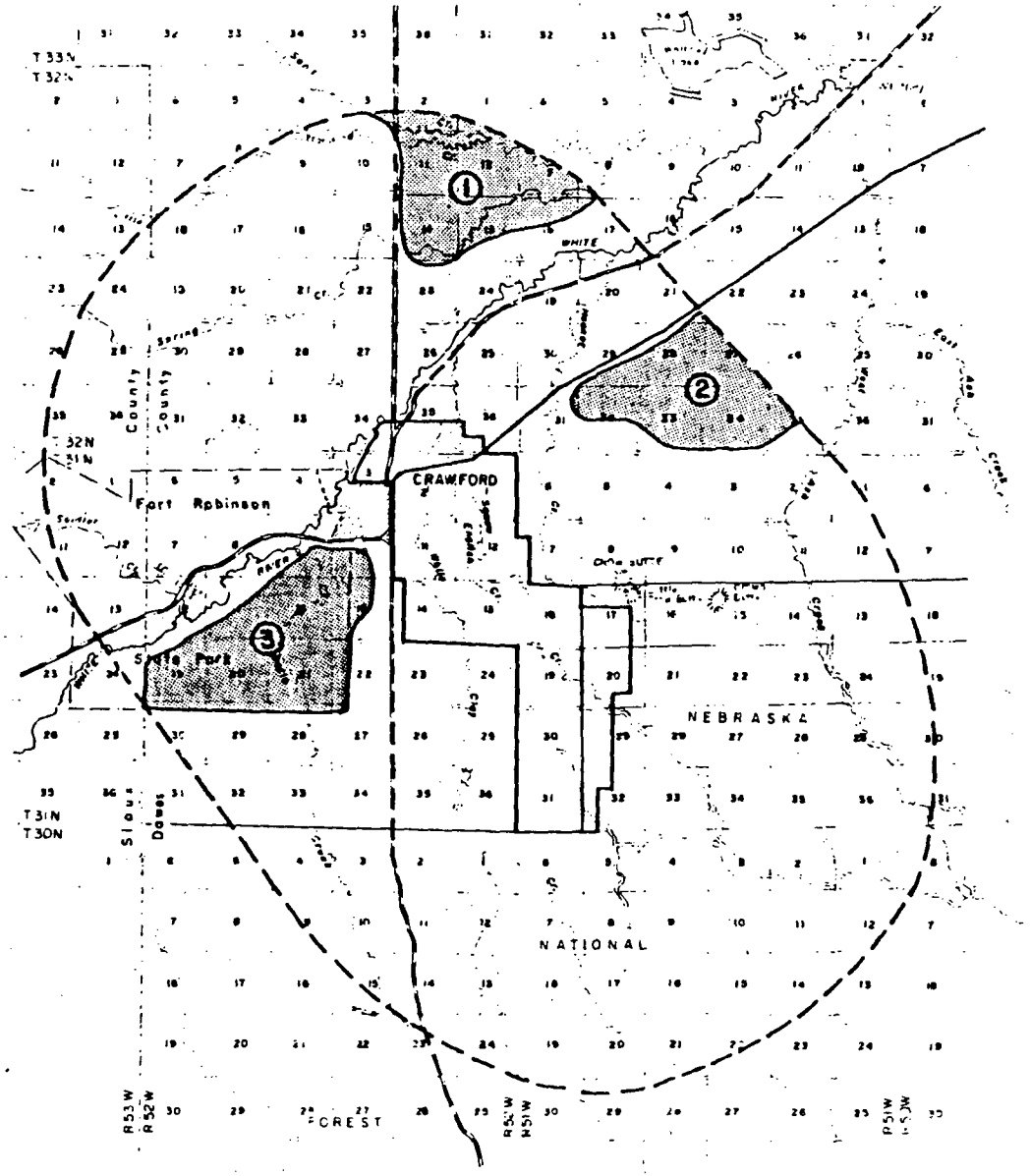
Compared to mule deer, whitetails were more commonly observed on the CSA, with 12 percent of observations recorded there. Greatest us of the CSA was observed in Woodland and Cultivated types along the lower portion of English, Squaw and White Clay Creeks, in the northern portion of the CSA.

Pronghorn in the region are divided into three separate populations (Figure 2.8-6). During the study period, the "Fort Robinson" population, consisting of 12 animals, ranged in and out of the park, northward to the outskirts of the town of Crawford. This population was restricted primarily to the Mixed grass Type (Table 2.8-6).

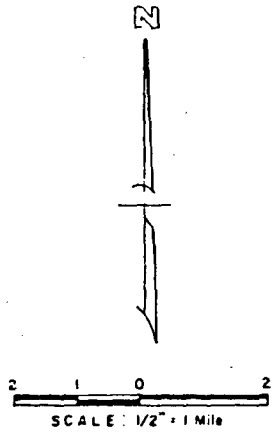
The "eastern" population ranged along the plains and foothills south of the White River, in Mixed Grass and Shortgrass habitat, eastward to perhaps the city of Chadron. A maximum number of 7 was recorded on the AA during the study period.

A large population of pronghorn ("northern" population), ranges over the Shortgrass prairie from the edge of the AA northward to the foothills of the Black Hills. Sagebrush communities would appear to be the preferred winter habitat of pronghorn. Since none of this habitat type is found on the CSA, no pronghorn were recorded there. During the winter months herds of up to 70 pronghorn were found in the sagebrush communities north of the study area. Most of them moved north towards the Black Hills in spring with only about 10 individuals remaining in the vicinity.

Elk or wapiti. Since the baseline studies were conducted in 1982, elk have been expanding their range (Figure 2.8-7)to include Pine Ridge south of the project area and have been moving westward in the Nebraska National Forest



LOCATION MAP
N.T.S.

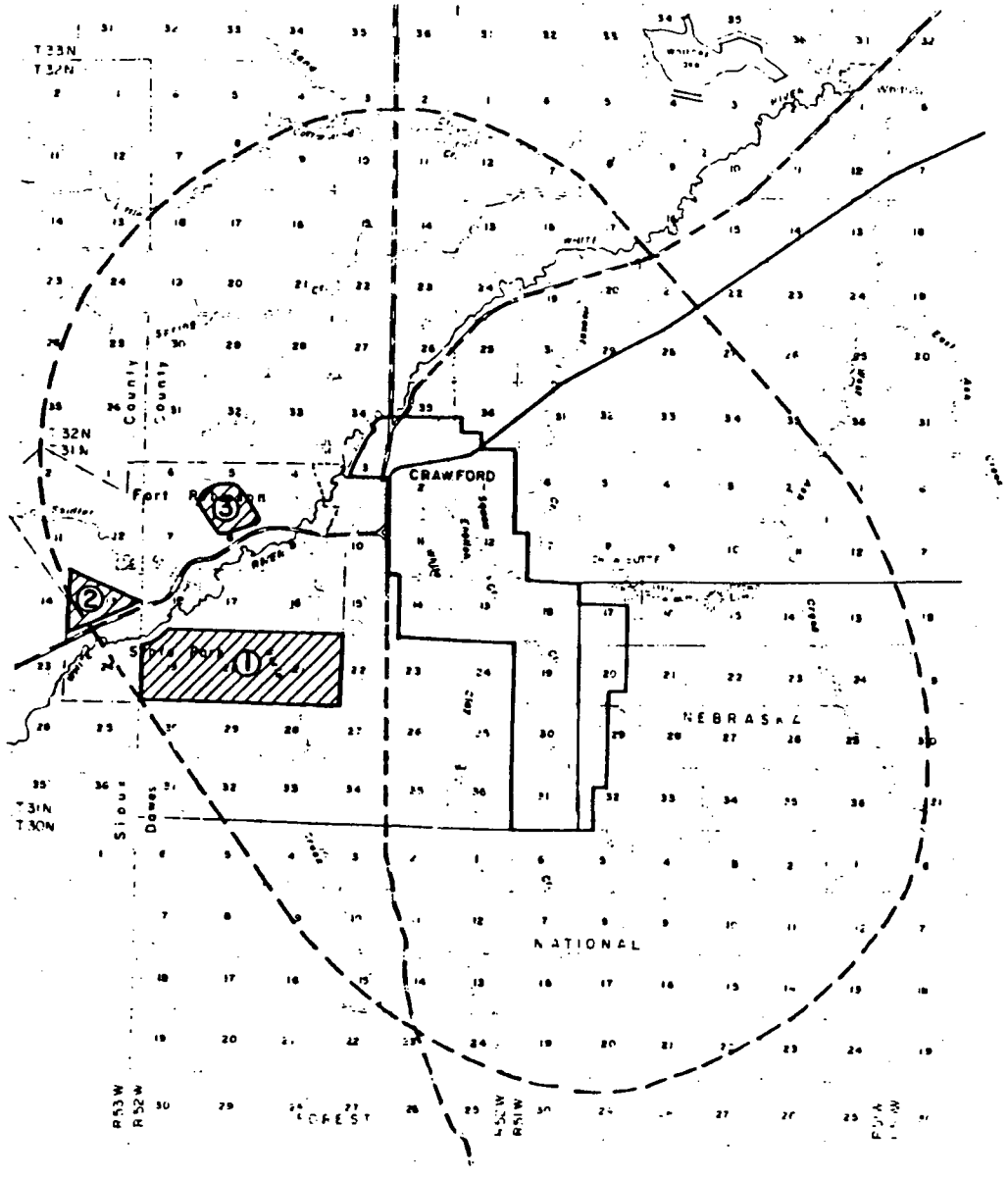


LEGEND

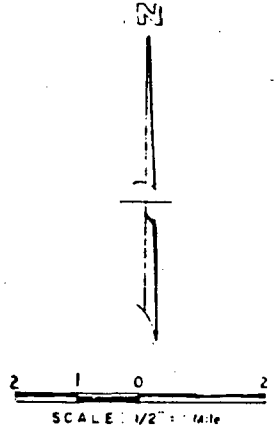
- LIMITS OF PRONGHORN DISTRIBUTION
- (1) "NORTHERN" POPULATION
- (2) "EASTERN" POPULATION
- (3) "FORT ROBINSON" POPULATION

REV.	BY	DATE	FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT Dawes County, Nebraska
			PRONGHORN DISTRIBUTION
			PREPARED BY: F. Harrington & Assoc.
			DWN. BY: D&D Graphics DATE: 8-1-82 FIG. 2.8-6

2.8(40) 07/29/87



LOCATION MAP
N T S



LEGEND

① BISON WINTER COMPOUND

② BISON SUMMER COMPOUND

③ BIGHORN SHEEP, WAPITI COMPOUND

			FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT Dawes County, Nebraska
			CAPTIVE UNGULATES Bison, Bighorn Sheep, Wapiti (Fort Robinson)
			F. Harrington & Assoc.
			DBD Graphics 8-1-82 FIG. 2.8-7

2.8(41) 07/29/87

toward the project area (Suetsuga, Lemmons, 1987). The project area could be used sporadically by elk for feeding, but it would not be classified as home territory (Prochazka 1987). Elk have also been seen more frequently north of the project area between Crawford and Harrison.

According to USFS and Nebraska Game and Parks, Ferret Nebraska's expansion to a commercial facility should have no adverse impacts on elk.

Captive Ungulates. About 200 bison are impounded at Fort Robinson State Park in two seasonal compounds encompassing Mixed Grass habitat (Figure 2.8-7). The animals are maintained as a tourist attraction, but are also cropped and offered as fare in the Park dining room and evening "buffalo cookouts".

Elk (8) and bighorn sheep (22) are maintained in a separate compound (Figure 2.8-7), consisting of Cliff, Ponderosa-Grassland, and Mixed Grass habitat types. One bighorn ram was reported west of the compound, and another found dead (shot) two years previously (J. Murphy, pers.comm.). There are no elk and few bighorn sheep at Fort Robinson.

One cow moose, evidently a migrant from Wyoming, was observed for a number of years west of Fort Robinson, but the species does not occur regularly in the Pine Ridge area.

Neither bison, bighorn sheep, nor moose occur on the CSA, nor are they expected to occur there.

Carnivores. Populations of carnivores on the study area are conspicuously low, compared to studies using similar methods elsewhere in the region. A number of factors is believed to contribute to the relatively low numbers: 1) a federal predator control agent has been operating in the area, 2) trapping by area residents is conducted intensively throughout the area, and 3) landowners routinely kill all carnivores encountered. Don Fryda, Animal Control Officer for the project and surrounding area, stated recently (1987) that the R&D project has had no effect on the number of calls he has received for predator control.

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The most commonly observed carnivore on the study area was the feral house cat, occurring widely and in a ratio of 5 cats per wild carnivore observed (estimated ratio, records for this species were not kept until well into the study).

Coyotes range widely throughout the study area in low numbers, with most observations in the western portion of the study area. Preferred habitats were grasslands (Table 2.8-7). An individual, believed to be a young male, was observed regularly in the central portion of the CSA. The species can be expected to range over the site in search of suitable prey such as jack-rabbits and rodents.

Red Foxes were observed primarily in cultivated habitat (Table 2.8-7). Tracks of the species, however, suggested that they ranged to some degree throughout the study area. Two dens were located north of the CSA, with 5 and 3 pups, respectively. The former den, and presumably its occupants, were destroyed by the landowner. Red fox tracks suggest that the species regularly ranges over the study area, primarily in association with stands of Yucca, which afford plentiful denning opportunities for rodents.

Tracks of bobcats were observed at widely spaced locations in Deciduous and Coniferous Woodland types within the AA. An individual was documented dead on the highway in the southern portion of the AA. The species is relatively uncommon in the area.

Striped skunks were seen primarily in roadside situations, but judging from tracks the species occurs throughout the study area in low numbers.

Long-tailed weasels are widely distributed in a variety of habitats, judging from tracks presumably of this species. An individual was found dead on the highway in the southern portion of the AA. The species can be expected to occur there in proportion to the seasonal populations of small mammals.

Evidence of badgers was recorded on the edge of the study area, north of Little Cottonwood Creek. The species can be reasonably expected to occur on the study area in low numbers.

TABLE 2.8-7

CARNIVORE HABITAT AFFINITIES

Species	Aquatic Habitats		Deciduous Woodlands		Coniferous Shrublands		Shortgrass Prairie		Mixed Grass Prairie		Range Rehab.		Cultivated		Structure Biotopes		Totals	
	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)
Coyote			2	(8.0)	4	(16.0)	2	(8.0)	17	(68.0)							25	(100)
Red Fox	1	(6.2)							1	(6.2)	1	(6.2)	12	(75.2)	1	(6.2)	16	(100)
Striped Skunk									2	(28.6)					5	(71.4)	7	(100)
Long-tailed Weasel															1*	(100)	1	(100)
Bobcat															1*	(100)	1	(100)
Raccoon	3	(13.6)	9	(40.9)	1	(4.5)					1	(4.5)	3	(13.6)	5	(22.9)	22	(100)

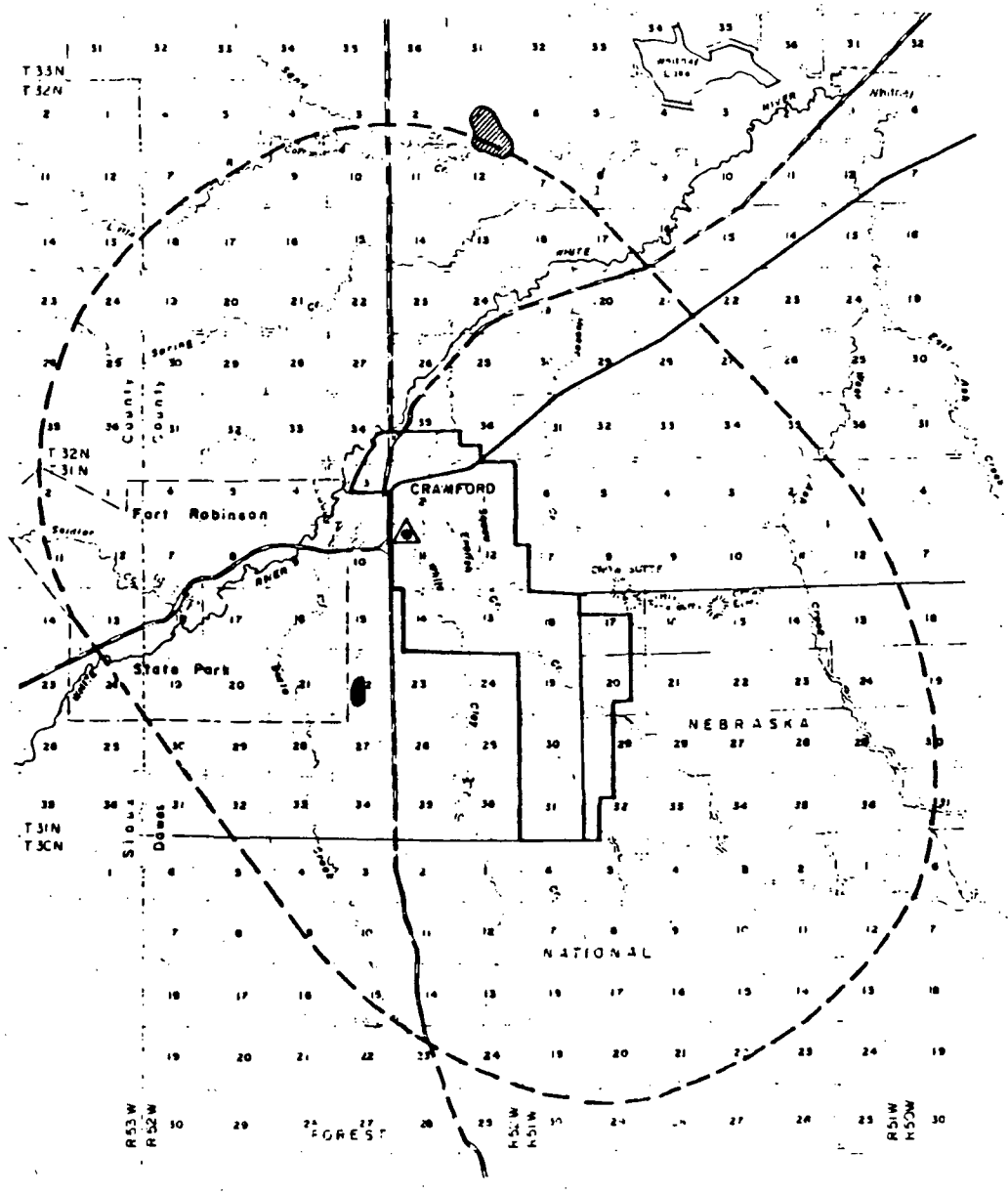
* Dead on Road

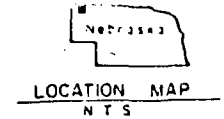
Tracks of a single **mink** were observed along the White River within Fort Robinson State Park. The species is relatively rare in the area and probably restricted to the larger streams.

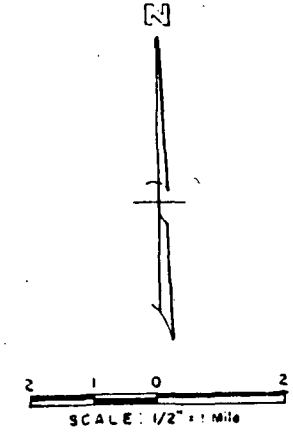
Threatened and Endangered Carnivores which may occur in the region include **swift fox** (state designated) and **black-footed ferret** (federal designated). Approximately forty (40) sightings of swift fox (confirmed and probable) have been documented in northwest Nebraska by Nebraska Game and Parks since the late 1970's (Appendix 2.8-A). Most of these sightings have occurred west of Fort Robinson State Park. However, two confirmed and 1 probable sighting of swift fox have occurred within the 5 mile radius of the AA. These sightings were in the shortgrass prairie west of the CSA in habitat typical of the species. The closest sighting occurred just west of the CSA near Highway 2 in 1986. No sightings have occurred on the CSA and although the swift fox could use the CSA as a hunting area, the amount of cultivated land and poor condition of the range would most likely preclude the swift fox from inhabiting the CSA. Swift foxes, however, might be expected to occur in low numbers anywhere within the grassland habitat within the region. Protection of the species would appear to be problematic in the local area, however, given the intensity of trapping and poisoning.

The black-footed ferret was last observed in the state north of the study area in 1959 (USFS 1978). Its principal prey, prairie dogs, are uncommon on the study area. The two colonies, and a single observation on the CSA (Figure 2.8-8) are probably insufficient to sustain a viable ferret population. Protection of the species would appear difficult given the policy of county and state agencies to poison prairie dogs.

Other Mammals. Small mammal live-trapping was conducted during the spring season (Table 2.8-8). The most ubiquitous species, and the most abundant, was the deer mouse, occurring at every sampling site. Other species captured included white-footed mouse, 13 lined ground squirrel, and meadow mole. Greatest densities (0.16 per trap-night) were recorded in the Lower Wooded Riparian transect, and lowest (0.01 per trap-night) in the Non-Wooded Riparian. Greatest diversity (1.04, Shannon and Weaver 1949) was detected in the Shortgrass type, and lowest diversity (0.00) in the Non-Wooded Riparian and Lower Wooded Riparian types.







LEGEND

PRAIRIE DOG COLONY

SINGLE PRAIRIE DOG OBSERVATION

NO.	BY	DATE	FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT Dawes County, Nebraska
			Location Of PRAIRIE DOG COLONIES
			ENGINEER: W. F. Harrington & Assoc.
			ART BY: D&D Graphics DATE: 8-1-82 FIG. 2.8-8

2.8(47) 07/29/87

TABLE 2.8-8

SMALL MAMMAL TRAPPING RESULTS - SPRING 1982

Species	Night	Ad ♂	Ad ♀	Juv ♂	Juv ♀	Total	Recapture	Juv: Ad	Male:Female	#/Trap-Night	Composition (%)
						SHORTGRASS (150 Trap-Nights)					
Deer Mouse	1	2				2	-	-	-	.04	
	2			1		1	0	-	-	.02	
	3			1		1	1	-	-	.02	
	T	2		2		4	1	1:0: 1	-	.03	21%
Thirteen-lined Ground Squirrel	1	2	2			4	-	-	1.0: 1	.08	
	2	1	3			4	2	-	0.3: 1	.08	
	3		2			2	2	-	-	.04	
	T	3	7			10	4	-	0.4: 1	.06	53%
White-footed Mouse	1					0	-	-	-	.00	
	2	3		2		5	-	0.7: 1	-	.10	
	3					0	0	-	-	.00	
	T	3		2		5	0	0.7: 1	-	.03	26%
Totals						**19**	**6**			**.13**	**100%**

Diversity Index = 1.014

TABLE 2.8-8 (Continued)

SMALL MAMMAL TRAPPING RESULTS - SPRING 1982

Species	Night	Ad ♂	Ad ♀	Juv ♂	Juv ♀	Total	Recapture	Juv: Ad	Male:Female	#/Trap-Night	Composition (%)
						PONDEROSA PINE (150 Trap-Nights)					
White-footed Mouse	1	1				1	-	-	-	.02	
	2	1				1	0	-	-	.02	
	3			1		1	0	-	-	.02	
	T	2		1		3	0	0.5: 1	-	.02	33%
Deer Mouse	1					0	-	-	-	.00	
	2					0	-	-	-	.00	
	3	3		1	1	5	-	0.7: 1	4.0: 1	.10	
	T	3		1	1	5	-	0.7: 1	4.0: 1	.03	55%
Meadow Vole	1					0	-	-	-	.00	
	2					0	-	-	-	.00	
	3	1				1	-	-	-	.02	
	T	1				1	-	-	-	.01	12%
Totals						**9**	**0**			**.06**	**100%**

Diversity Index = 0.949

TABLE 2.8-8 (Continued)

SMALL MAMMAL TRAPPING RESULTS - SPRING 1982

Species	Night	Ad ♂	Ad ♀	Juv ♂	Juv ♀	Total	Recapture	Juv: Ad	Male:Female	#/Trap-Night	Composition (%)
MIXED GRASS (150 Trap-Nights)											
Deer Mouse	1	1				1	-	-	-	.02	
	2	2				2	1	-	-	.04	
	3	1				1	1	-	-	.02	
	T	4				4	2	-	-	.03	40%
Thirteen-lined Ground Squirrel	1	1	2			3	-	-	0.5: 1	.06	
	2	1	2			3	2	-	0.5: 1	.06	
	3					0	0	-	-	.00	
	T	2	4			6	2	-	0.5: 1	.04	60%
Totals						**10**	**4**			**.06**	**100%**
Diversity Index = 0.673											
LOWER WOODED RIPARIAN (100 Trap-Nights)											
Deer Mouse	1	5	1	2		8	-	0.3: 1	7.0: 1	.16	
	2	6		1	1	8	5	0.3: 1	7.0: 1	.16	
	3	(Flood - Traps Inundated)								-	
	T	11	1	3	1	16	5	0.3: 1	7.0: 1	.16	100%
Totals						**16**	**5**			**.16**	**100%**
Diversity Index = 0.000											

TABLE 2.8-8 (Continued)

SMALL MAMMAL TRAPPING RESULTS - SPRING 1982

Species	Night	Ad ♂	Ad ♀	Juv ♂	Juv ♀	Total	Recapture	Juv: Ad	Male:Female	#/Trap-Night	Composition (%)
UPPER WOODED RIPARIAN (150 Trap-Nights)											
Deer Mouse	1	1				1	-	-	-	.02	
	2	1	1			2	1	-	1.0: 1	.04	
	3	1				1	1	-	-	.02	
	T	3	1			4	2	-	3.0: 1	.03	67%
White-footed Mouse	1	1				1	-	-	-	.02	
	2	1				1	1	-	-	.02	
	3					0	0	-	-	.00	
	T	2				2	1	-	-	.01	33%
Totals						**6**	**3**			**.04**	**100%**
Diversity Index = 0.634											
NON-WOODED RIPARIAN (150 Trap-Nights)											
Deer Mouse	1					0	-	-	-	.00	
	2				1	1	-	-	-	.02	
	3					0	-	-	-	.00	
	T				1	1	0	-	-	.01	100%
Totals						**1**	**0**			**.01**	**100%**
Diversity Index = 0.000											

TABLE 2.8-8 (Continued)

SMALL MAMMAL TRAPPING RESULTS - SPRING 1982

Species	Night	Ad ♂	Ad ♀	Juv ♂	Juv ♀	Total	Recapture	Juv: Ad	Male:Female	#/Trap-Night	Composition (%)
						CULTIVATED (150 Trap-Nights)					
Deer Mouse	1			1		1	-	-	-	.02	
	2	1				1	0	-	-	.02	
	3	1				1	1	-	-	.02	
	T	2		1		3	1	0.5: 1	-	.02	60%
Thirteen-lined Ground Squirrel	1		1			1	-	-	-	.02	
	2		1			1	1	-	-	.02	
	3					0	0	-	-	.00	
	T		2			2	1	-	-	.01	40%
Totals						**5**	**2**			**.03**	**100%**

Diversity Index = 0.673

9 8/53 7/20/87

Other small mammals observed or captured during extensive trapping exercises included eastern mole (uncommon along streambanks and in Mixed Grass habitats), spotted ground squirrel (uncommon in Shortgrass habitat), northern pocket gopher (common throughout), house mouse (common in structure biotopes) and meadow jumping mouse (uncommon along streambanks).

Muskrats were recorded commonly along watercourses and occur in all permanent impoundments. Beaver are located in the White River Basin and have been introduced into Squaw Creek since 1982. It is not yet known if they have established themselves into a viable colony. Porcupines are common, ranging throughout the woodland area. Fox squirrels are abundant in woodlands, farmyards and towns.

Two species of jackrabbits range over the study area. White-tailed jackrabbits are common in grassland and cultivated areas, and black-tailed jackrabbits are relatively scarce in the same habitats. This would appear to be a reflection of the relatively cold winter climate. Eastern cottontails are common on the study area in upland as well as woodland and cultivated types. Cottontails observed in the northern portion of the AA, in Shortgrass and Sand-Sagebrush habitats, are believed to be desert cottontails, judging from the smaller size and pale coloration.

Birds

According to published sources (Johnsgard 1979, USFS 1981), 302 species of birds have been reported within 80-km of the study area. In the course of the present study, 201 species have been documented within the study area (Table 2.8-9).

Upland Game Birds. The Turkey is the most popular game bird in the region. The species is not native to the Pine Ridge area. After the introduction of 28 Merriam's Turkeys in 1959 about 29-km northwest of the CSA, the population increased to an estimated 1500-2000 birds in three breeding seasons (USFS 1978).

TABLE 2.8-9

BIRD SPECIES LIST

Common Name	Scientific Name	Status
GAVIIFORMES		
Common Loon	*Gavia immer*	R-OA-O-m
Arctic Loon	*Gavia arctica*	R-OA-O-m
PODICIPEDIFORMES		
Red-necked	*Podiceps grisegena*	R-OA-O-m
Horned Grebe	*Podiceps auritus*	D-AA-U-m
Eared Grebe	*Podiceps caspicus*	D-CA-U-sv
Western Grebe	*Aechmophorus occidentalis*	D-CA-U-sv
Pied-billed Grebe	*Podilymbus podiceps*	
PELECANIFORMES		
White Pelican	*Pelecanus erythrorhynchos*	D-AA-U-sr**
Double-crested Cormorant	*Phalacrocorax auritus*	D-CA-U-sr**
CICONIIFORMES		
Great Blue Heron	*Ardea herodias*	D-CA-U-sr
Green Heron	*Butorides virescens*	R-OA-O-m
Cattle Egret	*Bubulcus ibis*	R-OA-O-m
Great Egret	*Casmerodius albus*	R-OA-O-m
Snowy Egret	*Leucophoyx thula*	R-OA-O-m
Black-crowned Night Heron	*Nycticorax nycticorax*	D-CA-U-sr**
Yellow-crowned Night Heron	*Nyctanassa violacea*	R-OA-O-m
American Bittern	*Botaurus lentiginosus*	D-AA-U-sr**
White-faced Ibis	*Plegadia chihi*	R-OA-O-m
ANSERIFORMES		
Whistling Swan	*Olor columbianus*	R-OA-O-m
Trumpeter Swan	*Olor buccinator*	D-AA-O-m
Canada Goose	*Branta canadensis*	D-CA-U-pr
Brant	*Branta bernicla*	R-OA-U-m
White-fronted Goose	*Anser albifrons*	D-AA-U-m
Snow Goose	*Chen hyperborea*	D-CA-U-m
Mallard	*Anas plantyrhynchos*	D-CA-C-pr*
Black Duck	*Anas rubripes*	R-OA-O-m
Gadwall	*Anas strepera*	D-CA-C-sr**
Pintail	*Anas acuta*	D-CA-C-sr**
Green-winged Teal	*Anas Carolinensis*	D-CA-U-sr**
Blue-winged Teal	*Anas discors*	D-CA-C-sr**

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
ANSERIFORMES		
Cinnamon Teal	*Anas cyanoptera*	D-CA-U-sr**
American Wigeon	*Mareca americana*	D-CA-U-sr**
Northern Shoveler	*Spatula clypeata*	D-CA-C-sr**
Wood Duck	*Aix sponsa*	D-CA-U-sv**
Redhead	*Aythya americana*	D-CA-U-sv
Ring-necked Duck	*Aythya collaris*	D-AA-U-m
Canvasback	*Aythya valisineria*	D-AA-U-m
Lesser Scaup	*Aythya affinis*	D-CA-C-m
Common Goldeneye	*Bucephala clangula*	D-CA-U-m
Barrow's Goldeneye	*Bucephala islandica*	R-OA-O-wv
Bufflehead	*Bucephala albeola*	D-CA-C-m
Oldsquaw	*Clangula hyemalis*	R-OA-U-m
White-winged Scoter	*Melanitta deglandi*	R-OA-U-m
Surf Scoter	*Melanitta perspicillata*	R-OA-U-m
Black Scoter	*Oidemia nigra*	R-OA-U-m
Ruddy Duck	*Oxyura jamaicensis*	D-CA-C-sr**
Hooded Merganser	*Lophodytes cucullatus*	D-CA-U-m
Common Merganser	*Mergus merganser*	D-CA-U-m
Red-breasted Merganser	*Mergus serrator*	R-OA-O-m
FALCONIFORMES		
Turkey Vulture	*Cathartes aura*	D-CA-U-sr**
Goshawk	*Accipiter gentilis*	D-CA-U-wv
Sharped-shinned Hawk	*Accipiter striatis*	D-AA-U-pr**
Cooper's Hawk	*Accipiter cooperi*	D-AA-U-pr*
Red-tailed Hawk	*Buteo jamaicensis*	
(Light Phase)	"	D-CA-C-sr*
(Dark Phase)	"	D-AA-U-m
Red-shouldered Hawk	*Buteo lineatus*	R-OA-O-m
Broad-winged Hawk	*Buteo platypterus*	R-OA-O-m
Swainson's Hawk	*Buteo swainsoni*	R-OA-U-sr**
Rough-legged Hawk	*Buteo lagopus*	D-CA-C-wv
Ferruginous Hawk	*Buteo regalis*	D-AA-U-sr*
Golden Eagle	*Aquila chrysaetos*	D-CA-C-pr*
Bald Eagle	*Haliaeetus leucocephalus*	D-CA-F-wv
Northern Harrier	*Circus cyaneus*	D-CA-C-pr**
Osprey	*Pandion haliaetus*	R-AA-O-sv
Gyrfalcon	*Falco rusticolus*	D-AA-U-m
Prairie Falcon	*Falco mexicanus*	D-CA-C-pr**
Peregrine Falcon	*Falco peregrinus*	R-OA-F-m
Merlin	*Falco columbarius*	D-AA-U-pr**
American Kestrel	*Falco sparverius*	D-CA-A-pr*

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
GALLIFORMES		
Sharp-tailed Grouse	*Pedioecetes phasianellus*	D-CA-C-pr*
Bobwhite	*Colinus virginianus*	R-OA-O-pr
Ring-necked Pheasant	*Phasianus colchicus*	D-CA-C-pr*
Turkey	*Meleagris gallopavo*	D-AA-C-pr*
Gray Partridge	*Perdix perdix*	D-AA-O-pr**
GRUIFORMES		
Sandhill Crane	*Grus canadensis*	D-OA-U-m
Virginia Rail	*Rallus limicola*	D-AA-U-sr**
Sora Rail	*Porzana carolina*	D-CA-U-sr**
American Coot	*Fulica americana*	D-CA-C-sr**
CHARADRIIFORMES		
Semipalmated Plover	*Charadrius semipalmatus*	R-OA-U-m
Piping Plover	*Charadrius melodus*	R-OA-U-m
Snowy Plover	*Charadrius alexandrinus*	R-OA-O-m
Killdeer	*Charadrius vociferus*	D-CA-C-sr*
American Golden Plover	*Pluvialis dominica*	R-OA-U-m
Black-bellied Plover	*Squatarola squatarola*	D-AA-U-m
Marbled Godwit	*Lemosa fedoa*	D-AA-U-m
Whimbrel	*Numenius phaeopus*	R-OA-O-m
Long-billed Curlew	*Numenius americanus*	D-AA-U-sr**
Upland Sandpiper	*Bartramia longicauda*	D-AA-U-sr**
Greater Yellowlegs	*Totanus melanoleucus*	D-CA-C-m
Lesser Yellowlegs	*Totanus flavipes*	D-CA-C-m
Solitary Sandpiper	*Tringa solitaria*	D-CA-U-m
Willet	*Catoptrophorus semipalmatus*	D-CA-U-sr**
Spotted Sandpiper	*Actitis macularia*	D-CA-C-sr**
Common Snipe	*Capella gallinago*	D-CA-C-pr*
Short-billed Dowitcher	*Limnodromus griseus*	R-OA-U-m
Long-billed Dowitcher	*Limnodromus scolopaceus*	D-AA-C-m
Red Knot	*Calidris canutus*	R-OA-O-m
Sanderling	*Calidris alba*	D-AA-U-m
Semipalmated Sandpiper	*Ereunetes pusillus*	D-AA-U-m
Western Sandpiper	*Ereunetes mauri*	R-OA-U-m
Least Sandpiper	*Eriola minutilla*	D-CA-U-m
White-rumped Sandpiper	*Eriola fuscicollis*	R-OA-U-m
Baird's Sandpiper	*Eriola bairdii*	D-AA-C-m
Pectoral Sandpiper	*Eriola melanotos*	R-OA-U-m
Stilt Sandpiper	*Micropalama himantopus*	D-AA-C-m

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
CHARADRIIFORMES		
Buff-breasted Sandpiper	*Tryngites subrufficollis*	R-OA-U-m
American Avocet	*Recurvirostra americana*	D-AA-C-sr**
Wilson's Phalarope	*Steganopus tricolor*	D-CA-C-sr**
Northern Phalarope	*Lobipes lobatus*	D-AA-U-m
Parasitic Jaeger	*Stercorarius parasiticus*	R-OA-O-m
Herring Gull	*Larus argentatus*	R-OA-U-m
California Gull	*Larus californicus*	R-OA-U-m
Ring-billed Gull	*Larus delawarensis*	D-CA-C-sv
Black-headed Gull	*Larus ridibundus*	R-OA-O-m
Franklin's Gull	*Larus pipixcan*	D-AA-C-sv
Bonaparte's Gull	*Larus philadelphia*	R-OA-U-m
Forster's Tern	*Sterna forsteri*	D-AA-U-sv
Common Tern	*Sterna hirundo*	R-OA-O-m
Little (Least Interior) Tern	*Sterna albifrons*	R-OA-S-m
Black Tern	*Chlidonias niger*	D-AA-U-sr**
COLUMBIFORMES		
Mourning Dove	*Zenaidura macroura*	D-CA-A-sr*
Rock Dove	*Columba livia*	D-CA-C-pr*
CUCULIFORMES		
Yellow-billed Cuckoo	*Coccyzus americanus*	D-CA-U-sr**
Black-billed Cuckoo	*Coccyzus erythropthalmus*	D-CA-U-sr**
STRIGIFORMES		
Barn Owl	*Tyto alba*	D-AA-U-pr**
Screech Owl	*Otus asio*	D-AA-U-pr**
Great Horned Owl	*Bubo virginianus*	D-CA-C-pr*
Snowy Owl	*Nyctea scandiaca*	R-OA-U-wv
Burrowing Owl	*Speotyto cunicularia*	D-AA-U-sr*
Barred Owl	*Strix varia*	R-OA-O-pr
Long-eared Owl	*Asio otus*	R-OA-U-pr
Short-eared Owl	*Asio flammeus*	D-CA-U-pr**
Saw-whet Owl	*Aegolius Acadicus*	D-AA-U-pr**

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
CAPRIMULGIFORMES		
Common Poor-will	*Phalaenoptilus nuttallii*	D-AA-U-sr**
Common Nighthawk	*Chordeiles minor*	D-CA-C-sr**
APODIFORMES		
Chimney Swift	*Chaetura pelagica*	D-AA-U-sr**
White-throated Swift	*Aeronautes saxatalis*	D-AA-U-sr**
Broad-tailed Hummingbird	*Selasphorus platycercus*	R-OA-O-m
Rufous Hummingbird	*Selasphorus rufus*	R-OA-O-m
CORACIIFORMES		
Belted Kingfisher	*Megaceryle alcyon*	D-CA-U-sr**
PICIFORMES		
Common Flicker	*Colaptes auratus*	D-CA-C-pr*
Red-bellied Woodpecker	*Centurus carolinus*	R-OA-O-sr
Red-headed Woodpecker	*Melanerpes erythrocephalus*	D-CA-C-sr*
Lewis' Woodpecker	*Asyndesmus lewis*	D-AA-U-sr**
Yellow-bellied Sapsucker	*Sphyrapicus varius*	R-OA-U-m
Hairy Woodpecker	*Dendrocopos villosus*	D-CA-C-pr**
Downy Woodpecker	*Dendrocopos pubescens*	D-CA-C-pr**
PASSERIFORMES		
Tyannidae		
Eastern Kingbird	*Tyrannus tyrannus*	D-CA-C-sr*
Western Kingbird	*Tyrannus verticalis*	D-CA-C-sr*
Cassin's Kingbird	*Tyrannus vociferans*	R-OA-U-sv
Scissor-tailed Flycatcher	*Muscivora forfic*	R-OA-O-m
Great Crested Flycatcher	*Myiarchus crinitus*	D-CA-U-sr**
Eastern Phoebe	*Sayornis phoebe*	D-AA-U-sr**
Say's Phoebe	*Sayornis saya*	D-CA-U-sr**
Black Phoebe	*Sayornis nigricans*	D-AA-O-m
Willow Flycatcher	*Empidonax traillii*	D-AA-U-sr**
Least Flycatcher	*Empidonax minimus*	D-AA-U-m
Hammond's Flycatcher	*Empidonax hammondii*	R-OA-O-m
Western Flycatcher	*Empidonax difficilis*	R-OA-O-m
Eastern Pewee	*Contopus virens*	D-AA-U-sr**
Western Pewee	*Contopus sordidulus*	D-CA-C-sr*
Olive-sided Flycatcher	*Nuttalornis borealis*	R-OA-U-m

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
Alaudidae		
Horned Lark	*Eremophila alpestris*	D-CA-C-pr*
Hirundinidae		
Violet-green Swallow	*Tachycineta thallassina*	D-CA-U-sr**
Tree Swallow	*Iridoprocne bicolor*	D-CA-U-sr**
Bank Swallow	*Riparia riparia*	D-CA-C-sr*
Rough-winged Swallow	*Stelgidopteryx ruficollis*	D-CA-U-sr**
Barn Swallow	*Hirundo rustica*	D-CA-C-sr*
Cliff Swallow	*Petrochelidon pyrrhonota*	D-CA-C-sr*
Purple Martin	*Progne subis*	R-OA-O-m
Corvidae		
Gray Jay	*Perisoreus canadensis*	R-OA-O-wv
Blue Jay	*Cyanocitta cristata*	R-CA-C-pr**
Steller's Jay	*Cyanocitta stelleri*	R-OA-O-wv
Black-billed Magpie	*Pica pica*	D-CA-C-pr*
American Crow	*Corvus brachyrhynchos*	D-CA-C-pr*
Pinyon Jay	*Gymnorhinus cyanocephalus*	D-CA-C-pr**
Clark's Nutcracker	*Nucifraga columbiana*	R-OA-O-wv
Paridae		
Black-capped Chickadee	*Parus atricapillus*	D-CA-C-pr**
Tufted Titmouse	*Parus bicolor*	R-OA-O-m
Sittidae		
White-breasted Nuthatch	*Sitta carolinensis*	D-CA-C-pr**
Red-breasted Nuthatch	*Sitta canadensis*	D-CA-C-pr**
Pygmy Nuthatch	*Sitta pygmaea*	D-AA-C-pr**
Certhiidae		
Brown Creeper	*Certha familiaris*	D-AA-U-pr**
Cinclidae		
Dipper	*Cinclus mexicanus*	R-OA-U-wv

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
Troglodytidae		
Northern House Wren	*Troglodytes aedon*	D-CA-C-sr**
Winter Wren	*Troglodytes troglodytes*	R-OA-U-wv
Bewick's Wren	*Thryomanes bewickii*	R-OA-O-m
Carolina Wren	*Thryothorus ludovicianus*	R-OA-O-m
Marsh Wren	*Telmatodytes palustris*	D-AA-U-sr**
Canyon Wren	*Catherpes mexicanus*	R-OA-O-wv
Rock Wren	*Salpinctes obsoletus*	D-AA-U-sr**
Mimidae		
Mockingbird	*Mimus polyglottos*	R-OA-U-sv
Gray Catbird	*Dumetella carolinensis*	D-CA-C-sr**
Brown Thrasher	*Toxostoma rufum*	D-CA-C-sr**
Sage Thrasher	*Orescoptes montanus*	R-OA-U-sv
Turdidae		
American Robin	*Turdus migratorius*	D-CA-C-sr*
Wood Thrush	*Hylocichla mustelina*	D-AA-U-m
Hermit Thrush	*Hylocichla guttata*	D-AA-U-m
Swainson's Thrush	*Hylocichla ustulata*	D-CA-C-m
Gray-cheeked Thrush	*Hylocichla ustulata*	D-CA-C-m
Veery	*Hylocichla fuscenscens*	D-CA-U-m
Eastern Bluebird	*Sialia sialis*	R-OA-U-sv
Mountain Bluebird	*Sialia currucoides*	D-CA-C-sr**
Townsend's Solitaire	*Myadestes townsendi*	D-AA-U-pr**
Sylviidae		
Blue-gray Gnatcatcher	*Polioptila caerulea*	R-OA-O-m
Golden-crowned Kinglet	*Regulus satrapa*	R-OA-U-m
Ruby-crowned Kinglet	*Regulus calendula*	D-AA-U-m
Motacillidae		
Water Pipit	*Anthus spinoletta*	D-AA-C-m
Bombycillidae		
Bohemian Waxwing	*Bombycilla garrulus*	D-CA-C-wv
Cedar Waxwing	*Bombycilla cedrorum*	D-PA-C-sr**

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
Laniidae		
Northern Shrike	*Lanius excubitor*	D-CA-U-wv
Loggerhead Shrike	*Lanius ludovicianus*	D-CA-U-sr**
Sturnidae		
European Starling	*Sturnus vulgaris*	D-CA-C-pr*
Vireonidae		
White-eyed Vireo	*Vireo griseus*	R-OA-O-m
Bell's Vireo	*Vireo bellii*	D-AA-U-sr**
Yellow-throated Vireo	*Vireo flavifrons*	R-OA-O-m
Solitary Vireo	*Vireo solitarius*	R-OA-U-sv
Red-eyed Vireo	*Vireo olivaceus*	D-CA-C-sr**
Philadelphia Vireo	*Vireo philadelphicus*	R-OA-O-m
Warbling Vireo	*Vireo gilvus*	D-CA-C-sr**
Parulidae		
Black and White Warbler	*Mniotilta varia*	D-AA-U-m
Prothonotary Warbler	*Protonotaria citrea*	R-OA-O-m
Tennessee Warbler	*Vermivora peregrina*	D-AA-U-m
Orange-crowned Warbler	*Vermivora celata*	D-CA-U-m
Nashville Warbler	*Vermivora ruficapilla*	D-AA-U-m
Northern Parula	*Parula Americana*	R-OA-U-m
Yellow Warbler	*Dendroica petechia*	D-CA-C-sr**
Magnolia Warbler	*Dendroica magnolia*	R-OA-U-m
Cape May Warbler	*Dendroica tigrina*	R-OA-U-m
Yellow-rumped Warbler	*Dendroica coronata*	
(Audubon Race)	"	D-CA-C-sr**
(Myrtle Race)	"	D-CA-U-m
Townsend's Warbler	*Dendroica townsendi*	R-OA-U-m
Black-throated Green Warbler	*Dendroica virens*	R-OA-U-m
Cerulean Warbler	*Dendroica cerulea*	R-OA-O-m
Blackburnian Warbler	*Dendroica fusca*	R-OA-O-m
Chestnut-sided Warbler	*Dendroica pensylvanica*	R-OA-U-m
Blackpoll Warbler	*Dendroica striata*	D-AA-U-m
Palm Warbler	*Dendroica palmarum*	R-OA-U-m
Ovenbird	*Seiurus aurocapillus*	D-AA-U-sr**
Northern Waterthrush	*Seiurus noveboracensis*	D-CA-U-m

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
PARULIDAE		
Mourning Warbler	*Oporornis philadelphia*	R-OA-O-m
MacGillivray's Warbler	*Oporornis tolmiei*	R-OA-U-m
Common Yellowthroat	*Geothlypis trichas*	D-CA-C-sr**
Yellow-breasted Chat	*Icteria virens*	D-CA-C-sr**
Hooded Warbler	*Wilsonia citrina*	R-OA-O-m
Wilson's Warbler	*Wilsonia pusilla*	D-AA-C-m
American Redstart	*Setophaga ruticilla*	D-RA-C-sr**
Ploceidae		
House Sparrow	*Passer domesticus*	D-CA-C-pr*
Icteridae		
Bobolink	*Dolichonyx oryzivorus*	D-CA-U-sr**
Eastern Meadowlark	*Sturnella magna*	D-AA-U-sr**
Western Meadowlark	*Sturnella neglecta*	D-CA-C-sr*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	D-CA-U-sr**
Red-winged Blackbird	*Agelaius phoeniceus*	D-CA-C-sr*
Orchard Oriole	*Icterus spurius*	D-CA-C-sr**
Northern (Bullock) Oriole	*Icterus galbula*	D-CA-U-sr**
Rusty Blackbird	*Euphagus carolinus*	R-OA-U-m
Brewer's Blackbird	*Euphagus cyanocephalus*	D-CA-U-sr**
Common Grackle	*Quiscalus quiscula*	D-CA-C-sr**
Brown-headed Cowbird	*Molothrus ater*	D-CA-C-sr**
Thraupidae		
Western Tanager	*Piranga ludoviciana*	D-CA-U-sr**
Scarlet Tanager	*Piranga olivacea*	R-OA-O-m
Fringillidae		
Cardinal	*Richmondena cardinalis*	R-OA-O-pr
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	R-OA-U-m
Blue Grosbeak	*Guiraca caerulea*	D-CA-U-sr**
Indigo Bunting	*Passerina cyanea*	D-CA-U-sr**
Lazuli Bunting	*Passerina amoena*	D-CA-C-sr**
Indigo x Lazuli Hybrid	*P. cyanea x amoena*	D-CA-U-sr**

TABLE 2.8-9 (Continued)

BIRD SPECIES LIST

Common Name	Scientific Name	Status
FRINGILLIDAE		
Dickcissel	*Spiza americana*	R-OA-U-sv
Evening Grosbeak	*Herperiphona vespertina*	D-AA-C-wv
Purple Finch	*Carpodacus purpureus*	R-OA-U-m
Cassin's Finch	*Carpodacus cassinii*	R-OA-U-m
House Finch	*Carpodacus mexicanus*	D-CA-U-m
Pine Grosbeak	*Pinicola enucleator*	R-OA-O-wv
Gray-crowned Rosy Finch	*Leucosticte tephrocotis*	R-OA-U-wv
Common Redpoll	*Acanthis flammea*	R-OA-U-wv
Pine Siskin	*Spinus pinus*	D-CA-C-pr**
American Goldfinch	*Spinus tristis*	D-CA-C-pr**
Red Crossbill	*Loxia curvirostra*	D-AA-A-pr**
White-winged Crossbill	*Loxia leucoptera*	R-OA-O-wv
Green-tailed Towhee	*Chlorura chlorura*	R-OA-O-m
Rufous-sided Towhee	*Pipilo erythrophthalmus*	D-CA-C-sr**
Lark Bunting	*Calamospiza melanocoryx*	D-CA-C-sr**
Savannah Sparrow	*Passerculus sandwichensis*	D-CA-C-m
Grasshopper Sparrow	*Ammodramus savannarum*	D-AA-U-m
Vesper Sparrow	*Pooecetes gramineus*	D-CA-U-sr**
Lark Sparrow	*Chondestes grammacus*	D-CA-C-sr*
Black-throated Sparrow	*Amphispiza bilineata*	R-OA-O-m
Dark-eyed Junco	*Junco hyemalis*	
(White-winged Race)	"	D-CA-C-pr**
(Slate-colored Race)	"	D-CA-C-wv
(Oregon Race)	"	D-CA-C-wv
(Gray-headed Race)	"	D-AA-U-m
Tree Sparrow	*Spizella arborea*	D-CA-C-wv
Chipping Sparrow	*Spizella passerina*	D-CA-C-sr**
Clay-colored Sparrow	*Spizella pallida*	D-CA-C-sr**
Brewer's Sparrow	*Spizella breweri*	D-AA-U-sr**
Field Sparrow	*Spizella pusilla*	R-OA-U-m
Harris' Sparrow	*Zonotrichia querula*	R-OA-U-m
White-crowned Sparrow	*Zonotrichia leucophrys*	D-CA-C-m
White-throated Sparrow	*Zonotrichia albicollis*	R-OA-U-m
Fox Sparrow	*Passerella iliaca*	R-OA-O-m
Lincoln's Sparrow	*Melospiza lincolnii*	D-AA-U-m
Swamp Sparrow	*Melospiza georgiana*	R-OA-O-m
Song Sparrow	*Melospiza melodia*	D-CA-C-wv
McCown's Longspur	*Rhynchophanes mccownii*	D-AA-U-sr**
Lapland Longspur	*Calcarius lapponicus*	D-AA-C-m
Chestnut-collared Longspur	*Calcarius ornatus*	D-AA-U-sr**
Snow Bunting	*Plectrophenax nivalis*	D-AA-C-wv

SEE TABLE 2.9-5A FOR STATUS CODES

The turkey is widely distributed on the study area, primarily along the foothills and plateaus, within the Ponderosa habitat, and along drainages in the northern portion of the study area. Of 701 observations of the species from January to mid-July, most (38%) were observed in structure biotopes, mainly farmyards, with 24 percent in Deciduous Woodlands, 21 percent in Coniferous Woodlands, and the remainder in Cultivated, Mixed Grass, and Range Rehabilitation types (Table 2.8-10).

In winter, nearly all observations of the species were in four concentration areas, inside the study area and outside, where the birds were being fed or were feeding among livestock in farmyard situations: 1) Lux Ranch (AA) - 55, 2) Ponderosa Wildlife Area (AA) - 20, 3) Ostermeyer Ranch (10-km northwest of the AA) - 200, and 4) Johnson Ranch (2-km southwest of the AA) - 150. The total winter population was estimated at 450 birds, including 350 outside the study area. Additional concentrations in the OA were recorded between Whitney and Chadron, along the White River in farmyard situations (about 500). Only about 75 birds in the study area proper, and none within the CSA.

In spring, there was a broad dispersal of birds away from the winter concentration areas. Courtship was first observed 30 March, and shortly thereafter males with harems were observed primarily in woodland habitats at widely separated locations.

In May, tracks of a single turkey were documented along Squaw Creek within Section 19 - the only record of the species on the CSA. The first brood (5 young) was observed east of the CSA on 27 June.

In summary, the turkey constitutes a semi-domesticated bird in this area. There are no historical records of turkeys in the region probably because there is inadequate winter habitat, and an absence of mast-produced trees. Birds, therefore, are required to rely on supplemental feeding in winter. Although the species does not regularly occur on the CSA, it may be expected to occur in proportion to the amount of supplemental winter feeding offered by local landowners.

TABLE 2.8-10

GAME BIRD HABITAT AFFINITIES

Species	Riverine Habitats Obs	(%)	Deciduous Woodlands Obs	(%)	Coniferous Woodlands Obs	(%)	Mixed Grass Prairie Obs	(%)	Range Rehab. Obs	(%)	Cultivated Obs	(%)	Structure Biotopes Obs	(%)	Totals Obs	(%)
Sharp-tailed Grouse																
CSA*			10	(58.8)			5	(29.4)	2	(11.8)					17	(100)
Total Area			10	(8.1)	2	(1.6)	80	(65.0)	4	(3.2)	10	(8.1)	17	(14.0)	123**	(100)
Pheasant																
CSA	2	(2.3)	9	(10.7)			2	(2.3)	16	(19.0)	4	(4.8)	51	(60.9)	84	(100)
Total Area	5	(2.9)	24	(13.9)			10	(5.8)	18	(10.4)	12	(6.9)	104	(60.1)	173	(100)
Turkey																
CSA	(NOT OBSERVED ON COMMERCIAL STUDY AREA)															
Total Area			167	(23.8)	148	(21.1)	12	(1.7)	29	(4.1)	80	(11.4)	265	(37.9)	701	(100)
Gray Partridge																
CSA	(NOT OBSERVED ON COMMERCIAL STUDY AREA)															
Total Area													2	(100)	2	(100)

* CSA (Commercial Study Area) ** Excludes 568 Observations on Leks

Pheasants are common on the study area, with about half the observations recorded on the CSA. Preferred habitats (Table 2.8-10) were structure biotopes and cultivated types, with most pheasants observed in roadside situations.

Pheasant crowing counts were conducted along a route lying largely within the CSA (Table 2.8-11; Figure 2.8-9). Number of calls for the route (20 listening stations, 2 minutes each) ranged from 15 in April to 106 in late May, with courtship activity declining sharply thereafter. Based on the above counts and taking into consideration the sex ratio observed during the same period (0.68 females/male), the total CSA population was estimated at 180 birds in spring. Most of those were distributed from the central portion of the CSA northward. The first pheasant brood was observed 27 June (5 young).

Sharp-tailed grouse are common on the study area, distributed primarily in foothills areas and plains. During the study period the preferred habitat was Mixed Grass Prairie (Table 2.8-10).

In spring, an intensive search revealed the presence of 6 sharptail leks within the study area, and 2 additional leks on the perimeter (Table 2.8-12; Figure 2.8-9). Peak mate attendance ranged from 4 to 33 (x=15.6). Activity on the leks was evident from mid-April into late May, with the peak of attendance from late April into early May.

No lek was found on the CSA, and only about 10% of birds were recorded there. The absence of leks may be due to 1) the higher level of disturbance which exists on the CSA (roads, railroads, farming activities), 2) unfavorable climatic conditions, much of the CSA lies within a wind-lane in the eastern part of the valley. Sharptails typically display reduced activity on windy days, 3) the high level of raptor activity and abundance of raptor perching sites on the CSA, telephone and power transmission poles, including two high voltage electric transmission lines.

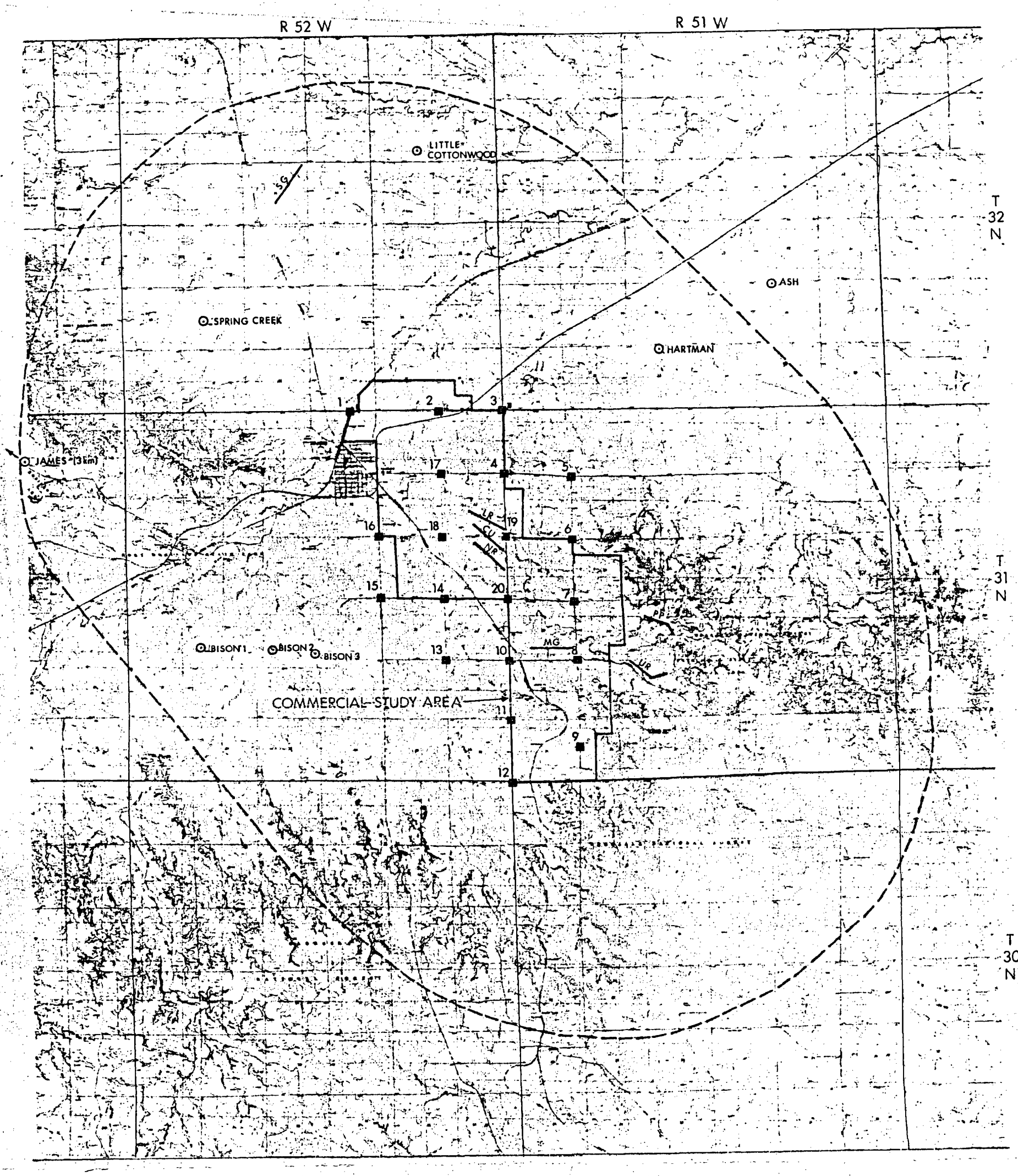
One pair of Gray Partridge was observed on 26 June in the AA, in a roadside situation adjacent to a Range Rehabilitation area about 4-km northeast of the CSA. This is the first record of the species in the area.

TABLE 2.8-11

PHEASANT AND DOVE CALLING COUNTS*

Station	Pheasant			Dove
	22 April 82	17 May 82	25 May 82	25 May 82
1	0	2	2	41
2	2	4	2	46
3	0	0	0	2
4	3	0	2	54
5	0	1	1	30
6	0	0	0	0
7	0	0	0	15
8	0	2	0	5
9	0	1	0	0
10	0	5	5	28
11	1	3	6	30
12	1	2	5	41
13	0	0	1	7
14	2	1	12	37
15	0	1	5	11
16	1	1	5	31
17	2	3	5	25
18	1	1	6	13
19	2	2	9	6
20	0	2	4	21
Total Calls	**15**	**31**	**106**	**443**
Males Observed	**0**	**2**	**2**	**-**
Females Observed	**0**	**0**	**0**	**-**
Total Birds Observed	**0**	**2**	**2**	**87**

* Calls per Two-Minute Interval



LEGEND

⊙ SHARP-TAILED GROUSE LEK

■ LISTENING STATION (Pheasant and Dove Counts)

BIRD AND SMALL MAMMAL SAMPLING LOCATIONS

SG	SHORTGRASS
MG	MIXED GRASS
CU	CULTIVATED
LR	LOWER WOODED RIPARIAN
UR	UPPER WOODED RIPARIAN
NR	NON-WOODED RIPARIAN
PP	PONDEROSA PINE

LOCATION MAP
N.T.S.

N

4000 0 4000
SCALE: 1" = 4000'

2.8(68) 07/29/87

REV. DATE	FERRET OF NEBRASKA, INC.		
	CROW BUTTE PROJECT Dawes County, Nebraska		
	UPLAND GAME BIRD PHENOMENA AND SAMPLING LOCATIONS		
	PREPARED BY: FEN		
	DWN. BY: JC	DATE: 8/5/87	FIGURE: 2.8-9

TABLE 2.8-12

SHARP-TAILED GROUSE LEK COUNTS

Lek Name	Date Located	No. Counts	Peak Male Attendance	Highest Count (M&F)
Bison 1	11 March	11	18 (14 April)	18 (14 April)
Bison 2	22 April	6	11 (24 April)	11 (24 April)
Bison 3	24 April	5	16 (17 May)	18 (28 April)
James	18 April	6	19 (18 April)	19 (18 April)
Spring Creek	22 April	6	33 (22 April)	34 (22 April)
Little Cottonwood	22 April	5	4	5 (22 April)
Hartman	21 April	5	13 (17 May)	13 (17 May)
Ash	23 April	4	11 (24 April)	11 (24 April)
Totals, 1982			**125**	**128**
$\bar{x}$, 1982			**15.6**	**16.0**

Mourning Doves are abundant throughout the study area during the summer residence period. Count data (Table 2.8-11) compare favorably with other areas in the region. The species is common on the CSA.

Bobwhite Quail were reported by local residents as /common in the past, but were evidently extirpated. The species was not recorded on the study area. If present, the distinctive calls of the species would most certainly have been heard. The demise of the species in the local area would appear to reflect the on-going degradation of riparian areas due to over-grazing and deleterious land practices, patterns which have doubtlessly led to the decline of other species as well.

Raptors. A large number of raptor species was documented on the study area, a reflection of the diversity in habitat types and the existence of a large number of suitable nesting sites such as trees and cliff sites.

Golden Eagles are permanent residents of the area, ranging over most of the study area in a variety of habitats. Most eagles (55%) were observed perched on cliffs and escarpments (Table 2.8-13). Indeed, eagles, perched on escarpments, could be observed at any time within the study area, if one chose to scan the area with a spotting scope. The presence of 5 active golden eagle nesting territories on the study area (Table 2.8-14; Figure 2.8-10) would suggest that the species is at saturation density in the area. The presence of another territory along Sand Creek in the northern AA was deemed possible, but only red-tailed hawks (below) were found there. All golden eagle nests were located on northeast cliff exposures, perhaps a reflection of temperatures during the late nesting period, and all appeared to have been used for several years, if not decades.

The eagle distribution pattern suggested that the CSA falls chiefly within the territory of the pair occupying GE-1, about 200m south of the CSA boundary. The nest was reported by the landowner (Lux) as active for the past several years. Nesting was unsuccessful in 1982. Incubation was first observed on 28 March. The female assumed a brooding position on 25 April, but abandoned the nest on 7 May. She attended an alternate nest (GE-1A1) for several days and then departed. We are not certain to what

TABLE 2.8-13

RAPTOR HABITAT AFFINITIES*

Species	Cliff Sites Obs	(%)	Riverine Habitats Obs	(%)	Deciduous Woodlands Obs	(%)	Coniferous Woodlands Obs	(%)	Shortgrass Prairie Obs	(%)	Mixed Grass Prairie Obs	(%)	Range Rehab. Obs	(%)	Cultivated Obs	(%)	Structure Biotopes Obs	(%)	Totals Obs	(%)
Golden Eagle**	44	(55.0)			9	(11.3)	5	(6.3)			8	(10.0)	4	(5.0)	6	(7.6)	3	(3.8)	80	(100)
Bald Eagle**					3	(60.0)	2	(40.0)											5	(100)
Red-tailed Hawk																				
Light Phase**	3	(1.7)			97	(57.4)	4	(2.4)	7	(4.1)	27	(16.0)	5	(3.0)	20	(11.6)	6	(3.6)	169	(100)
Dark Phase					4	(80.0)									1	(20.0)			5	(100)
Rough-legged Hawk**			1	(3.6)	5	(17.9)					7	(25.0)	6	(21.4)	9	(32.1)			28	(100)
Ferruginous Hawk									1	(16.7)	3	(50.0)			2	(33.3)			6	(100)
Prairie Falcon**	14	(56.0)			1	(4.0)			1	(4.0)	5	(20.0)	1	(4.0)	2	(8.0)	1	(4.0)	25	(100)
Gyrfalcon, Dark Phase											1	(100)							1	(100)
Merlin											2	(40.0)			1	(20.0)	2	(40.0)	5	(100)
Kestrel**	*		*		*		*		*		*		*		*		*		ABUNDANT	
Goshawk**					3	(75.0)	1	(25.0)											4	(100)
Cooper's Hawk**					2	(50.0)	1	(25.0)									1	(25.0)	4	(100)
Sharp-shinned Hawk					4	(80.0)			1	(20.0)									5	(100)
Northern Harrier**					14	(20.9)			2	(3.0)	18	(16.9)	17	(25.4)	25	(37.3)	1	(1.6)	67	(100)
Turkey Vulture	4	(20.0)			11	(55.0)	3	(15.0)	1	(5.0)	1	(5.0)							20	(100)
Great Horned Own**					74	(80.0)	3	(3.3)			4	(4.3)			1	(1.1)	10	(10.9)	92	(100)
Screech Owl					1	(50.0)					1	(50.0)							2	(100)
Barn Owl																	1	(100)	1	(100)
Short-earred Owl**											2	(100)							2	(100)
Saw-whet Owl					1	(100)													1	(100)
Burrowing Owl											4	(100)							4	(100)

* Commercial Study Area and Adjacent Area Data Combined

** Observed on Commercial Study Area

TABLE 2.8-14

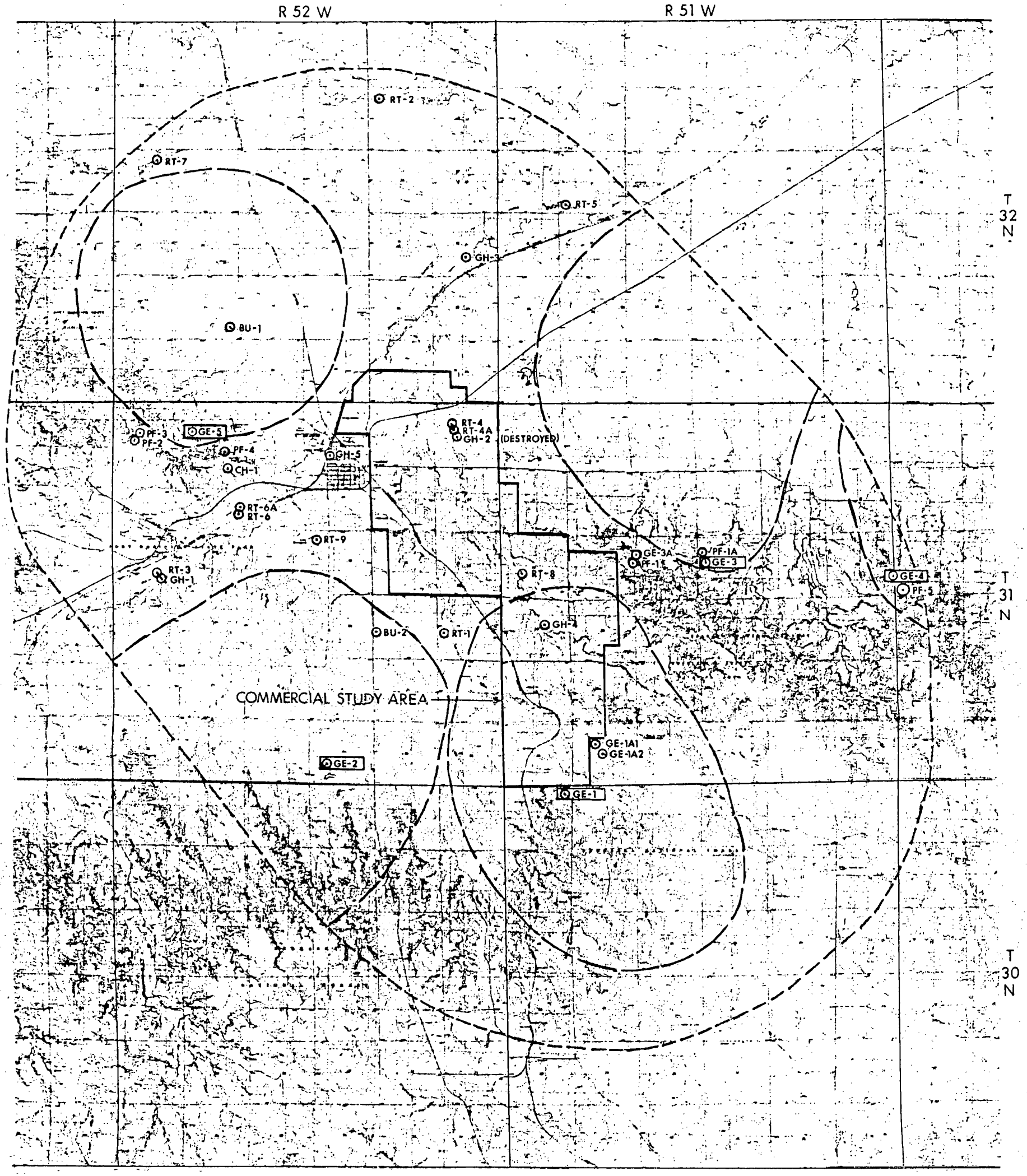
RAPTOR NESTING DATA

Species Nest Number	UTM Location	Nest Site	Nesting Status, 1982
Golden Eagle			
GE-1	471862,063577	Cliff	Incubating 28 Mar, Abandoned 7 May
GE-1A1*	471970,063666	Cliff	Unoccupied
GE-1A2	471962,063667	Cliff	Unoccupied
GE-2	471908,062995	Cliff	2 Young Fledged - 1 July
GE-3	472439,063911	Cliff	1 Young Fledged - 5 July
GE-3A	472433,063760	Cliff	Unoccupied
GE-4	472838,064378	Cliff	1 Young Fledged - 1 July
GE-5	472745,062645	Cliff	2 Young Fledged - 1 July
Red-tailed Hawk			
RT-1	472248,063278	Cottonwood	Incubation 30 Mar, Abandoned 7 May
RT-2	473600,063090	Cottonwood	1 Young Fledged - 1 July
RT-3	472386,062561	Cottonwood	2 Young Fledged - 10 July
RT-4	472780,063276	Cottonwood	Incubating 12 May, Abandoned 10 July
RT-4A	472780,063276	Cottonwood	Unoccupied
RT-5	473340,063560	Cottonwood	2 Young Fledged - 1 July
RT-6	472548,062765	Cottonwood	1 Young Fledged - 30 June
RT-6A	472552,062768	Cottonwood	Unoccupied
RT-7	473429,052544	Cottonwood	2 Young Fledged - 1 July
RT-8	472401,063466	Willow	2 Young Fledged - 30 June
RT-9	472475,062952	Cottonwood	2 Young Fledged - 5 July
Cooper's Hawk			
CH-1	472651,062735	Ponderosa	Nest Occupied 1 July, Incubation

TABLE 2.8-14 (Continued)

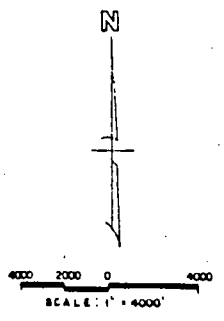
RAPTOR NESTING DATA

Species Nest Number	UTM Location	Nest Site	Nesting Status, 1982
Prairie Falcon			
PF-1	472450,063745	Cliff Cavity	Courtship May, Unoccupied 1 July
PF-1A	472456,063908	Cliff Cavity	Courtship May, Unoccupied 1 July
PF-2	472720,062503	Cliff Cavity	Occupied 1 July, 1+ Young
PF-3	472728,062518	Cliff Cavity	Occupied 1 July, 1+ Young
PF-4	472692,062710	Cliff Cavity	Occupied 1 July, 1+ Young
PF-5	(Barrel Butte)	Cliff?	Nest Not Located 1 July, Pair in Vicinity
Great Horned Owl			
GH-1 (RT-3A?)	472378,062567	Cottonwood	2 Young Fledged - 25 May
GH-2 (RT-4A?)	472769,062379	Cottonwood	1 Young Present 20 April Nest Destroyed 4 May
GH-3 (RT-10?)	473205,063303	Cottonwood	1+ Young Fledged - 25 May
GH-4 (RT-8A)	472271,063512	Cottonwood	2 Young Fledged - 5 June
GH-5	472691,062982	Cottonwood	2 Young Fledged - 28 May
Burrowing Owl			
BU-1	472023,062744	Burrow	Occupied 1 July, Status Uncertain
BU-2	472250,063105	Burrow	Occupied 1 July, Status Uncertain



LEGEND

GE	GOLDEN EAGLE (PRIMARY)
GE	GOLDEN EAGLE (ALTERNATE)
RT	RED - TAILED HAWK
CH	COOPER'S HAWK
GH	GREAT HORNED OWL
BU	BURROWING OWL
PF	PRAIRIE FALCON
)	ESTIMATED LIMITS OF GOLDEN EAGLE TERRITORY



REV. DATE	FERRET OF NEBRASKA, INC.		
	CROW BUTTE PROJECT Dawes County, Nebraska		
	RAPTOR NEST LOCATIONS		
	PREPARED BY: FEN		
	DWN. BY: JC	DATE: 8/5/87	FIGURE: 2.8-10

2.8(74) 07/29/87

the abandonment may be attributed, infertility, young mortality, or nest predation. It is probable that nesting attempts will take place every year, however. The remaining nests were successful, producing 1, 1, 2 and 2 fledglings respectively. Conversation with residents and state and federal agency representatives in 1987 confirmed that the status of golden eagles in the area has remained unchanged since 1982.

Bald Eagles (protected under federal act) were observed at several locations on the study area in winter and early spring. An individual was observed perched in the center of the CSA in March 1982. Evidently the species is an uncommon winter resident and migrant, with its primary winter distribution lying along rivers 100-km* to the east (Lock 1974). The species does not nest on the area, and neither critical habitat nor regular roosting sites are present on the CSA.

Two races of red-tailed hawks occur on the study area. The dark phase (Harlan's) was recorded in spring migration in the AA (Table 2.8-13). The pale phase (paler than Harlan's but darker than birds of the Rocky Mountain region to the west) is a regular summer resident and breeder. The first spring arrivals appeared on territories 1 March 1982.

Nine nesting territories were located on the study area and believed to represent the entire summer population. Seven of the 9 nests were successful, producing a total of 12 fledglings (x=1.3/nesting territory). The female which was unsuccessful at RT-1 was believed to have renested at RT-4 and was unsuccessful there also. The eggs were probably infertile on both attempts. No male was present during the second attempt.

Rough-legged hawks are common winter residents, occurring on the study area until early April. They occur in a variety of habitats but typically perch in tall cottonwoods and feed over grassland habitat. The species was observed regularly on the CSA in winter.

Ferruginous hawks are migrants, moving through the study area in small numbers in mid to late March. Nesting of the species in the Shortgrass Prairie about 30-km north of the CSA was confirmed during an aerial reconnaissance of the northern plains area in April. The species would appear to be plentiful within its preferred range.

Swainson's hawks are reported as "common summer residents" in the Crawford area (USFS 1981). But we observed none in the course of the 6 month study period. Either the species is more common to the east, outside the realm of the red-tailed hawk, or errors in identification were made by the responsible agency officials. It is possible, as is often the case, the species was confused with juvenile red-tailed hawks.

The prairie falcon is a common permanent resident and breeder, perching on cliffs and ranging over a variety of habitats (Table 2.8-13). Four active nests of the species were located on the study area, all in cliff cavities. A fifth nest was believed to exist in the extreme eastern portion of the AA (Barrel Butte), but was not located.

A single gyrfalcon, probably in migration, was observed in the northeast portion of the AA.

Merlins are uncommon, with 5 observations recorded on the AA. The species is probably a resident and may nest in the Pine Ridge area, but no nest was found.

Kestrels are abundant summer residents, recorded in all habitat types. The species may number in the hundreds on the study area in migration, and breeding territories were deemed too numerous to address within the terms of reference of the current study.

Goshawks are uncommon winter residents, evidently ranging over large areas. Four were observed at widely separated locations, including one in the northern portion of the CSA in March.

Cooper's hawks formerly reported as winter residents in the area, were determined in the course of the study to be permanent residents and breeders. One nest was found in the AA, on Fort Robinson State Park. The species was not observed on the CSA, but probably forages over the entire area from time to time.

Sharp-shinned hawks were seen on several occasions on the study area. A pair was observed in courtship on Fort Robinson, but no nest was found.

Northern harriers are permanent residents on the study area, ranging primarily over grassland habitats, and more common in summer. The species was frequently observed on the CSA and may nest there, but no nest was found. Courtship was seen on Fort Robinson, and it is likely that the species (a ground-nester) more regularly nests in the taller grasses found there.

Turkey vultures are common migrants and uncommon summer residents, occasionally seen soaring above cliffs. The species was recorded on the CSA only during migration.

Great horned owls are common permanent residents. A large population was documented, primarily within Deciduous Streambank Forest habitat. During February, when courtship was evident and the owls were vocalizing a great deal, it was estimated that a pair of owls existed every 4-km along the White River. Five nests were found, two of which were located on the CSA. One nest, located in the northern portion of the CSA, along Squaw Creek, was destroyed, evidently by area residents. Another nest, located in the center of Section 19 in a cottonwood on Squaw Creek produced 2 young. Of raptor species, great horned owls are most apt to be tolerant of disturbance. Nest GH-5, for example, was located at the corner of 1st and Elm Streets in the city of Crawford, and 2 young were successfully fledged 28 May.

The burrowing owl is a summer resident. Two dens were found in the AA. The species is relatively uncommon on the study area and probably does not nest on the CSA.

One barn owl was found dead on the highway on the northeast perimeter of the AA. The species is evidently uncommon in the area, and was not found in a search of abandoned buildings and barns on the CSA.

Two short-eared owls were observed in May, probably in migration, in Mixed Grass habitat in the center of the CSA.

Two screech owls were documented, one on Fort Robinson and another on the Ponderosa Wildlife Area east of the CSA. The species is probably more common than observations would suggest.

One saw-whet owl was recorded in the West Ash Creek drainage of the eastern AA. The status of the species is unclear, but is probably relatively common though infrequently observed.

Waterfowl. Ground surveys for waterfowl were initiated in March 1982 and were conducted weekly until the end of June. Procedures established by Duzbin (1969) for assessing breeding populations of ducks were utilized. Data collected during surveys included the following: date, time, weather conditions, habitat type, species, numbers, sex and location.

A total of 24 species was observed in 9 habitat types (Table 2.8-15). The mallard (see species list for scientific names) was the most commonly observed species of waterfowl while the snow goose and hooded merganser were the least commonly observed. Impoundments were important to the largest number of species and the greatest numbers of waterfowl. Class II, III and V Wetlands were also important habitats for dabblers. These wetlands were concentrated in an area 1-2-km north and northwest of impoundment M-1 (see Figure 2.8-11 in the Aquatics Section) in the 8-km AA.

Habitat utilization shifted from riverine in early March when these were the only open water areas, to impoundments and natural wetlands after mid-March, when these areas became ice-free. The Class II, III, and V wetlands became increasingly important in May as spring rains filled them.

TABLE 2.8-15

WATERFOWL HABITAT AFFINITIES

Species	Class II Wetland		Class III Wetland		Class V Wetland		Riverine		Impoundment		Range Rehab.		Cultivated		Roadside		Total	
	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)	Obs	(%)
Trumpeter Swan									4	(100)							4	(100)
Canada Goose			7	(47)							8	(53)					15	(100)
White-fronted Goose			1	(100)													1	(100)
Snow Goose	1	(20)							4	(80)							5	(100)
Mallard	74	(6)	249	(19)	16	(1.1)	59	(4.3)	907	(69)			4	(.3)	4	(.3)	1313	(100)
Pintail	28	(3.6)	603	(77)	8	(1)	1	(.1)	137	(17.6)			3	(.4)	2	(.3)	782	(100)
Cadwall	7	(2)	58	(12)	115	(25)			286	(61)							466	(100)
American Wigeon	24	(6)	97	(23)	148	(34)			161	(37)							430	(100)
Northern Shoveler	34	(6)	67	(11.9)	10	(1.8)	2	(.3)	455	(80)							568	(100)
Blue-winged Teal	34	(14)	51	(21)	16	(7)	4	(2)	133	(56)							238	(100)
Green-winged Teal	23	(5.1)	105	(24)	13	(3)	6	(1.3)	295	(66)					3	(.6)	445	(100)
Cinnamon Teal					1	(12)			7	(88)							8	(100)
Wood Duck	2	(67)			1	(33)											3	(100)
Redhead	8	(5)	12	(8)					128	(67)							148	(100)
Canvasback									40	(100)							40	(100)
Ring-necked Duck					13	(3)			434	(97)							477	(100)
Wooded Merganser									1	(100)							1	(100)
Common Merganser									46	(100)							46	(100)
Lesser Scaup			2	(.4)	10	(20)			549	(97.6)							561	(100)
Common Goldeneye									14	(100)							14	(100)
Bufflehead									65	(100)							65	(100)
Ruddy Duck									64	(100)							64	(100)
American Coot			7	(25)					21	(75)							28	(100)
Double-crested Cormorant									45	(100)							45	(100)

Two areas of waterfowl concentration were identified, one on the CSA and one on the AA. The area of waterfowl concentration on the CSA included impoundment M-1 and the Class II, III and V wetlands north and northwest of this impoundment.

Nineteen species were observed on the CSA, with 18 of the 19 species reported for I-6 (Table 2.8-16). I-1 was the only impoundment where no species of waterfowl were observed. This is a small stockwater pond which had little water in March and April. Heavy livestock use, lack of aquatic vegetation and a low water level during early spring probably precluded use of this impoundment by waterfowl.

Estimates of breeding pairs of waterfowl on the CSA and AA are presented in Table 2.8-17. The mallard was the most common of nesting waterfowl on both the CSA and AA. Although several thousand ducks stopped on the study area during migration, very few remained to nest. The greatest number of ducks thought to be nesting on the study area utilized the Class III and V wetlands and impoundment M-1 on the AA. Heavy grazing by livestock and cultivation limit the quantity and quality of upland nesting cover for dabblers, and the limited amount of emergent vegetation in the impoundments provides few nesting areas for species which nest over water.

Two broods of mallards were the only waterfowl broods observed during May and June 1982. The first hen with three young was on I-6 in the CSA and the second hen with eight young was on the White River in the AA. A few observations of broods is due in part to poor visibility caused by the presence of tall vegetation on the Class III and V wetlands and the tall perimeter vegetation on many of the impoundments.

Eared grebes, pied-billed grebes and western grebes were observed on the CSA. The pied-billed grebe is the only species of the grebe thought to nest on the CSA. Horned grebes were observed during migration on the AA.

During early April a migrating flock of 45 lesser sandhill cranes was observed flying over the AA. No sandhill cranes were observed to stop on the study area.

TABLE 2.8-16

WATERFOWL OCCURRENCE ON COMMERCIAL STUDY AREA IMPOUNDMENTS

	I-1	I-2	I-3	I-4	I-5	I-6	I-7	I-8
Snow Goose					x	x		
Mallard		x	x	x	x	x	x	x
Pintail					x	x		x
Gadwall		x		x	x	x		x
American Wigeon		x	x	x	x	x		x
Northern Shoveler			x	x	x	x		
Blue-winged Teal		x	x	x	x	x	x	
Green-winged Teal			x	x	x	x	x	x
Cinnamon Teal							x	
Redhead				x	x	x		x
Canvasback						x		x
Ring-necked Duck			x	x	x	x	x	x
Hooded Merganser						x		
Common Merganser				x	x	x		
Lesser Scaup				x	x	x	x	x
Bufflehead				x	x	x	x	
Ruddy Duck						x	x	
Double-crested Cormorant				x	x	x	x	x
Coot						x		x

TABLE 2.8-17

WATERFOWL BREEDING PAIR ESTIMATES
(1982)

	Assigned Breeding Pairs	
	Commercial Study Area	Adjacent Area
Mallard	14	21
Pintail	1	7
Gadwall		10
American Wigeon		1
Northern Shoveler	1	3
Blue-winged Teal	3	8
Green-winged Teal		3
Wood Duck	1	
Redhead		
Lesser Scaup		1
Ruddy Duck	2	
Coot	1	4

Whooping cranes were not observed on the study area. The nearest confirmed report for the period 1950 to 1980 was about 100-km southeast of the study area (USFWS 1981). Whooping cranes would not be expected on the study area, since the western boundary of the regular migration corridor is over 200-km east of the study area (USFWS 1981).

The interior least tern (little tern) a state-listed threatened species, which nests on islands of the Platte River, was not observed on the study area.

No mountain plovers (state-listed threatened species) were observed on the study area. This species is relatively common on the shortgrass prairie 250-km south of the study area.

White pelicans were seen during April on Lake Whitney and a lake near Toadstool Park, located northeast and north of the AA, respectively. They evidently do not breed in the vicinity of the study area.

Twenty species of shorebirds were seen during spring, with the killdeer being the most common. Due to the dry weather in April and early May, during the period of peak shorebird migration, there was little suitable habitat available. The largest number of species and individuals were seen on the Class III and V wetlands and the impoundment M-1 on the AA.

Other Bird Species. Seven 1-km flush transects were located within the AA and CSA in order to sample bird populations (Figure 2.8-10). Transect sites were selected in a fashion judged representative of the diversity of bird habitats and feeding niches within the study area, Lower Wooded Riparian (Deciduous Streambank Forest within grassland and cultivation), (Ponderosa Pine, Grassland, Shrubland), Upper Wooded Riparian (Deciduous Streambank Forest-Ponderosa Pine Interspersion), Non-wooded Riparian (Deep Marsh, Shallow Marsh, Wet Meadow Riparian Complex), Cultivated (primarily alfalfa), Mixed Grass Prairie, and Shortgrass Prairie.

Greatest bird densities in spring (Table 2.8-18) were observed in the Upper Wooded Riparian area (18.50 birds/ha), and lowest in the Cultivated Area (0.43 birds/ha). The most abundant bird was the red crossbill, with densities of 12.50/ha in the Upper Wooded Type and 5.90/ha in Ponderosa Pine. This reflects the high ponderosa pine seed production in 1982. Numbers of red crossbills fluctuate widely in the region, and in years of poor seed production the species is expected to be scarce or absent entirely.

Other common birds, with densities of more than 1/ha in suitable habitat in spring were the redwing blackbird, blackcapped chickadee, mourning dove, rufous-sided towhee, yellow warbler, house wren, violet-green swallow and pine siskin.

Greatest diversities (Shannon and Weaver 1949) were observed in the Lower Wooded Riparian and Upper Wooded Riparian Types (2.924 and 2.080, resp; 31 and 26 species, resp). Lowest diversity was recorded in the Cultivated Type (0.325, 2 species).

The data may underestimate the overall importance of the Mixed Grass Prairie type. The site is relatively impoverished due to abusive land practices, and therefore does not properly represent the full capability of the Mixed Grass type. Only 2 species were observed during 5 transect exercises in spring, yielding a computed density of 0.64 birds/ha, and a diversity index of 0.468.

In 1987, Nebraska Game and Parks, Fort Robinson State Park, Ponderosa State Wildlife Area, USFWS, US Forest Service, Upper Niobrara-White River Consertion District personnel and local residents were contacted to verify the status of birds in the study area. All people contacted claimed that no change in the status of birds in the area has occurred since 1982.

Reptiles and Amphibians

Of 25 species of reptiles and amphibians recorded for the region (Table 2.8-19), 13 were documented on the study area during the period of investigation.

TABLE 2.8-18

SPRING 1982 BIRD DENSITIES - TRANSECT DATA

Species	No. Obs.	Mean Dist. (m)	Density Birds/ha	Percent
SHORTGRASS				
Horned Lark	8	18.1	0.44	34.8
Western Meadowlark	14	40.6	0.34	60.9
Upland Sandpiper	1	6.0	0.17	4.3
Totals	**23**	**32.0**	**0.72**	**100.0**
Diversity Index = 0.797				
MIXED GRASS				
Western Meadowlark	13	35.2	0.36	81.2
Bank Swallow	3	5.0	0.60	18.8
Totals	**16**	**29.6**	**0.64**	**100.0**
Diversity Index = 0.468				
NON-WOODED RIPARIAN				
Common Snipe	12	12.4	0.96	3.8
Western Meadowlark	29	46.4	0.62	9.3
Redwing Blackbird	222	47.0	4.72	70.7
Killdeer	23	32.7	0.70	7.4
Common Flicker	2	47.5	0.04	0.6
Starling	5	50.0	0.10	1.6
Bobolink	2	15.0	0.13	0.6
Common Grackle	8	80.0	0.10	2.5
Mourning Dove	1	60.0	0.02	0.3
Blue-winged Teal	5	33.0	0.15	1.6
Mallard	3	31.0	0.10	1.0
Lark Bunting	2	41.0	0.05	0.6
Totals	**314**	**44.9**	**6.99**	**100.0**
Diversity Index = 1.200				
CULTIVATED				
Western Meadowlark	19	42.9	0.44	90.5
Robin	2	100.0	0.02	9.5
Totals	**21**	**48.3**	**0.43**	**100.0**
Diversity Index = 0.325				

TABLE 2.8-18 (Continued)

SPRING 1982 BIRD DENSITIES - TRANSECT DATA

Species	No. Obs.	Mean Dist. (m)	Density Birds/ha	Percent
LOWER WOODED RIPARIAN				
Black-capped Chickadee	18	15.3	1.18	7.6
Great Horned Owl	5	23.0	0.21	2.0
Common Crow	7	30.0	0.23	2.9
Pine Siskin	25	32.0	0.78	10.6
Starling	24	27.8	0.86	9.9
American Robin	28	15.1	1.85	11.7
Common Flicker	4	21.0	0.19	1.6
Redwing Blackbird	4	20.0	0.10	0.8
Mourning Dove	33	18.4	1.79	13.6
Yellow-rumped Warbler	12	21.5	0.55	4.9
Common Grackle	6	25.8	0.23	2.6
Pheasant	5	80.0	0.06	2.0
Hairy Woodpecker	1	40.0	0.02	0.4
Tree Sparrow	3	15.0	0.20	1.2
Slate-colored Junco	4	18.7	0.21	1.7
Western Meadowlark	4	15.0	0.27	1.7
Brown Thrasher	3	6.7	0.45	1.2
Chipping Sparrow	2	20.0	0.10	0.8
Clay-colored Sparrow	2	20.0	0.10	0.8
Orange-crowned Warbler	1	20.0	0.05	0.4
Lark Sparrow	5	15.0	0.33	2.0
Yellow Warbler	11	7.7	1.42	4.5
Eastern Kingbird	2	5.5	0.36	0.8
Rufous-sided Towhee	8	7.5	1.06	3.3
House Wren	14	9.6	1.45	5.8
Downy Woodpecker	5	8.0	0.62	2.0
Violet-Green Swallow	1	1.0	1.00	0.4
American Redstart	2	9.0	0.22	0.8
Northern Waterthrush	1	10.0	0.10	0.4
American Goldfinch	2	15.0	0.13	0.8
Mallard	2	5.0	0.40	0.8
Totals	**242**	**5.0**	**11.90**	100.0

Diversity Index = 2.924

TABLE 2.8-18 (Continued)

SPRING 1982 BIRD DENSITIES - TRANSECT DATA

Species	No. Obs.	Mean Dist. (m)	Density Birds/ha	Percent
UPPER WOODED RIPARIAN				
Common Flicker	1	10.0	0.10	0.2
Red Crossbill	172	13.8	12.50	46.6
B.-c. Chickadee	30	24.3	1.23	8.2
Black-billed Magpie	2	30.0	0.06	0.5
Starling	19	37.9	0.50	5.2
Downy Woodpecker	8	39.6	0.20	2.3
Blue Jay	1	20.0	0.05	0.2
Evening Grosbeak	49	9.6	5.10	13.3
Slate-colored Junco	6	26.7	0.22	1.6
Hairy Woodpecker	1	20.0	0.05	0.2
American Robin	8	11.6	0.68	2.2
Pinyon Jay	10	40.0	0.25	2.8
Pygmy Nuthatch	2	1.0	2.00	0.5
Red-breasted Nuthatch	12	13.8	0.87	3.3
Oregon Junco	4	40.0	0.10	1.1
Great Horned Own	1	20.0	0.05	0.2
Kestrel	4	43.7	0.09	1.1
House Wren	18	32.7	0.55	4.9
Mourning Dove	5	37.0	0.13	1.3
Rufous-sided Towhee	5	40.0	0.12	1.3
Black-headed Grosbeak	3	18.3	0.16	0.8
Blackpoll Warbler	1	20.0	0.05	0.2
Hermit Thrush	1	60.0	0.02	0.2
Brewer's Blackbird	4	52.5	0.01	1.1
Ruby-crowned Kinglet	1	100.0	0.01	0.2
Chipping Sparrow	2	40.0	0.05	0.5
Totals	**370**	**19.9**	**18.50**	**100.0**

Diversity Index = 2.080

TABLE 2.8-18 (Continued)

SPRING 1982 BIRD DENSITIES - TRANSECT DATA

Species	No. Obs.	Mean Dist. (m)	Density Birds/ha	Percent
		PONDEROSA PINE		
Red Crossbill	227	38.5	5.90	86.5
Red-br. Nuthatch	14	28.2	0.50	5.5
Downy Woodpecker	2	32.5	0.06	0.7
Pine Siskin	1	1.0	1.00	0.3
B.-c. Chickadee	3	50.0	0.06	1.1
Slate-colored Junco	2	30.0	0.06	0.7
Ruby-crowned Kinglet	3	41.7	0.07	1.1
Mourning Dove	6	25.0	0.24	2.3
Rufous-sided Towhee	4	47.5	0.08	1.5
House Wren	1	10.0	0.10	0.3
Totals	**263**	**42.4**	**6.20**	**100.0**

Diversity Index = 0.551

TABLE 2.8-19

REPTILE AND AMPHIBIAN SPECIES LIST

Common Name	Scientific Name	Status
Tiger Salamander	*Ambystoma tigrinum*	E-CA-C
Plains Spadefoot	*Scaphiopus bombifrons*	D-AA-C
Woodhouse's Toad	*Bufo woodhousei*	D-CA-C
Great Plains Toad	*Bufo cognatus*	D-CA-C
Boreal Chorus Frog	*Pseudacris triseriata*	D-CA-C
Leopard Frog	*Rana pipiens*	D-CA-C
Bullfrog	*Rana catesbeiana*	D-CA-C
Snapping Turtle	*Chelydra serpentina*	D-CA-C
Western Box Turtle	*Terrepene ornata*	E-CA-U
Painted Turtle	*Chrysemys picta*	D-CA-U
Spiny Softshell	*Trionyx spiniferus*	E-AA-U
Lesser Earless Lizard	*Holbrookia maculata*	E-AA-U
Eastern Fence Lizard	*Sceloporus undulatus*	E-AA-U
Short-horned Lizard	*Phrynosoma douglassi*	E-CA-U
Great Plains Skink	*Eumeces obsoletus*	E-CA-U
Many-lined Skink	*Eumeces multivirgatus*	E-CA-U
Six-lined Racerunner	*Cnemidophorus sexlineatus*	E-CA-U
Western Hognose Snake	*Heterodon nasicus*	E-CA-U
Racer	*Coluber constrictor*	D-AA-U
Bullsnake	*Pituophis melanoleucas*	D-CA-C
Milk Snake	*Lampropeltis triangulum*	E-CA-U
Common Water Snake	*Natrix spipedon*	E-OA-U
Common Garter Snake	*Thamnophis sirtalis*	D-CA-U
Plains Garter Snake	*Thamnophis radix*	D-CA-C
Prairie Rattlesnake	*Crotalus viridis*	R-CA-U

Toads which were observed, and distribution determined primarily by their calls, were Woodhouse's toad (not numerous, but occurring on all the large impoundments and watercourses), Great Plains toad (not numerous, but widely distributed in a variety of habitats), and plains spadefoot (abundant at selected locations, permanent and seasonal wetlands within the prairie areas).

Documented frogs included the boreal chorus frog (common and widely distributed in a variety of habitats), leopard frog (common in areas of perennial water), and bullfrogs (abundant in impoundments where they have been stocked, in the central and northern portions of the CSA and uncommon elsewhere).

The two species of turtles observed were the snapping turtle (common in all streams and permanent impoundments) and painted turtle (common at selected locations, larger impoundments and rivers).

No lizard was recorded during the study period.

Bullsnakes and the plains garter snake were commonly seen. The common garter snake and racer were each observed on only one occasion each. Surprisingly, in view of reports, no rattlesnake was observed, and none found dead on roads.

2.8-2 AQUATIC ECOLOGY

Introduction

Aquatic habitats on the CSA consist of three streams and eight impoundments. Within the CSA, English Creek, Squaw Creek and White Clay Creek are first-order streams (smallest perennial streams marked on a 1:24,000 scale map) that form the drainage basin for the CSA (Figure 2.8-11). English Creek is entirely within the confinement of the CSA originating from springs on the eastern edge of Section 13 and flowing northerly for about 5.6-km (3.5 mi) where it empties into Squaw Creek in Section 35. Squaw Creek originates in the Nebraska National Forest and the Ponderosa State Wildlife Area to the southeast and flows through the CSA to its confluence with White Clay Creek. White Clay Creek drains from the national forest to the south and flows northerly through the CSA and empties into the White River. Seven of the eight impoundments are on-stream with four on English Creek, two on White Clay Creek and one on Squaw Creek. The remaining impoundment is a stock pond created by a dam on a small drainage area.

In addition, a spring fed impoundment just off the CSA in Section 7 and the White River north of the CSA were included for sampling.

The objectives of this study were designed to provide the information necessary to assess the aquatic resources of streams and impoundments on the CSA. Specifically, the objectives of the study were as follows:

1. To determine water quality parameters.
2. To inventory and compile species lists of aquatic vertebrates, invertebrates and plants (macrophytes, algae and diatoms).
3. To determine the relative abundance and habitat utilization of aquatic vertebrates, invertebrates and plants.

Methods

Surface water quality for biological studies. Streams and impoundments were selected for physical and biological sampling based on the following rules:

R 52 W

R 51 W

T 32 N

T 31 N

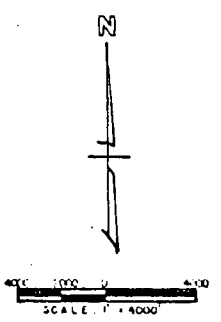
T 30 N

W-3
M-2
M-1
W-2
WC-2
I-8
E-3
S-4
S-4A
I-7
B-1
I-9
I-6
I-5
I-4
I-3
I-2
I-1
E-2
E-1
W-1
FR-1
FR-3
FR-4
SO-1
FR-9
FR-8
FR-7
FR-6
FR-5
FR-2
WC-1
S-3
S-2
S-1
WA-1
L-1

COMMERCIAL STUDY AREA

SAMPLING SITE KEY

B	BRITTON
E	ENGLISH CREEK
FR	FORT ROBINSON
I	IMPOUNDMENT
L	LUX
M	MANSFIELD
S	SQUAW CREEK
SO	SOLDIER CREEK
W	WHITE RIVER
WA	WEST ASH CREEK
WC	WHITE CLAY CREEK



REV. DATE	FERRET OF NEBRASKA, INC.		
	CROW BUTTE PROJECT Dawes County, Nebraska		
	AQUATIC SAMPLING SITE LOCATIONS		
	PREPARED BY: FEN		
	DWN. BY: JC	DATE: 8/5/87	FIGURE: 2.8-11

2.8(92) 07/29/87

1. All streams and impoundments within the CSA were chosen for collection of biological and water quality data (Figure 2.8-12). Small diversion structures which are used primarily for irrigation were not considered as impoundments. Sample site S-4A as shown in Figure 2.8-12 was not sampled, rather it was an alternate site for flood conditions if they occurred.

2. Within the 8-km AA impoundments with permanent water, which could possibly support fish populations, and selected streams were chosen for collection of water quality data.

Information concerning water quality parameters in the section is not intended to replace that collected for studies for surface water hydrology, but to provide on-site information for biological studies.

Samples of surface water were taken from streams, springs and impoundments during February and April 1982. The sampling time was made as uniform as possible with all field samples and physico-chemical determinations being made between 0800 and 1600 hours.

Nine physico-chemical determinations: air temperature, water temperature, dissolved oxygen, total alkalinity, carbon dioxide, pH, conductivity, turbidity and hydrogen sulfide, were made on each stream, spring or impoundment within or on the boundary of the CSA. Impoundments within the AA had six parameters: air temperature, water temperature, dissolved oxygen, pH, conductivity, and hydrogen sulfide, checked during the February sampling season, and all parameters were checked during April.

Fish. A variety of sampling gear and methods was employed to collect fish from the study area streams and impoundments. Choice of equipment was indicated by the type of habitat being sampled, the effectiveness of the equipment, and by prior knowledge of the presence of important species. Methods used to collect fish included electrofishing, gill-netting, hoop-netting, minnow-trapping and angling with rod and reel.

The sampling effort expended in collecting fish was not standardized due to differences in the 1) amount of suitable habitat present, 2) types of habitats sampled, 3) sampling equipment used, and 4) abundance of fish present at each location. As such, fish were collected at each location to document their occurrence and to determine their relative abundance but no attempt was made to determine absolute densities.

At each sampling location all fish collected were identified, counted, measured for total length, and whenever possible, returned unharmed to the water.

Benthic Macroinvertebrates. Quantitative samples of Benthic Macroinvertebrates were collected from soft substances in streams and impoundments with a Ponar Dredge (0.22m^2) and from gravel riffle substrates with a Surber Sampler (0.0093m^2). All dredge and surber samples were collected in triplicate at each location. Samples were preserved in 70% ethanol.

Invertebrates were hand-picked from substrate material and identified to the lowest practical level with the aid of stereoscopic and standard taxonomic references (Ward and Whipple 1959; Pennak 1953). Data from Ponar and Surber samples were reported as number of individuals per square meter of bottom by multiplying by 45.93 and 10.76, respectively. Qualitative samples collected by sweep netting were used to augment the species list. Shannon-Weaver (1949) diversity indices were calculated from all Ponar and Surber samples.

Periphyton (Algae and Diatoms). Single qualitative samples of periphyton were collected at each sampling location by scraping the surface of several rocks, sticks, plant or other substrate material with a pocket knife and were preserved in 5% formalin. Preserved samples were identified under a compound microscope using appropriate taxonomic references (Ward and Whipple 1959; Prescott 1962; Weber 1966). Diatom proportional counts were performed at the generic level after counting a minimum of 250 valves. Green and blue-green algae were identified and their occurrence noted for each sampling location.

RESULTS AND DISCUSSION

Water Quality. The sampling sites were grouped into two categories: streams which include two springs (E-1 and E-2) at the upper end of English Creek, and impoundments (Figure 2.8-12). The streams had flows ranging from .75 cms on the White River to less than 0.1 cms on lower Squaw Creek during the two sampling periods. Impoundments ranged in size from 0.2 ha to 7.7 ha for FR-3 and I-6 respectively.

Comparison of constituents at stream and spring sample sites for February and April 1982 are presented in Table 2.8-20. Dissolved oxygen was above 10 mg/l at all stream stations, with the exception of S-4 during February. The reduced dissolved oxygen at S-4 was probably due to ice coverage extending several hundred meters upstream from the sampling site. The spring, E-1, had dissolved oxygen levels below 10 mg/l during both sampling periods, while E-2 was below 10 mg/l only during February. Lower dissolved oxygen levels would be expected from springs, as groundwater generally has lower levels of dissolved oxygen than surface water.

TABLE 2.8-20

SURFACE WATER QUALITY FOR CROW BUTTE, 1982
SAMPLED STREAMS AND SPRINGS

Constituent	Stream Station											
	S-1		S-2		S-3		S-4		WA-1		SO-1	
	02/25	04/19	02/25	04/19	02/25	04/19	02/25	04/19	02/22	04/21	02/22	04/21
Air Temperature (Degrees C)	-3	4	-3	6	-3	7	- 1	8	16	13	21	13
Water Temperature (Degrees C)	1	5	1	7	1	8	1	10	5	12	8	10
Dissolved Oxygen (mg/l)	12.0	11.9	12.1	12.4	12.1	11.2	7.8	12.3	11.2	10.2	10.2	11.1
Total Alkalinity (mg/l $CaCO_3$)	206	195	213	195	215	198	286	257	165	193	160	180
Carbon Dioxide (mg/l)	12.0	4.0	11.0	5.0	11.0	5.5	15.0	9.0	11.5	9.0	10.5	9.0
pH	7.71	7.30	7.78	7.73	7.83	7.80	7.58	7.91	7.70	7.23	7.60	7.20
Conductivity (mhos/cm)	420	380	430	390	430	390	560	530	380	380	310	350
Turbidity (FTU)	3	6	3	4	8	8	10	9	3	4	7	4
Hydrogen Sulfide (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 2.8-20 (Continued)

SURFACE WATER QUALITY FOR CROW BUTTE, 1982
SAMPLED STREAMS AND SPRINGS

Constituent	Stream Station													
	W-1		W-2		R-1*		R-2*		R-3		WC-1		WC-2	
	02/24	04/21	02/24	04/21	02/22	04/22	02/22	04/22	02/24	04/20	02/24	04/22	02/24	04/22
Air Temperature (Degrees C)	0	8	-1	9	8	15	18	15	3	3	3	16	4	19
Water Temperature (Degrees C)	3	4	3	6	11	9.5	10	12	4	4	3	8	2	9
Dissolved Oxygen (mg/l)	11.2	12.3	12.1	13.9	9.8	8.2	5.1	11.2	10.8	11.9	11.4	12.9	11.0	10.6
Total Alkalinity (mg/l $CaCO_3$)	187	178	191	186	230	213	226	205	209	375	192	182	244	233
Carbon Dioxide (mg/l)	15.0	10.0	17.0	11.0	13.5	15.0	20.0	10.0	17.5	8.0	8.0	9.0	18.0	11.0
pH	7.74	7.05	7.50	7.72	7.37	6.60	7.50	6.90	7.38	7.70	8.05	7.63	7.52	7.75
Conductivity (mhos/cm)	350	340	390	350	460	450	400	440	420	770	380	380	520	520
Turbidity (FTU)	28	12	31	3	7	7	12	5	12	6	9	10	12	15
Hydrogen Sulfide (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

* Sample stations R-1 and R-2 are springs at the top of English Creek.

Total alkalinity fluctuated little between February and April 1982 for the stream and spring sample sites, with the exception of E-3 (Table 2.8-20). Flow at E-3 in April was about 30% of that in February. The decreased flow would maintain the concentration of constituents picked up from the alluvial aquifer, and the four impoundments on English Creek were ice-free in April. Thus, evaporation and the concentration of ions was greater in April than February. Total alkalinity increased between stations on a stream as distance increased between stations and the number of impoundments on a stream became greater.

The greatest concentrations of carbon dioxide (20 mg/l) was recorded at E-3. E-3 is a spring and groundwater often exceeds surface water concentrations of carbon dioxide. Lower concentrations of carbon dioxide were found in April than in February within stream stations. This may have been due to increased algae and the initiation of aquatic plant growth.

Hydrogen-ion concentration expressed as pH varied from 6.60 for stream station E-1 to 8.05 for stream station WC-1.

Conductivity, like alkalinity, increased with greater distance between stations on a stream and with a greater number of impoundments between the upstream and downstream stations. The highest conductivity reading (770 umhos/cm) was recorded at E-3 in April. As was mentioned in the section on total alkalinity the flow at this station in April was very low and there are four impoundments upstream from it, thus limiting flow and increasing concentrations of salts from greater evaporation.

Turbidity values were low for all streams and springs. The highest value recorded was 28 FTU (formazin turbidity units) at W-1 in February. The streams in the project area have a sand and gravel substrate with little clay, silt or fine organic matter which are the major causes of higher turbidity values.

The high oxygen levels in the streams and springs precluded detectable levels of hydrogen sulfide (H_2S). These levels of oxygen would oxidize sulfides to sulfates.

Impoundments, with the exceptions of I-1, FR-8 and FR-9, had high levels of dissolved oxygen during February (Table 2.8-21). All impoundments were ice covered at this time. The average thickness was 25 cm and ranged from 10 to 50 cm.

Impoundment I-1 is a small stock pond with little aquatic vegetation to produce oxygen, while FR-8 had a large amount of dead emergent vegetation at its upper end. This large amount of oxidizable material in FR-8 probably caused the low concentration of dissolved oxygen (1.9 mg/l). The water from FR-8 drains directly into FR-9 and combined with the dead emergent vegetation in FR-9 probably causes this impoundment to have a dissolved oxygen concentration of 2.6 mg/l. Impoundment L-1, however, had a supersaturation of 20 mg/l. This was probably due to the clearness of the ice and the amount of green plants beneath the ice.

Total alkalinity content of the impoundments within or on the boundary of the CSA generally had the highest levels in April. This was probably due to low precipitation during early spring. More precipitation would have diluted ion concentrations in the impoundments. The lowest recorded total alkalinity was during February 1982 in I-1 (50 mg/l $CaCO_3$) during April. Total alkalinity values for the streams and impoundments fell within the range which are considered to have little direct affect on fish. However, fish may be indirectly affected by total alkalinity, as waters with values below 40 mg/l are biologically less productive than those with higher values (Lagler, 1956).

The pH values for all impoundments, with the exception of I-1 which had a supersaturation of oxygen in February, were lowest in winter. Dissolved oxygen and carbon dioxide, both of which affect pH values, are readily influenced by the processes of plants and animals. No extremely low or high pH values were recorded, as the lowest and highest values were 6.05 and 8.7 respectively.

The conductivity of the impoundments ranged from 110 to 960 umhos/cm. As with alkalinity there was generally a trend of higher conductivity readings for the downstream impoundments on the stream system.

TABLE 2.8-21

SURFACE WATER QUALITY RESULTS FOR CROW BUTTE, 1982
SAMPLED IMPOUNDMENTS

	I-1		I-2		I-3		I-4		I-5		I-6		I-7		I-8	
Constituent	02/17	04/21	02/17	04/22	02/17	04/20	02/17	04/20	02/17	04/20	02/16	04/19	02/16	04/20	02/16	04/21
Air Temperature (Degrees C)	9	12	11	17	14	3	13	3	11	2	12	8	12	3	14	11
Water Temperature (Degrees C)	1	8.5	4	7	1	3	1	5	17	6	1	9	1	8	1	8
Dissolved Oxygen (mg/l)	4.8	11.8	10.1	11.8	7.8	11.0	9.9	10.7	7.8	10.8	10.4	10.6	6.2	9.2	9.8	11.6
Total Alkalinity (mg/l $CaCO_3$)	50	68	201	211	182	228	149	230	213	248	141	190	298	237	184	217
Carbon Dioxide (mg/l)	8.0	7.0	9.0	10.0	10.0	11.0	10.0	11.0	9.0	10.0	9.0	11.0	14.0	12.0	8.0	9.0
pH	6.07	7.70	7.40	7.64	7.20	8.13	7.26	7.81	7.10	7.83	7.14	7.88	6.78	7.52	7.56	7.81
Conductivity (mhos/cm)	110	190	410	450	380	490	310	480	430	530	280	400	580	570	330	490
Turbidity (FTU)	47	26	28	16	8	28	11	20	6	48	58	115	34	10	55	26
Hydrogen Sulfide (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 2.8-21 (Continued)

SURFACE WATER QUALITY RESULTS FOR CROW BUTTE, 1982
SAMPLED IMPOUNDMENTS

	I-9		FR-1		FR-2		FR-3		FR-4		FR-5		FR-6	
Constituent	02/16	04/21	02/14	04/18	02/14	04/18	02/14	04/18	02/14	04/18	02/14	04/17	02/14	04/17
Air Temperature (Degrees C)	12	12	18	4	16	4	12	5	10	5	9	17	10	17
Water Temperature (Degrees C)	3	7	1	9	1	11	1	9	1	11	4	10	1	10.5
Dissolved Oxygen (mg/l)	13.2	12.5	7.8	10.4	11.8	10.4	8.8	14.8	10.2	14.0	14.2	12.1	11.0	11.8
Total Alkalinity (mg/l $CaCO_3$)	65	152		142		185		166		113		147		136
Carbon Dioxide (mg/l)	5.0	12.0		10.5		10.0		10.0		4.5		10.0		9.0
pH	7.40	7.85	6.82	7.90	7.79	7.82	6.91	7.52	6.42	8.48	7.20	7.55	7.15	7.89
Conductivity (mhos/cm)	150	340	310	250	380	390	120	280	120	240	420	350	400	310
Turbidity (FTU)	24	9		2		1		1		4		2		3
Hydrogen Sulfide (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 2.8-21 (Continued)

SURFACE WATER QUALITY RESULTS FOR CROW BUTTE, 1982
SAMPLED IMPOUNDMENTS

	Impoundment													
	FR-7		FR-8		FR-9		B-1		M-1		M-2		L-1	
Constituent	02/14	04/17	02/14	04/17	02/14	04/17	02/15	04/18	02/15	04/18	02/15	04/18	02/15	04/18
Air Temperature (Degrees C)	10	17	7	17	5	17	12	17	10	17	9	17	4	14
Water Temperature (Degrees C)	1	11	1	12	1	13	1	9	1	11	1	11	1	12
Dissolved Oxygen (mg/l)	11.2	11.3	1.9	8.8	2.6	10.7	12.5	10.0	12.1	11.6	12.6	13.1	20.0	11.2
Total Alkalinity (mg/l $CaCO_3$)		121		136		166		334		220		161		162
Carbon Dioxide (mg/l)	5.0	9.0		11.0		12.5		5.0		3.5		3.0		7.0
pH	7.40	8.00	7.06	7.45	6.95	7.67	8.02	8.71	7.04	8.39	7.55	8.70	8.50	7.92
Conductivity (mhos/cm)	450	290	480	320	520	350	960	920	340	550	500	380	380	350
Turbidity (FTU)		4		4		4		155	42	42		22		10
Hydrogen Sulfide (mg/l)	<0.01	<0.01	2.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

The highest turbidity value for impoundments was greater than the highest for streams, 155 FTU and 28 FTU respectively. The greater amount of silt and especially fine organic matter provided by aquatic plants in the impoundments would cause this difference.

The only impoundment with a detectable level of hydrogen sulfide during February 1982 was FR-8 (2.0 mg/l). The large amount of dead emergent vegetation at the upper end of this impoundment, the ice covering and the low level of dissolved oxygen were responsible for this condition.

Habitat Characteristics. In general, all aquatic habitats on the CSA suffer from ongoing environmental stresses. Naturally occurring stresses include: unstable substrates and banks, low flows, and periodic flooding. Overgrazing on adjacent rangelands and in riparian areas, and farming practices along the stream courses further compound these problems. Commercial baitfish practices such as poisoning, dewatering and introducing bait minnows has affected many of the impoundments. Livestock grazing and watering add to impoundment problems. The end result of these environmental stresses is reflected in a fishery mostly consisting of non-game, tolerant species. Periodic stocking by the Nebraska Game and Parks Commission has created some put-and-take sport fisheries in the area but these are not self-sustaining due to environmental factors.

English Creek. English Creek flows through rangeland on the CSA. The riparian zone consists mostly of grasses and aquatic plants including cattails (Typha ssp.), bulrushes (Scirpus spp.), and sedges (Carex spp.). Low flow and a vegetation choked stream channel do not provide for much in the way of habitat for fish. On-stream impoundments and pools created by washouts below culverts provide about the only suitable fish habitat.

Squaw Creek. Squaw Creek changes dramatically from the upstream areas to the lower reaches. At the upper sampling station (S-1) the pine and grass-covered slopes, and the thick, undisturbed riparian zone provide for a relatively stable watershed. The substrates in this area consist of hardpan, gravel riffle areas, and some silted-in pools. The streambanks

are relatively stable with overhanging trees and vegetation with some undercutting. The creek is generally less than 2 m wide. Log jams, undercut tree roots and banks and pools to 1.5 m deep provide cover and probable overwintering areas for fish.

From station S-2 downstream to I-6 Squaw Creek looks entirely different. Although cottonwoods continue to provide the overstory as in the upper reaches, the understory in this lower section has virtually been eliminated by livestock grazing. The stream banks are degraded and unstable and the substrate is mostly sand. The stream is generally less than 2 m wide. Few gravel riffle areas are present and most of the pools are heavily silted. Pools to 1.5 m deep, undercut tree roots and log jams provide cover for fish. Aquatic vegetation is rather sparse in this section of stream with some Cladophora growing in shallow fast-flowing areas.

The watershed in this lower area is unstable and, as evidenced by highwater debris, is subjected to periodic severe flooding. During the evening of 19 May 1982, about 2 inches of rain fell in one hour on the middle and lower Squaw Creek watershed. Considerable damage to roads and riparian areas on and below the CSA was caused by this event. Squaw Creek flowed over the road one-half mile above I-6 causing gullies across the road. English Creek went over the road northwest of I-6, over U.S. Highway 20 and washed out the culvert at E-3. Squaw Creek was diverted into English Creek at I-6 which was the cause of the overflow on Highway 20 and the washing out of culvert E-3. Bridges have been built on Squaw Creek to accommodate floods, whereas only culverts exist on English Creek which were designed to carry the flow of a much smaller watershed.

Sand and silt deposits up to 24 inches and log jams up to 4 ft above the channel were observed the following day on Squaw Creek above I-6. The damage to riparian areas on the CSA was aggravated by a flood of similar or greater proportion during the previous summer and the heavy use of these areas by livestock. Very little ground cover existed in riparian areas prior to the event, which could have reduced water velocity and the resultant damage.

Measurements of maximum depth and extent of flooding were taken the day following the event in an effort to estimate water volumes. These measurements were used to provide streamflow estimates for Squaw Creek stations S-1 and S-5 using a HP 67 Trapezoidal Channel Program. The estimated streamflow at S-1 was .18 cms while at S-2 it was 3.09 cms. The very high increase from S-1 to S-3, a distance of two miles, was probably due in part to less precipitation on the upper watershed, but mainly to differences of vegetation cover. Much of the upper watershed is forested and the area immediately above S-1 is the Ponderosa Wildlife Area where livestock grazing and cultivation is prohibited, whereas, the middle and lower watershed is comprised of heavily grazed rangeland, cultivated small grains or summer fallow.

Estimates of streamflow below S-3 are much less accurate as water overflowed the stream channel making it impossible to use the Trapezoidal Channel method. Based on highwater marks and other evidence, it would appear that flow in English Creek at E-3 was close to 5 cms.

The problem of flooding on English Creek could be greatly reduced or eliminated if more water could be released from I-6 or an emergency spillway constructed to prevent the water from Squaw Creek from flowing into English Creek. But most importantly, watershed management of Squaw Creek could be improved by reducing grazing pressure on rangelands, reducing or eliminating grazing in riparian zones and improving soil conservation practices for cultivated lands.

White Clay Creek. White Clay Creek flows through a riparian grass area at Station WC-1. The stream channel is generally less than a meter wide with relatively stable stream banks provided by grasses. The substrate in this section is mud and sand. Depths range from 25 to 74 cm with no well defined pools or riffles. At station WC-2 the creek flows through pastureland. In this section the substrate consists of sand, gravel and rubble with some silting in pools. Riffle areas are present as well as pools to 75 cm deep. Although this area is grazed by livestock, the stream banks appear to be relatively stable.

White River. The White River has a shifting sand and silt substrate and appears turbid most of the time due to suspended materials. Very few riffle areas exist and pools are not well defined. Some shallow sand bars are present along the edges but for the most part depths range from 0.5 to probably 2 m. Eroding stream banks are present along most sections. Stream width varies from about 3 to 5 m. Cover for fish is provided by deep water, log jams and undercut tree roots. Some good riparian areas exist along the river especially around Fort Robinson State Park. Other riparian areas are heavily grazed and lack understory vegetation. The White River is subject to fluctuating water levels and flooding.

Impoundments. Impoundments range in size from 0.4 ha (I-1) to 7.7 ha (I-6). I-1 is a small stockwater pond created by an earthen dam on a small drainage basin. Heavy livestock use and lack of water during some periods have prevented the growth of aquatic vegetation. Other impoundments on the CSA have extensive aquatic vegetation growth including: cattails, bulrushes, horned pondweed (Zanichellia sp), aquatic buttercup (Ranaunculus sp), smartweed (Polygonum spp), hornwort (Ceratophyllum sp and stonewort (Chara sp). Impoundments I-4, 5, 6, 7, and 8 have been or are now being, managed for raising baitfish. Impoundment I-9 has been stocked with brook trout for recreational fishing and also serves for stock watering.

Fish. The status and distribution of fish species for the study area are presented in Table 2.8-22. Fourteen species of fish were collected from the CSA streams and impoundments (Table 2.8-23). Game fish collected included: black bullheads, rainbow trout, brown trout, and brook trout. Black bullheads were collected from White Clay Creek but were not present in sufficient number or of sufficient size to contribute to a sport fishery.

Brook trout were collected from Squaw Creek, which is not stocked, at several locations. Six brook trout were captured at station S-1 in approximately 500 m of stream. In over 1-km of stream sampled between station S-2 and I-6, two brook trout were collected. Trout ranged in size from 184 to 245 mm (7&1/4 to 9&1/2 in). Periodic stocking by the Nebraska

TABLE 2.8-22

FISH SPECIES LIST

Family/Common Name	Scientific Name	Status
Hiodontidae		
Goldeye	*Hiodon alosoides*	R-OA
Salmonidae		
Brook trout	*Salvelinus fontinalis*	D-PP-O
Brown trout	*Salmo trutta*	D-AA-C
Rainbow trout	*Salmo gairdneri*	D-AA-C
Esocidae		
Northern pike	*Esox lucius*	R-OA
Cyprinidae		
Fathead minnow	*Pimephales promelas*	D-PP-C
Creek chub	*Semotilus atromaculatus*	D-PA-C
Longnose dace	*Phinichthys cataractae*	D-PP-C
Golden shiner	*Notemigonus crysoleucas*	D-PA-C
Sand shiner	*Notropis stramineus*	D-PA-U
Common shiner	*Notropis cornutus*	R-OA
Red shiner	*Notropis lutrensis*	R-OA
Flathead chub	*Hybopsis gracilis*	R-OA
Plains minnow	*Hybognathus placitus*	D-PA-O
Carp	*Cyprinus carpio*	D-OA-C
Catostomidae		
White sucker	*Catostomus commersoni*	D-PA-C
Longnose sucker	*Catostomus catostomus*	R-OA
River carpsucker	*Carpiodes carpio*	R-OA
Ictoluridae		
Black bullhead	*Ictalurus melas*	D-PA-U
Channel catfish	*Ictalurus punctatus*	D-OA-U
Stonecat	*Noturus flavus*	D-AA-O
Cyprinodontidae		
Plains topminnow	*Fundulus sciadicus*	D-PA-O
Percichthyidae		
White bass	*Morone chrysops*	D-OA-C

TABLE 2.8-22 Continued)

FISH SPECIES LIST

Family/Common Name	Scientific Name	Status
Centrarchidae		
Smallmouth bass	*Micropterus dolomieui*	R-OA
Largemouth bass	*Micropterus salmoides*	D-OA-C
Green sunfish	*Lepomis cyanellus*	D-PA-C
Bluegill	*Lepouis macrochirus*	D-OA-C
Black crappie	*Pomoxis nigromaculatus*	D-OA-C
Peridae		
Walleye	*Stizostedion vitreum*	D-OA-C

TABLE 2.8-23

OCCURRENCE OF FISH SPECIES BY HABITAT

Fish Species	English Cr.	Squaw Cr.	White Clay Cr.	White River	Impoundments 1	2	3	4	5	6	7	8	9
SALMONIDAE													
Brook Trout		X											X
Brown Trout				X									
Rainbow Trout				X									
CYPRINIDAE													
Creek Club	X		X	X		X							
Fathead Minnow	X	X	X	X					X	X	X		
Longnose Dace		X	X	X									
Plains Minnow			X										
Sand Shiner				X		X							
Golden Shiner	X		X						X	X			
CATOSTOMIDAE													
White Sucker			X	X		X							
ICTALURIDAE													
Black Bullhead			X										
Stone Cat				X									
CYPRINODONTIDAE													
Plains Topminnow	X		X										
CENTRARCHIDAE													
Green Sunfish	X		X	X		X			X				
NUMBER OF SPECIES	5	3	9	9		4			3	2			1
Sampling Method													
Electrofishing	o	o	o	o		o			o				o
Gill Netting													
Pond Netting													
Minnow Trapping	o	o	o	o		o			o				o
Rod & Reel Angling													o

Game and Parks Commission provides a limited put-and-take fishery of local importance in the Ponderosa State Wildlife Area.

Periodic severe flooding is probably the most important factor limiting the effectiveness of stocking and reducing the trout population in Squaw Creek.

Brown trout and rainbow trout were collected in the White River at station W-1 and brown trout were collected at W-2. Eight brown trout were captured in approximately 350 m of stream and ranged in size from 184 to 390 mm (7-1/4 to 15-1/2 in). Only one rainbow trout was caught and it measured 217 mm (8-1/2 in). A regionally important put-and-take fishery exists in the White River around the Fort Robinson State Park area. Currently, the White River is on a stocking schedule of 2000 - 3500 catchable trout/year in the upper end, while the lower end receives 4000 catchable trout/year.

Fluctuating flows, periodic flooding, sand and silt substrates, and warm water temperatures are probably the most important factors limiting natural trout production in the White River.

Longnose dace were the most abundant fish species captured at the White River stations and they appear to be an important forage fish for trout (Tables 2.8-24A and 2.8-24B). Several brown trout stomachs were examined and were found to contain from one to three longnose dace. Good benthic macroinvertebrate production areas in the White River are generally lacking and as a result aquatic insects are probably not as important in the diet as longnose dace.

Impoundment I-9 has been stocked with brook trout but is not a public area and therefore provides only a limited amount of recreational fishing. The other impoundments have been or are now managed for baitfish production which includes fathead minnows and golden shiners. The presence of golden shiners in White Clay Creek and English Creek undoubtedly results from these operations.

TABLE 2.8-24A

RELATIVE ABUNDANCE (PERCENT OCCURRENCE) OF FISH COLLECTED AT EACH SAMPLING LOCATION, 1982

	Streams								Impoundments								
Fish Species	R-3	S-1	S-2 S-3	S-4	WC-1	WC-2	W-1	W-2	1	2	3	4	5	6	7	8	9
Salmonidae																	
Brook trout		5.7	1.2														100
Brown trout							18.5	3.2									
Rainbow trout							3.7										
Cyprinidae																	
Creek chub	0.3				44.8	1.1											
Fathead minnow	71.1	11.3	65.5	100	30.6	64.1							89.0	100	100		
Longnose dace		83.0	33.3		6.0	11.1	59.3	76.3									
Plains minnow						0.3											
Sand shiner																	
Golden shiner	3.9					0.6							2.4				
Catostomidae																	
White sucker					2.2	1.1	18.5	20.4									
Ictaluridae																	
Black bullhead						0.9											
Cyprinodontidae																	
Plains topminnow						0.3											
Centrarchidae																	
Green sunfish	24.7				16.4	20.5				100		100	8.6				
Electrofishing																	
Total	55	106	174	18	112	335	27	93					193	126			
Minnow Trap																	
Total	249			31	71	16				3		21	52	21	5		
Angling Total																	6
GRAND TOTAL	304	106	174	49	183	351	27	93		3		21	245	147	5		6

TABLE 2.8-24B

POPULATION ESTIMATES DERIVED FROM ONE-PASS ELECTROFISHING, JUNE 1982

Number of Fish/100 m of Stream
Sampling Location

Fish Species	S-1	S-2 S-3	S-4	WC-1	WC-2	E-3 W-0*	W-1	W-2	W-3	
Rainbow trout								0.6		
Brown trout								2.8	2.6	
Brook trout	1.3	0.3								
Creek chub				58.6	4.4	2.2				20
Longnose dace	19.6	7.2		7.1	86.6		31.1	8.9	61.8	6
Sand shiner							0.9			4
Plains minnow					2.2					
Fathead minnow	2.7	14.3	40	5.0	486.7	82.1				10
Golden shiner					4.4	15.5				
White sucker				2.9	8.9		2.0	2.8	16.5	4
Stone cat										0.5
Plains topminnow					2.2					
Green sunfish				6.4	148.7	22.2				0.5
TOTAL FISH/100 m	23.6	21.8	40	80.0	744.1	122.0	34	15.1	80.9	45
NUMBER OF SPECIES	3	3	1	5	8	4	3	4	3	7
METERS SAMPLED	450	800	45**	140	45**	45**	450	180	115	200

* Upstream from FR-2 footbridge

** Total extent of stream channel a) suitable for electrofishing at the site, or b) total extent between sites (S-2 to S-3)

Additional information on fish populations at Stations W-1 and W-3 obtained from three-pass electrofishing in November 1983 is presented in Appendix 2.8(B).

Benthic Macroinvertebrates. Aquatic insects accounted for 33 of the taxa identified and noninsect invertebrates made up the 18 remaining taxa (Table 2.8-25). Distribution of taxa within the insect orders were as follows: Diptera (true flies) 13; Coleopetra (beetles) 7; Ephemeroptera (mayflies) 4; Trichoptera (caddis flies) 4; Odonata (Dragon flies and Damsel flies) 3; Plecoptera (stone-flies) 1; and Hemiptera (true bugs) 1.

Non-insect invertebrates included snails (Gastropoda), leeches (Hirudinea), aquatic worms (Oligochaeta), Crustacea (Crayfish, scuds, seed shrimp), clams (Pelecypoda), planaria (Turbellaria), and round worms (Nematoda).

Of approximately 6,500 macroinvertebrates counted and identified 33.6% were midges (Tendipedidae=Chironomidae), 20% black flies (Simulidae), 19.1% aquatic worms (Oligochaeta), 14.5% biting midges (Ceratopogonidae), 7% mayflies, and 1.4% caddis flies. Together these six taxa accounted for over 95% of the total number of invertebrates collected. Percent contribution of these taxa to the total number of benthic macroinvertebrates collected at each station is presented in Table 2.8-26. In general, midges or aquatic worms were numerically dominant at most sampling stations. Exceptions occurred at sampling stations E-1 and E-2 where biting midges were most abundant; station S-2 where caddis flies and mayflies dominated; and at station S-3 where black flies were dominant. Aquatic worms occur widely in all types of habitats, but the greatest abundance is usually associated with organically rich substrates and such is the case in most of the impoundments.

Table 2.8-26 presents data on other benthic macroinvertebrates community values. Although densities were high at most sampling stations, diversity values were low. The use of diversity indices is based on the generally observed phenomenon that relatively undisturbed environments support communities having large numbers of species with no individual species present in overwhelming abundance. Healthy streams usually have diversity

TABLE 2.8-25

OCCURRENCE OF BENTHIC MACROINVERTEBRATES IN STUDY AREA STREAMS AND IMPOUNDMENTS FOR SAMPLES COLLECTED IN APRIL 1982

Taxon	English Cr.	Squaw Cr.	White Clay Cr.	White River	Impoundments 1	2	3	4	5	6	7	8	9
Class: Insecta (Insects)													
Order: Coleoptera (Beetles)													
Family: Dryopidae													
Helichus		X											
Family: Dytischidae													
Agabinus		X											
Hydrovatus		X											
Family: Elmiade													
Dubiraphia		X											
Neoelmis		X											
Optioservus		X											
Family: Hydrophilidae													
Berosus									X				
Order: Diptera (True Flies)													
Family: Anthomyiidae													
Limnophora	X	X											
Family: Ceratopogonidae													
Palpomyia	X	X	X	X	X		X						X
Family: Dolichopodidae	X												
Family: Ptychopteridae													
Bittacomorpha	X												
Family: Simulidae		X											
Family: Stratiomyiidae	X												
Euparyphus	X												
Odontomyia	X												
Family: Tendipedidae	X	X	X	X	X	X	X	X	X		X	X	X
Family: Tipulidae													
Hexatoma		X											
Limnophila		X											
Limonia		X											
Tipula		X											

TABLE 2.8-25 (Continued)

OCCURRENCE OF BENTHIC MACROINVERTEBRATES IN STUDY AREA STREAMS AND IMPOUNDMENTS FOR SAMPLES COLLECTED IN APRIL 1982

Taxon	English Cr.	Squaw Cr.	White Clay Cr.	White River	Impoundments 1	2	3	4	5	6	7	8	9
Order: Ephemeroptera (Mayflies)													
Family: Baetidae													
Baetia		X		X									
Caenis								X			X		X
Callibaetis								X					
Tricorythodes		X		X									
Order: Hemiptera (True Bugs)													
Family: Gerridae													
Gerris		X											
Order: Odonata													
Suborder: Anisoptera (Dragon Flies)													
Family: Libellulidae													
Libellula							X						X
Suborder: Zygoptera (Damsel Flies)													
Family: Agrionidae													
Amphiagrion							X						
Family: Coenagrionidae													
Argia													X
Order: Plecoptera (Stoneflies)													
Family: Perlodidae													
Isoperla		X											
Order: Trichoptera (Caddisflies)													
Family: Hydropsychidae													
Cheumatopsyche		X											
Hydropsyche		X		X									

TABLE 2.8-25 (Continued)

OCCURRENCE OF BENTHIC MACROINVERTEBRATES IN STUDY AREA STREAMS AND IMPOUNDMENTS FOR SAMPLES COLLECTED IN APRIL 1982

Taxon	English Cr.	Squaw Cr.	White Clay Cr.	White River	Impoundments 1	2	3	4	5	6	7	8	9
Family: Limnephilidae													
Hesperophylax		X											
Limnephilus	X												
OTHER INVERTEBRATES													
Class: Crustacea													
Subclass: Malacostraca													
Order: Amphipoda (Scuds)													
Family: Gammaridae													
Gammarus	X												
Family: Talitridae													
Hyallela axteca	X		X					X	X				X
Subclass: Malacostraca													
Order: Decopoda (Crayfish)													
Family: Astacidae													
Orconectes immunis	X	X	X	X									
Subclass: Ostracoda (Seed Shrimp)		X						X					
Class: Gastropoda (Snails)													
Order: Pulmonata													
Family: Ancylidae													
Ferrissia													X
Family: Lymnaeidae													
Lymnaea	X						X						
Family: Physidae													
Physa	X	X							X		X		X
Family: Planorbidae													
Gyraulus									X				

TABLE 2.8-25 (Continued)

OCCURRENCE OF BENTHIC MACROINVERTEBRATES IN STUDY AREA STREAMS AND IMPOUNDMENTS FOR SAMPLES COLLECTED IN APRIL 1982

Taxon	English Cr.	Squaw Cr.	White Clay Cr.	White River	Impoundments 1	2	3	4	5	6	7	8	9
Class: Hirudinea (Leeches)													
Order: Arhynchobdellida													
Family: Erpobdellidae	X	X	X		X		X				X		X
Order: Rhynchobdellida													
Family: Glossiphonidae													
Glossiphonia somplanata	X	X											
Helobdella stagnalis	X						X						X
Placobdella rugosa					X								
Phylum: Nematoda (Round Worms)	X	X						X			X		
Class: Obligochaeta (Worms)													
Order: Opisthopora		X	X	X	X	X		X			X		
Order: Plesiopora	X	X	X	X	X	X	X	X	X	X	X		X
Order: Prosopora													X
Class: Pelecypoda (Clams)													
Order: Heterodonta													
Family: Sphaeridae													
Musculium					X								
Psidium	X	X	X		X								
Class: Turbellaria													
Order: Tricladia													
(Planaria)	**X**												**X**
Number of Taxa	18	33	8	7	8	3	8	9	6	1	7	1	13

TABLE 2.8-26

BENTHIC MACROINVERTEBRATE COMMUNITY VALUES FOR STUDY AREA STREAMS AND IMPOUNDMENTS DERIVED FROM SAMPLES TAKEN IN APRIL, 1982

SAMPLING LOCATIONS

	Streams												Impoundments								
Parameter/sample	B-1	B-2	B-3	S-1	S-2	S-2	S-3	S-4	WC-1	WC-2	W-1	W-2	1	2	3	4	5	6	7	8	9
Sampling Method*	D	D	D	S	D	S	S	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Density (Org./m²)																					
1	5695	3766	3674	549	8451	377	8468	4777	322	459	505	3261	0	6992	6155	4731	5190	138	965	505	12998
2	15387	1378	2251	785	6071	1754	3325	1883	9186	367	276	5741	0	1288	6063	7165	8543		1010	138	10151
3	18188	92	4271	785	2664	560	5896	2526	6798	459	276	8451	46	13432	14698	2480	459		965	184	7578
$\bar{x}$	13090	1745	3399	706	5729	897	5896	3062	5435	428	352	5818	15	7237	8972	4792	4731	138	980	276	10242
Diversity ($\bar{d}$)																					
1	0.75	1.40	0.71	3.07	0.10	1.59	1.09	1.44	1.38	0.72	1.24	1.28		1.07	0.96	0.85	1.06	0	1.37	0	1.48
2	0.48	1.60	1.33	3.07	0.13	1.22	1.24	2.00	1.95	1.41	0.92	1.37		1.09	1.17	1.31	0.17		1.37	0	2.10
3	0.24	0	1.01	3.41	0.34	1.20	1.13	2.09	0.65	1.36	0.92	0.78	0	0.64	0.66	1.47	1.96		2.07	0	1.49
$\bar{x}$	0.49	1.0	1.02	3.18	0.19	1.34	1.15	1.84	1.33	1.16	1.03	1.14	0	0.93	0.93	1.21	1.06	0	1.60	0	1.69
No. of Taxa	11	9	7	22	5	8	16	9	8	4	3	7	1	8	8	9	6	1	7	1	13
Community Structure (% Occurrence)																					
Taxon																					
Tendipedidae	0.9	17.5	82.0	10.7	98.1	18.0	14.1	45.5	71.8	42.9	47.8	72.4		3.8	19.2	12.3	87.7	48.4	100	37.4	33.6
Oligochaeta		1.8	5.0	3.6	0.8	3.2	0.2	36.0	14.4	50.0	47.8	19.7	100	89.3	78.3	81.3	3.6	39.1		39.5	19.1
Ephemeroptera				20.3		65.2	6.8					7.9				0.9		4.7		16.6	7.0
Trichoptera			0.5	37.1	0.5	0.4	0.5				4.3	0.5									1.4
Ceratopogonidae	94.5	56.1		0.5		0.4	0.2	1.0	8.7	7.1		0.3		1.7	0.6					4.2	14.5
Simulidae			8.6		11.6	76.8															20.0

D = Punar Dredge Sample; S = Surber Sample

values between 3.0 and 4.0, but many forms of stress tend to reduce diversity by making the environment unsuitable for some species or by giving other species a competitive advantage. Squaw Creek at S-1 was the only stream sampling station that had diversity values within this range indicating a higher quality and a more stable habitat.

The density and diversity of benthic macroinvertebrates in the impoundments also reflects the quality of habitat. Impoundment E-1 is a mud bottom stockpond with little aquatic vegetation that supports an impoverished benthic community. Impoundment I-9 on the other hand, is spring fed, cool, productive, has a rich organic substrate and supports a diverse and abundant benthic community.

Periphyton. The Periphyton community of the aquatic habitats on the study area was composed of diatoms (21 genera) with a few green algae (8 genera) and one blue-green algae (Table 2.8-27). In general, only minor differences were found between communities in the streams and those in impoundments.

A good diversity of diatoms was present at each sampling location with the number of genera ranging from 8 to 15 and averaging 11. Cymbella, Nauicula, Nitzschia, Surirella, and Synedra were the most common genera and were found in every sample. In addition, Synedra was numerically dominant in 7 of 18 samples, Nitzschia 4/18, Nauicula 2/18, and Cymbella 1/18. Although Surirella was found in all samples, its present occurrence was low and in only one sample did it occur in excess of 10%.

Green algae were found in all sampling locations, with the greatest development occurring in the impoundments. Clodophora was the most common and abundant green algae found in the streams and at some locations formed thick mats with tassels approaching a meter in length.

TABLE 2.8-27

DIATOM PROPORTIONAL COUNTS (PERCENT OCCURRENCE) AND OCCURRENCE OF OTHER ALGAE BY SAMPLING LOCATION. DATA ARE FROM SAMPLES COLLECTED IN APRIL, 1982

	Streams											Impoundments							
Diatoms	E-1	E-2	E-3	S-1	S-2	S-3	S-4	WC-1	WC-2	W-1	W-2	1	2	3	4	5	7	8	9
Acnanthes	17.9	1.2	0.3	76.7		14.3	19.7	22.3	2.0	40.3			2.8				4.3	2.6	2.1
Amphora	0.5			0.5				0.3									0.3	1.8	
Cocconeis			0.3	2.4	0.7	4.8	1.7	1.2	11.3	1.9	0.3	1.1			0.4	0.6	0.3	1.4	0.7
Cyclotella			2.1		2.2	1.0	8.2	7.6		0.6				0.3		6.6	6.0	1.0	0.9
Cymatopleura							0.4												
Cymbella	6.3	0.3	0.3	1.9	6.1	2.9	8.2	25.9	7.0	7.8	1.8		7.1	1.3	11.3	3.9	1.4	8.5	13.7
Diatoma		0.6						6.4	1.0	0.9	21.6		0.7						17.9
Epithemia	1.1						1.3		0.4					12.6	2.1	1.7	2.6	4.4	
Fragilaria	3.3	66.5	0.3	0.5	2.9			0.3					0.7		9.3		0.6		0.2
Gomphonema	14.4	0.3	80.5	3.4	4.3			0.3			7.5		17.3	0.3	1.7	5.8	2.3	9.9	0.7
Gyrosigma									0.4							0.3			
Hantzschia													0.4	0.5	0.4		0.3		
Melosira																	0.6		
Meridion	0.8		0.3				2.1												
Navicula	3.8	2.6	8.2	5.3	15.8	16.2	13.7	9.8	58.6	33.4	47.7		3.2	6.2	5.5	2.5	18.2	21.0	1.2
Nedium	0.3																		
Nitzschia	13.0	6.6	3.8	5.3	65.9	58.1	13.7	15.2	10.6	11.3	19.1		6.0	12.9	7.6	3.6	30.4	12.1	34.4
Rhopalodia									0.4					3.2		0.3	1.4	0.2	
Stauroneis	0.3													0.3				0.4	
Surirella	0.5	0.3	1.0	0.5	0.4	1.9	3.9	1.2	6.6	3.4	0.5		0.7	0.3	2.5	5.8	12.5	1.0	0.2
Synedra	**37.8**	**22.0**	**2.7**	**1.5**	**1.8**	**1.0**	**27.0**	**9.5**	**2.0**	**0.3**	**1.5**		**60.1**	**62.2**	**58.6**	**69.1**	**19.0**	**35.6**	**27.9**
Green Algae																			
Ceratophylum															x				
Chara															x	x			
Cladphora			x	x		x	x	x	x	x	x								
Mougeotia	x	x												x					
Oedigonium															x		x		
Rhizoclonium							x												
Spirogyra	x	x					x		x						x		x		
Zygnema	x	x					x								x		x		
Blue-green Algae																			
Anag																x			

2.8-3 POTENTIAL IMPACTS

In the assessment of potential impacts of the proposed development, particular attention was paid to "important species" (USNRC 1980). These include 1) commercially or recreationally valuable species, 2) threatened or endangered species, 3) species affecting the well-being of species within criteria 1) or 2), and 4) species which are critical to the structure and function of the ecological system or biological indicators of chemical pollutants or radionuclides in the environment. Anticipated impacts of the proposed project are outlined below.

Short-term Impacts

Economic Considerations. Although the Pine Ridge area is among the most popular hunting and fishing areas in the state of Nebraska, most activities take place on public lands adjacent to the CSA: Fort Robinson State Park, Fort Robinson Wildlife Area, Ponderosa Wildlife Area, the Nebraska National Forest, and the Oglala National Grassland. The proposed project is not expected to diminish in any way the hunting and fishing opportunities on those areas.

The entire CSA is privately owned, and hunting and fishing opportunities are the prerogative of individual landowners. Harvestable wildlife populations are relatively low, and a sport fishery is practically non-existent. Estimates of total annual harvest on the CSA based on observed phenomena and discussions with landowners are: mule deer (fewer than 5); white-tailed deer (fewer than 5); other big game species (0); turkeys (fewer than 5); pheasants (fewer than 20); sharp-tailed grouse (fewer than 10); quail and partridges (0); doves and pigeons (fewer than 10); ducks and geese (fewer than 30); rabbits, all species (fewer than 10); squirrels (fewer than 10); game fish (0).

Flora. No threatened or endangered plant species was documented on the CSA.

Mammals, General. No threatened or endangered species was documented on the CSA.

Big Game Mammals. The big game mammals that are known to or could inhabit the CSA (white-tailed and mule deer, elk and pronghorn antelope) will not be affected by the proposed project. The elk and deer tend to use the wooded watercourses for shelter moving into the cultivated and grassland areas for feeding. The areas of disturbance for wells and access roads will impact less than 100 acres of the Commercial Permit Area at any one time. The remainder will be in native or cultivated habitat.

Impacts caused by the proposed project to big game hunting will be minimal. The yearly harvest from the CSA has averaged only 10 total deer (white-tailed and mule) and no elk or pronghorn antelope. These deer were generally harvested from private property and FEN's proposed project will not affect or preclude the landowners from allowing big game hunters from hunting on their property.

Carnivores. Red foxes, coyotes, raccoons, long-tailed weasels and striped skunks are expected to occur regularly but in low numbers on the CSA. Impacts are expected to be in direct proportion to the reduction in suitable prey species, including small mammals, birds and insects. If reasonable attention is given to protection of vegetation during the operational phase, there is no reason to anticipate a significant reduction in the prey base.

Birds, General. No federal or state designated threatened or endangered species was documented on the CSA. Bald eagles, protected under federal act, were recorded on the AA, including one on the CSA. The species is an uncommon winter resident and migrant. Critical habitat does not exist for the species within or near the study area.

Game Birds. No significant impacts to the game bird populations or hunting opportunities are anticipated. Only a single turkey has been recorded on the CSA, and pheasant, which are relatively common on the CSA, are found mainly in structure biotopes and cultivated areas with most in roadside

situations. The proposed project will have minimal impact on these types of areas. Sharp-tailed grouse are common on the study area, but only a small population and no leks were recorded on the CSA. The low population figures for the CSA would limit hunting opportunities for sharp-tailed grouse.

Raptors. The CSA, with an abundance of raptor habitat, has a large number of raptors, including golden eagles, red-tailed hawks, rough-legged hawks, northern harriers, prairie falcons, kestrels and great horned owls both nesting on the area and using it as a hunting ground. Impacts are expected to be in direct proportion to any reduction in suitable prey, including small mammals, birds, reptiles and insects. In view of the degraded range conditions on the site, it is probable that habitat conditions for rodents, lagomorphs, and other suitable prey species can be enhanced during the operational and reclamation stages of development, if attention is paid to vegetation protection and rehabilitation.

Reptiles, Amphibians and Fish. No threatened or endangered species were recorded, and none is expected to occur on the CSA. Owing to the unstable nature of Squaw Creek on the CSA, it is likely that aquatic conditions can be enhanced during the operational phase, if attention is paid to vegetation protection and rehabilitation.

Disturbances, General. Impacts caused by expansion to and operation of FEN's proposed commercial facility will be minimal. The processing facility, active wells, and wells being reclaimed will total less than 100 acres of disturbance at any one time.

Long-term Impacts. No long-term impacts from the project are anticipated, and no impairment of ecological stability, or diminishment of biological diversity should be realized.

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SECTION 2.9

BACKGROUND NONRADIOLOGICAL CHARACTERISTICS

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2.9 BACKGROUND NONRADIOLOGICAL CHARACTERISTICS

In order to establish baseline conditions of the commercial scale site and surrounding areas a preoperational monitoring program was conducted for nonradiological characteristics. Categories chosen for sampling included water, sediment and soils. Wherever possible, sites for radiological and nonradiological samples were the same.

During the year of 1982 and continuing into 1983, a preoperational nonradiological environmental monitoring program was conducted for the Crow Butte Project. This program was designed to collect baseline environmental data for both the R&D and the commercial scale operations simultaneously. Coordination of these two programs allowed more comprehensive surveys plus availability of regional data for the R&D phase. The results of the R&D project preoperational monitoring are presented in this section. The R&D operational monitoring (1985-87) and the commercial preoperational data which were collected from 1985 through 1987, are also presented in this section.

The nonradiological monitoring program is presented in Table 2.9-1. This program is adapted from the monitoring recommended in U.S. NRC Regulatory Guide 4.14 to provide companion data to the Crow Butte preoperational radiological monitoring program described in Section 2.10 of this report. Site specific data have been collected from monitor and baseline wells, Squaw Creek which passes through the restricted area, and soils. Other groundwater and impoundment samples were obtained within the Commercial Permit Area. Soils reported here were collected within the Commercial Permit Area and at a greater frequency in Section 19 which contains the restricted area. The area within Section 19 will be used for the first ten years of operations.

Figure 2.9-1 is a topographic map locating the nonradiological sample points for the commercial project. Illustrated are water and sediment sites within the commercial permit area.

TABLE 2.9-1

NONRADIOLOGICAL PREOPERATIONAL MONITORING PROGRAM
CROW BUTTE

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
WATER						
Ground Water						
	One from each water supply well	All wells within 1 km of restricted area boundary	Grab	3 Times	Each Sample	Complete Table 5.7-6 list
	One from each well	Selected Regional wells	Grab	3 Times	Each Sample	Same
	One from each DEC baseline & monitor well	As required by DEC	Grab	Quarterly	Quarterly	Complete Table 5.7-6 list once; common ions only-other quarters
Surface Water						
	One from each pond or impoundment		Grab	Once	Once	Complete Table 5.7-6 list
	Two from Squaw Creek	One up-stream one down-stream of restricted area	Grab	Quarterly	Quarterly	Complete Table 5.7-6 list once; common ions-only other quarters

Background Nonradiological Characteristics (Cont'd)

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
	Two from Squaw Creek	One up-stream one down-stream of restricted area	Grab	Quarterly	Quarterly	Suspended sediment
Water Levels						
	One from each monitor well, baseline well, and selected private wells	Surrounding and within wellfield	Electric line	Monthly	Monthly	Map
Flow						
	Two from Squaw Creek	One up-stream one down-stream of restricted area	Flow Meter	Monthly through 1982; then quarterly	Monthly through 1982; then quarterly	Tabular
SOILS						
Surface						
	One each	Six locations in Section 19	Grab	Once	Once	Arsenic, Selenium
	One each	Nine locations in Commercial Permit Area	Grab	Once	Once	Arsenic, Selenium
	One each	Seven locations in Proposed Restricted Area	Grab	Once	Once	Vanadium

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: FIGURE NO.: 2.9-1, "NON-RADIOLOGICAL SAMPLE LOCATIONS"

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT FIGURE NO.: 2.9-1

D-02

2.9.1 Groundwater

Investigations of the groundwater quality and usage for the Commercial Permit Area was made for this report.

The first step was to identify the aquifers present on a regional basis between the White River to the north and the Pine Ridge escarpment to the south. Geologic literature and maps were consulted to determine boundaries of outcropping formations and the local stratigraphy. Electric logs were examined and sand units within the formations identified. The water user survey provided information on which aquifers are currently being tapped for potable water. In some cases potentiometric data were also available. Existing hydrologic studies were then compared with these findings. A thorough discussion of the groundwater hydrology is found in Section 2.7.1 of this document.

Water samples were taken from selected representative wells within the commercial permit area and surrounding areas. The objective of this sampling was to characterize the water quality in the mineralized production zone and any overlying aquifer(s). This was accomplished in several ways. Eighteen of the nearby private wells identified in the water user survey were chosen for quarterly sampling during 1982. Sampling continued on a quarterly basis from 1982 and 1983, went to semiannual in 1984 and annual in 1985 and 1986. Their selection was to provide information supplemental to that from wells installed by Wyoming Fuel Company and since taken over by FEN. A majority of the local private wells and all but three of those sampled are completed in shallow Brule sands due to the lower drilling costs and more desirable quality water than that of the deeper Chadron Formation aquifer. The locations of these wells are found in Figure 2.9-1. Table 2.9-2 lists the private wells that were sampled to evaluate the local water quality.

Eleven wells originally drilled by WFC and since taken over by FEN expressly for baseline determination were sampled. The locations of these wells are shown in Figure 2.9-1 and the wells are listed in Table 2.9-3. Four are completed in the Brule Formation and seven in the Chadron Sandstone (production zone).

TABLE 2.9-2

PRIVATE WELLS SAMPLED WITHIN AND AROUND THE COMMERCIAL AREA

Well No.	Formation	Estimated Depth (ft)	Use
13	Brule	----	Stock
17	Brule	80	Domestic, Stock
19	Brule	80	Stock
25	Brule	75	Domestic, Stock
26	Brule	80	Domestic, Stock
27	Brule	80	Stock
30	Brule	55	Stock
40	Brule	60	Stock
56	Brule	200	Domestic, Stock
57	Brule	25	Domestic, Stock
61	Chadron	280	Domestic, Stock
62	Chadron	470	Industrial Well
63	Brule	100	Domestic
65	Chadron	260	Stock
66	Brule	60	Domestic, Stock
74	Brule	60	Stock
88	Brule	60	Domestic, Stock
95	Brule	100	Domestic, Stock

TABLE 2.9-3

BASELINE WELLS ORIGINALLY DRILLED BY WFC

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

Sample collection and preservation were performed using standard EPA methods. Prior to sampling, all field pH and conductivity meters were calibrated using known standards. In some cases, a backup meter was also used to verify readings from the primary instrument. Results of the sampling program are included as Appendix 2.9(A). A summary of these results on the eleven baseline wells drilled by WFC is given in Table 2.9-4.

2.9.2 R&D Area Groundwater Quality

Initial baseline and operational samples have been collected from the R&D wellfield and selected monitor wells. Figure 2.9-2 illustrates the locations of the production zone baseline and overlying aquifer baseline wells, and the monitor wells used during mining. Table 2.9-5 lists the depth and geologic unit for each baseline well.

Water samples were collected in the same manner as the regional baseline wells. Results of this sampling are presented in Appendix 2.9(A).

2.9.3 Water Levels

Monthly water level measurements were made on 23 representative wells within the commercial permit area. Of these wells, 12 are completed in the Brule Formation and 11 in the Chadron Formation aquifers. The objective was to determine if seasonal or periodic fluctuation in the piezometric surfaces occurs in the Crow Butte area.

Seasonal fluctuations in water level are commonly observed in shallow unconfined aquifers where effects of the hydrologic cycle are more immediate. Decreases occur in response to aquifer discharge to surface water systems during dry periods. Infiltration of precipitation, runoff and excess stream flow will serve to recharge the aquifer. Confined aquifers should exhibit little fluctuation in the piezometric surface except where groundwater withdrawal rates are high and/or seasonal.

TABLE 2.9-4

AQUIFER WATER QUALITY SUMMARY

Brule Formation*

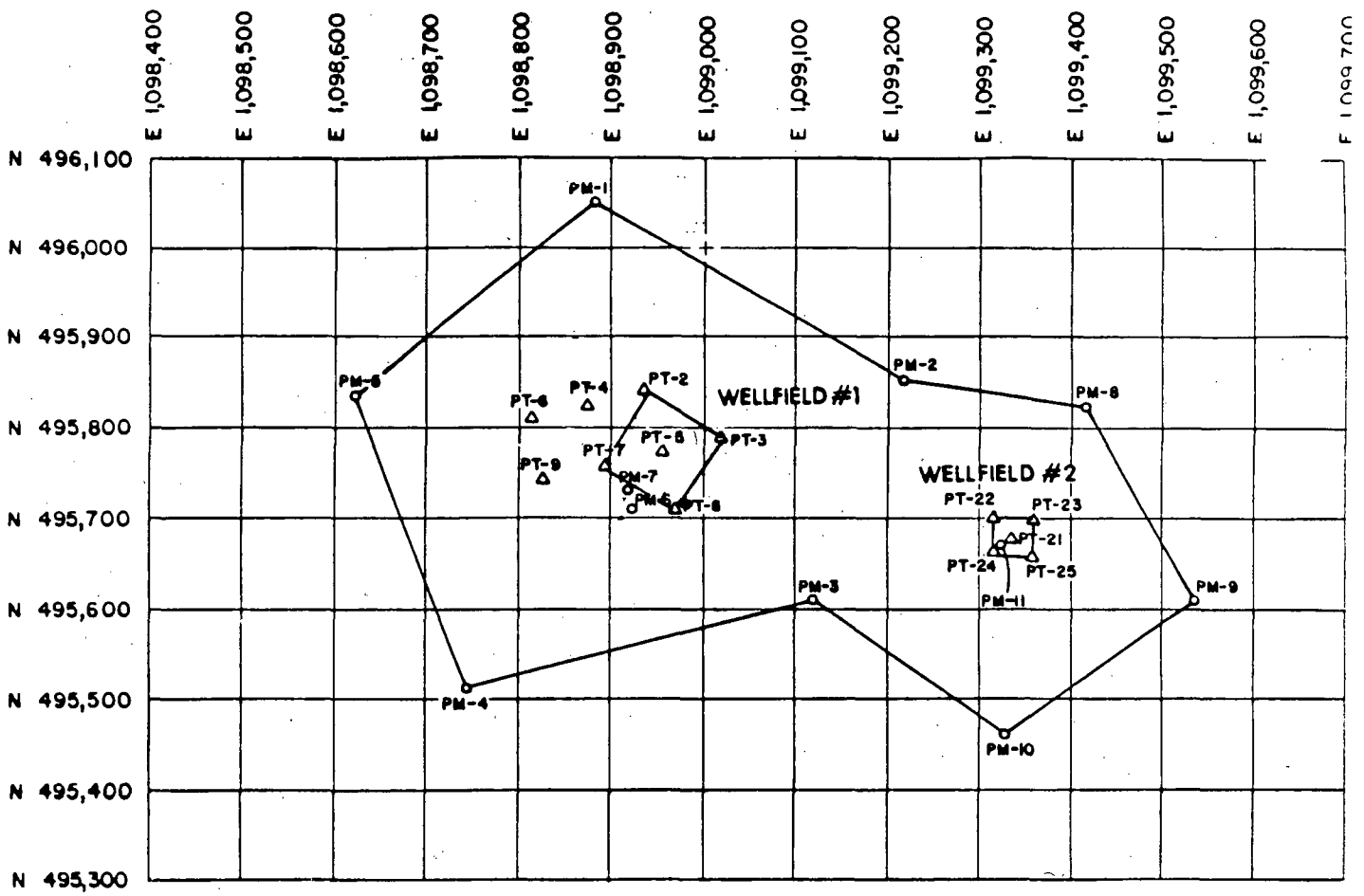
	Range	Mean
Calcium	7.1 - 98	48
Magnesium	0.3 - 16	6.6
Sodium	12 -340	104
Potassium	4.1 - 15.9	9.9
Bicarbonate	137 -627	364
Sulfate	1 - 23	10
Chloride	1.6 -192	48
Conductance	246-1481	714
pH	6.8 -8.5	7.8

Chadron Formation*

	Range	Mean
Calcium	11 - 41	20
Magnesium	0.8 - 7.2	3.2
Sodium	340 - 540	411
Potassium	7.0 -19.8	12.4
Bicarbonate	308 - 411	368
Sulfate	254 - 620	407
Chloride	134 - 250	176
Conductance	1500 -2500	1932
pH	7.6 - 8.7	8.2

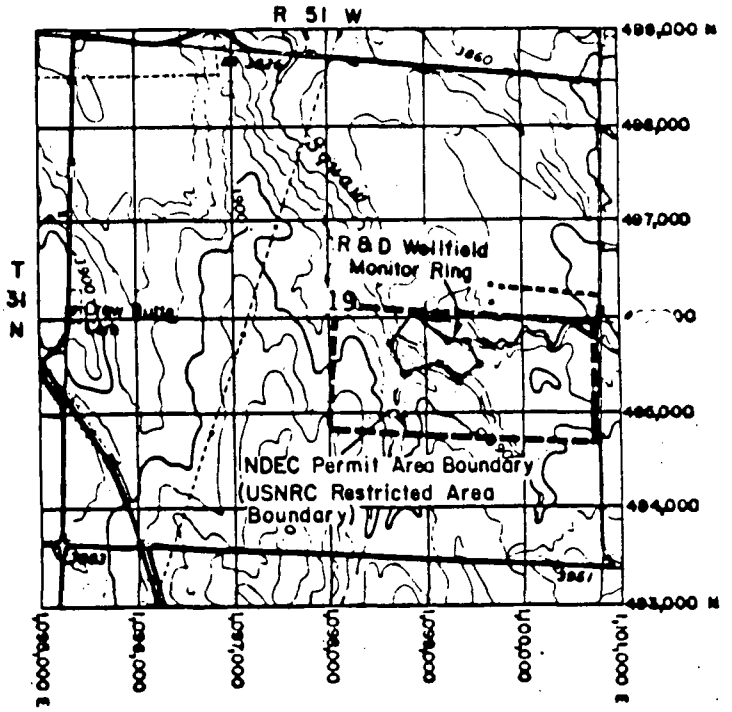
* Summary of average values for baseline wells drilled by WFC listed in Table 2.9-3.

In mg/l, except pH (units), Ra-226 (pCi/l), and Conductance (umhos).



Legend

- △ Pilot Test Wells
- ○ Pilot Monitor Wells



Scale 1"=200'

50 25 0 50 Meters

200 100 0 200 Feet

REV	BY	DATE	FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT Dawes County, Nebras
		2.9(10)	07/29/87
			R & D WELLFIELD WATER QUALITY WELLS
			PREPARED BY: SADavis
			DWN BY: SADavis — DATE: 5/24/84 — Figure 2.9-2

TABLE 2.9-5

WATER QUALITY WELLS USED FOR PREOPERATIONAL AND OPERATIONAL DATA

Well No.	Formation	Screen Interval (ft)	Depth to Bottom of Screen Assembly(ft)
OB-1 (PT-4)	Chadron	637.1-647.1, 652.1-657.1	662.1
OB-2 (PT-6)	Chadron	652 - 667	667
Wellfield Domestic	Brule	20 - 60	60
PT-2	Chadron	641 - 656	661
PT-3	Chadron	638 - 648	653
PT-5	Chadron	638 - 653	670
PT-7	Chadron	649 - 664	669
PT-8	Chadron	653 - 668	673
PT-9	Chadron	659 - 674	680.2
PT-21	Chadron	652 - 657	660
PT-22	Chadron	652.5-657.5	662.5
PT-23	Chadron	655.5-660.5	665.5
PT-24	Chadron	647.1-652.1	654.1
PT-25	Chadron	650 - 655	659
PM-1	Chadron	649.5-669.5	674.5
PM-2	Chadron	641 - 651;661 - 671	676
PM-3	Chadron	616-626;631-641;464-656	661
PM-4	Chadron	641.5-646.5;654.5-669.5	674.5
PM-5	Chadron	648-658;668-678;683-688	693
PM-6	Brule	196 - 211	216
PM-7	Brule	89.5-94.5;99.5-104.5; 109-114;119.5-124.5	129.5
PM-8	Chadron	631-641;651-661	666
PM-9	Chadron	633-643;698-658	663
PM-10	Chadron	619-629;635-645;651-661	666
PM-11	Brule	252-267	272

Water levels were determined using battery operated instruments. Measurements were recorded together with the date and name of individual taking the readings. Values were then corrected to mean sea level (msl). Selected results are presented in Figure 2.9-3 and 2.9-4 and all results listed in Tables 2.9-6 and 2.9-7.

2.9.4 Surface Water Quality

Samples were collected from Squaw Creek and all surface bodies of water within the commercial permit area. Table 2.9-1 outlines the sampling schedule and the parameters for analysis. This schedule was begun in 1982 and has continued into 1987. All data are presented here in Appendix 2.9(A).

Squaw Creek passes through the Crow Butte commercial permit area as it flows towards the White River. Four sampling points located on Squaw Creek are shown in Figure 2.9-1. Location W-2 (Not shown on Figure 2.9-1 since Location W-2 is positioned 5575 feet upstream of the confluence with Squaw Creek) on the White River is also part of the commercial preoperational monitoring program.

Water quality results of the sampling are included in Appendix 2.9(A). As can be seen, none of the EPA drinking water standards are exceeded in any surface water sample. Total dissolved solids are generally in the 200 to 300 mg/l range with calcium and bicarbonate being the predominant ions.

The stream and river samples were also analyzed for suspended sediment content. Sampling was initiated in 1982 and samples were taken from sites S-1. S-2, S-3 and W-2 (White River) for four quarters in 1982. Sampling continued at sites S-2 and S-3 from 1982 through 1987. Results of the suspended sediment sampling are found in Table 2.9-8. Average Squaw Creek suspended sediment rantes from 5.6 to 29.1 mg/l with site S-3 consistently higher in suspended sediments than sites S-1 and S-2.

The White River suspended sediment was an average of 74 mg/l for the year period.

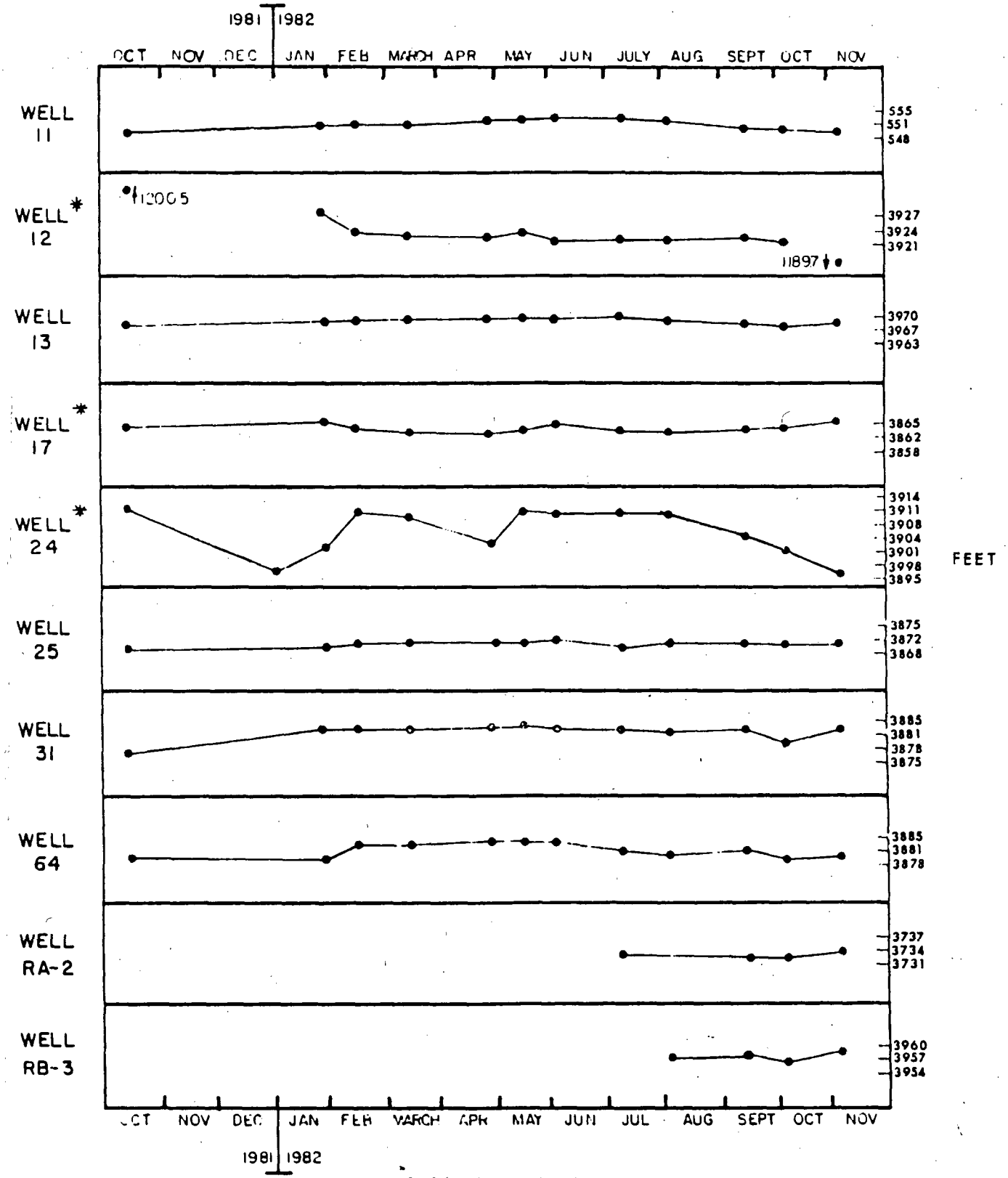
FIGURE 2.9-3

SEASONAL WATER LEVEL FLUCTUATIONS

In Wells Within Area of Review

Crow Butte R & D Project

Brule Formation



1-12-83

* - Well pumping prior to water level measurement in some cases

FIGURE 2.9-4

SEASONAL WATER LEVEL FLUCTUATIONS

In Wells Within Area of Review

Crow Butte R & D Project

Chadron Formation

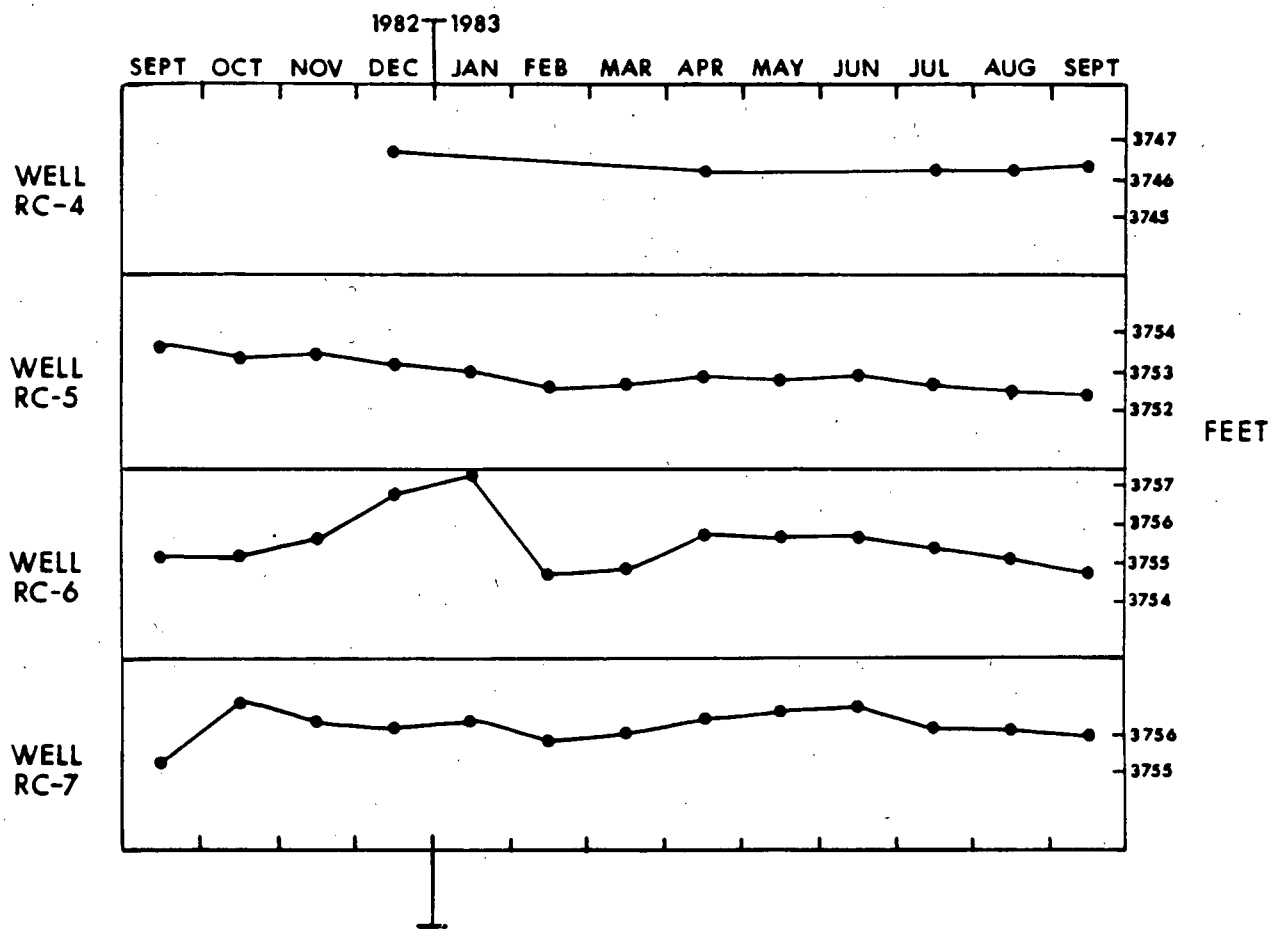


TABLE 2.9-6

BRULE WATER LEVELS
in feet above mean sea level

Well	1982 Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec	1983 April	July
11**	3831.7	3831.5	3831.8	3833.0	3833.0	3833.6	3833.0	3832.6	3831.5	3830.6	3830.3	3830.3	3843.5*	3837.0
12**	3928.0	3924.0	3923.0	3922.7	3923.7	3921.1	3922.1	3921.5	3922.2	3921.3	3903.3*	3918.7	3922.9	3920.0
13	3968.5	3968.7	3968.8	3969.4	3969.6	3969.2	3969.5	3968.9	3968.1	3967.5	3968.1	3968.4	3969.0	3970.0
17	3865.0	3863.5	3863.3	3862.6	3863.6	3864.8	3863.3	3862.8	3863.5	3863.8	3865.3	3864.6	3864.8	3862.8
24**	3902.0	3910.5	3909.0	3903.0	3910.9	3910.5	3910.5	3910.0	3904.7	3901.5	3895.7*	3910.1	3910.4	3911.0
25	3870.0	3870.8	3870.0	3871.0	3871.0	3871.3	3869.5	3870.9	3870.6	3870.5	3870.8	3870.9	3870.1	3871.6
31**	3883.1	3883.1	3883.2	3883.1	3883.3	3883.0	3882.6	3882.3	3882.6	3880.0	3882.3	3882.5	3882.5	3872.3*
64	3882.0	3882.9	3882.6	3883.5	3883.6	3883.8	3881.4	3880.8	3881.5	3880.0	3880.4	3882.0	3884.3	3883.5

	1982 Sept	Oct	Nov	Dec	1983 Jan	Feb	March	April	May	June	July	August	Sept
RA-2	3737.1	3737.0	3738.5	3737.9	3739.2	3739.1	3739.7	3740.2	3740.9	3741.0	3739.9	3739.2	3738.1
RB-3	3962.6	3961.2	3963.5	3963.6	3963.8	3963.8	3963.3	3969.7*	3963.7	3963.7	3964.2	3964.1	3964.2
PM-6	-----	3844.9	3844.9	-----	3843.5*	3844.5	3844.9	3845.3	3845.5	3846.0	3845.9	3945.9	3845.7
PM-7	-----	3845.7	3845.5	-----	3845.9	3845.8	3845.7	3846.1	3846.3	3846.9	3846.7	3846.7	3846.6

* Suspect data
** Well may have been pumping prior to water level measurement

TABLE 2.9-7

CHADRON WATER LEVELS
in feet above mean sea level

Well	1982 Sept	Oct	Nov	Dec	1983 Jan	Feb	March	April	May	June	July	August	Sept
62	3748.4	3748.0	3747.2	3746.6	-----	-----	3746.1	3746.2	-----	------	3746.1	3745.8	3745.4
RC-4	-----	-----	-----	3746.7	-----	-----	----	3746.2	-----	------	3746.2	3746.2	3746.3
RC-5	3753.6	3753.4	3753.4	3753.2	3753.0	3752.6	3752.7	3752.9	3752.8	3752.9	3752.7	3752.5	3752.4
RC-6	3755.2	3755.2	3755.7	3756.8	3757.5	3754.7	3754.9	3755.7	3755.6	3755.6	3755.4	3755.2	3754.7
RC-7	3755.2	3756.8	3756.3	3756.2	3756.4	3755.8	3756.0	3756.4	3756.5	3756.7	3756.2	3756.1	3755.9
PM-1	-----	3754.5	3754.4	3754.1	3754.3	3754.0	3753.8	3754.0	3754.2	3754.1	3753.8	3753.5	3753.5
PM-4	-----	3755.2	3755.2	3754.4	3754.4	3754.1	3754.2	3754.4	3754.8	3754.6	3754.3	3753.9	3754.6
PT-2	-----	3747.1*	3747.1*	3754.0	3754.6	3754.3	3754.1	3754.3	3754.5	3754.7	3754.3	3753.9	3753.7
PT-7	-----	3755.1	3755.0	3754.2	3754.2	3754.0	3754.0	3754.1	3754.8	3754.6	3754.3	3754.1	3753.9
PT-8	-----	3755.5	3755.6	3754.6	3754.4	3754.4	3755.7	3754.4	3754.5	3754.6	3754.2	3753.8	3753.7
PT-9	-----	3753.5	3753.5	3754.9	3754.6	3754.6	3754.6	3754.8	3854.8	3754.9	3754.5	3754.3	3754.1

* Suspect data

TABLE 2.9-8

SUSPENDED SEDIMENT IN FLOWING WATERS
SQUAW CREEK AND WHITE RIVER

Results given as Total Suspended Solids in mg/1.

	Time Period	Range	Average	Std. Dev.
S-1	1982	5-36	13.5	15.1
S-2	1982 - 1987	<1-24	5.6	5.6
S-3	1982 - 1987	2.7-76	29.1	24.4
W-2	1982	7-190	73.8	80

Eight impoundments are located within the commercial permit area of review; I-1 through I-8. These impoundments are shown on Figure 2.9-1.

Samples were collected and handled in the same manner as described above. Sampling sites were also used for obtaining sediment material for radiometric determinations discussed in Section 2.10.

2.9-5 Stream Flow

Squaw Creek flows through the Crow Butte commercial permit area from east to northwest. The flowrate of this perennial stream was monitored at two locations according to the schedule given in Table 2.9-1.. In addition, discharge rates of the Squaw Creek above the commercial permit area and the White River were monitored. Figure 2.9-1 shows locations of all but the White River station(W-2). The latter is positioned 5575 ft upstream of the confluence with Squaw Creek.

Flow was determined using a water current meter. This instrument operated utilizing a propeller driven photo-optical device to measure water velocity. It is a broad range, low threshold instrument. Measurement range is 0-6.1 m/sec (0-20 ft/sec) with an accuracy of $\pm$ 1 percent.

Flow rates were determined as follows. First the height of the water at the deepest point and width of water were measured and drawn on the cross-section. Next, the number of flow measurements to be taken were determined. If the stream width was less than one meter, then one measurement was taken at a point 0.5 times the width. The depth of measurement was 0.6 times the depth, down from the surface. If the width was greater than one meter, then three sets of measurements were made at two depths each (USDI, 1981). Data were then analyzed by determining the cross-sectional area of the water and the average flow velocity.

Table 2.9-9 lists the flow rates measured during 1982. An upstream station, S-1 and a White River station, W-2, are included for comparison. The data are shown graphically in Figure 2.9-5.

TABLE 2.9-9

1982 STREAM DISCHARGE RATES
(m_3/sec)
CROW BUTTE R&D PROJECT

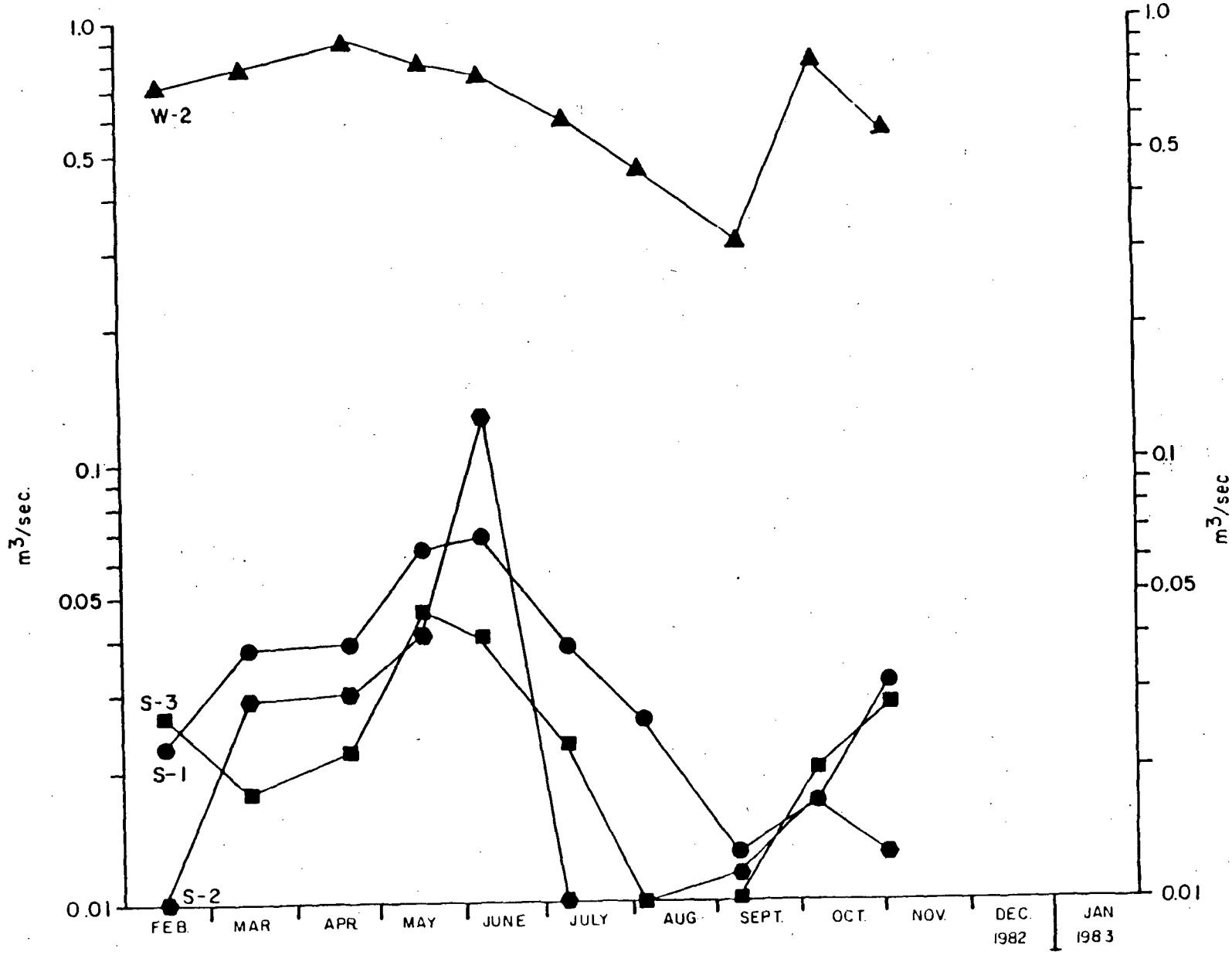
Station	Feb.	Mar.	Apr.	May	June	July	August	Sept.	Oct.	Nov.
Squaw Creek 1 (S-1)	.023	.038	.039	.064	.068	.038	.026	.003	.017	.003
Squaw Creek 2 (S-2)	.007	.029	.030	.041	.128	.008	.007	.002	.017	.013
Squaw Creek 3 (S-3)	.027	.018	.022	.046	.040	.023	.002	.000	.020	.028
White River 2 (W-2)	.707	.783	.901	.844	.763	.595	.463	.315	.806	.571

FIGURE 2.9-5

STREAM DISCHARGE RATES

FERRET OF NEBRASKA, INC.

CROW BUTTE R & D PROJECT



2.9(20) 07/29/87

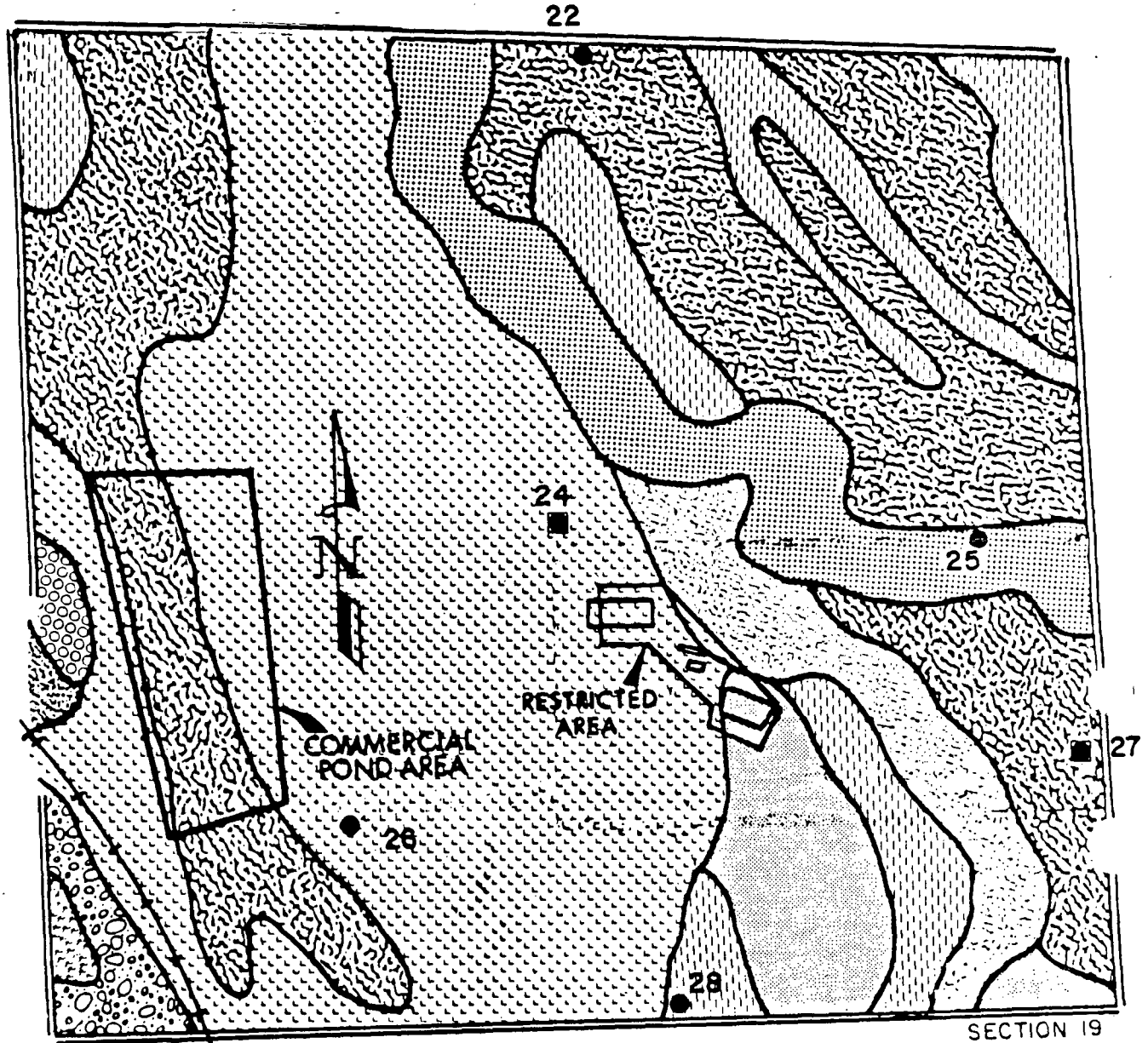
1/82

2.9-6 Soils

Soils samples were collected to determine baseline concentrations of selected elements in the different soils types. Nine samples were collected in the Commercial Permit Area and the locations are shown in Figure 2.9-1. Six locations were chosen within and nearby Section 19 to provide background information on where the commercial process facility will be located and where maximum surface disturbance will occur. (Figure 2.9-6). Seven sites were also sampled in the proposed restricted area (Figure 2.9-7). At the plant and pond locations, another set of samples will be obtained before commercial construction and also after topsoil removal and excavation is complete.

Material collected for nonradiological analysis was in the form of surface samples. These were collected as follows: A two meter transect was laid out in either a north-south or east-west direction at the desired location. Points along this line were situated at 0, 0.67, 1.33 and 2 meters. At each point soil was removed from a 5 to 7.6 cm (2 to 3 in.) diameter circular area to a depth of 5 cm (2 in.).

Three trace elements were chosen for consideration in this sampling. Arsenic, selenium and vanadium are commonly associated with uranium ore deposits. This is especially true in roll-front type deposits where halos of metal sulfides and other reduced compounds occur at the "nose" or in front of the uranium mineralization. When leaching takes place during mining, varying concentrations of these companion compounds will also be solubilized. Thus, a surface spill of leach solution might contain small amounts of these three elements. The leach solution will also contain uranium and radium-226. The baseline uranium and radium-226 levels in the soil are found in Section 2.10.

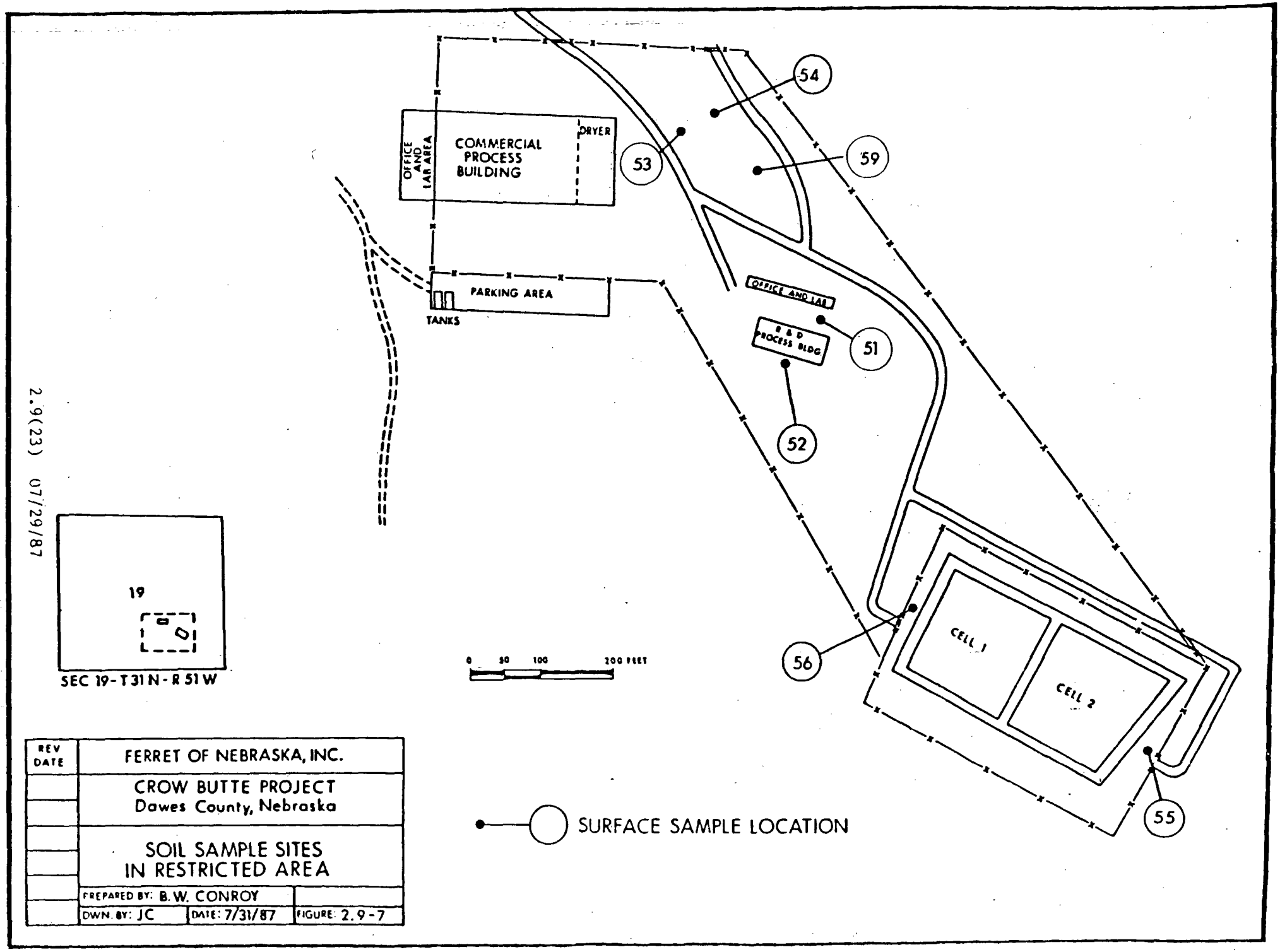


AcD2 Alliance silt loam, 3 to 9% slopes, eroded
BuD2 Busher loamy very fine sand, 5 to 9% slopes, eroded
BuF Busher loamy very fine sand, 9 to 20% slopes
BxF Busher and Tassel loamy very fine sands, 5 to 20% slopes
JvD Jayem and Vetal loamy very fine sands, 5 to 9% slopes
Sn Sandy alluvial land
SvF Sarben and Vetal loamy very fine sands, 9 to 30% slopes
SyF Schamber soils, 3 to 30%
TaF Tassel soils, 3 to 30% slopes
VeC Vetal and Bayard soils, 1 to 5% slopes

● - Surface Sample Site

METERS
400 200 0 400
1250 750 250 0 1250
FEET

REV	BY	DATE	FERRET OF NEBRASKA, INC.
			CROW BUTTE PROJECT
			Dawes County, Nebraska
			SOIL SAMPLE LOCATION
			PREPARED BY: F.E.N.
			DWN BY: JC DATE: 8/87 FIGURE 2.9-6


OFFICE AND LAB AREA
COMMERCIAL PROCESS BUILDING
DRYER
PARKING AREA
TANKS
OFFICE AND LAB
R & D PROCESS BLDG
54
53
59
51
52
56
55
CELL 1
CELL 2
0 50 100 200 FEET
SURFACE SAMPLE LOCATION
19
SEC 19-T31N-R51W
2.9(23) 07/29/87
REV DATE
FERRET OF NEBRASKA, INC.
CROW BUTTE PROJECT
Dawes County, Nebraska
SOIL SAMPLE SITES IN RESTRICTED AREA
PREPARED BY: B.W. CONROY
DWN. BY: JC
DATE: 7/31/87
FIGURE: 2.9-7

Samples from the Permit Area (Figure 2.9-1) and the specific samples from Section 19 (Figure 2.9-5) were analyzed for arsenic and selenium and the samples from the proposed restricted area (Figure 2.9-7) were analyzed for vanadium.

Results of the soil sampling are found in Tables 2.9-10 and 2.9-11. As can be seen from the data in Table 2.9-10 the arsenic concentration ranges from 0.59 mg/g to 3.30 ug/g and the selenium concentration ranges from <0.01 ug/g to 0.06 ug/g. There does not appear to be any relationship between the soils type and the levels of these elements. The vanadium analysis shown in Table 2.9-11 indicate that the vanadium levels in the proposed restricted area are very consistent with a range of 22 to 29 ug/g.

Soils develop over long periods of time and contained elements are in equilibrium with the established chemical environment. Several factors govern solubility and stability of elements in soils. These include pH, drainage status, organic content, sulfate content, etc. In addition, many studies have pointed out there is no absolute correlation between the total concentration of an element in the soil and its uptake by plants. However, uptake of arsenic, selenium, and vanadium by plants depends highly on the chemical form and availability of the elements and upon the plant species.

TABLE 2.9-10

SOILS ANALYSIS RESULTS
COMMERCIAL PERMIT AREA AND SECTION 19

Sample Site	Soils Map Unit	Sample Date	Arsenic ug/g	Selenium ug/g
2	Sarben	7/24/82	0.59	<0.01
5	Keith	7/23/82	1.10	0.04
6	Keith	7/23/82	1.00	0.03
10	Rosebud	7/23/82	1.00	0.03
11	Rosebud	7/24/82	0.80	0.03
13	Jayem	7/23/82	0.80	0.03
15	Duroc	7/24/82	0.70	0.06
19	Sarben	7/24/82	0.88	0.03
22	Vetal	7/24/82	0.88	<0.01
24	Busher	7/24/82	1.00	0.03
25	Sandy Alluvial	7/24/82	0.64	0.04
26	Busher	7/24/82	0.99	0.01
27	Vetal	7/24/82	0.72	0.05
28	Jayem	7/24/82	0.94	0.03
49	Sarben	7/23/82	3.30	0.04

(1) See soils map in Section 2.7 for further information on soils map unit.

TABLE 2.9-11

SOILS ANALYSIS RESULTS IN PROPOSED RESTRICTED AREA

Sample Site	Sample Date	Vanadium ug/g
51	12/15/82	22
52	12/15/82	28
53	12/15/82	22
54	12/15/82	27
55	12/15/82	27
56	12/15/82	29
59	12/15/82	26

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