CHAPTER 2
DESCRIPTION OF EXISTING ENVIRONMENT

2. Description of Existing Environment

The following discussion describes the project area in general and the plant-mine site and product pipeline route in detail. The water pipeline and railroad spur are closely adjacent to the plant-mine site, so the description of the existing environment of the plant-mine site would include them also. To avoid duplication, only aspects of the product pipeline differing from the plant-mine site are covered in detail.

ANGCGC commissioned Woodward-Clyde Consultants, and Great Lakes commissioned Ecology and Environment, Inc., to study the existing environment at and near the plant-mine site and product pipeline route, respectively. Much of the following description is based on data from their reports (4, 14). Appendix C summarizes the environmental studies which have been undertaken to assess the environmental impacts of the proposed gasification plant and its associated systems. More detailed data on some aspects of the proposed systems and existing environment are available in the reports of these studies.

2.1 Physical Environment

2.1.1 Climate

The climate in the area of the proposed project is semiarid. It is a region of climatic extremes; summers are hot and winters are cold and long. Averages are misleading, for seldom does "average" weather actually occur. Instead, weather tends to fluctuate widely around the annual averages. Blizzards and cold waves occur every winter. However, most of the annual precipitation occurs in the spring and summer associated with thunderstorm activity which can occasionally deposit large amounts of rain in a relatively short time. Normal and extreme precipitation and temperature data at Bismarck, North Dakota, are shown in Table 2-1.

Precipitation in the area is light, averaging 16.16 inches annually at Bismarck, and 17.20 inches annually at Beulah. Snowfall is moderate (38.4 inches annually), but has occurred in every month except July and August. Extreme snowfall for 1 month was about 31 inches (March 1975 and November 1896). The maximum daily temperature is greater than 100° F about once a year and below 0° F about 7 days a year. Minimum temperatures are below 0° F about 51 days per year.

The prevailing wind direction at the plant-mine site is from the northwest. Easterly winds occur with the greatest frequency from

TABLE 2-1

PRECIPITATION AND TEMPERATURE DATA FOR BISMARCK, NORTH DAKOTA (3)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Average Precipitation (Inches)	0.44	0.43	0.78	1.22	1.97	3.40	2.19	1.73	1.19	0.85	0.59	0.36	15.15
Temperature (F)													
Average Max.	19.1	24.5	35.4	54.8	67.1	75.8	84.3	83.5	71.3	60.3	39.4	26.0	53.0
Average Min.	-2.8	2.4	14.7	31.1	41.7	51.8	57.3	54.0	43.7	33.2	18.3	5.2	29.3
Mean	8.2	13.5	25.1	43.0	54.4	63.8	70.8	69.2	57.5	46.8	28.9	15.6	41.4
Highest	60	68	81	92	102	107	114	109	105	95	75	66	114
(Year)	1908	1958	1946	1952	1934	1921	1936	1941	1876	1953	1975	1939	
Lowest	-45	-45	-36	-12	13	30	32	32	10	-10	-29	-43	-45
(Year)	1916	1936	1897	1975	1907	1969	1884	1911	1876	1919	1964	1967	

May to August. The average annual wind speed is 11.6 mph. Winds are strongest in April, averaging 14.4 mph and weakest in July (10.8 mph). Tornadoes are rare in the area; the probability that one would strike the plant is 0.00034 and the mean recurrence interval is 2,950 years (4, 5).

2.1.2 Air

2.1.2.1 Meteorology

Meteorological parameters were continuously recorded by an instrument package installed near the plant-mine site (Figure 2-1). Hourly averages of wind speed and direction were documented from sensors 33-feet and 133-feet above-ground. Average annual wind flows for 2 years data are shown in Figure 2-2. Comparative data for Williston and Bismarck are presented in Appendix D. Wind flow at all three locations was primarily from either the north-west or the south-east quadrants. The absence of calms at the Beulah site can be partly explained by its better exposure.

Temperature inversions considerably reduce the ability of the atmosphere to disperse pollutants. Data from 1955 through 1964 show that inversion conditions exist 24 percent of the time at Bismarck. During these times, wind speed is usually from the east averaging 5.7 mph. Inversions are most prevalent during summer and least prevalent during the spring. In 35 years of record, no stagnation lasting more than 4 days has been noted for North Dakota (6).

For air quality purposes, the stability of the air is related to stability classes. The frequency of occurrence of the three main stability classes at the meteorological station is summarized below:

Vertical Temperature Gradient (^{o}C/100m)	Stability Category	Pasquill Stability Class	% Frequency of Occurrence 1/
-1.9 to -1.5	Unstable	A, B, C	24.5
-1.5 to 0.5	Neutral	D	28.5
0.5 to 4.0	Stable	E, F, G	47.0

1/ Based on 7,477 hours of observations from February through December 1974.

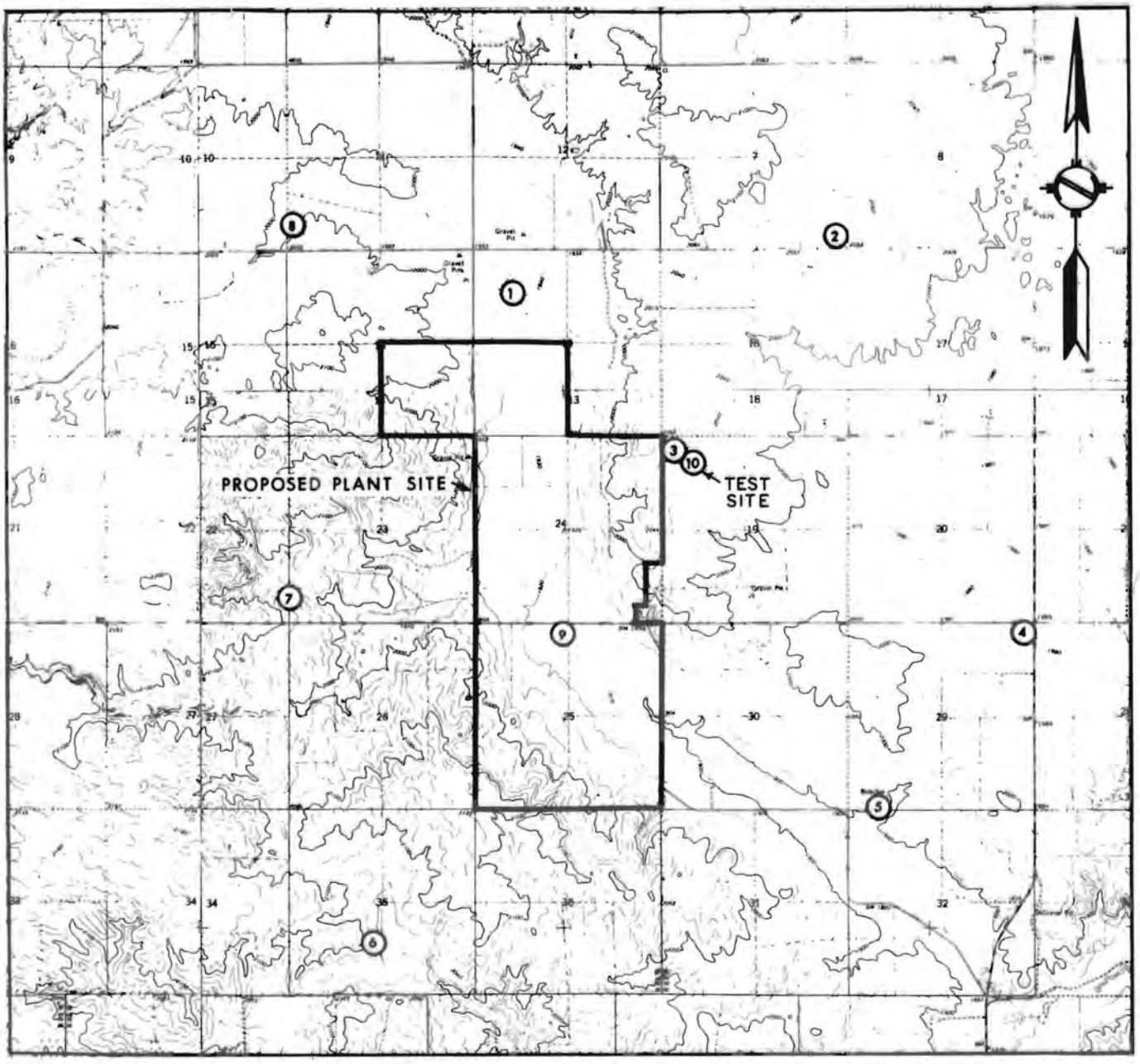


FIGURE 2-1 SULFATION PLATE AND DUSTFALL SAMPLING NETWORK: METEOROLOGICAL TEST SITE

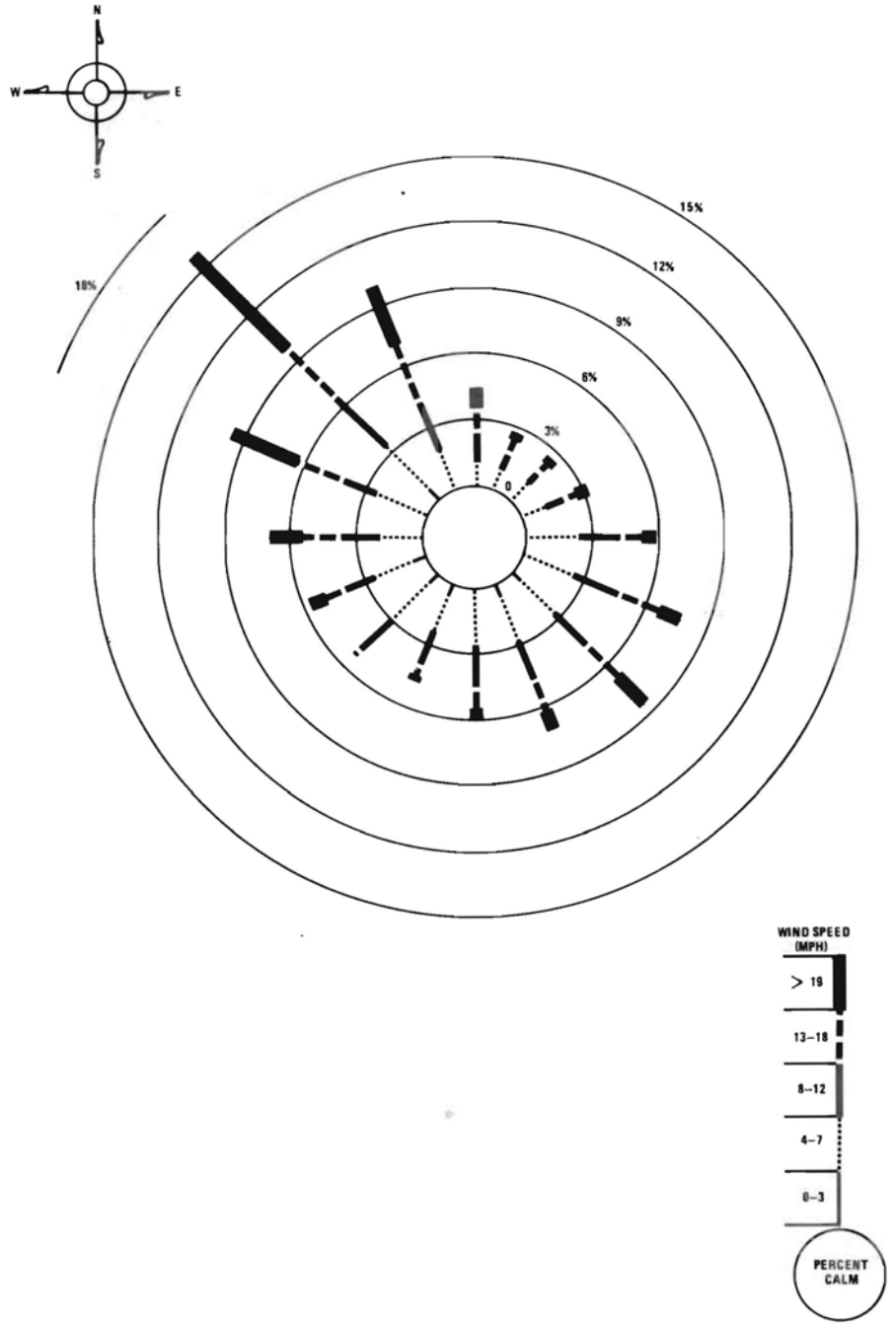


Figure 2-2
ANNUAL PERCENTAGE FREQUENCY OF WIND SPEED AND DIRECTION METEOROLOGICAL TEST SITE, 1974 THROUGH 1975

2.1.2.2 Quality

a. Plant-Mine Site

To obtain data on present ambient air quality, a baseline study was conducted from June 15 to July 31, 1974, at the meteorological test site. Measurements were made of all air contaminants for which standards have been established by the North Dakota State Department of Health. Tests were also made of suspended nitrates, fluorides, and trace metals (mercury, arsenic, molybdenum, selenium, lead, beryllium, antimony, and cadmium); radionuclides were identified by gross alpha and beta radiation. A summary of air quality data from other North Dakota stations is presented in Appendix D.

Sulfur Dioxide (SO_2): Measurements of SO_2 concentrations were made using the coulometric automated continuous sampler. The percent frequency of concentration levels are shown in Appendix D while Figure 2-3 details levels by date. An additional monitoring period was conducted (Figure 2-4) because of a coal fire at a coal mine 12 miles east of the study area which may have caused unusually high SO_2 levels during the June 15 to July 31 test period. The highest 24-hour concentration recorded was 156 ug/m^3 (0.06 ppm), which is 60 percent of the State standard (see Section 4.1.2.1 for Federal and State air standards). The highest 1-hour concentration was 260 ug/m^3 (0.10 ppm); 36 percent of the State standard. Concentrations decreased during August-September indicating that the June-July readings may have been abnormally high and nonrepresentative of the usual ambient background level.

Sulfation Rate: Sulfation rates were obtained using lead dioxide plates exposed to the air for 30 days. Figure 2-1 shows the plant-mine area sampling network. The maximum 1-month value was about 0.20 mg/100 cm^2/day; the minimum sample value was less than 0.13 mg/100 cm^2/day (Appendix D). None of the stations exceeded the State reactive sulfation rate standard of 0.50 mg/100 cm^2/day. Data from three State monitoring stations are included in Appendix D for comparison.

Suspended Particulates (tape): Co-efficient of haze (COH), sulfuric acid mist (H_2SO_4), and hydrogen sulfide (H_2S) were measured by tape samplers. The 1-month geometric means for COH calculated from data obtained during June and July were 0.030 and 0.018 COH/1000 linear feet, respectively. The State standard is 0.4 COH/1000 linear feet. The average H_2SO_4 concentration (3-hour samples composited for a 7-day single analysis) was 9.81 ug/m^3, which is less than the State standard of 12 ug/m3 and 30 ug/m^3,

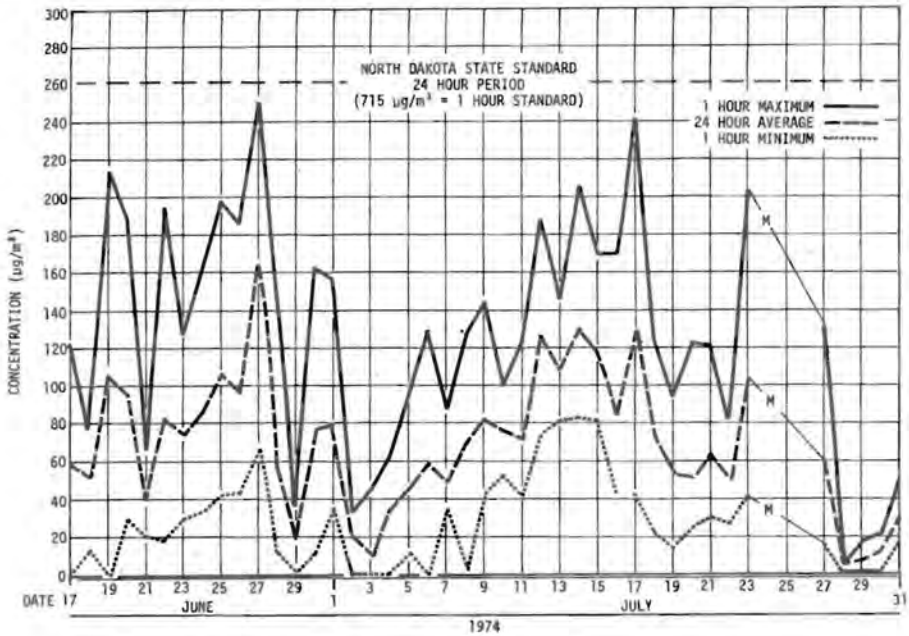


Figure 2-3 OBSERVED SULFUR DIOXIDE CONCENTRATIONS: 24 HOUR AVERAGE, 1 HOUR MAXIMUM, AND 1 HOUR MINIMUM AVERAGES AT METEOROLOGICAL TEST SITE FROM 17 JUNE THROUGH 31 JULY, 1974

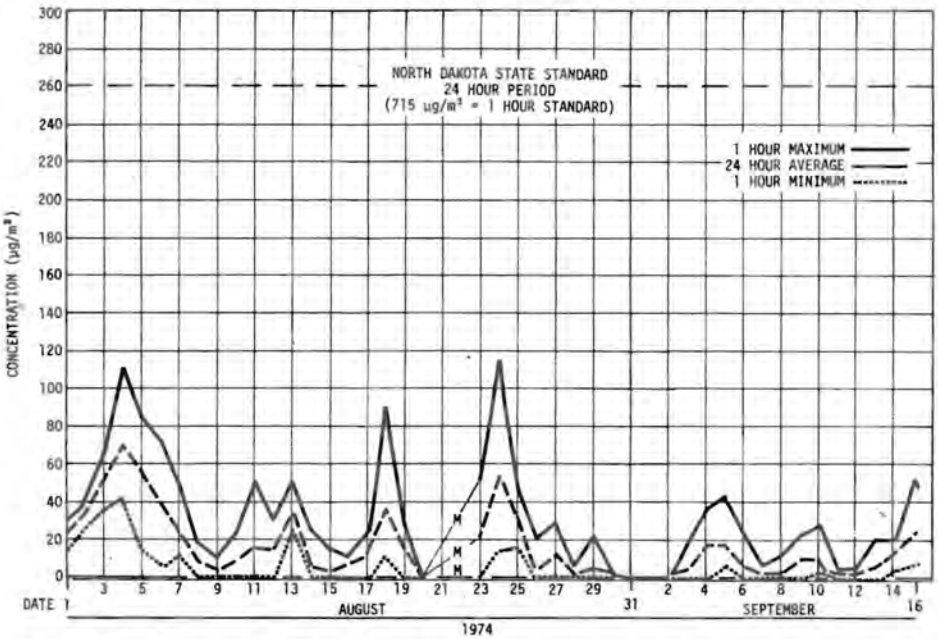


Figure 2-4 OBSERVED SULFUR DIOXIDE CONCENTRATIONS: 24 HOUR AVERAGE, 1 HOUR MAXIMUM, AND 1 HOUR MINIMUM AVERAGES AT METEOROLOGICAL TEST SITE FROM 1 AUGUST THROUGH 15 SEPTEMBER, 1974

maximum 24- and 1-hour concentrations not to be exceeded over 1 percent of the time. Of 2,042 half-hour samples of H_2S, only 13 samples showed any concentrations at all. The maximum half-hour H_2S concentration was 2.11 ug/m^3 (0.0015 ppm) as compared to the State standard of 45.0 ug/m^3.

Suspended Particulates (Hi-Vol): A Weather Measure APS-24 high-volume sampler system was used to measure total suspended particulates (TSP), suspended sulfates, nitrates, fluorides, pH, trace metals, and radionuclides. All samples of TSP were below the State standard (150 ug/m^3 of air, maximum 24-hour concentration not to be exceeded more than once per year) except one sample on July 6 (Figure 2-5). Comparable data for three State stations for 1972-1974 are shown in Figure 2-6.

None of four groups of 24 1-hour samples (corrected to be one 24-hour sample each) for suspended sulfates exceeded the State standard of 12 ug/m^3 (maximum 24-hour concentration not to be exceeded over 1 percent of the time). A comparison of site readings with State data is found in Appendix D. Nitrate concentrations for four 24-hour samples varied from 0.33 to 0.44 ug/m^3. There are no State standards for nitrates or fluorine. Fluorine samples at the site ranged from .003 to .022 ug/m^3 for four 24-hour samples. Results of the pH, trace metals, and radionuclide analyses are also shown in Appendix D. The pH of suspended particulates varied from 9.2 to 9.6. Iron (1.50 ug/m^3) and copper (0.114 ug/m^3) were the major trace metals. Alpha and beta activity was normal for the area.

Dustfall: The site network for sampling dustfall was shown in Figure 2-1. Data from the site was similar to that for Bismarck, 1972-1974 (Appendix D). None of the stations exceeded the State standard of 15 tons/mi^2/mo, maximum 3-month average.

Photochemical Oxidants-Ozone (O_3): Ozone concentrations were higher than expected (Figure 2-7). The average of all measurements was 124 ug/m^3 (0.062 ppm), or 77.5 percent of the State standard (160 ug/m^3). Nearly 23 percent of the 1-hour concentrations exceeded the standard with a daily 1-hour maximum average of 172 ug/m^3 (0.086 ppm). There is no obvious explanation as to why these concentrations were high.

Carbon Monoxide (CO): Measurements at the test site showed the maximum 1-hour concentration of CO to be 0.11 mg/m^3 (0.1 ppm), which is only 0.3 percent of the State standard. The maximum 8-hour concentration was 0.90 mg/m^3 (0.08 ppm), or 0.9 percent of the State standard.

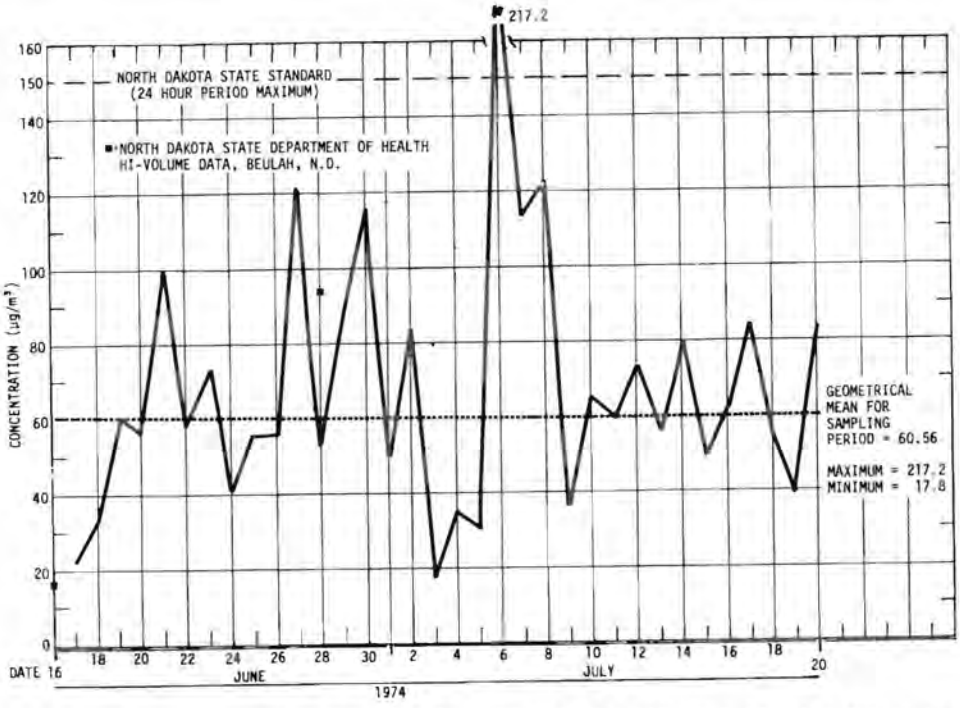


Figure 2-5 DAILY DISTRIBUTION OF SUSPENDED PARTICULATE MATTER: HI-VOLUME SAMPLER AT METEOROLOGICAL TEST SITE FROM 17 JUNE THROUGH 20 JULY, 1974

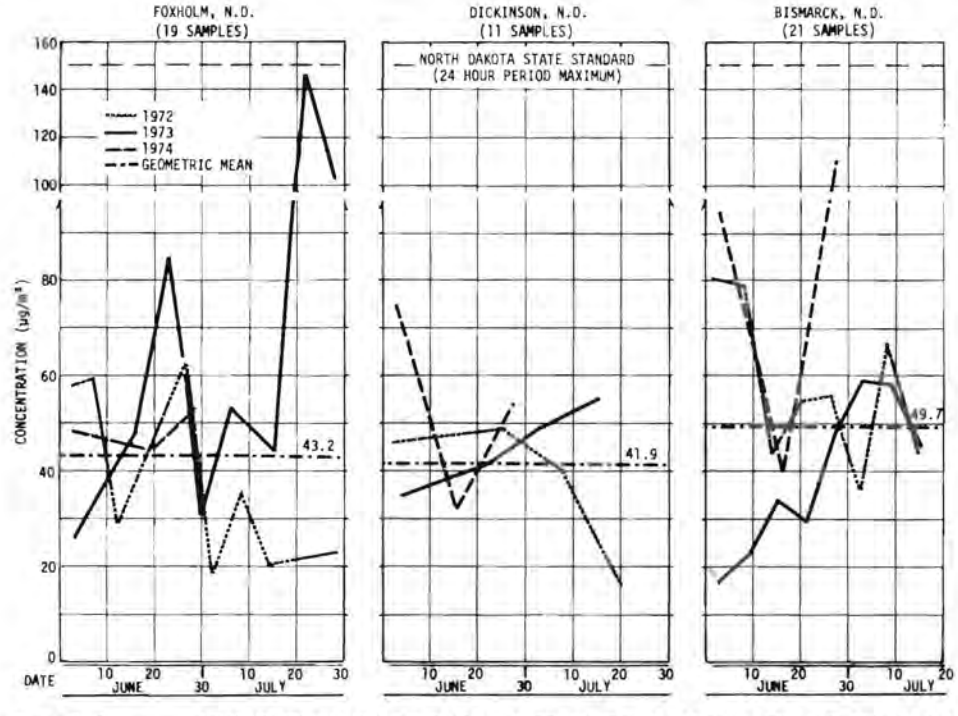


Figure 2-6 CONCENTRATION OF TOTAL SUSPENDED PARTICULATES AT INDICATED NORTH DAKOTA STATE STATIONS FOR MONTHS JUNE AND JULY

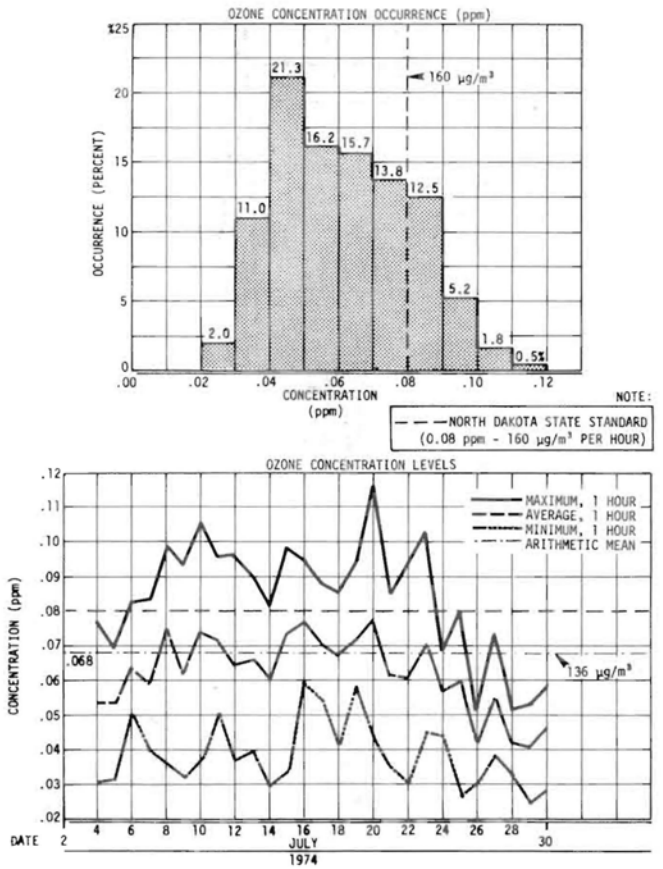


Figure 2-7 **PHOTOCHEMICAL OXIDANTS HOURLY CONCENTRATIONS: METEOROLOGICAL TEST SITE FROM 2 JULY THROUGH 30 JULY, 1974**

Hydrocarbons (HC): The maximum 3-hour average concentration of hydrocarbons was 55.6 ug/m^3 (0.08 ppm) (Figure 2-8), or 34.8 percent of the State standard of 160 ug/m^3 (0.24 ppm). Except for one other 3-hour maximum of 53.3 ug/m^3 (0.08 ppm), no other 3-hour value exceeded 33.4 ug/m^3 (0.05 ppm).

Nitrogen Dioxide (NO_2): Of the 1,067 1-hour averaged observations of NO_2 concentrations, 99.7 percent was equal to or less than 20 percent of the State standard of 200 ug/m^3 1-hour concentration not to be exceeded over 1 percent of the time (Figure 2-9). Only 3 hours (0.3 percent) exceeded concentrations of 40 ug/m^3 (0.02 ppm).

b. Product Pipeline

The general climate and existing air quality along the proposed product pipeline route are essentially the same as that described for the plant-mine site. Exceptions to this are localized, minor deteriorations in air quality near small population centers and locally high concentrations of particulates, SO_2, and NO_2 near the two steam-electric powerplants between Stanton and Washburn, North Dakota.

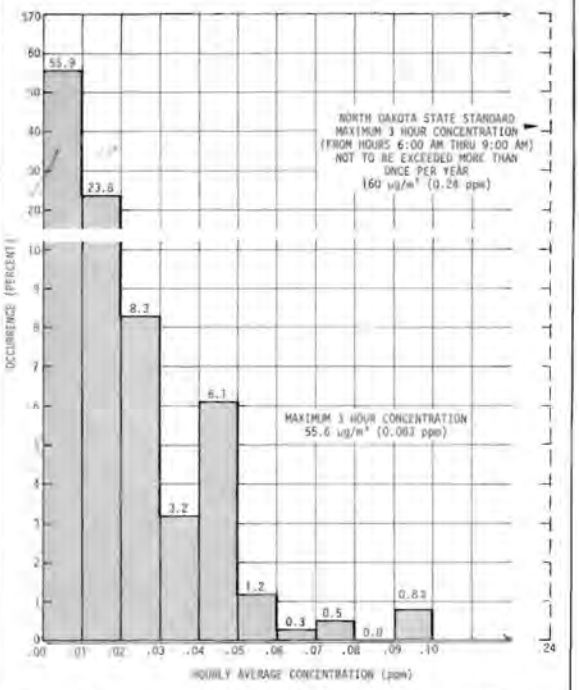


Figure 2-8 **HYDROCARBONS (HC) CONCENTRATIONS: METEOROLOGICAL TEST SITE FROM 28 JUNE THROUGH 31 JULY, 1974**

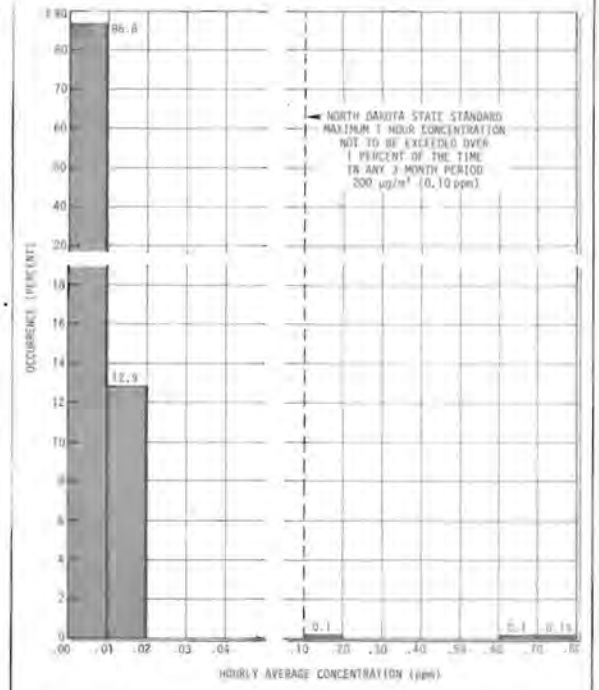


Figure 2-9 **NITROGEN DIOXIDE CONCENTRATIONS: METEOROLOGICAL TEST SITE FROM 16 JUNE THROUGH 31 JULY, 1974**

2.1.2.3 Noise

To define existing noise levels, an ambient noise survey was conducted around the proposed plant-mine site June 28 through July 2, 1974. Points on the site boundary and at the nearest residences were monitored throughout the day and night for 2 weekdays and 2 weekend days to determine existing sound levels (Figure 2-10). There were no significant differences in noise levels between the four points monitored. The primary reason for this homogeneity of noise levels is an almost complete lack of human influence. Though differences in noise levels between the weekend and weekdays did exist, observations of the noise survey members indicated the changes were due to varying meteorological conditions rather than human activity. The most significant meteorological parameter in terms of noise levels at the site was wind speed (Figure 2-11).

The quality of the present sound environment was determined by comparing the 24-hour L_{90}, L_{50}, and L_{10} decile values (see Glossary) with limits proposed by HUD for potential housing development sites. The comparison (Figure 2-12) showed all levels to be

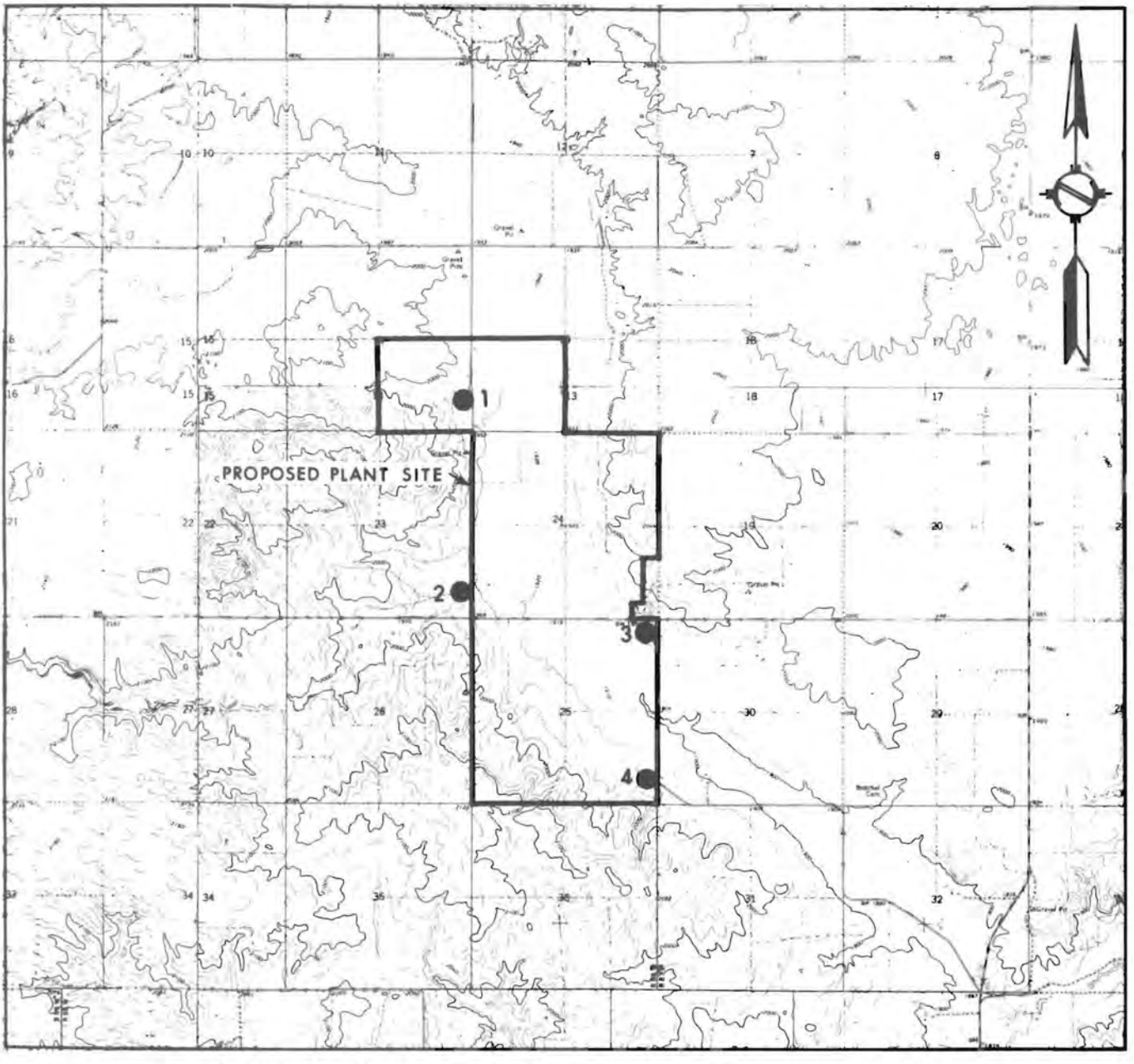


FIGURE 2-10 NOISE MONITORING POINT LOCATIONS: BEULAH QUADRANGLE, MERCER COUNTY, NORTH DAKOTA

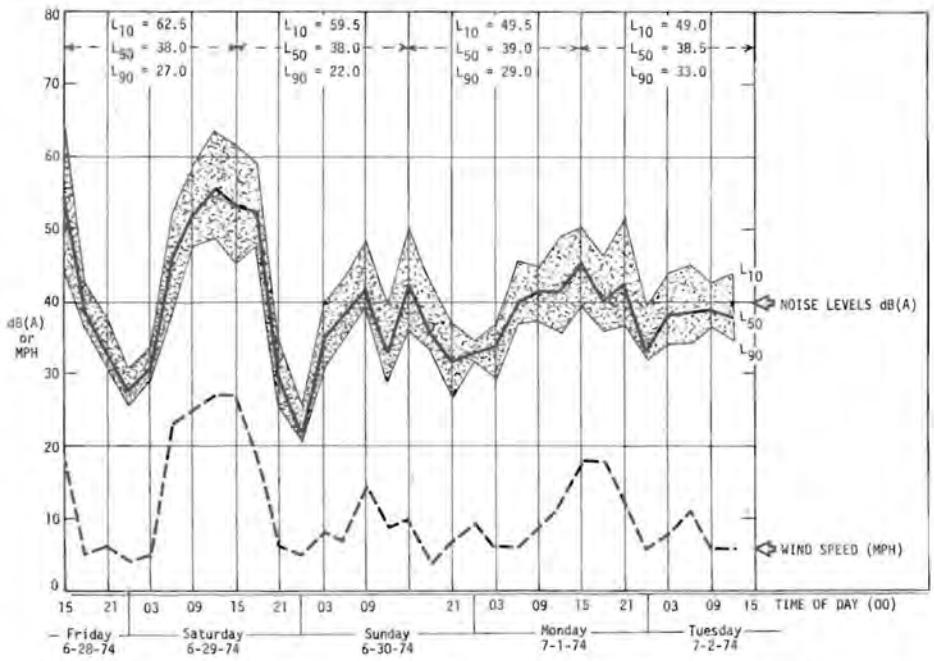


Figure 2-11 MEAN dB (A) NOISE LEVEL OF ALL MONITORING POINTS AND WIND SPEED VERSUS TIME, PROPOSED COAL GASIFICATION PLANT NEAR BEULAH, NORTH DAKOTA

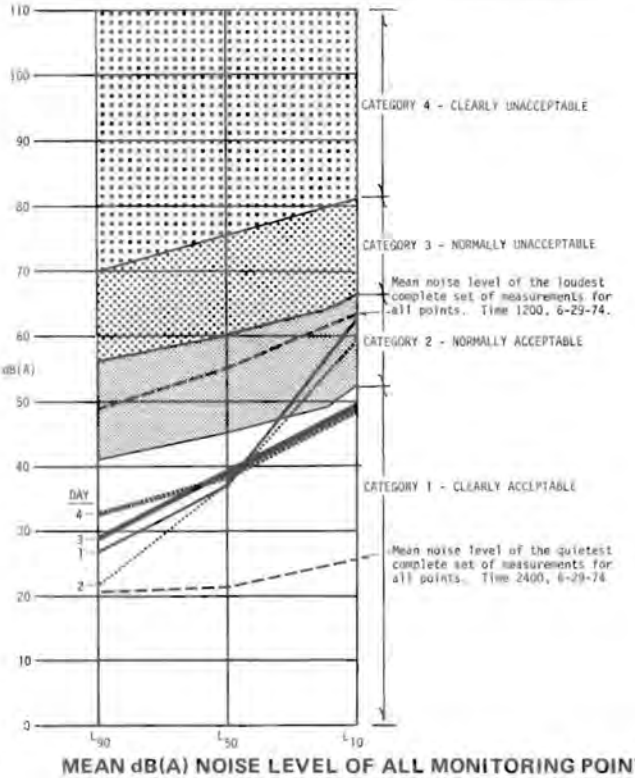


Figure 2-12 MEAN dB(A) NOISE LEVEL OF ALL MONITORING POINTS VERSUS HUD'S COMMUNITY ACCEPTABILITY CRITERIA AT THE PROPOSED COAL GASIFICATION PLANT - BEULAH, NORTH DAKOTA

"clearly acceptable" except the L_{10} level for the first 2 days when wind speed was highest. At these times the L_{10} level was in the "normally acceptable" category.

Existing noise levels along the proposed product pipeline route are typical of rural areas where natural background levels are produced by wind and animals, and man-made noise is generally daytime, nonpersistent noise. The proposed route is mostly along existing railroad right-of-way (ROW) so that ambient noise levels will be fairly high when a train passes. Several highways also parallel the route so occasional high ambient levels occur associated with combined railroad and highway traffic (as high as 90 dBA) (14).

2.1.2.4 Odor

The odor survey program at the plant-mine site was conducted by nine persons selected without regard to training or sensitivity to duplicate the average response of the general public. Three of the nine members performed each odor measurement on a semirotational basis depending on availability.

The survey, conducted over a 10-week period, consisted of 30 sets of measurements with each set containing 1 measurement upwind and 1 downwind of the site. Monitoring locations were selected to permit this as much as possible while still encircling the site (Figure 2-13). The results indicate no odor was detectable at a dilution to threshold ratio (D/T) greater than 1.5 during the survey period. The few odors which were detected were all at low concentrations with D/T ratios of 1 or 1.5, and were typical of odors present in a clean, nonpolluted farming environment. The odors were not detected in any particular location but were scattered and closely associated with their source. The smell of dust was evident near the unpaved roads, hay near freshly cut hay fields, and cow manure near a small pond where cattle drank. The typically moderate to high winds tend to disperse odors and prevent any degree of concentration.

2.1.3 Water

2.1.3.1 Hydrology

The plant-mine hydrologic impact area includes the proposed plant-mine site and those adjacent areas in which water occurrences may be altered in any way by the intended action (Figure 2-14). The southern portion of the impact area is encompassed by the

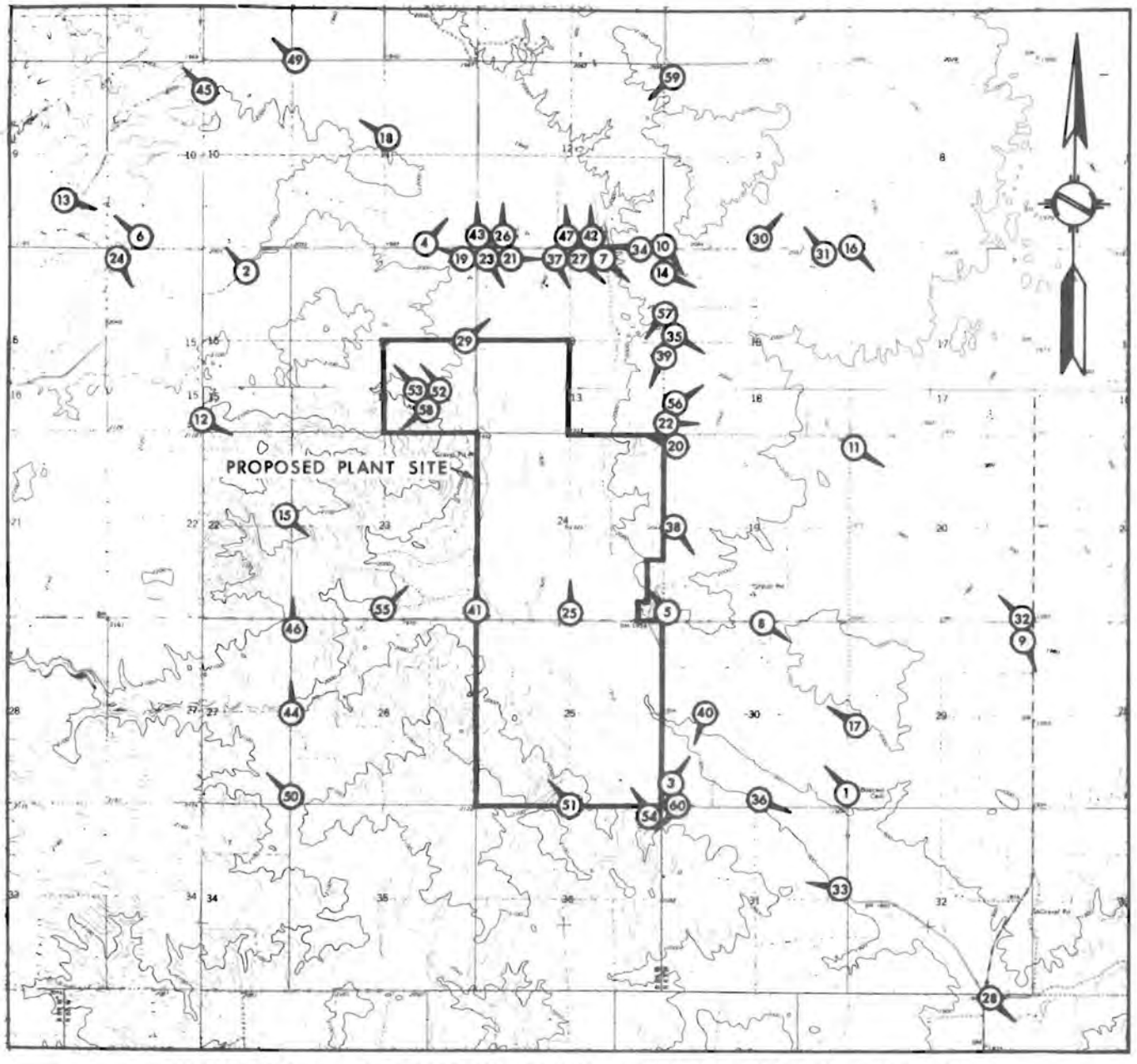


FIGURE 2-13 ODOR MONITORING POINTS WITH WIND DIRECTION INDICATION

Lower Spring Creek-Upper Knife River drainage basin while the northern portion is part of the basin directly contributing runoff to Lake Sakakawea. Some interior drainage also takes place through localized topographic depressions. The most imposing physiographic feature of the study area is the Beulah Trench, a typical glacially carved valley which winds its way from Beaver Creek Bay, through the proposed plant site, to a point about 4 miles north of Beulah where it divides and continues eastward toward Hazen and westward toward Zap (Figure 2-14). Because the trench actually divides the plant-mine site, it plays a significant role in this report. In the vicinity of Section 11, T. 145 N., R. 88 W., Beulah Trench is intersected by the Krem Moraine and an eastward trending surface water drainage divide follows the peak of the deposit and coincides with its strike. North of the divide, runoff flows northward toward Lake Sakakawea; south of the divide, runoff flows southward toward Spring Creek and the Knife River.

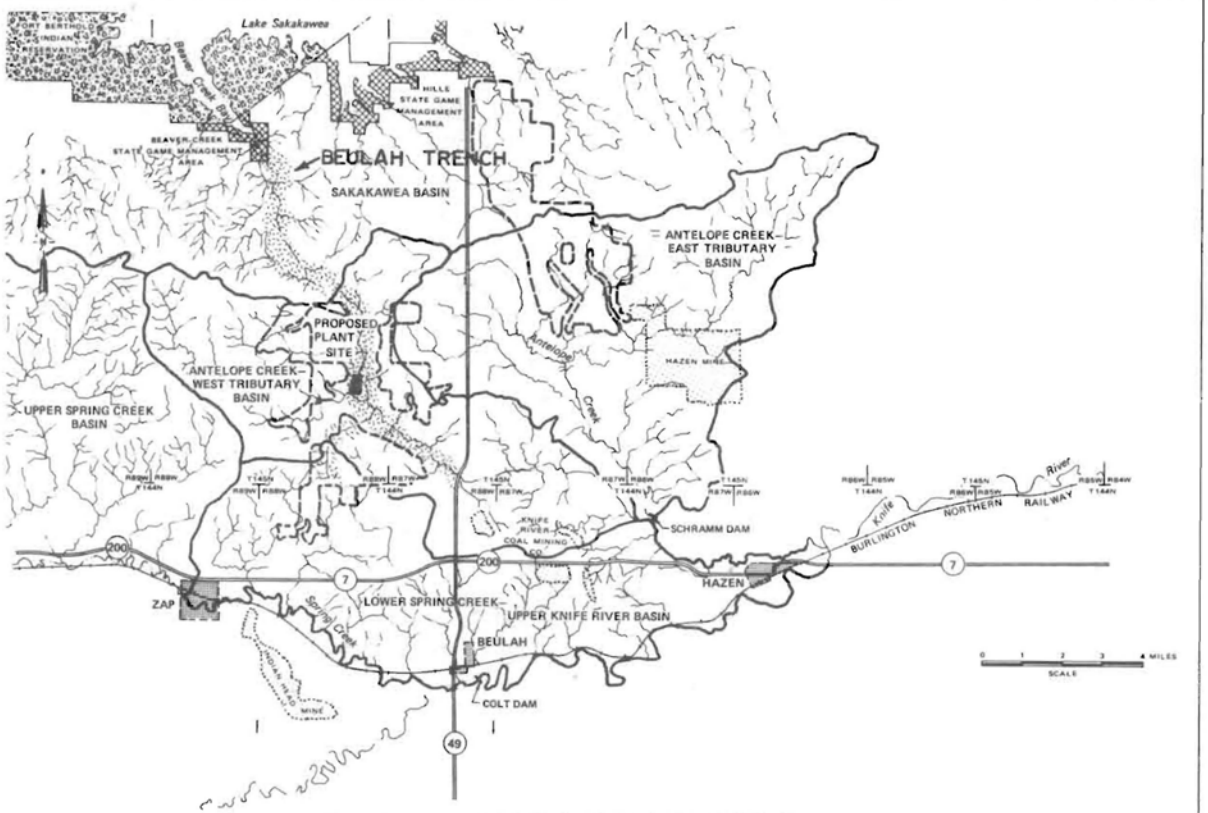


Figure 2-14 SUB-BASINS AND DRAINAGES

a. Watershed Divisions

Antelope Creek Basin - West Tributary: The west tributary of Antelope Creek drains a narrow, elongated basin 44.5 mi^2 in area including large portions of the proposed mine. The main channel is 19.8 miles long and is fed by numerous small tributaries. The stream is intermittent and retains standing or ponded water much of the year. The channel is winding to convoluted and its average slope is 25 ft/mile. Maximum channel width is about 50 feet. Sediments characteristic of the channel include alluvium varying from clay size particles to boulders, organic matter, and debris. Fine-grained alluvium is predominant and bank and bottom vegetation is common.

Antelope Creek Basin - East Tributary: The east tributary of Antelope Creek drains a broad area covering parts of the proposed eastern mine site. Total area of the basin is 51.3 mi^2. The main channel is 20.3 miles long and is fed by four major tributaries. Like the west tributary of Antelope Creek, the east tributary is intermittent, winding to convoluted, and its average slope is about 12.5 ft/mile. The east tributary of Antelope Creek is impounded by Schramm Dam near Hazen which is primarily a recreation dam, but also provides for some flood control. Channel sediment characteristics of Antelope Creek east tributary are similar to those of the west tributary.

Upper Spring Creek Basin: Spring Creek is a major stream in the study area. Upper Spring Creek Basin is that portion of the Spring Creek Basin upstream of the mine area into which no drainage from the mine site flows. The downstream limit of this basin has been placed at the U.S. Geological Survey (USGS) gage near Zap. The drainage area at this point is 549 mi^2. The maximum discharge at the gage (Table 2-2) for the period of record (March to September 1924, October 1945 to current year) was 6,130 cfs, while, at times, there has been no flow. Flow from this point is mixed with runoff from the proposed mine area into Spring Creek and the Knife River.

Lower Spring Creek - Upper Knife River Basin: The Knife River is also a major stream in the study area. Spring Creek joins the Knife River in Section 35, T. 144 N., R. 88 W. The Lower Spring Creek - Upper Knife River Basin is the area between the USGS gage on Spring Creek near Zap, and Antelope Creek. A USGS gage is located just upstream from the confluence of Antelope Creek and the Knife River near Hazen. The drainage area at this point is approximately 2,240 mi^2. Maximum discharge during the period of record (Table 2-2) was 35,300 cfs, while no flow was recorded at times.

TABLE 2-2
PEAK DISCHARGE HISTORY NEAR PROPOSED MINE

Gaging Station	Period of Record	Maximum Flood			
		Date	Gage Height (feet)	Discharge CFS	Discharge Recurrence Interval (years)
Knife River Near Golden Valley	1903-Present	Mar. 26,27, 1943	26.7	11,500	21.0
Spring Creek at Zap	1924, 1947-Present	Apr. 2, 1952	20.03	6,130	16
Knife River at Hazen	1928-33,1937-Present	June 24, 1966	26.3	35,300	50

Sources: USGS Water Supply Paper #1679, 1966.
Personal Communication with USGS Office, Bismarck, N.D., 1974

A portion of the Lower Spring Creek - Upper Knife River Basin north of Spring Creek and the Knife River is of importance because it includes a portion of the proposed mine site. This part of the mine site would drain directly to Spring Creek and eventually to the Knife River.

Lake Sakakawea Basin: North of the Antelope Creek Basin, runoff drains to Lake Sakakawea. About half of the eastern mine area currently drains to the Lake. Dendritic drainage systems in these areas flow into Beaver Creek Bay near the Hille State Game Management Area. Channels are well developed, though flow is intermittent, and they retain standing or ponded water much of the year. The convoluted channels are characterized by alluvium and grass.

b. Surface Water

Current Use: Table 2-3 lists the quantities of surface water used in Mercer County between 1969 and 1973. The greatest quantity of water was withdrawn from the Missouri River for industrial use.

Only 1,650 acre-feet of the 244,650 withdrawn for industrial use was for consumptive use; most was used for once through cooling systems at coal-fired powerplants near Stanton. The only surface water withdrawn for municipal use was at Pick City just west of the Garrison Dam. Substantial quantities of water were withdrawn for irrigation purposes.

TABLE 2-3
SURFACE WATER USE (IN ACRE-FEET PER YEAR) IN MERCER COUNTY

Use Category	1969	1970	1971	1972	1973	Average
Industrial	244,650	244,650	244,650	244,650	244,650	244,650
Municipal	5.9	6.2	7.3	6.0	8.0	6.7
Irrigation	2,996	2,495	2,372	1,563	2,393	2,364
Stock	781	825	887	943	1,015	890
TOTALS	248,432.9	247,976.2	247,916.3	247,162	248,066	247,910

Compiled by: Woodward-Envicon, Inc. 1974.

Runoff: To evaluate the potential effects of drainage from the plant-mine site, surface water stations were established on tributaries within the study area (Figure 2-15). Anticipated mean monthly runoff values are shown in Table 2-4. Total calculated runoff from the tributaries draining the plant-mine site averages 7,892 acre-feet/year (or about 1 inch of precipitation over the entire area). Most (77 percent) of the annual runoff occurs during the March, April, and May snow melt. The June, July, and August storm runoff (15 percent) is sporadic flow occurring during and shortly after heavy rains. Flood magnitudes for various recurrence intervals were estimated, using regional flood frequency curves, for ungaged surface water sites in the impact area (Table 2-5).

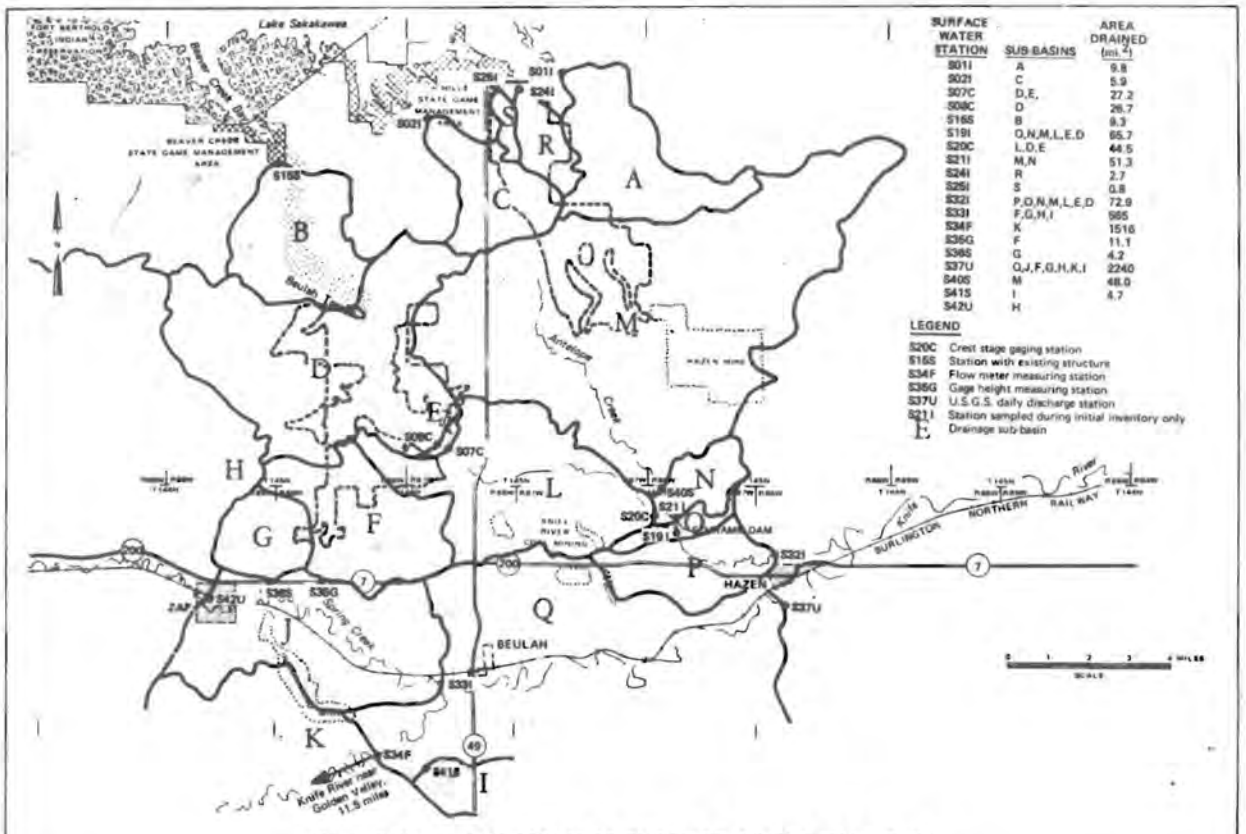


Figure 2-15 LOCATION OF SURFACE WATER STATIONS

TABLE 2-4

ANTICIPATED MONTHLY DISCHARGE AT SURFACE WATER STATIONS IN THE STUDY AREA (CFS - DAYS)

Surface Water Station	Basin Area mi.²	Avg. Daily Discharge (cfs)	Avg. Annual Discharge (cfs-days)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
S011	9.8	0.8	287.0	1.9	6.9	116.8	62.3	40.5	27.9	12.2	4.9	3.9	4.0	3.4	2.7
S021	5.9	0.5	171.5	1.7	4.1	69.8	37.2	24.2	16.1	7.4	3.9	1.7	2.4	2.1	1.6
S07C	27.2	2.2	796.0	8.0	19.1	324.0	173.0	112.0	74.8	34.2	15.5	8.0	11.1	9.5	7.4
S08C	26.7	2.1	781.0	7.8	18.7	318.0	170.0	110.0	73.4	33.6	14.3	7.8	10.9	9.4	7.3
S16S	9.3	0.7	274.0	2.7	6.6	111.0	59.7	38.6	25.8	11.8	4.7	2.7	3.8	3.3	2.5
S19I	65.7	5.2	1,916.0	19.2	46.0	780.0	418.0	270.0	180.0	82.4	33.6	19.2	26.8	23.0	17.8
S20C	44.5	3.6	1,298.0	13.0	31.2	529.0	283.0	183.0	122.0	55.9	22.1	13.0	18.2	15.6	12.1
S21I	51.3	4.1	1,496.0	15.0	35.9	609.0	326.0	211.0	141.0	64.3	25.4	15.0	20.9	17.9	13.9
S24I	2.7	0.22	78.8	0.8	1.9	32.1	17.1	11.1	7.4	3.4	1.3	0.8	1.1	0.9	0.7
S25I	0.8	0.06	23.7	0.2	0.6	9.6	5.1	3.3	2.2	1.0	0.4	0.2	0.3	0.3	0.2
S32I	72.9	5.8	2,132.0	21.3	51.2	868.0	465.0	301.0	200.0	91.7	36.2	21.3	29.8	25.6	19.8
S33I	985.0	45.2	16,498.0	165.0	396.0	6,715.0	3,597.0	2,326.0	1,551.0	709.0	280.0	165.0	231.0	198.0	153.0
S34F	1,516.0	121.0	44,267.0	443.0	1,063.0	18,017.0	9,650.0	6,242.0	4,161.0	1,903.0	752.0	443.0	620.0	531.0	412.0
S35G	11.1	0.9	325.0	3.2	7.8	132.0	70.8	45.8	30.5	14.0	5.5	3.2	4.5	3.9	3.0
S36G	4.2	0.3	124.0	1.2	3.0	50.5	27.0	17.5	11.7	5.3	2.1	1.2	1.7	1.5	1.1
S37U	2,240.0	179.0	65,408.0	654.0	1,570.0	26,621.0	14,259.0	9,223.0	6,148.0	2,812.0	1,112.0	654.0	916.0	785.0	608.0
S40S	48.0	3.8	1,402.0	14.0	33.6	571.0	306.0	198.0	132.0	60.2	23.8	14.0	19.6	16.8	13.0
S41S	4.7	0.4	135.0	1.4	3.3	56.1	30.1	19.6	13.1	6.0	2.4	1.4	1.9	1.7	1.3
S42U	149.0	11.9	4,331.0	160.0	383.0	6,525.0	3,494.0	2,260.0	1,507.0	689.0	272.0	160.0	224.0	192.0	148.0
Knife River near Golden Valley	1,230.0	98.4	35,916.0	358.0	862.0	14,618.0	7,830.0	5,064.0	3,376.0	1,544.0	611.0	359.0	503.0	431.0	334.0

Source: Woodward-Envicon, Inc. 1974.

TABLE 2-5

ESTIMATES OF FLOOD MAGNITUDES IN THE STUDY AREA BASED ON U.S. GEOLOGICAL SURVEY FLOOD-FREQUENCY CURVES

Surface Water Site[1]	Mean Annual Flood (cfs)[2]	Flood Intensity (in cfs) for Selected Recurrence Intervals: 1.1 Years Discharge (cfs)	2 Years Discharge (cfs)	5 Years Discharge (cfs)	10 Years Discharge (cfs)	25 Years Discharge (cfs)
S19I	500	60	425	960	1,375	2,065
S20C	400	48	340	768	1,100	1,625
S21I	450	54	383	864	1,238	1,859
S32I	550	66	467	1,056	1,375	2,271
S35G	180	22	153	346	495	743
S08C	290	35	247	557	797	1,198
S07C	300	36	255	576	855	1,239
S40S	430	52	366	826	1,183	1,776
S33I	1,900	228	1,615	3,648	5,225	7,847
S34F	3,400	408	2,890	6,528	9,350	14,042
S37U	4,400[3]	528	3,740	8,448	12,100	18,172
S42U	1,800[4]	216	1,530	3,456	4,950	7,434

[1] Stations with drainage basins less than 10 mi^2 have been excluded.

[2] Defined as a flood having a recurrence interval of 2.33 years in the annual flood series.

[3] Calculated value = 4,300 cfs.

[4] Calculated value = 1,850 cfs.

Source: Woodward-Envicon, Inc. Analysis, 1974.
USGS Water Supply Paper #1679, 1966.

Three dams, Garrison, Colt, and Schramm, are the largest control structures affecting the study area. Most of the smaller control structures in the area are earthen dams or roadways. Many residents have impounded water in streams transecting their property. Consequently, runoff at the surface water stations is probably lower than the calculated values (Table 2-4).

Soil Storage: Figure 2-16 details the general soil drainage characteristics of the plant-mine study area (defined in Figure 2-14). Numerous shallow depressions dot the study area and retain ponds

of water during certain times of the year. Total surface area of these potholes is about 640 acres. For a maximum infiltration rate of 0.01 feet/day (7), and 10 months/year, the contribution to recharge of the underlying aquifers of these potholes would be about 1,900 acre-feet/year.

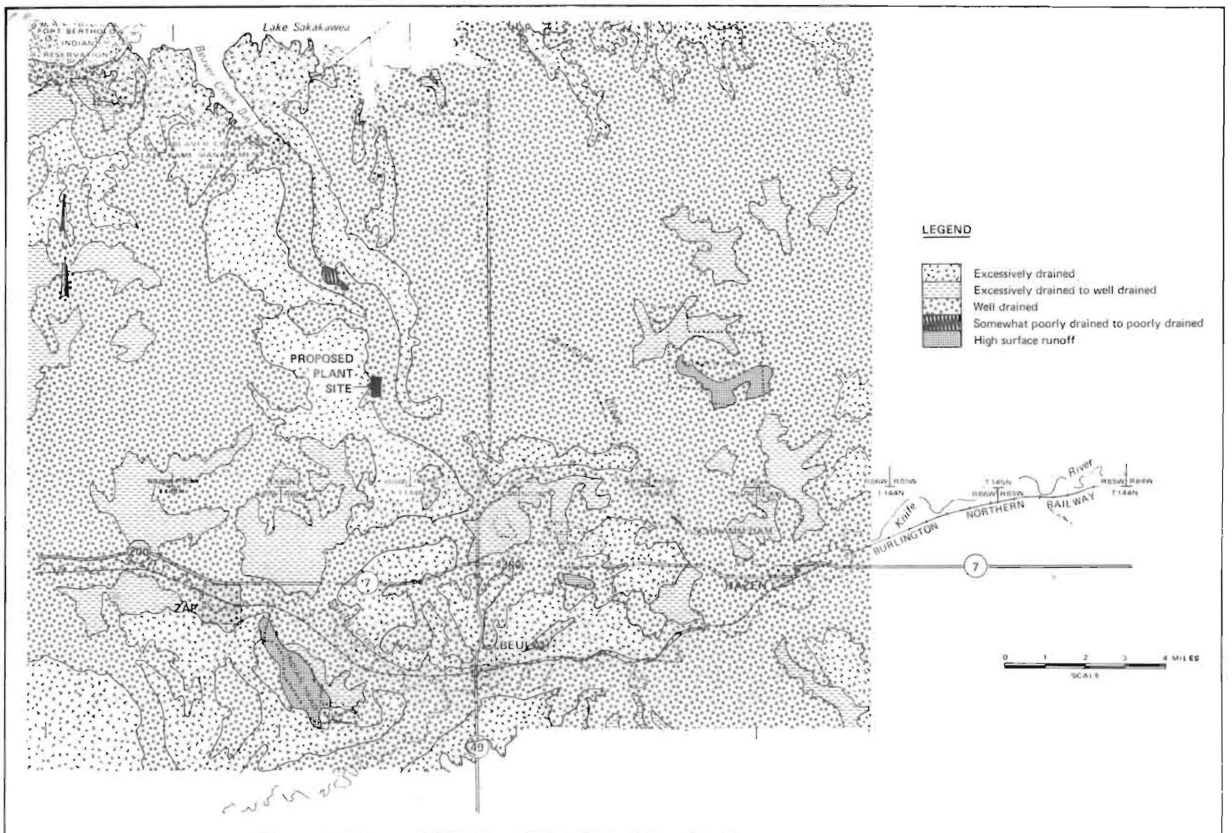
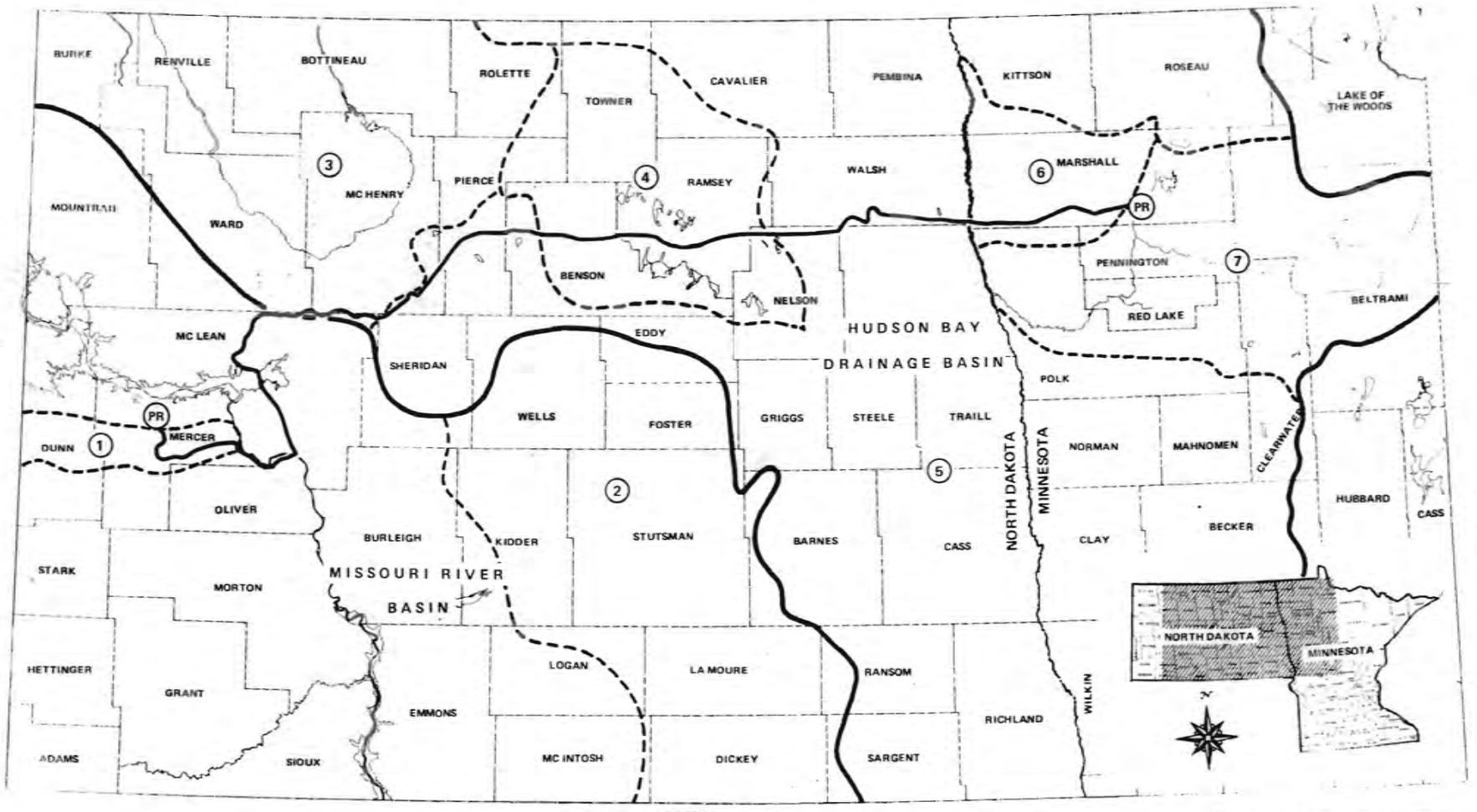


Figure 2-16 GENERALIZED SOIL DRAINAGE CHARACTERISTICS

Product Pipeline: The proposed product pipeline crosses parts of two major drainage systems; the Missouri River and the Hudson Bay drainages. The drainages and their subbasins are shown in Figure 2-17. Natural streamflows range from dry or nearly dry conditions in late summer to flood stage during the spring thaw and occasional intense summer showers. However, an extensive reservoir system regulates streamflows on the major rivers, with the exception of the main stem of the Red River of the North. Whereas large extremes in runoff can occur, average annual runoff is relatively small; ranging from one-fourth of an inch in portions of the Devils Lake subbasin up to about 2 inches near Red Lake, Minnesota (15, 16).



LEGEND:

MISSOURI RIVER BASIN
1. KNIFE RIVER DRAINAGE
2. JAMES RIVER SUBBASIN

HUDSON BAY BASIN
3. SOURIS RIVER SUBBASIN
4. DEVILS LAKE SUBBASIN
5. RED RIVER SUBBASIN
6. MIDDLE SNAKE RIVER WATERSHED
7. RED LAKE WATERSHED

(PR) PROPOSED ROUTE

Figure 2-17 WATERSHEDS AND MAJOR DRAINAGES WITHIN THE PROJECT REGION*

* ADAPTED FROM: U.S. DEPARTMENT OF INTERIOR, WATER ATLAS OF THE UNITED STATES

The principal waterways crossed by the proposed route are shown in Figure 2-18. On the Missouri River Basin the Knife River would be crossed east of Hazen just above the mouth of Antelope Creek, and the Missouri River would be crossed above Washburn. In the Hudson Bay drainage system the major rivers crossed include the Big Coulee, various branches of the Forest River, the Marias River, the Red River of the North, and the Snake River.

In all, 86 water crossings are projected along the pipeline route (Table 2-6). These crossings are tabulated in Table 2-7. Group classifications in Table 2-7 are defined in Table 2-6; best use classifications are related to water quality standards. Flow data for most major streams are available (17) and need not be detailed here.

TABLE 2-6

CUMULATIVE TABULATION OF PROPOSED PIPELINE WATER CROSSINGS

GROUP	DESIGNATED GROUP TYPES	NUMBER(S)
I	DRAINAGE DITCHES AND/OR CANALS	1
II	INTERMITTENT STREAMS	38
III	INTERMITTENT POTHOLE LAKES	27
IV	PERENNIAL POTHOLE LAKES	5
V	RIVERS AND CREEKS	10
VI	MAJOR RIVERS	2
VII	MAJOR LAKES AND/OR IMPOUNDMENTS	3
TOTAL		86*

*INCLUDES 4 CROSSINGS OF THE SNAKE RIVER.

c. Ground Water

Current Use: Table 2-8 lists the amount of ground water withdrawn for various uses in Mercer County during 1969 through 1973. Most ground water is withdrawn for domestic and stock use from private wells throughout the county. The towns of Beulah, Hazen, Zap, and Golden Valley have municipal water supply wells for which statistics are listed in Table 2-9.

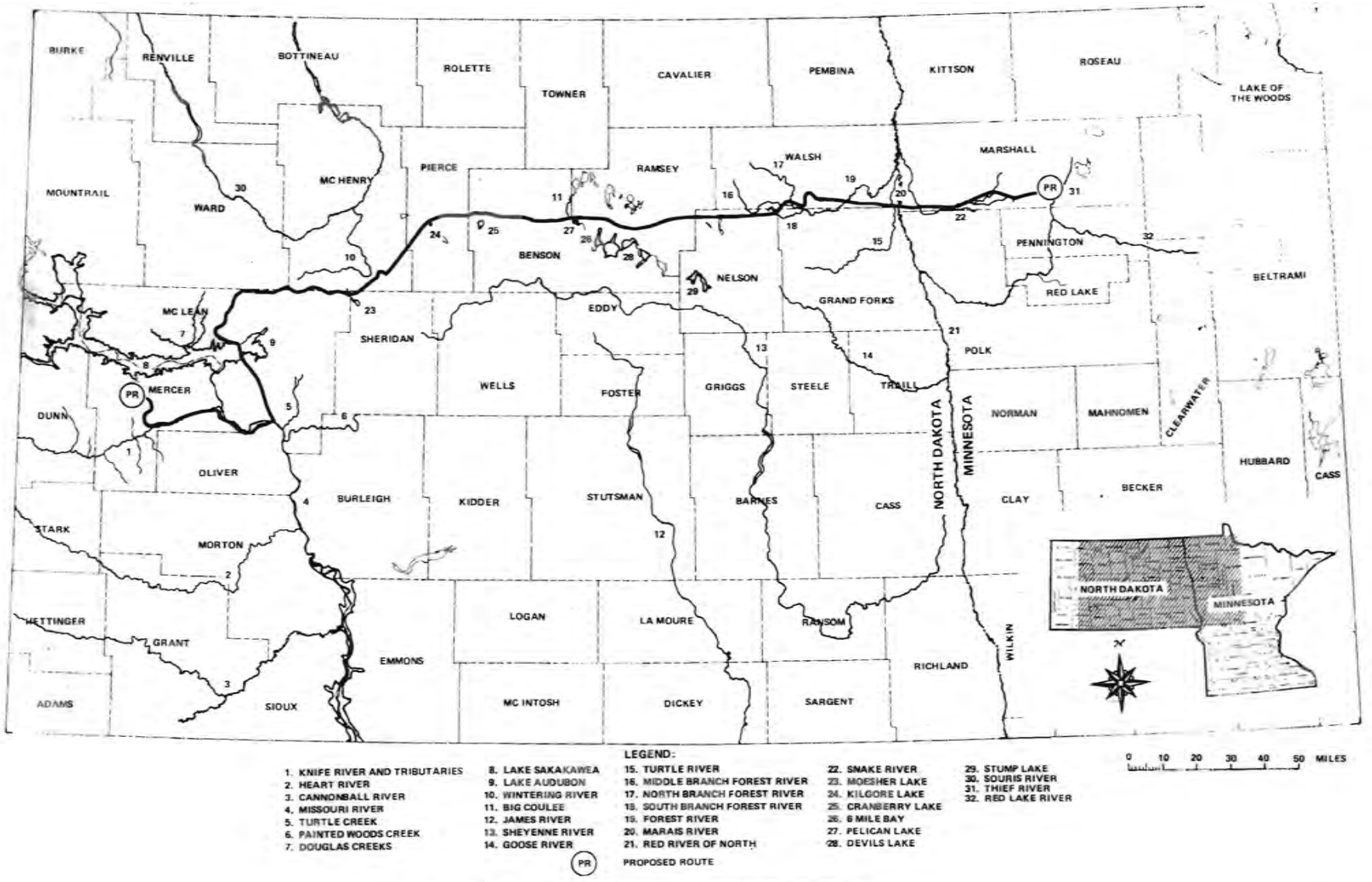


Figure 2-18 MAJOR WATERWAYS IN THE PROJECT REGION

TABLE 2-7
PIPELINE WATER CROSSINGS – PROPOSED ROUTE

NORTH DAKOTA		
COUNTY AND CROSSINGS	GROUP	BEST USE CLASSIFICATION
MERCER		
2 TRIBUTARIES, ANTELOPE CREEK	II	NC*
KNIFE RIVER	V	CLASS II
KINNEMAN CREEK	II	NC
ALDERIN CREEK	II	NC
UNNAMED TRIBUTARY, MISSOURI RIVER	II	NC
OLIVER		
4 UNNAMED TRIBUTARIES		
MISSOURI RIVER	II	NC
MISSOURI RIVER	VI	CLASS I
MC LEAN		
BUFFALO CREEK	II	NC
3 POTHOLES	IV	NC
WOLF CREEK	II	NC
LAKE SAKAKAWEA	VII	CLASS I
LAKE AUDUBON	VII	CLASS I
UNNAMED TRIBUTARY, LAKE SAKAKAWEA	II	NC
BAY OF LAKE SAKAKAWEA	VII	CLASS I
POTHOLE LAKE	IV	NC
4 POTHOLES	III	NC
WARD		
POTHOLE LAKE	III	NC
UNNAMED TRIBUTARY	II	NC
MC LEAN		
4 POTHOLE LAKES	III	NC
MC HENRY		
UNNAMED TRIBUTARY, WINTERING RIVER	II	NC
MC LEAN		
3 UNNAMED TRIBUTARIES, COTTONWOOD LAKE	II	NC
SHERIDAN		
UNNAMED TRIBUTARY FROM MOESNER LAKE	II	NC
POTHOLE LAKE	III	NC
MC HENRY		
2 UNNAMED TRIBUTARIES, AYLMER LAKE	II	NC
PIERCE		
TRIBUTARY OF KILGORE LAKE	II	NC
POTHOLE LAKE	IV	NC
POTHOLE LAKE	III	NC
TRIBUTARY SMALL RESERVOIR	II	NC
3 POTHOLE LAKES	III	NC

*NC – NON-CLASSIFIED

TABLE 2-7 (Continued)
PIPELINE WATER CROSSINGS – PROPOSED ROUTE

NORTH DAKOTA (Continued)		
COUNTY AND CROSSINGS	GROUP	BEST USE CLASSIFICATION
BENSON		
UNNAMED TRIBUTARY, CRANBERRY LAKE	II	NC
TRIBUTARY, BIG COULEE	II	NC
3 POTHOLE LAKES	III	NC
2 TRIBUTARIES, DEVILS LAKE	II	NC
MARSH	III	NC
BIG COULEE	V	NC
POTHOLE LAKE	III	NC
RAMSEY		
TRIBUTARY, 6 MILE BAY	II	NC
5 POTHOLE LAKES	III	NC
NELSON		
3 POTHOLE LAKES	III	NC
MIDDLE BRANCH FOREST RIVER	II	NC
2 TRIBUTARIES, SOUTH BRANCH, FOREST RIVER	II	NC
GRAND FORKS		
2 TRIBUTARIES, SOUTH BRANCH, FOREST RIVER	II	NC
WALSH		
MIDDLE BRANCH, FOREST RIVER	V	NC
NORTH BRANCH, FOREST RIVER	V	CLASS III
2 TRIBUTARIES, FOREST RIVER	II	NC
FOREST RIVER	V	CLASS II
2 TRIBUTARIES, ARDOCH LAKE	II	NC
MARAIS RIVER	V	NC
RED RIVER OF THE NORTH	VI	CLASS I
MINNESOTA		
COUNTY AND CROSSINGS	GROUP	BEST USE CLASSIFICATION
MARSHALL		
RED RIVER OF THE NORTH	VI	CLASSES 1C, 2C, & 3B
TRIBUTARY, SNAKE RIVER	II	UNCLASSIFIED
4 CROSSINGS, SNAKE RIVER	V	CLASSES 2B, 3C, & 4A
TRIBUTARY CANAL, MIDDLE RIVER	I	UNCLASSIFIED

TABLE 2-8

GROUNDWATER USE (IN ACRE-FEET/YEAR) IN MERCER COUNTY

Use Category	1969	1970	1971	1972	1973	Average
Industrial	101	101	101	101	101	101
Municipal	252	274	303	301	327	291
Domestic	194	194	179	179	166	182
Stock	335	354	380	404	435	382
TOTALS	882	923	963	985	1029	956

Calculated by: Woodward-Envicon, Inc. 1974.

TABLE 2-9

MUNICIPAL WELLS IN MERCER COUNTY

Location (township-range-section)	Municipality	Well Depth (feet)	Casing Dia. (in.)	Depth to 1st Perforation (feet)	Date Drilled	Aquifer
144/88/25AD2	Beulah	153	8	----	1953	Sentinel Butte
144/88/25CA	Beulah	114	10	----	1961	Outwash
144/88/25CCA	Beulah	46	--	----	1952	----
144/88/25CD	Beulah	126	--	----	1961	Outwash
144/86/18ADA2	Hazen	69	12	59	1944	Outwash
144/86/18ADA3	Hazen	65	--	----	1944	Outwash
144/86/18ADA4	Hazen	---	--	----	1964	Outwash
144/89/14CDD	Zap	1281	--	1249	1969	Hell Creek - Fox Hills
144/90/15DB	Golden Valley	1325	6	1275	1968	Hell Creek - Fox Hills

Source: North Dakota Geological Survey, Bulletin #56, Part II, 1970.

Geohydrology: Table 2-10 presents a stratigraphic column of the units in the study area which make up major aquifers, and shows various aquifer characteristics. The Fox Hills formation of Cretaceous age is the oldest unit that supplies water to wells in the area. Deeper units have not been tapped to date. The permeable sands and sandstones of Cretaceous and Paleocene age make up the principle aquifers in the area; Paleocene lignite deposits make up the lesser aquifers. (Lesser aquifers yield less water than principle aquifers.) In addition, small areas of perched water occur locally in near-surface sediments. The most significant water bearing strata are the glacial and fluvial sands and gravels in the Beulah Trench. Wells into these sediments exhibit large yields of relatively good quality water.

Wells and Springs: An inventory of wells and springs in the impact area is summarized in Appendix E. In addition, well points and casing were installed in 13 coal boreholes. These wells are in, just below, and just above the Beulah-Zap bed, and within the lower seams. The wells selected for ground-water studies are shown in Figure 2-19.

Figures 2-20 and 2-21 show historic water levels (1966-1969) and flow patterns in aquifers in the study area. The cone of depression in the potentiometric surface of the Fox Hills - Basal Hell Creek aquifer is reportedly due to an estimated withdrawal of 0.5 mgd flowing from wells tapping the aquifer (8).

Figures 2-22 and 2-23 show ground-water level data obtained during the inventory and baseline survey. It is apparent that a ground-water divide exists in Beulah Trench a few miles south of Beaver Creek Bay (1865.8 water level). Figure 2-24 presents hydrographs of selected wells in the study area. The wells, located near Lake Sakakawea, Beulah Trench, Beulah, and Hazen, penetrate outwash aquifers (water table and artesian), lignite aquifers, and the Fox Hills - Basal Hell Creek aquifer. The water level declines in three wells (Hazen, northwest of Hazen, and south of Beulah) may be associated with their location in the areas of development and municipal ground-water use.

The relationship of water levels in wells near Lake Sakakawea to storage in the lake shows the effect that storage has on the total ground-water regime. A water level reading taken in 146-88-10DDC during July 1951, prior to the onset of storage in the lake (November 1953), indicates that the water level was more than 20 feet below what it was in 1967.

TABLE 2-10
STRATIGRAPHY AND PHYSICAL PARAMETERS OF AQUIFERS OCCURRING IN THE STUDY AREA

System	Series	Group or Formation		Dominant Lithology	Aquifer	Aquifer Thickness (ft)	Dip of Potentiometric Surface	Hydraulic Gradient (ft/mi)	Transmissivity (gpd/ft)	Storage	Expected Yield (gpm)
Quaternary	Holocene Pleistocene	Wash Coleharbor		Silt, clay & sand Sandy loam, sand & gravel	Antelope Creek and Alluvial - all parameters variable -	0-250	North to South & South to North	Variable	----	(total) 260,000 acre-feet	100-500
Tertiary	Eocene	Golden Valley		Clay, sandstone & lignite	----------						
	Paleocene	Fort Union Group	Sentinel Butte	Shale, clay, sandstone & lignite	Tongue River - Sentinel Butte -	Variable	Variable	Variable	Variable	Variable	Probably <10
			Tongue River	Shale, sandstone & lignite							
			Cannonball-Ludlow	Marine sandstone & shale	Upper Hell Creek - Lower Cannonball - Ludlow -	70-150	West to East	----	180-4,200	(coefficient) 1-4	5-100
Cretaceous		Montana Group	Hell Creek	Continental Sandstone & shale							
			Fox Hills	Marine sandstone & shale	Fox Hills - Basal Hell Creek	150-370	West to East	7.5-4.0	13-3,100 (avg. 510)	(coefficient) 1-4 to 1-5	25-150

Source: North Dakota Geological Survey Bulletin 56 - Parts I and III, 1973.

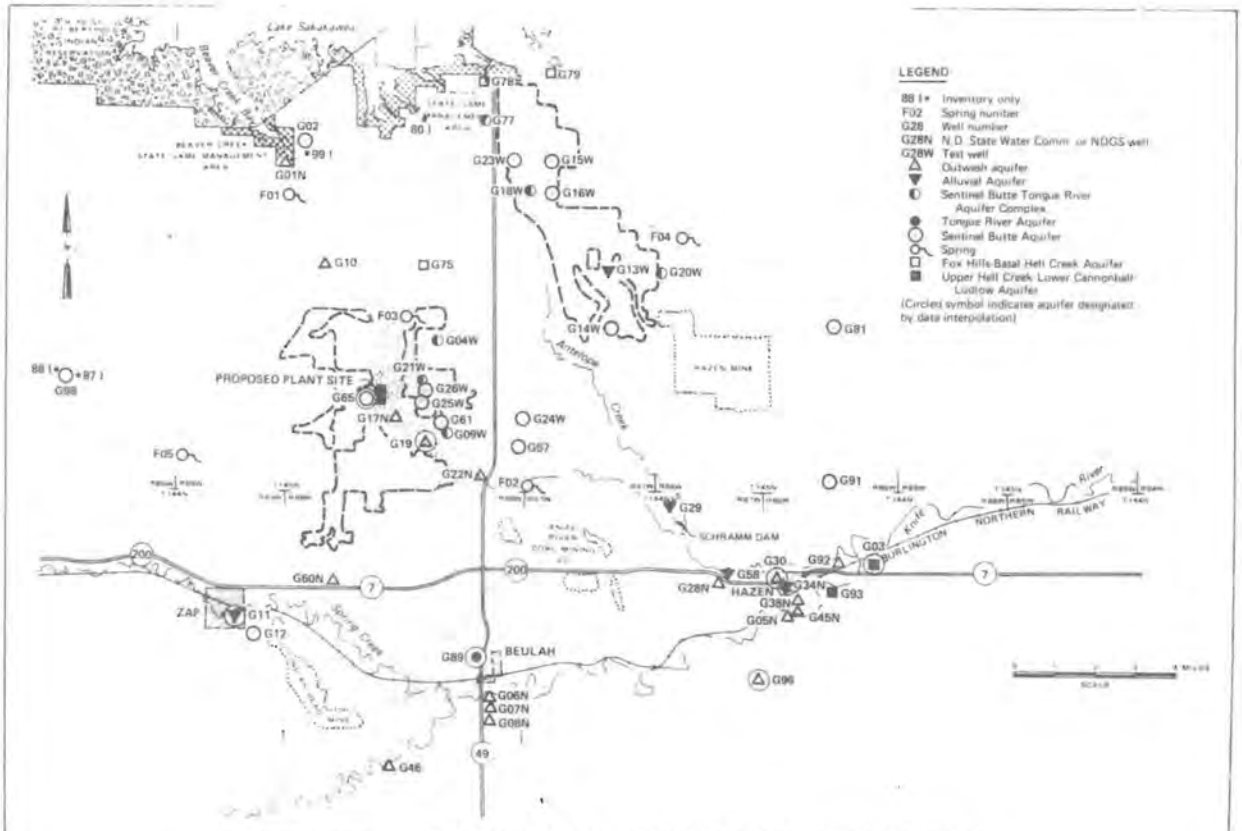
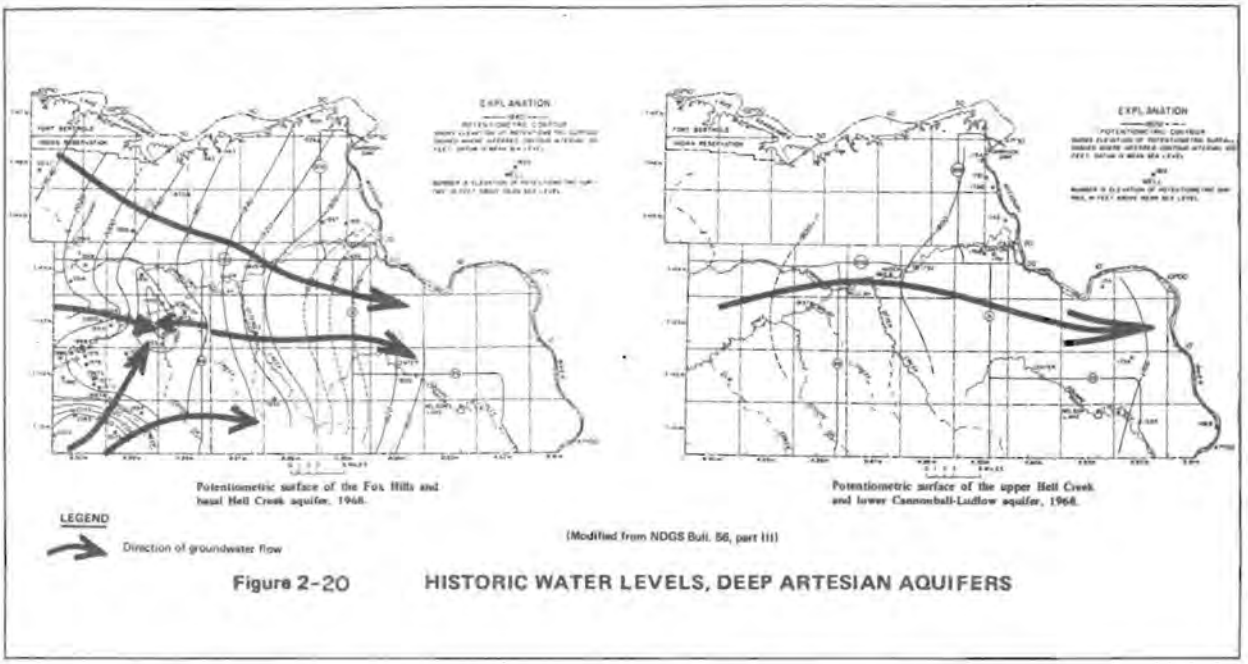


Figure 2-19 LOCATIONS OF SPRINGS AND WELLS INVESTIGATED



Potentiometric surface of the Fox Hills and basal Hell Creek aquifer, 1968.

Potentiometric surface of the upper Hell Creek and lower Cannonball-Ludlow aquifer, 1968.

(Modified from NDGS Bull. 56, part III)

Figure 2-20 HISTORIC WATER LEVELS, DEEP ARTESIAN AQUIFERS

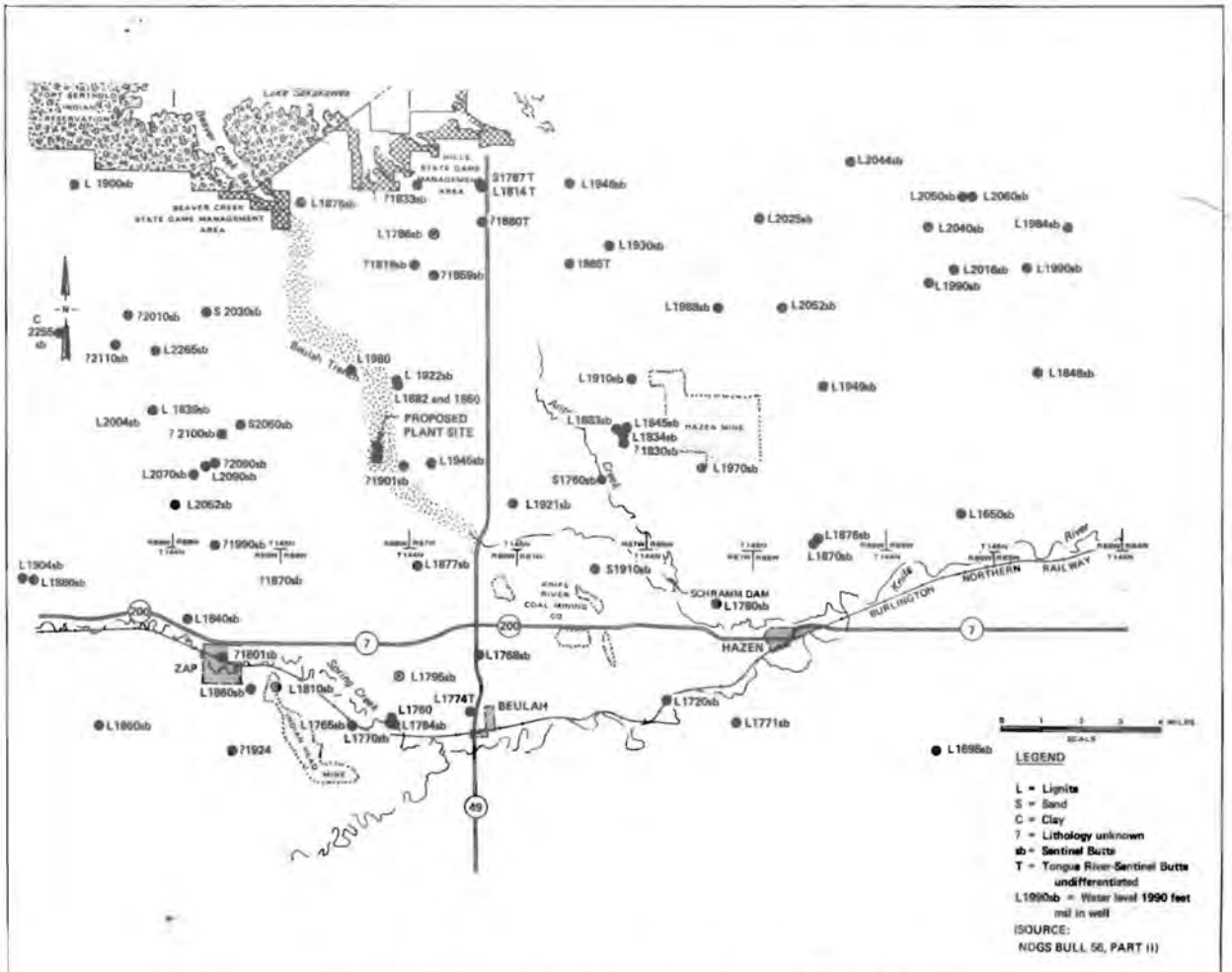


Figure 2-21 HISTORIC WATER LEVELS (1966-1969) TONGUE RIVER-SENTINEL BUTTE AQUIFERS

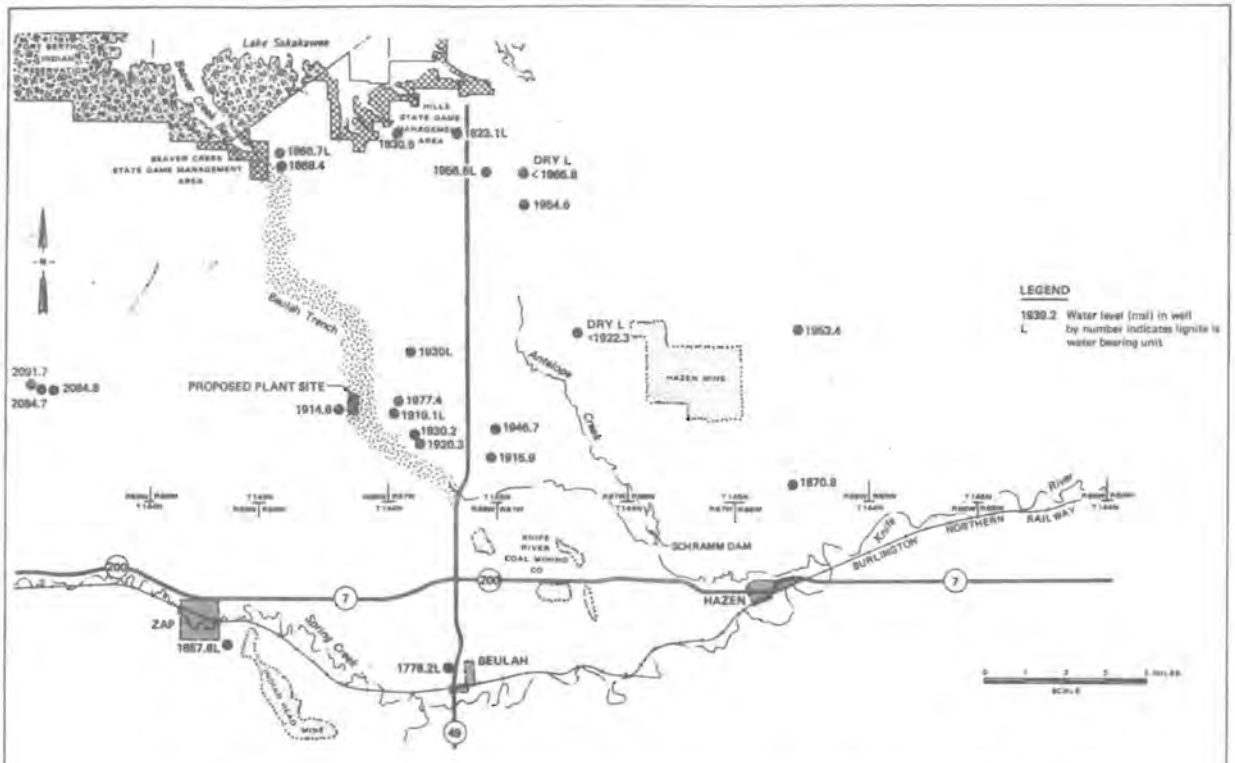


Figure 2-22 BASELINE WATER LEVELS IN TONGUE RIVER-SENTINEL BUTTE AQUIFER COMPLEX (MSL)

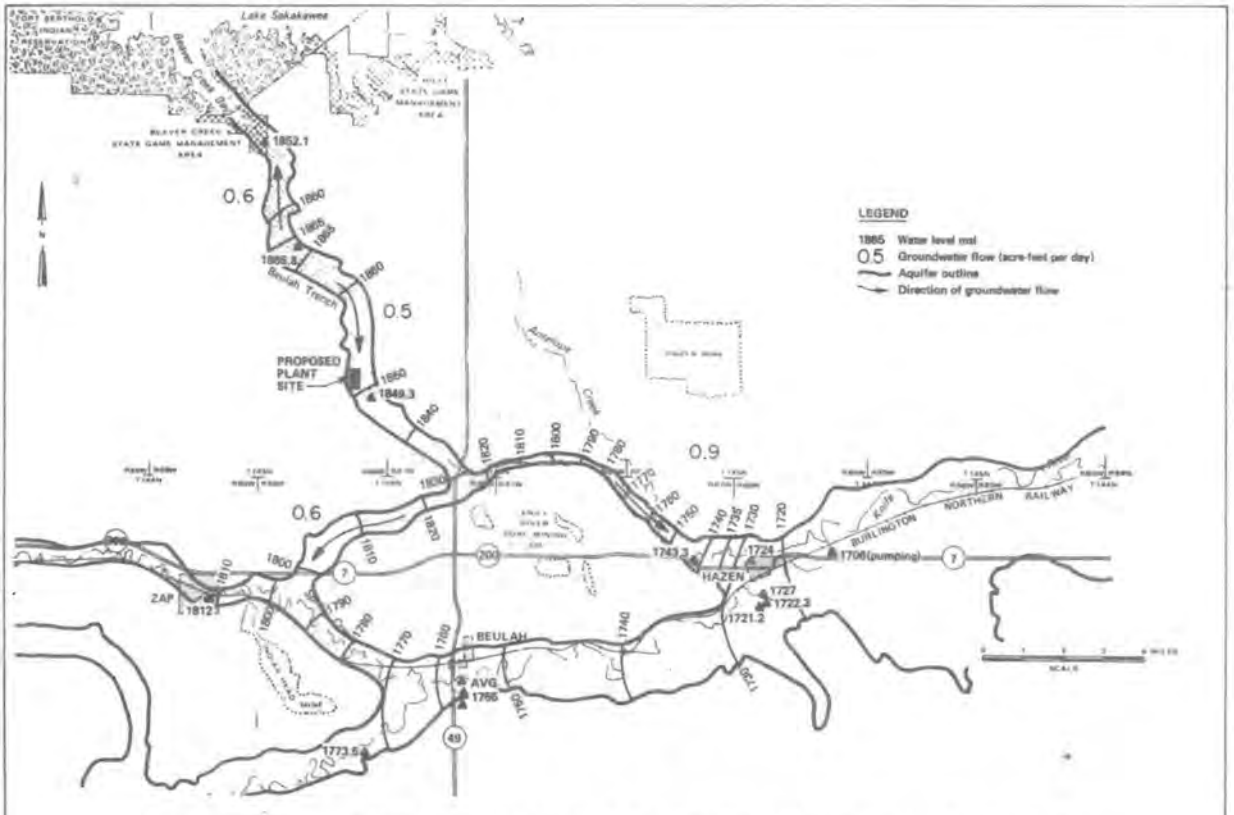


Figure 2-23 BASELINE WATER LEVELS (MSL) IN GLACIAL OUTWASH AQUIFERS

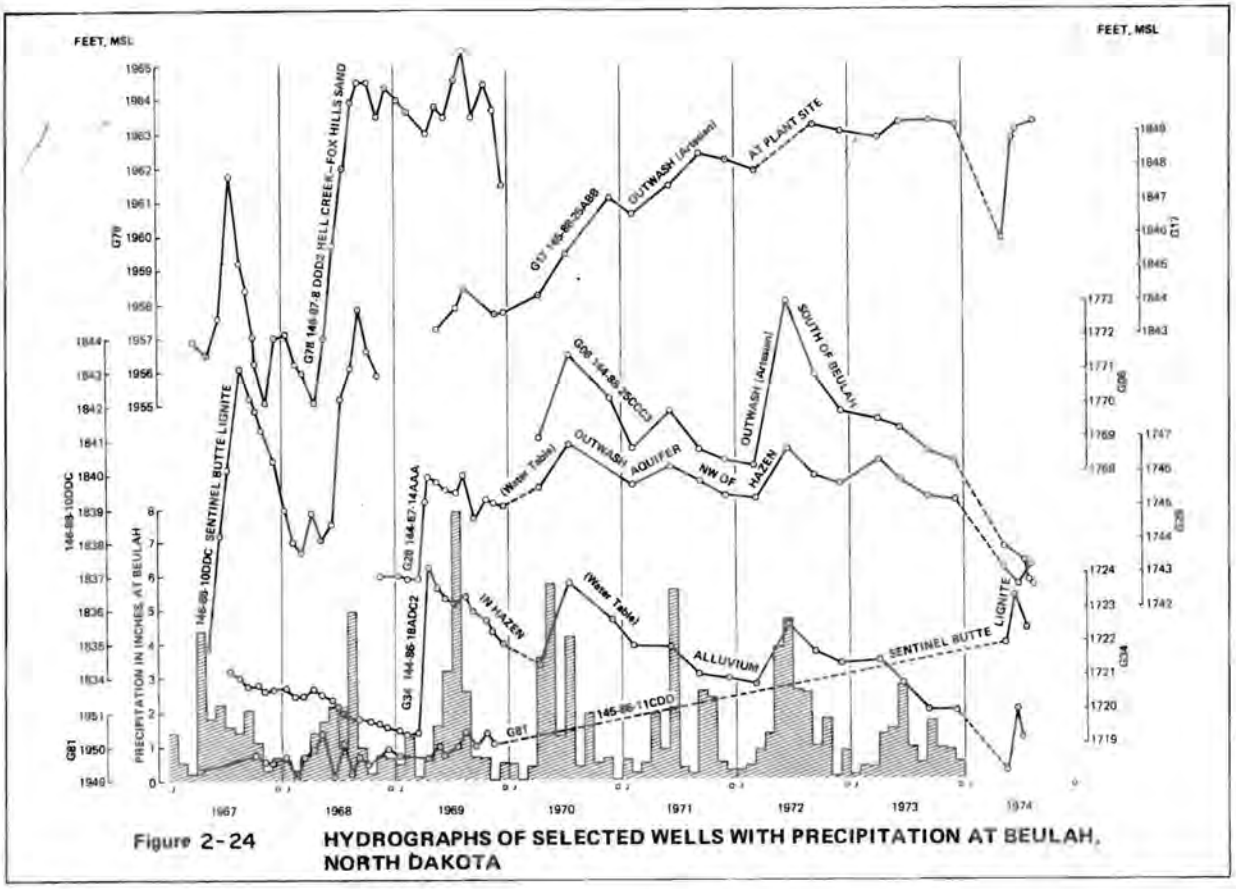


Figure 2-24 **HYDROGRAPHS OF SELECTED WELLS WITH PRECIPITATION AT BEULAH, NORTH DAKOTA**

Data on springs indicate that total discharge from measured springs was about 8.26 gpm (or a total discharge of about 2.2 acre-feet) during May and June. This represents only a portion of total spring discharge in the study area as numerous other springs and seeps are known to occur. Many residents pipe these springs into stock watering troughs. Springs occur along the slopes of Beulah Trench and in the stream channels adjacent and perpendicular to the trench where water-bearing Sentinel Butte sediments are exposed. Such springs are intermittent, and their flow rates are proportional to water levels in the sediments. Surface discharge of water from localized alluvial aquifers also occurs intermittently in a number of locations.

Recharge, Movement, and Discharge: The Antelope Creek aquifer is composed of permeable, glaciofluvial sand and gravel deposits which extend from Lake Sakakawea to its confluence with the Knife River aquifer near Hazen. Sandy silts and clays serve as

confining layers. The aquifer is less than 1 mile wide, about 250 feet thick, and about 18 miles long. Water from the aquifer is used for irrigation. Precipitation is a significant source of recharge. Ground-water outflow from Beulah Trench is estimated to be about 1.1 acre-feet/day (Figure 2-23), which is probably conservative because if net recharge is 1 inch per year, inflow would exceed outflow by more than seven times.

Water is contained within numerous aquifers in the Sentinel Butte and Tongue River formations including permeable units of sand, sandstone, and fractured lignite. Each of the two formations attains a maximum thickness of about 500 feet in Mercer County. Water levels in the Tongue River-Sentinel Butte aquifers are similar to, but more gently sloping than, the topography of the water-bearing beds. In areas where artesian conditions exist, pressures are generally low as are yields of wells penetrating the aquifers. The baseline inventory indicated that lignites in the study area are not totally saturated and that water contained in them is commonly under water-table (nonartesian) conditions. Generalized cross sections of wells installed in coal boreholes are shown in Figures 2-25 and 2-26. Saturated thickness of the lignites ranges from 0-18 feet. Injection tests of wells G09W and G16W yielded transmissivity values of about 10 to 350 gpd/foot. The average saturated thickness of the Beulah-Zap bed was estimated to be about 4 feet; however, even if a thickness of 9 feet is assumed, flow of water through a cross section of the aquifer parallel to a water level contour would be less than 0.01 gpm/linear foot of cross section. Considering the case where G26W penetrates a water-bearing silty, clayey sand unit in the Sentinel Butte with a water level at 1977.4 feet (above msl) and G25W penetrates water-bearing lignite with a water level of 1919.1 feet, downward leakage of the sand to the lignite (assuming a hydraulic conductivity of 0.134 feet/day) is about 0.2 gpd/feet^2.

The low leakage rate in to and out of lignite units from adjacent aquifers is believed to hold true for most of the impact area because of thick clays that separate the permeable units. The percentage of impermeable units in the overburden of the Beulah-Zap bed, calculated from stratigraphic logs of the 32 boreholes, ranges from 49 to 100 percent, averaging 88 percent. The strata between the Beulah-Zap bed and the lower seams is comprised of impermeable clays. No aquifers or potential aquifers have been identified between these horizons.

The overburden of the Beulah-Zap bed contains an average aggregate thickness of about 14 feet of permeable units, some of which may function as minor aquifers. Applying appropriate porosity values

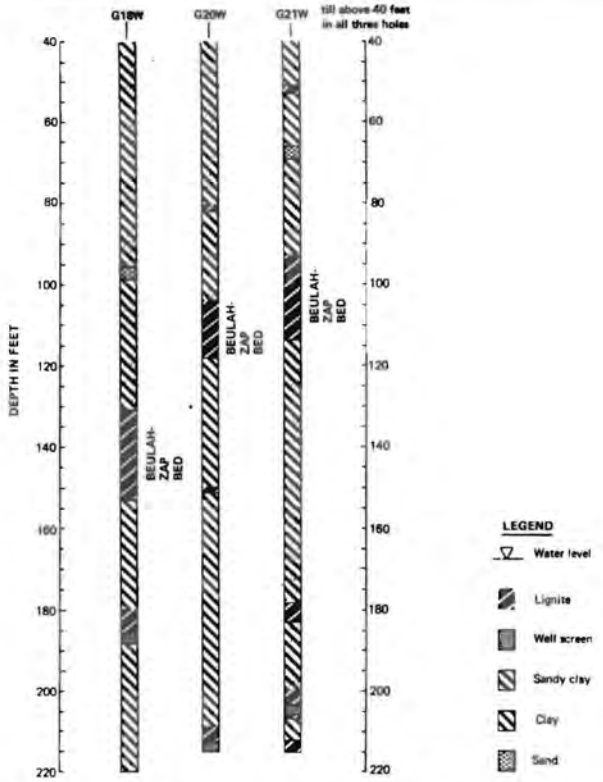


Figure 2-25 GENERALIZED CROSS SECTIONS OF TEST WELLS (THIS STUDY)

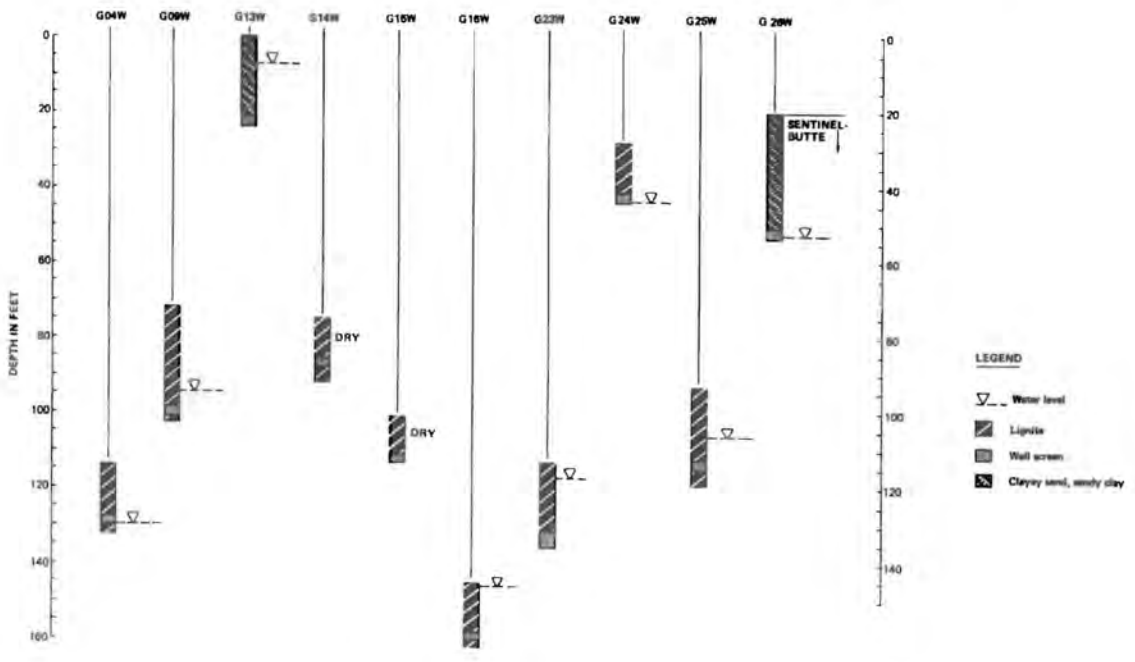


Figure 2-26 GENERALIZED CROSS SECTIONS OF TEST WELLS (THIS STUDY)

to the various lithic units, the total potential water content of permeable overburden averages about 4 feet/unit area. In many parts of the study area, no saturated permeable beds exist above the Beulah-Zap seam; therefore, actual water content of permeable overburden may be less than half the potential. Impermeable portions of the overburden contain water but do not function as aquifers. Clays frequently exhibit a water content of 20-30 percent of weight; however, this water is held in pore space and moves at extremely slow rates. Permeability of a slightly silty clay sample from Beulah Trench was calculated from compaction data to equal 0.34 feet/day. Depending on silt and sand content, permeability values of clay units may range from about 0.1 to over 10 feet/day. The impermeable character of the overburden and its low leakage rates, coupled with the semiarid climate of the area, suggest a low water content for the Tongue River-Sentinel Butte aquifers.

The average thickness of the Beulah-Zap bed within the mine area is 14 feet. If the bed were totally saturated throughout, it would contain about 3 feet of water per unit area. Wells for which stratigraphic data is available, however, indicate that saturation of the Beulah-Zap bed is highly variable, but averages about 1 foot/unit area. Some of the water in the Beulah-Zap bed slowly leaks downward through thick clays into lower seams. Since these seams are thin and contained by clays, their hydrologic characteristics are not significant enough to classify them as aquifers.

The upper Hell Creek-lower Cannonball-Ludlow aquifer underlies all of the study area and is composed of fine-grained sandstones. These sandstones lie near the formational boundary, and are underlain and overlain by continental siltstones, claystones, and a few thin beds of carbonaceous shale. Water from the aquifer is used for domestic and stock purposes.

The Fox Hills-Basal Hell Creek aquifer also underlies the entire study area. Water producing beds are sandstones of the upper Fox Hills and lower Hell Creek formations. Water from this aquifer is used for municipal, domestic, and stock purposes. Water age data indicates that recharge takes place very slowly. This is in part a function of the depth of the aquifer as well as its distance from recharge areas where it is at or near the surface.

Figures 2-27, 2-28, and 2-29 present the relationships between aquifers. Water from the Fox Hills-Basal Hell Creek aquifer moves upward to recharge the upper Hell Creek-lower Cannonball-Ludlow aquifer. Although the Tongue River-Sentinel Butte aquifers are primarily recharged by infiltration of rainfall and snowmelt, head

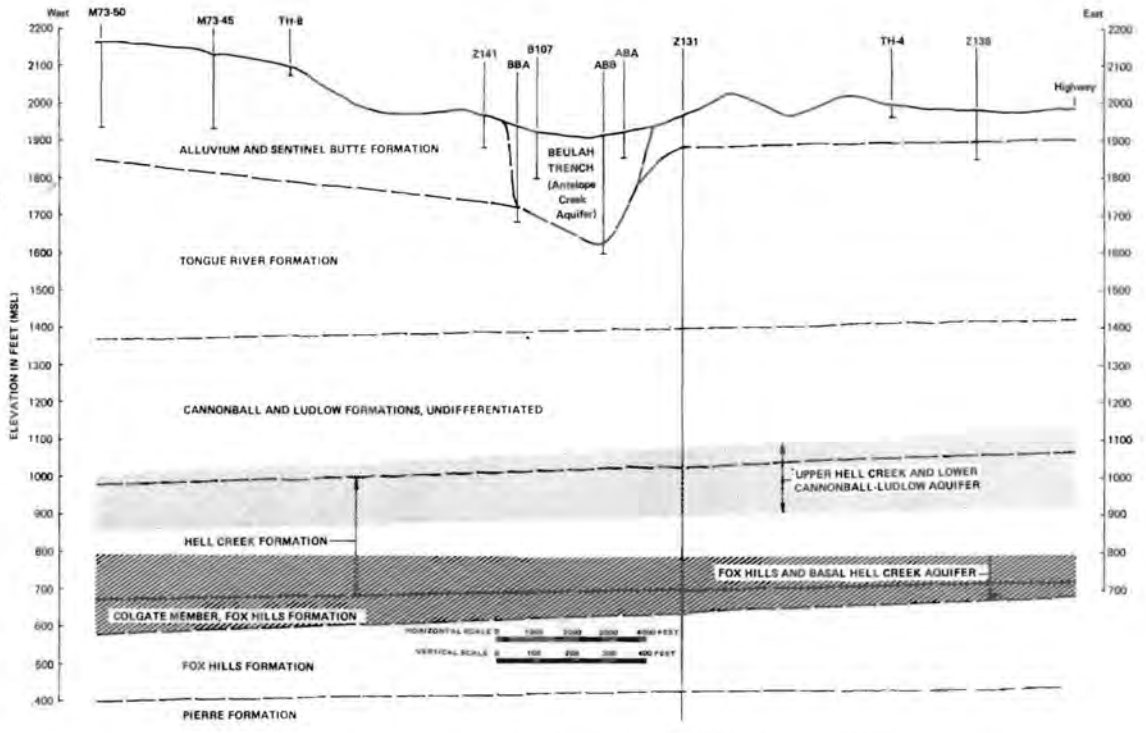


Figure 2-27 DIAGRAMMATIC HYDROGEOLOGIC SECTION

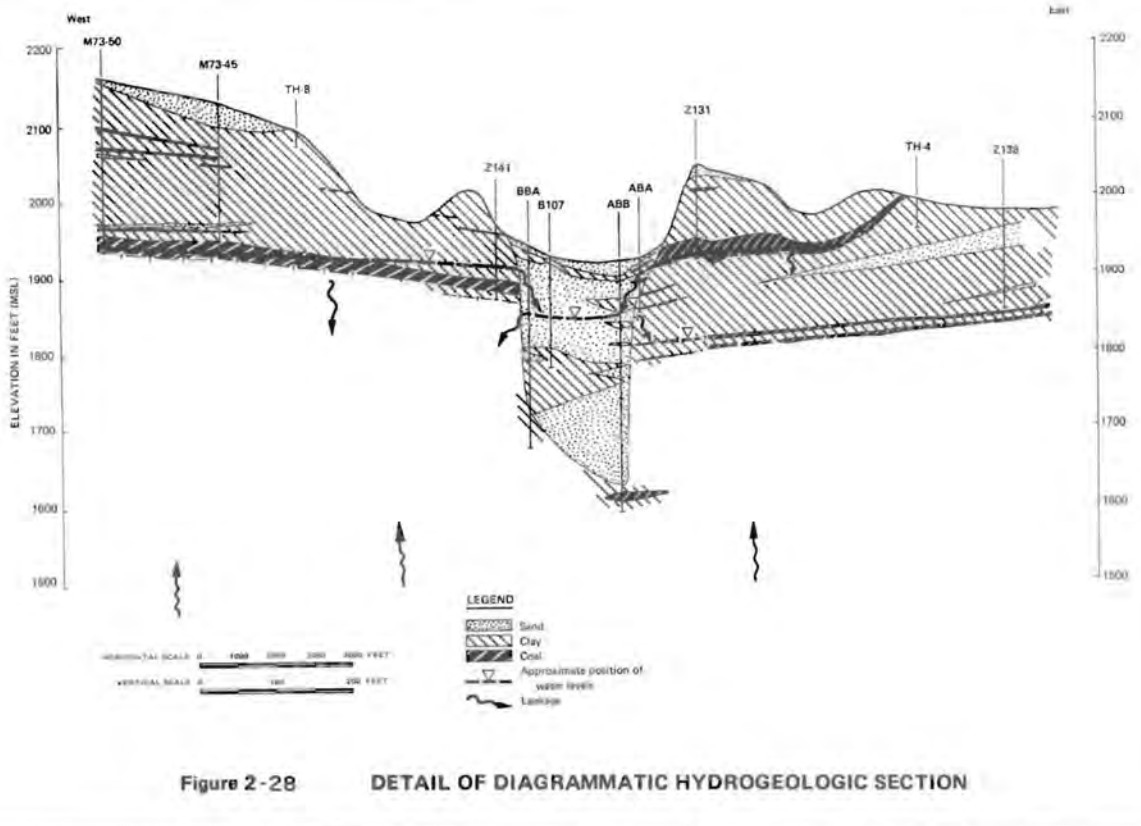


Figure 2-28 DETAIL OF DIAGRAMMATIC HYDROGEOLOGIC SECTION

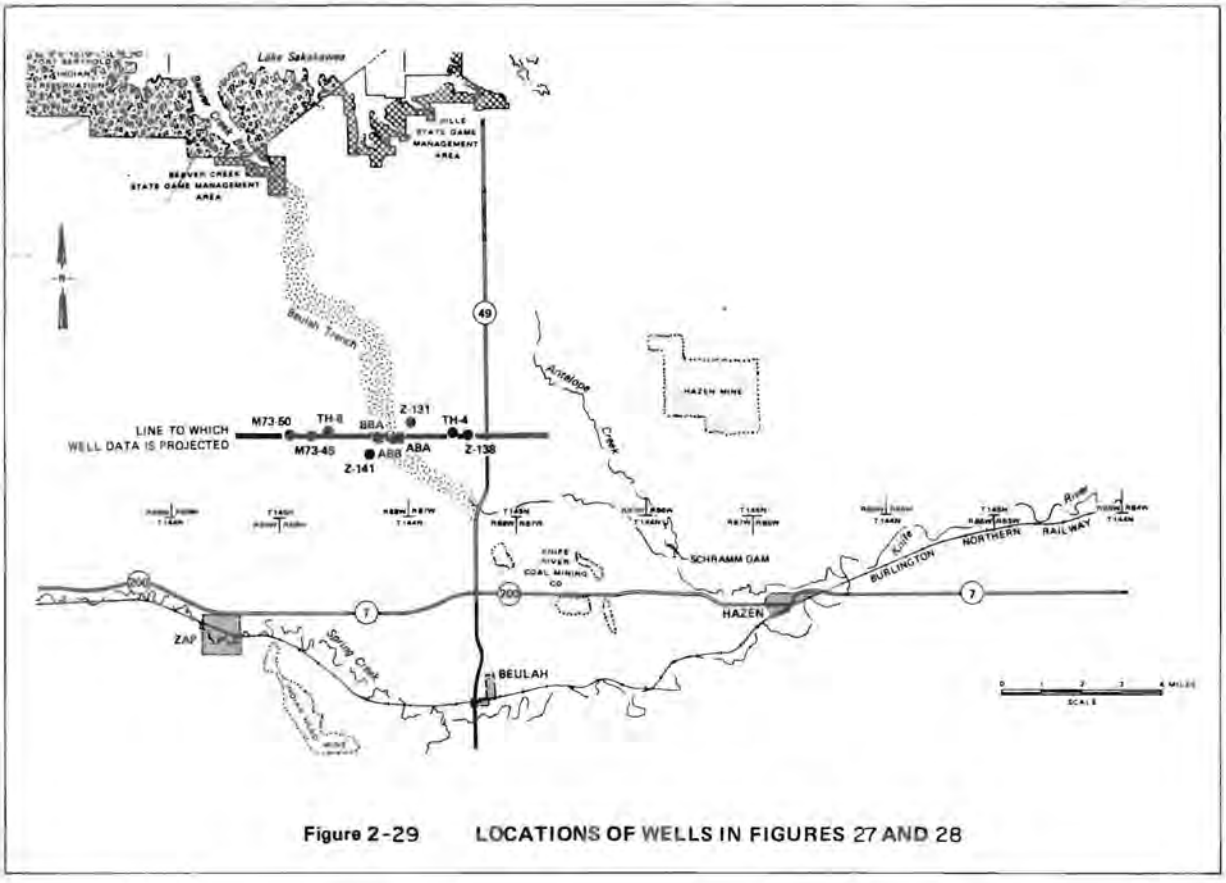


Figure 2-29 LOCATIONS OF WELLS IN FIGURES 27 AND 28

relationships indicate that some recharge from the deeper high pressure aquifers also takes place. In addition, both recharge from and discharge to the Antelope Creek aquifer takes place. Water from Lake Sakakawea enters the Antelope Creek aquifer when the lake is at a maximum elevation (1,850 feet) and percolates southward to the Knife River Valley near Hazen (8). Alluvial aquifers fed by precipitation serve as local recharge sources to underlying aquifers. Local and regional recharge and discharge and the seasonal fluctuations thereof are largely contingent upon the cumulative effects of climatological conditions. During the months when temperatures are below zero and all precipitation is frozen, no surface water infiltration to aquifers occurs.

Deep-Well Disposal: A deep-well feasibility study conducted by Woodward-Clyde Consultants (98) evaluated hydrologic and geophysical subsurface conditions beneath the plantsite vicinity. Data were derived from 5 deep wells in Mercer County, 10 in Dunn County, 4 in McLean County, and 5 in Oliver County.

Based on the above evaluations, the Dakota, Minnelusa, and Kibbey formations were each found to be a potential injection zone. Pertinent data regarding these zones are:

	Dakota	Minnelusa	Kibbey
Depth to top of zone (ft)	4,350	5,905	6,650
Thickness (ft)			
Upper Confining Layer	255	155	125
Injection Zone	400	175	170
Lower Confining Layer	200	125	125
Effective Thickness of I.Z. (ft)	250	100	60
Average Porosity (%)	26	22	12
Water Quality (ppm TDS - NaCl Equivalent)	5,000-7,500	150,000	150,000

The zone selected for the injection of 220 gpm of inorganic brine from the plant was the Minnelusa zone of the Absaroka sequence (Figure 2-30). The zone is about 4,000 feet below the closest freshwater aquifer and the quality of the water in the zone is already quite salty. The Dakota zone would have been the preferred reservoir except that its use as a ground-water source 180 miles east of the plantsite renders it institutionally undesirable as the receiving formation.

Product Pipeline: The only aquifer of importance to the product pipeline is in the basal Cretaceous sands in the bed of extinct Lake Agassiz in the Red Valley. Ground water is often within 10 feet of the surface here and artesian conditions are occasionally encountered in some of the depressions near the Red River of the North and the Snake River. The Cretaceous sands yield water freely, but the salinity of much of the water due to sulfates and chlorides discourages its use (18).

2.1.3.2 Quality

a. Garrison Dam and Renner Bay

Existing and historical water quality data for Renner Bay and Lake Sakakawea are presented in Appendix E.

Data from five water quality sampling stations on Renner Bay showed a slow pronounced stratification during the summer of 1974 (Figure 2-31). In May and June, surface waters warmed, while deeper waters remained fairly cool. Surface warming through July and August increased the stability of the thermocline, but surface

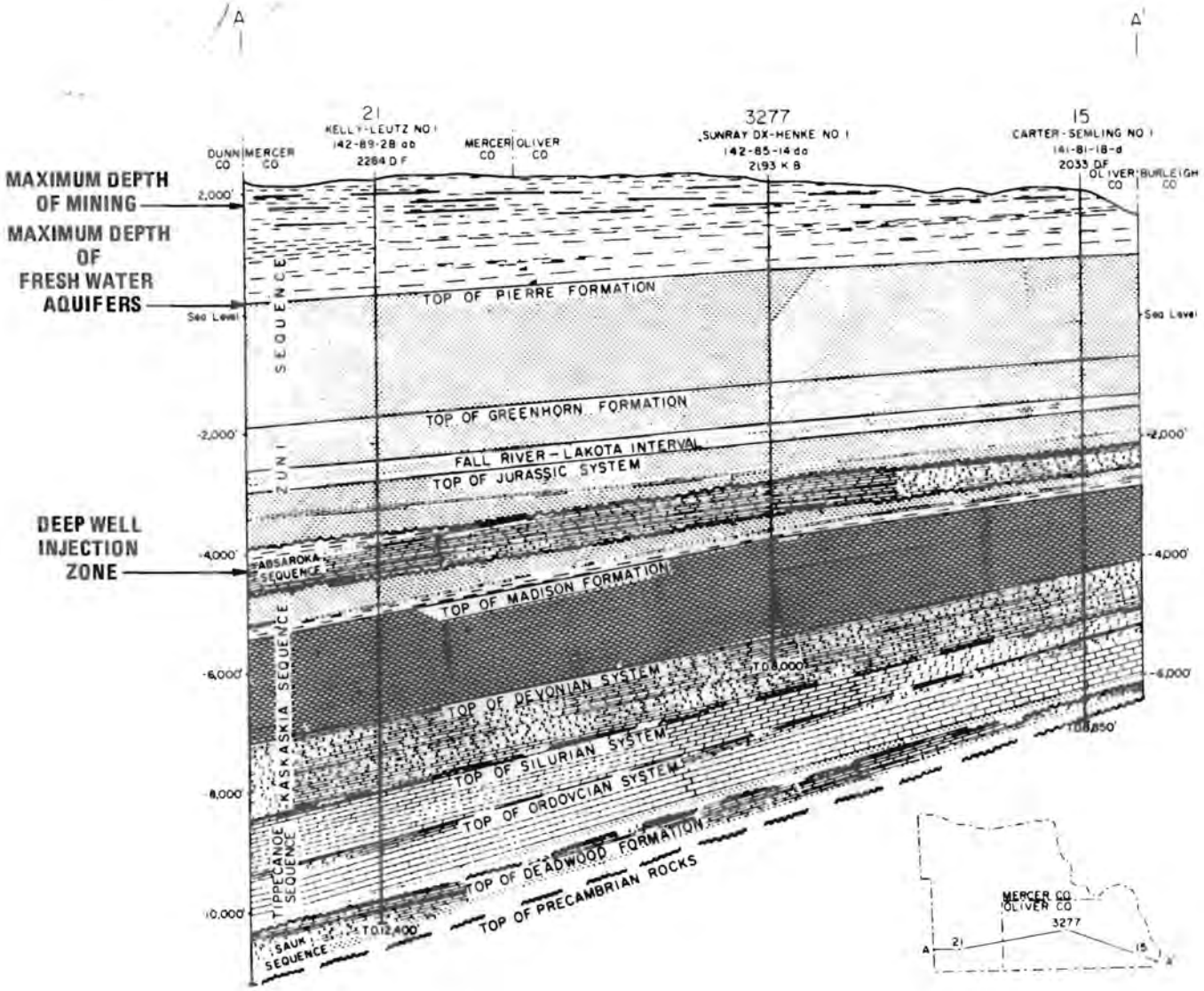


Figure 2-30 Cross sections of sedimentary rocks of Mercer and Oliver Counties.

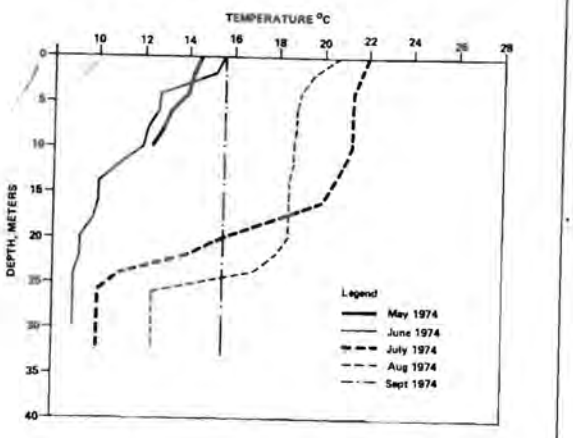


Figure 2-31 TEMPERATURE DISTRIBUTION WITH DEPTH, RENNER BAY, LAKE SAKAKAWEA, NORTH DAKOTA

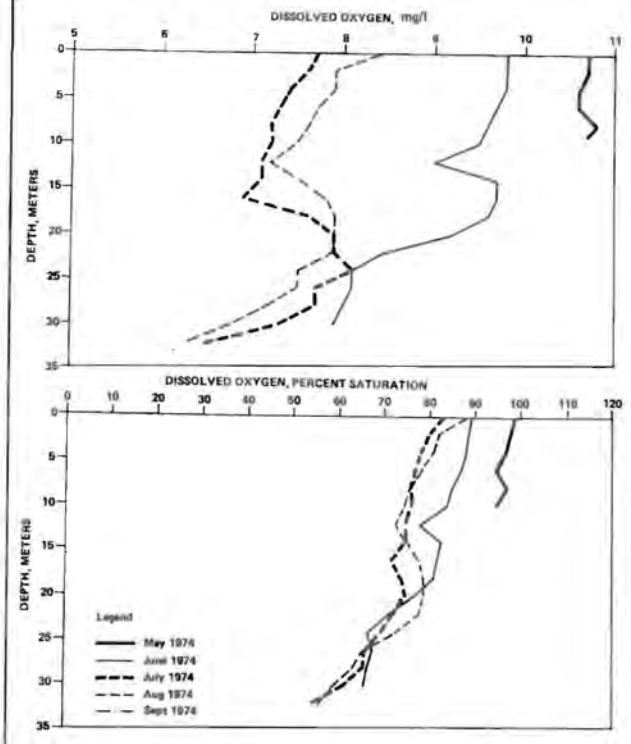


Figure 2-32 DISSOLVED OXYGEN DISTRIBUTION WITH DEPTH, LAKE SAKAKAWEA, NORTH DAKOTA

cooling in September resulted in mixing and return of uniform temperature with depth. During July, the surface water temperatures of the bay neared 22° C (72° F).

Typical dissolved oxygen (DO) profiles for the late summer months give little evidence of hypolimnetic DO depletion; although a maximum decrease from 8.4 to 6.4 mg/l was noted between the surface and bottom in August (Figure 2-32). Percent saturation was always greater than 70 percent in the top 20 meters; but below 20 meters values decreased to almost 50 percent, although DO concentrations were always above 6 mg/l.

The waters of the lake exhibit a high degree of hardness. Levels at Garrison Dam historically ranged from 190 to 230 mg/l as $CaCO_3$. Measurements at Renner Bay ranged from 204 to 240 mg/l. Dissolved sulfate levels historically ranged from 120 to 190 mg/l at the dam, while total sulfate ranged from 112 to 169 mg/l in the Bay.

At Garrison Dam total dissolved solids (TDS) historically ranged from 400 to 448 mg/1. A slightly higher range, 422 to 514 mg/1, was found in Renner Bay. The State TDS criteria for Lake Sakakawea is 500 mg/1. Settlement of most suspended solids occurs within 10 miles of the entry of the Little Missouri and Yellowstone Rivers into Garrison Reservoir; thus, total solid concentrations are predominately TDS, with less than 5 mg/1 being suspended solids. Less than 50 percent of the total solids present were volatile, which is a crude measure of organic content and decomposition or volatization losses of certain mineral salts. Turbidity ranged from 1.3 to 2.6 FTU, indicating that the Bay's water is very clear. Secchi disk measurements of 3 to 4 meters confirmed these findings.

Metals found in the surface waters of the Bay included aluminum, calcium, iron, magnesium, potassium, sodium, zinc, and barium. Bottom waters of the Bay were slightly richer in aluminum, magnesium, sodium, and zinc. Traditionally, nitrate + nitrite and total phosphorous concentrations at the dam have varied from 0.09 to 0.13 mg/1 and 0.01 to 0.08 mg/1, respectively. These nutrient ranges indicate that the lake is not significantly enriched (9).

b. Streams

Historically, water quality has been measured at Spring Creek near Zap (S01) and the Knife River at Hazen (S03). Additional locations were established on the Knife River below Zap (S02), the west branch of Antelope Creek (S04), and the east branch of Antelope Creek (S05) (Figure 2-33). The data gathered are summarized in Appendix E. Peak temperatures in both Spring Creek and the Knife River occurred in July and August, while Antelope Creek reached peak temperatures in June and July.

Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) levels ranged from 2 to 7 mg/1 and 28 to 63 mg/1, respectively. During the high flow periods, the BOD increased noticeably due to runoff from nonpoint sources and the release of wastewater from treatment lagoons by communities on the Knife River and Spring Creek. The high value for Antelope Creek was probably due to rural drainage.

Mean TDS levels during the study period were 983±246 mg/1 in Spring Creek and 1,002±314 mg/1 in the Knife River. Water quality criteria limits TDS levels to 1,000 mg/1. The naturally occurring TDS levels in both streams appear to exceed this level about 48 percent of the time, based on historical data. In Antelope Creek the west branch typically contained 75 percent less solids than the east branch, which consistently contained greater than 1,000 mg/1.

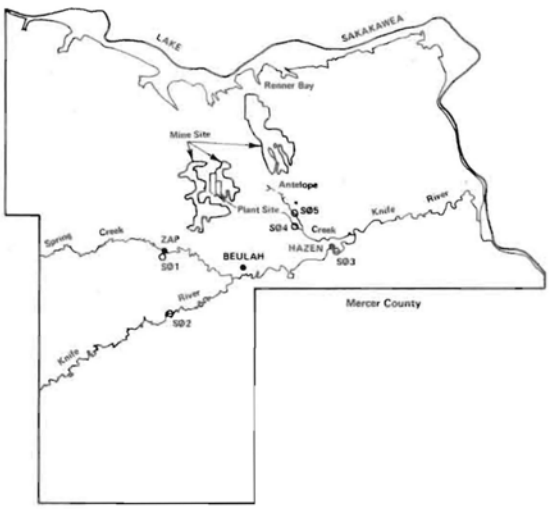


Figure 2-33 SURFACE WATER QUALITY SAMPLING LOCATIONS

Historical sulfate levels of the Knife River have been very high (68 to 640 mg/1) as have sulfate levels in Spring Creek (232 to 565 mg/1). Sodium sulfate and sodium bicarbonate are the major salts of the drainage basin (11). Hardness levels are also high; traditionally averaging 356±83 mg/1 for Spring Creek and 320±101 mg/1 in the Knife River.

For the period June through September 1974, the mean turbidity of Spring Creek was 24±12 FTU, while that of the Knife River was 24±7 FTU and 22±8 FTU at Zap and Hazen, respectively. Antelope Creek was less turbid than either Spring Creek or the Knife River, but the west branch was more highly colored than the east branch. The waters of Spring Creek exceeded the 15 Pt-Co (platinum-cobalt scale) color criteria in all 1974 samples as did the Knife River and Antelope Creek.

Historically, total phosphate levels in the Knife River ranged from 0.01 to 0.18 mg/1. However, 1974 field phosphate readings

are significantly higher than the recorded historical maxima ranging from 0.09 to 0.28 near Hazen.

c. Ground Water

Ground-water samples representing various aquifers were also obtained during Summer 1974 (Figure 2-34). Data from this sampling is summarized in Appendix E. The general quality of ground-water sources within the study area was as follows:

Source	Water Quality Type
Fox Hills-Basal Hell Creek Aquifer	sodium bicarbonate, soft, chloride high, sulfate low
Upper Hell Creek-Lower Cannonball-Ludlow Aquifer	sodium bicarbonate, soft, chloride high, sulfate low
Lignite Aquifers	highly variable, discolored, iron content high
Antelope Creek Aquifer	calcium or sodium bicarbonate, moderately mineralized.

Most samples exceeded the 500 mg/l recommended TDS limits for Lake Sakakawea, and a good many exceeded the 1,000 ppm TDS standard for Knife River and Spring Creek. Among the ions contributing to this excessive mineralization, sodium and either bicarbonate or sulfate are primary. Their concentrations can be attributed to leaching of sodium salts from soils and dissolution of such salts contained in water-bearing strata. These salts also contribute to the alkaline pH values characteristic of the samples. The high sodium content of ground water limits the suitability of the water for irrigation purposes and has long been an inherent problem to the area.

Historical and field chemical analysis data show that iron, fluoride, boron, and manganese are relatively significant constituents of ground water. However, boron was the only element which showed abnormally high concentrations (due to the high boron content of the coal), exceeding local surface water criteria in most of the samples.

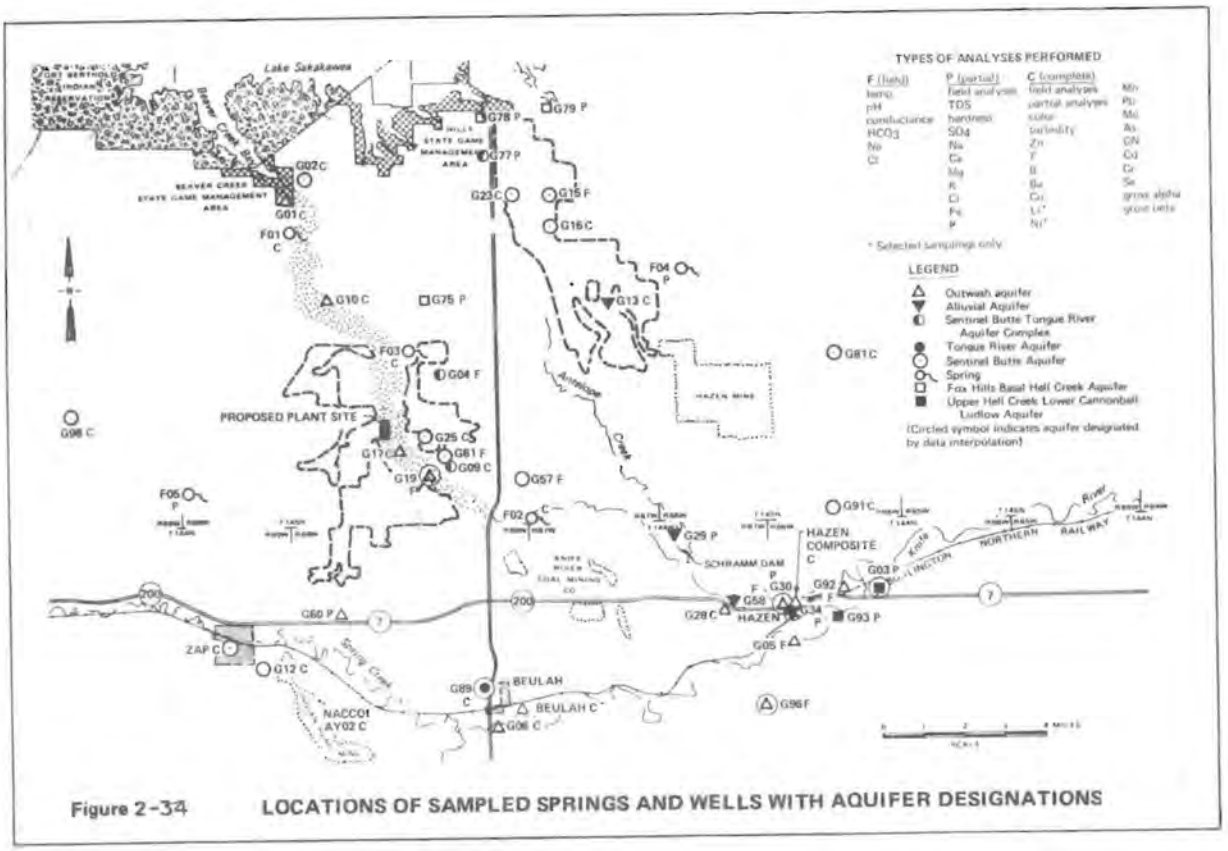


Figure 2-34 **LOCATIONS OF SAMPLED SPRINGS AND WELLS WITH AQUIFER DESIGNATIONS**

The two deep aquifers are chemically distinct from the other aquifers; the major difference being higher concentrations of chloride in the deeper aquifers. Temperature increases with depth as does mineralization. The exception here is that samples from the upper Hell Creek-lower Cannonball-Ludlow aquifer had higher TDS values than the deeper Fox Hills-Basal Hell Creek aquifer. The pH also increased with depth, which probably relates to TDS increases.

d. Springs

Analyses of spring samples (Appendix E) indicate that F01, F02, and F03 (Figure 2-34) are likely fed by Sentinel Butte sediments (including lignite) which outcrop nearby. Springs F04 and F05 show a chemical character partly similar to that of lignite aquifers and partly similar to that of alluvial or outwash aquifers. The geology near these springs would indicate that their flow could represent both sources.

e. Product Pipeline

Water quality in the various drainage subbasins along the proposed product pipeline route is highly variable. The Knife River drainage, the Missouri River, and the Eastern Dakota Subbasin generally have fair to good quality water (19). In contrast, water quality in the North Dakota portion of the Hudson Bay Drainage Basin and the Minnesota portion of the Red River Subbasin is rated poor and poor to fair, respectively, due to naturally high TDS levels.

The TDS concentrations for pertinent surface waters are shown in Table 2-11. Waters in the Missouri River Basin have generally lower TDS concentrations than the waters of the Hudson Bay Drainage. The chemical water quality of the Red River and its tributaries does not meet North Dakota and Minnesota Water Quality Standards or Public Health Standards for drinking water. However, due to lack of good quality ground water, many communities utilize surface water for domestic purposes.

The classification ratings in Table 2-7 refer to North Dakota and Minnesota Water Quality Standards and Best Use Classifications (24, 25). Class II waters differ from Class I waters primarily in that municipal use would require additional water softening in the treatment process. Class III waters usually would require saline water treatment methods for municipal use, have lower average flows, and prolonged periods of no flow.

2.1.4 Physiography

2.1.4.1 Regional Setting and Physiography

North Dakota and northwestern Minnesota can be divided into three physiographic areas: the Missouri Plateau, located in the southwestern half of North Dakota; the Drift Prairie, in east-central North Dakota; and the Red River Valley or Agassiz Basin of eastern North Dakota and western Minnesota (26, 27).

The Missouri Plateau includes the most southwesterly advance of the ice sheets. Glacial drift was deposited over all of the Plateau with the exception of the southwest corner. The Missouri slope (east of the Missouri River) leads up to an area known as the Missouri Coteau, a dissected escarpment. The Missouri Coteau occupies the eastern portion of the Plateau and is a 30- to 50-mile-wide land of "dead ice" moraines. East of this is the Drift Prairie which, together with the Red River Valley, is known as the Central Valley.

TABLE 2-II

RANGE OR AVERAGE CONCENTRATIONS OF TOTAL DISSOLVED SOLIDS IN PERTINENT STUDY AREA SURFACE WATERS(19,21,22,23)

SURFACE WATER RESOURCE	TOTAL DISSOLVED SOLIDS RANGE OR AVERAGE
MISSOURI RIVER BASIN	
KNIFE RIVER	500 – 1000 mg/l*
MISSOURI RIVER	< 500 mg/l
LAKE SAKAKAWEA	< 500 mg/l
LAKE AUDUBON	< 500 mg/l
HUDSON BAY DRAINAGE BASIN	
DEVILS LAKE COMPLEX** (AVERAGE 1956–1970)	
DEVILS LAKE	8,360 mg/l
EAST BAY DEVILS LAKE	8,330 mg/l
EAST DEVILS LAKE	51,370 mg/l
WEST STUMP LAKE	6,820 mg/l
EAST STUMP LAKE	98,790 mg/l
FOREST RIVER	348 mg/l
RED RIVER OF THE NORTH AT OSLO, MINNESOTA	340 – 1000 mg/l
SNAKE RIVER AT WARREN, MINNESOTA	445 mg/l

*MILLIGRAMS PER LITER – GENERALLY EQUIVALENT TO PARTS PER MILLION (ppm)

< LESS THAN

**ALTHOUGH THESE STUDY AREA LAKES ARE NOT EXPECTED TO BE AFFECTED BY THE PROPOSED PIPELINE SYSTEM, THEY HAVE BEEN INCLUDED AND MAY REPRESENT TDS CONCENTRATIONS OF POTHOLES AND SHALLOW LAKES WHICH ARE CROSSED BY THE PROPOSED ROUTE.

The Drift Prairie extends eastward from the Missouri Plateau to the Red River Valley. The western edge of the Red River Valley marks the eastern edge of the Great Plains. The Central Lowland is a product of several glacial advances which left drift deposits several hundred feet deep. The Red River Valley is the remnant of glacial Lake Agassiz. The level lake plain has deep, fertile soils;the eastern and western edges show sand and gravel ridges as evidence of glacial lake beaches.

The proposed plant-mine site is located near the eastern margin of the Williston Basin of the Missouri Plateau, which extends from eastern North Dakota to central Montana and from west-central South Dakota to southeast Saskatchewan (11). The Sentinel Butte Formation, the uppermost bedrock unit of the sedimentary series within the study area, dips westward towards the center of the basin (near Williston, N.D.) at 5 to 10 feet/mile.

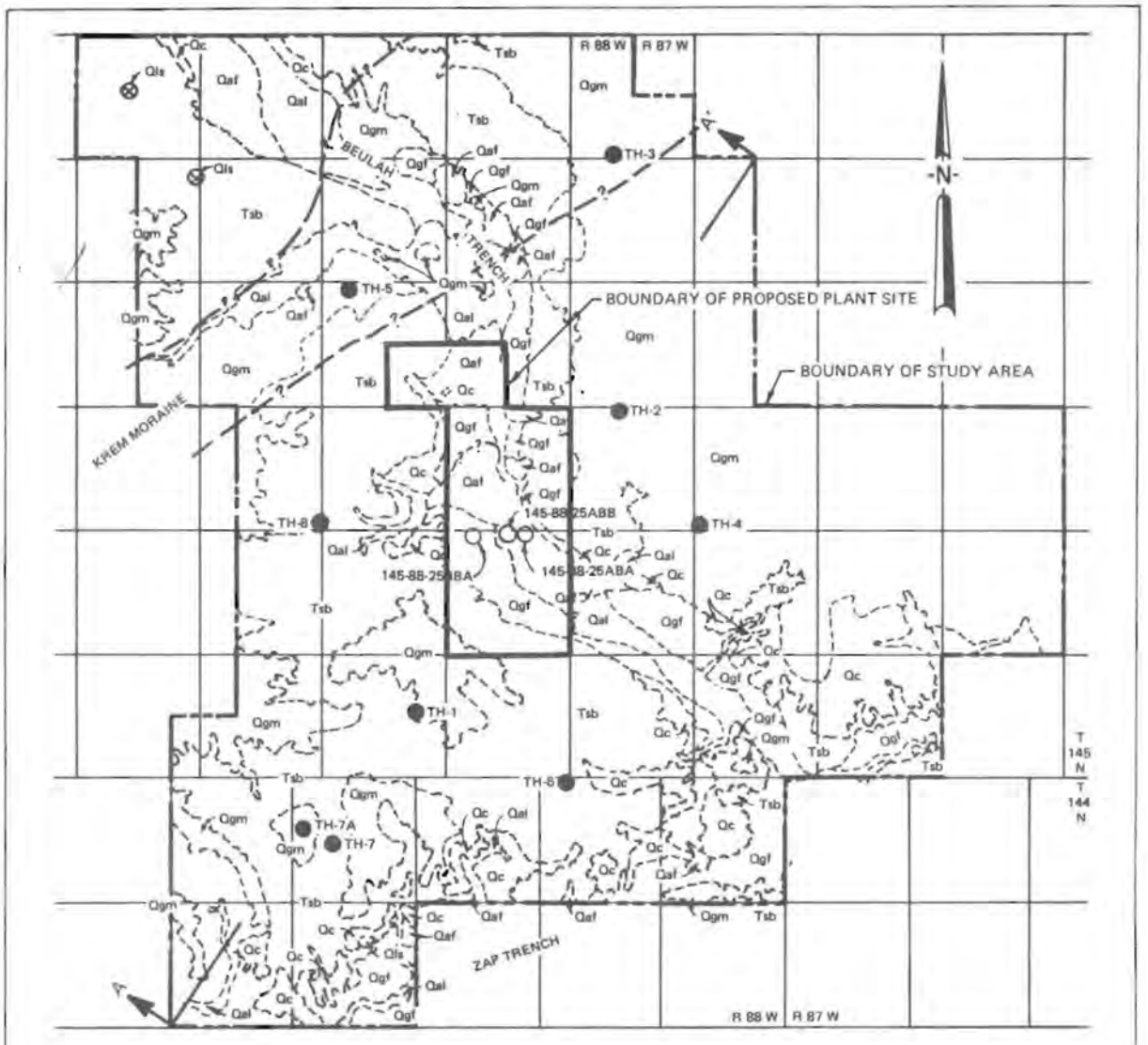
The most striking physiographic features near the plant-mine site are the Beulah Trench and its western extension, the Zap Trench (Figures 2-14, 2-22, and 2-29). These were formed during the Wisconsin stage of glaciation (18,000 years ago), when a continental glacier diverted the Missouri River along the margins of the ice sheet to erode the trenches into the upland surface. The Beulah Trench is crossed by the Krem Moraine in the northern sector of the study area. The moraine forms a divide that causes streams within the trench to drain north as well as south. A second stream divide is in the Zap Trench which causes water from the Beulah Trench and a small section of the Zap Trench to drain eastward into the Antelope Creek drainage. The remainder of the Zap Trench drains westward.

2.1.4.2 Geology

Near the plant-mine site the only geologic units that crop out are the late Paleocene (±65 million years old) Sentinel Butte Formation and the Pleistocene to Holocene (5,000 to 1 million years old) Coleharbor Group. The geologic map (Figure 2-35) and geologic cross section (Figure 2-36) illustrate the relationship of these units.

The Sentinel Butte Formation is a continental deposit of interbedded calcareous clays, sandy clays, and lignite beds, with isolated lenses of fine-grained sands, silts, and limestones. These sediments were deposited mainly in swamps or in the flood plains of slow, meandering rivers.

In western Mercer County, the Sentinel Butte Formation is about 500 feet thick. The upper part of the formation has been removed by erosion in eastern Mercer County; thus, it is only about 350 feet thick. The major coal seam under the project is the Beulah-Zap bed located about 140 feet above the formation's base. The only bedrock formation to be disturbed by strip mining will be the Sentinel Butte Formation. The Golden Valley Formation, which is stratigraphically above the Sentinel Butte Formation elsewhere, is absent in the project area due to erosion; therefore, only the younger glacial deposits of the Coleharbor Group overlie the formation.



SCALE

6000 0 6000 12000 FEET

LEGEND

Qal — ALLUVIUM: CLAYS, SILTS, AND SANDS, GRAVELS PRESENT LOCALLY; UNCONSOLIDATED, POORLY STRATIFIED, COMMONLY 5 TO 10 FEET THICK BUT LOCALLY AS THICK AS 20 FEET.

Qaf — ALLUVIAL FAN DEPOSITS: CLAYS, SILTS, SANDS, AND GRAVELS, UNCONSOLIDATED, POORLY STRATIFIED, THICKNESS VARIES WITH DISTANCE FROM DISCHARGE POINT, COMMONLY LESS THAN 10 FEET.

Qls — LANDSLIDES: AREA OF MASS EARTH MOVEMENT ON RELATIVELY STEEP SLOPE, ● INDICATES LANDSLIDE LESS THAN 1 ACRE IN SIZE.

Qc — CLINKER (SCORIA): FUSED CLAYS AND SILTS, VERY HARD, PRODUCTS OF BAKING OF OVERBURDEN (MAINLY SENTINEL BUTTE FORMATION) OVERLYING BURNED COAL BEDS (BEULAH-ZAP); MAXIMUM ESTIMATED THICKNESS ABOUT 50 FEET.

Qgf — GLACIO-FLUVIAL SEDIMENTS (COLEHARBOR GROUP): GRAVELS AND SANDS INTERBEDDED WITH SILTS AND CLAYS; AS MUCH AS 200 FEET THICK IN SOME AREAS; MANTLED BY GENERALLY LESS THAN 5 FEET OF SLOPEWASH AND RESIDUAL SOILS LOCALLY.

Qgm — GLACIAL DRIFT (COLEHARBOR GROUP): MAINLY CLAYS, LOCALLY SANDY, GRAVELLY AND BOULDERY, PRIMARILY GROUND MORAINE BUT INCLUDES SOME TERMINAL MORAINE. THICKNESS ABOUT 5 TO 85 FEET, MANTLED LOCALLY BY RESIDUAL SOILS GENERALLY LESS THAN 5 FEET THICK.

KREM MORAINE — KREM MORAINE: TERMINAL MORAINE INTERMIXED SANDS, CLAYS, GRAVELS AND LOCALLY BOULDERS WITH ISOLATED DEPOSITS OF RELATIVELY CLEAN SAND.

Tsb — SENTINEL BUTTE FORMATION: SANDS, CLAYS, SHALES, LIMESTONES AND LIGNITE; INTERBEDDED DEPOSITS, MAXIMUM THICKNESS 500 FEET, MANTLED LOCALLY BY GLACIAL, ALLUVIAL, RESIDUAL AND/OR SLOPEWASH SOILS, GENERALLY LESS THAN 5 FEET THICK.

GEOLOGIC CONTACT, APPROXIMATELY LOCATED.

TH-1 ● TEST HOLE, DRILLED AND LOGGED BY WOODWARD-THORTJANSON & ASSOCIATES, INC.

Q 145-88-25ABA WATER WELL; DATA AND LOCATION TAKEN FROM "GROUND WATER RESOURCES, MERCER AND OLIVER COUNTIES, NORTH DAKOTA" BY M. G. CROFT, 1973.

A A' LOCATION OF GEOLOGIC CROSS SECTION.

Compiled by: Woodward Environ, Inc. 1974

Figure 2-35 NORTH DAKOTA COAL GASIFICATION FACILITY GEOLOGIC MAP

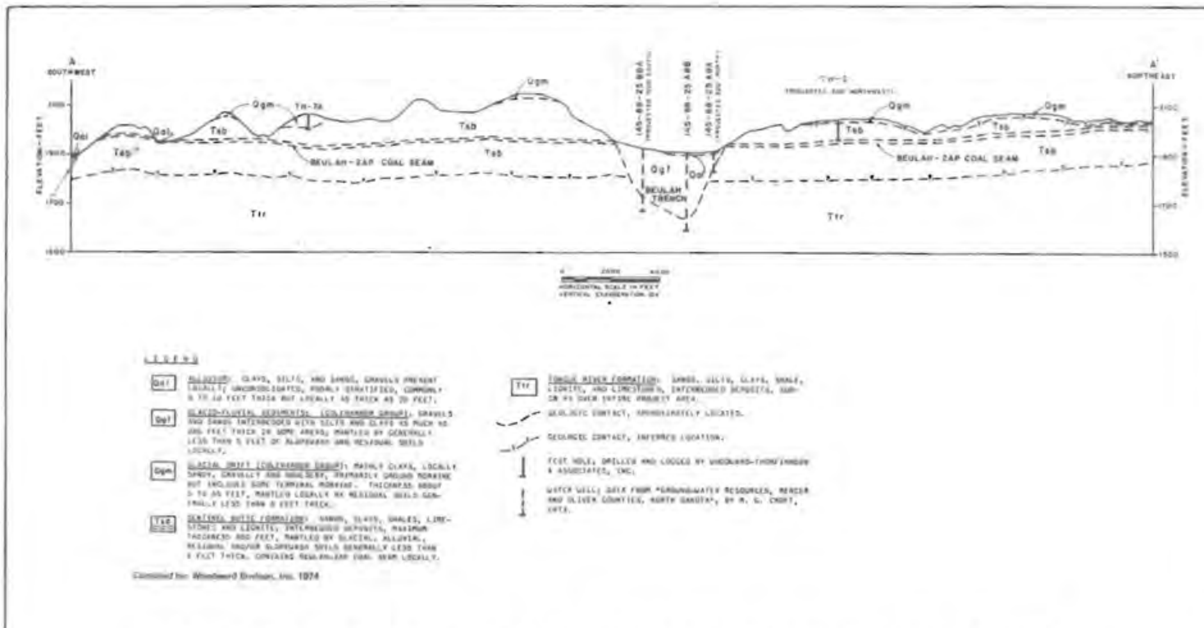


Figure 2-36 NORTH DAKOTA COAL GASIFICATION FACILITY GEOLOGIC CROSS SECTION A-A' (FROM FIGURE 2.1.2-1)

The Coleharbor Group is composed of the moraines (till) of the upland area, the glacio-fluvial sediments in the Beulah and Zap Trenches, and the Krem Moraine. The morainal deposits (5 to 65 feet thick) are mainly clays locally mixed with sands, gravels, and boulders. The glacio-fluvial sediments, poorly stratified lenticular clays, silts, sands, and gravels, are as much as 280 feet thick in the Beulah and Zap Trenches (12). The Krem Moraine incorporates intermixed sands, clays, gravels, and locally, boulders with isolated deposits of relatively clean sand.

The Sentinel Butte Formation and Coleharbor Group are mantled by a variety of post-glacial surficial deposits. The glacio-fluvial deposits in the Beulah and Zap Trenches are masked by later stream-deposited alluvium, slopewash, and clays, silts, and sands deposited as alluvial fans. These deposits range in thickness from a few inches to 10 feet or more. "Clinker" deposits, a ceramic-like product produced by the baking of sediments over burning coal seams, are up to 50 feet thick locally. These deposits are commonly hard, variable dense to highly porous, and closely fractured. They are often used as surface material for "graveled" county roads.

2.1.4.3 Soils

a. Upper Horizons

Upper horizon soils within the plant-mine area are composed of loamy glacial till, loamy to sandy residuums from underlying siltstone and sandstone bedrock, and alluvium in the valley. Soil depths and reclamation potentials are shown in Figure 2-37. Depth of soil and the absence of sodic salt accumulations were the criteria for judging reclamation potential. Detailed U.S. Soil Conservation Service maps and soil ratings were also used in judging reclamation capabilities. Most of the topsoil present is suitable for reclamation; thus, sufficient topsoil is available to provide a productive growth medium over the mined areas.

b. Lower Horizons

Materials from test holes were examined for trace elements, radioactivity, and chemical properties related to revegetation. Locations of the wells are shown in Figure 2-35 and geologic logs in Figure 2-38. Descriptions of the interval sample lithology and chemical analyses are shown in Appendix F.

Trace elements in the overburden samples occurred within a concentration range normally observed in soils, except that molybdenum was slightly outside normal range at one interval (TH-1; Sample 4). All samples with high pH values also had high exchangeable sodium percentages (ESP). Troublesome levels of soluble salts (conductivity greater than 4 mmhos/cm) exist in both the overburden and surface soils. Moderate to high levels of boron were found in a few intervals of TH-1 and TH-2. Copper, iron, and manganese were ample in all samples; zinc levels in the overburden were generally below amounts necessary for plant growth.

c. Product Pipeline

Over 40 different soil series can be found along the proposed product pipeline route. The parent material is primarily glacial drift. The route originates in Mercer County, North Dakota, where the soils are mostly derived from glacial till materials. Along the Knife River, sandy windblown soil materials mantle the glacial till. Bottomlands of alluvial soil are encountered at the Missouri River crossing, and poorly drained areas of these soils have become saline. From the Missouri River eastward, the route transverses a completely glaciated landscape having various types of glacial drift parent materials.

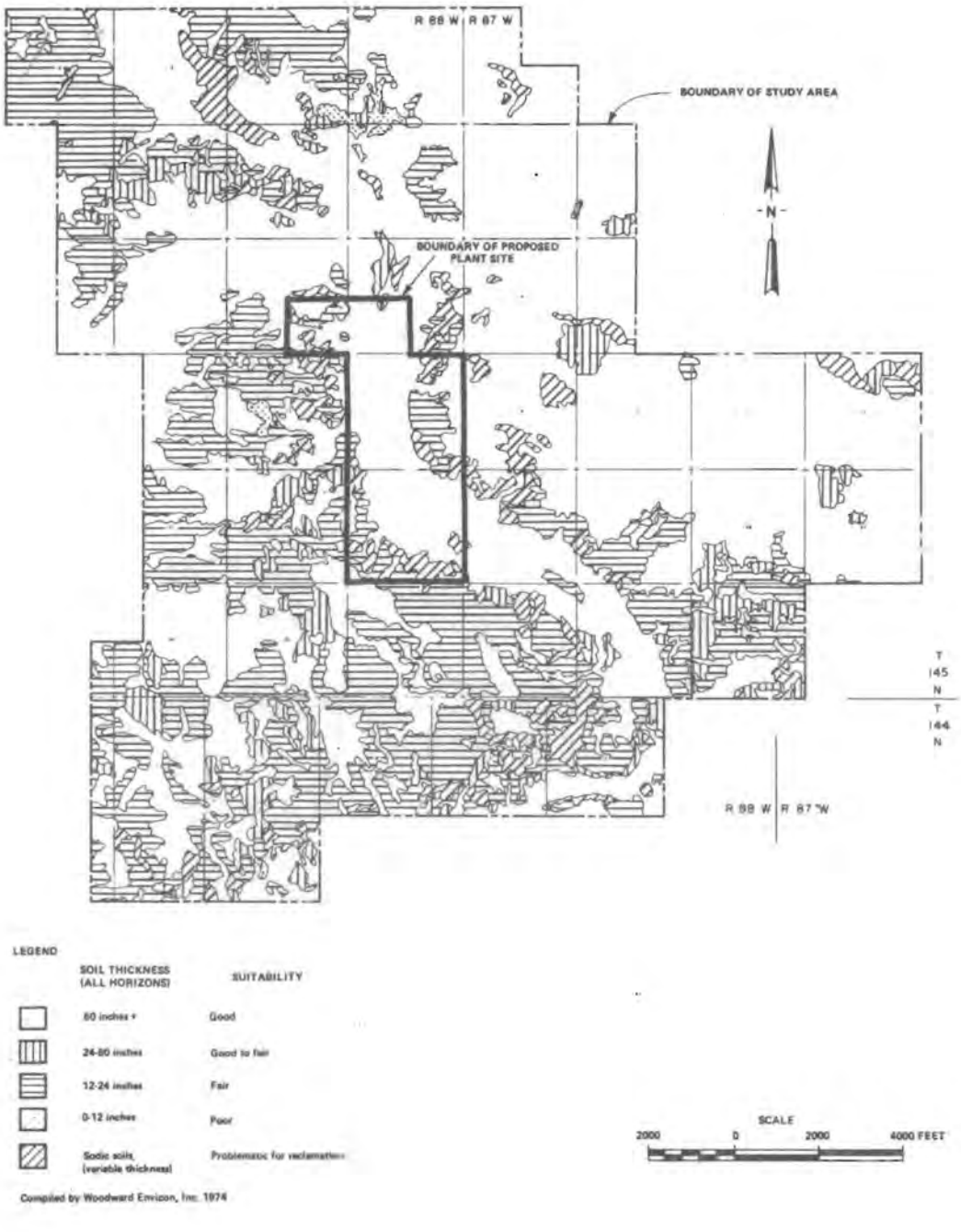


Figure 2-37 GENERAL SOIL SUITABILITY AND THICKNESS MAP

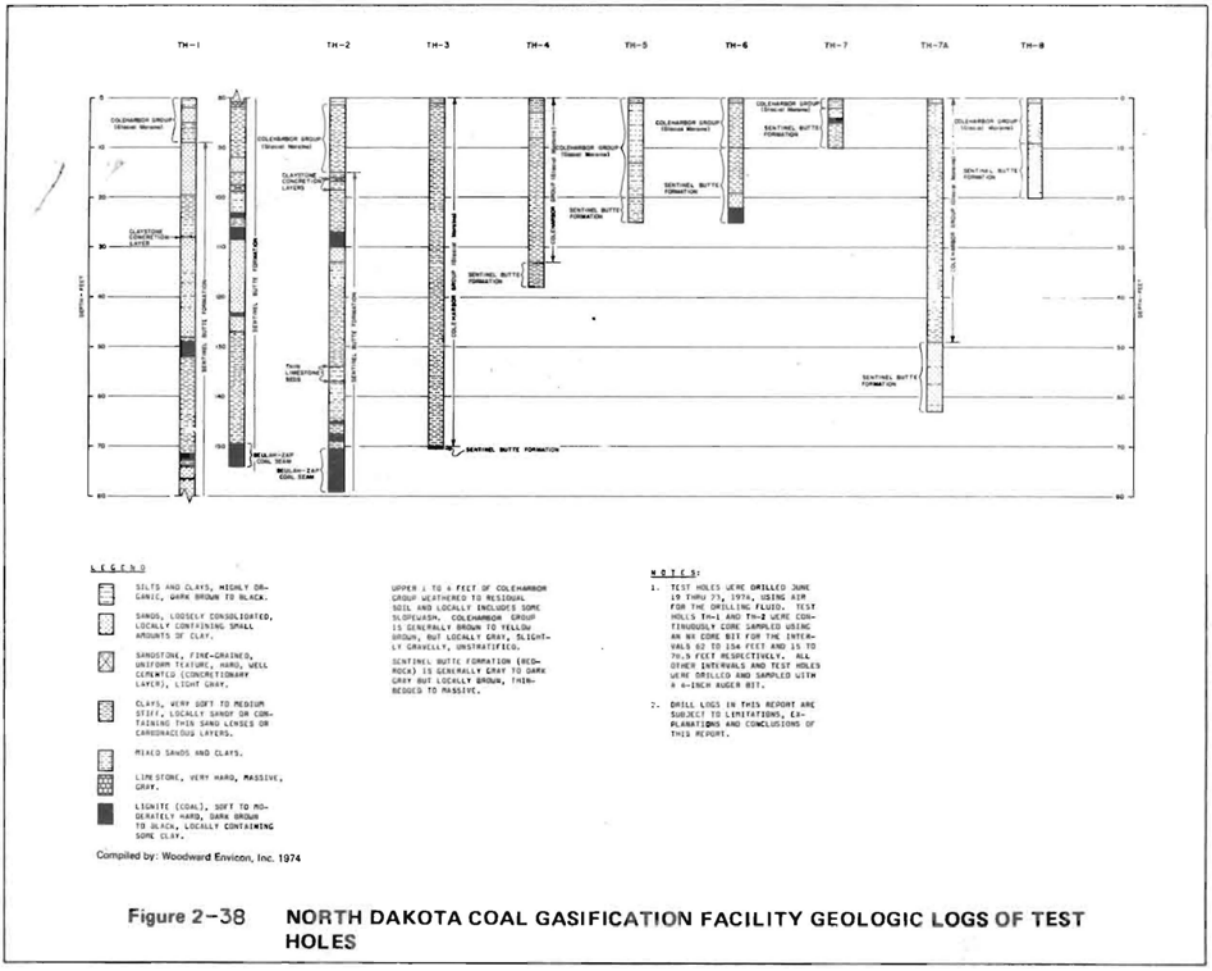


Figure 2-38 NORTH DAKOTA COAL GASIFICATION FACILITY GEOLOGIC LOGS OF TEST HOLES

The soils along the proposed route typically occur in patterns of two or more soil series known as soil associations. The soils in North Dakota have been grouped into 73 associations with 20 of them occurring on the proposed route (26). Of 57 Minnesota soil associations, 4 occur along the proposed route (28). Table 2-12 lists the soil associations along the proposed route and possible problem areas with each association.

2.1.4.4 Geological Hazards

The area around the plant-mine site in west-central North Dakota is not considered to be seismically active. Nevertheless, maximum earthquake intensities for a 100-year period have been projected for the plant-mine site based on historical records (4) and are shown in Table 2-13. No deep salt collapse structures were found to be present at the site.

TABLE 2-12

DEGREE OF LIMITATION FOR RECLAMATION OF DISTURBED AREAS

SOIL ASSOCIATION	WATER EROSION HAZARD[a]	WIND EROSION HAZARD[b]	SALINITY[c]	REVEGETATION DIFFICULTY[d]
NORTH DAKOTA				
3. BARNES-HAMERLY	2	1	1	1
4. BARNES-SVEA	2	1	2	2
10. SVEA-HAMERLY	1	1	1	1
12. EMBDEN-GLYNDON	1	2	1	2
15. HECLA-HAMAR	1	2	1	3
16. MADDOCK-BARNES	2	2	1	3
18. RENSHAW	2	2	1	4
21. BARNES-BUSE	3	1	1	2
33. WILLIAMS	2	1	1	1
35. PARSHALL-LIHEN	1	3	1	3
40. WILLIAMS-ZAHL	2	1	1	2
45. HEGNE-FARGO	1	1	1	1
46. BEARDEN	1	1	1	1
49. GLYNDON-VALLERS	1	1	1	1
54. BEARDEN, SALINE	1	1	3	2
60. HAVRE-BANKS	3	2	2	2
63. BAINVILLE-FLASHER-AGAR	3	2	1	3
66. BAINVILLE-ZAHL	3	1	1	3
72. ZAHL-WILLIAMS	3	1	1	3
73. VALENTINE-HECLA-HAMAR	1	3	1	4
MINNESOTA				
34. FARGO	1	1	1	1
35. GRIMSTAD	1	2	1	1
37. ROCKSBURY-PEAT	1	1	1	3
38. ULEN-SIOUX-GRIMSTAD	1	3	1	3

[a]WATER EROSION HAZARD 1 = SLIGHT 2 = MODERATE 3 = SEVERE

[b]WIND EROSION HAZARD 1 = SLIGHT 2 = MODERATE 3 = SEVERE

[c]SALINE AREAS 1 = NONE 2 = OCCASIONAL 3 = NUMEROUS

[d]REVEGETATION DIFFICULTY 1 = EASY 2 = MOD. DIFFICULT 3 = DIFFICULT 4 = VERY DIFFICULT

TABLE 2-13

MAXIMUM EXPECTED EARTHQUAKE INTENSITIES AND GROUND ACCELERATIONS AT THE PROPOSED PROJECT SITE [1]

Earthquake Location	Maximum Epicentral Intensity of Record	Distance From Epicenter to proposed coal gasification plant site	Maximum Probable Intensity at proposed coal gasification plant site	Maximum Ground Acceleration at proposed coal gasification plant site
Habgen Lake, Montana (1959)	IX-X	480 miles	II	Less than 0.01g
Southeastern Saskatchewan, Canada (1909)	VII	225 miles	III	Less than 0.01g
Hypothetical Earthquake	VI	20 miles	V	Approximately 0.02g
Hypothetical Earthquake	VI	50 miles	IV	Approximately 0.015g

[1] Based on a projected life of about 100 years.

2 Intensities based upon the Modified Mercalli scale (110; see also page 14 of BLM's comments).

Geological hazards which may affect the long-term stability of the product pipeline include land movements, earthquakes, gully erosion, scour, subsidence, and sand blowouts. Nine areas along the route west of the Missouri River show evidence of mass movement (Table 2-14). East of the Missouri unstable streambanks of the Forest River, Red River of the North, and the Snake River are actively slumping.

Earthquake potentials for the pipeline route are the same as for the plant-mine site. Gully erosion potential exists along the Knife River, the Missouri River, the Missouri Escarpment, and the Pembina Escarpment. Scour hazards exist at any stream crossing, but the Missouri River and Red River of the North have the greatest potential. Subsidence problem areas include: the Soo Line

TABLE 2-14

AREAS OF MASS MOVEMENT ALONG THE PROPOSED ROUTE ON RAILROAD R.O.W. WEST OF THE MISSOURI RIVER

LOCATION				OBSERVATIONS BASED ON FIELD EVALUATIONS AND ANALYSIS OF AERIAL PHOTOGRAPHS
RIVER VALLEY	SECTION	TOWNSHIP	RANGE	
KNIFE RIVER	28	144N	87W	LARGE SLIDE, ACTIVE TOE
	27	144N	87W	REPAIRED SINCE 1965, TEMPORARILY STABILIZED
	22 & 23	144N	87W	LARGE SLIDE AREA, EXTENDING UP ADJACENT GULLY, LONG HISTORY OF MOVEMENT
	9 & 10	144N	86W	OLD SLIDE AREA WHICH WAS DITCHED
	2	144N	86W	20-FOOT HIGH CLIFF SHOWING EVIDENCE OF MASS MOVEMENT
	5	144N	85W	BUILT ON SLUMP BLOCK
	36	145N	85W	MASS MOVEMENT ALONG RIVER MEANDER
MISSOURI R.	18	144N	84W	2 SMALL SLIDES UNDER OLD ROAD
	5	143N	83W	40-FOOT HIGH SLIDE

embankment across Pelican Lake (N.D.), a wetland area west of Ramsey (N.D.), the lakes near Fillmore and Baker (N.D.), Davis and Ranch Lakes southwest of Balta (N.D.), and the Knife River Slough. The beach ridges of glacial Lake Agassiz may be susceptible to sand blowouts, as would the edge of glacial Lake Souris between Kief and Balta and portions of the Knife River Valley.

2.1.4.5 Land Use

The 1975 land use within Mercer County is tabulated below (83):

Use	Acres	Percent
Cropland	294,000	44.7
Pasture	4,200	0.6
Rangeland	303,600	46.1
Forest Service Property	13,000	2.0
Surface Water	27,000	4.1
Other (Including Mining)	16,200	2.5
Total	658,000	100.0

Cropland (e.g., small grains and forage crops) and rangeland comprised about 90.8 percent of Mercer County's land use in 1975.

Most of the land on the plant-mine site is also used for crop production or grazing. The entire area of the plant and mine is under private surface ownership; Coteau Properties owns the coal lease rights. Twenty-five farmsteads are in the proposed mine area; of 85 structures, 60 are vacant. All of the acreage that would be disturbed by mining (12,500 acres) is located on these 25 farmsteads. Agricultural production in the plant-mine area was worth about $\$22,000/mi^2$ according to 1973 crop prices (13).

The three counties near the plant-mine site have varying degrees of zoning regulations to regulate industrial and urban development. Mercer County has a comprehensive zoning ordinance to provide for orderly development and a functioning Planning Commission. Appropriate zoning changes and conditional use permits are required for changes in land use. A Planning Commission meets as the need arises in Dunn County to consider rezoning requests pursuant to that County's land use regulations. New regulations are being formulated and should be issued by June 1978. Oliver County has no zoning regulations; however, legislation is currently being drafted and should become effective during the fall of 1977.

Current land use along most of the proposed pipeline route is existing railroad right-of-way (ROW) in a natural or seminatural condition. Only 79 acres of new ROW will be required and current use of this land is agricultural. Wetlands encountered along the proposed route are discussed in Section 2.2.2.3.

2.2 Biological Environment

2.2.1 General

North Dakota lies entirely within the grasslands biome which encompasses most of the midwest and north-central portion of the United States. The occurrence of large areas of grassland is due largely to low rainfall, high evaporation rates, and high temperature. Over one-half the land has been agriculturally developed resulting in a mixture of natural communities and those resulting from man's activities.

Three main natural vegetation types occur in association with the proposed plant-mine site and product pipeline, including (1) mixed-grass prairie on the Missouri Plateau (described in detail in Section 2.2.2.2), (2) tall-grass prairie in the Red River Valley region, and (3) a transitional zone in the Drift Prairie region. A fourth vegetation type is the Northern flood plain forest which occurs along the major drainages. Characteristic plant species include cottonwood, ash, willow, and elm.

Field studies were conducted over a 49-section study area at the plant-mine site (Figure 2-39) from late May to mid-October, 1974, to provide baseline information on the ecosystems involved (4). Studies of a 22-section study area surrounding Mine No. 2 were conducted at a later date, and it was determined that no large differences existed in the ecosystems of the two areas. Weather in 1974 was unusually wet and resulted in an abnormal occurrence of annual plants. However, conditions were not so severe as to affect the relative abundance of perennial plants or higher animals. Four major plant communities were identifiable in the study area - agricultural, prairie, wetland, and woodland. Acreages of the various plant-mine site plant communities and habitat types within the communities are summarized in Table 2-15. Botanical compositions of sampled habitat types are found in Appendix G. No endangered plant species were noted in the study area.

2.2.2 Terrestrial Plant Communities

2.2.2.1 Agricultural

Plant-Mine Site: Approximately 59 percent of the 49-section study area surrounding the plant-mine site consisted of agricultural communities. This community is created and maintained by man at the expense of the native prairie grasslands. Almost all land in the area suitable for cultivation is developed; slopes are plowed to the steepest point where machinery can operate or to where the topsoil depth is less than plow depth. Five habitats are recognizable in this community -croplands, domestic haylands, retired croplands, fence rows, and farmsteads.

a. Croplands

About 72 percent of the agricultural community is used as cropland. Major crops in 1974 were spring wheat (45 percent), oats (22 percent), and corn (5 percent). Small acreages of barley, rye, flax, and sunflowers were also grown. (See Appendix G for a listing of plants on the plant-mine study area and scientific names.) Nearly 28 percent of the cropland was in summer fallow.

b. Domestic Haylands

Domestic haylands accounted for 26 percent of the agricultural community in 1974. Planted pastures are included in this habitat type. Hay species included alfalfa, sweetclover, smooth brome, and crested wheatgrass. Kentucky bluegrass is commonly encountered as a volunteer in planted hayfields.

c. Retired Cropland

Retired fields are generally seeded to a variety of grasses and legumes that include smooth brome, crested wheatgrass, western

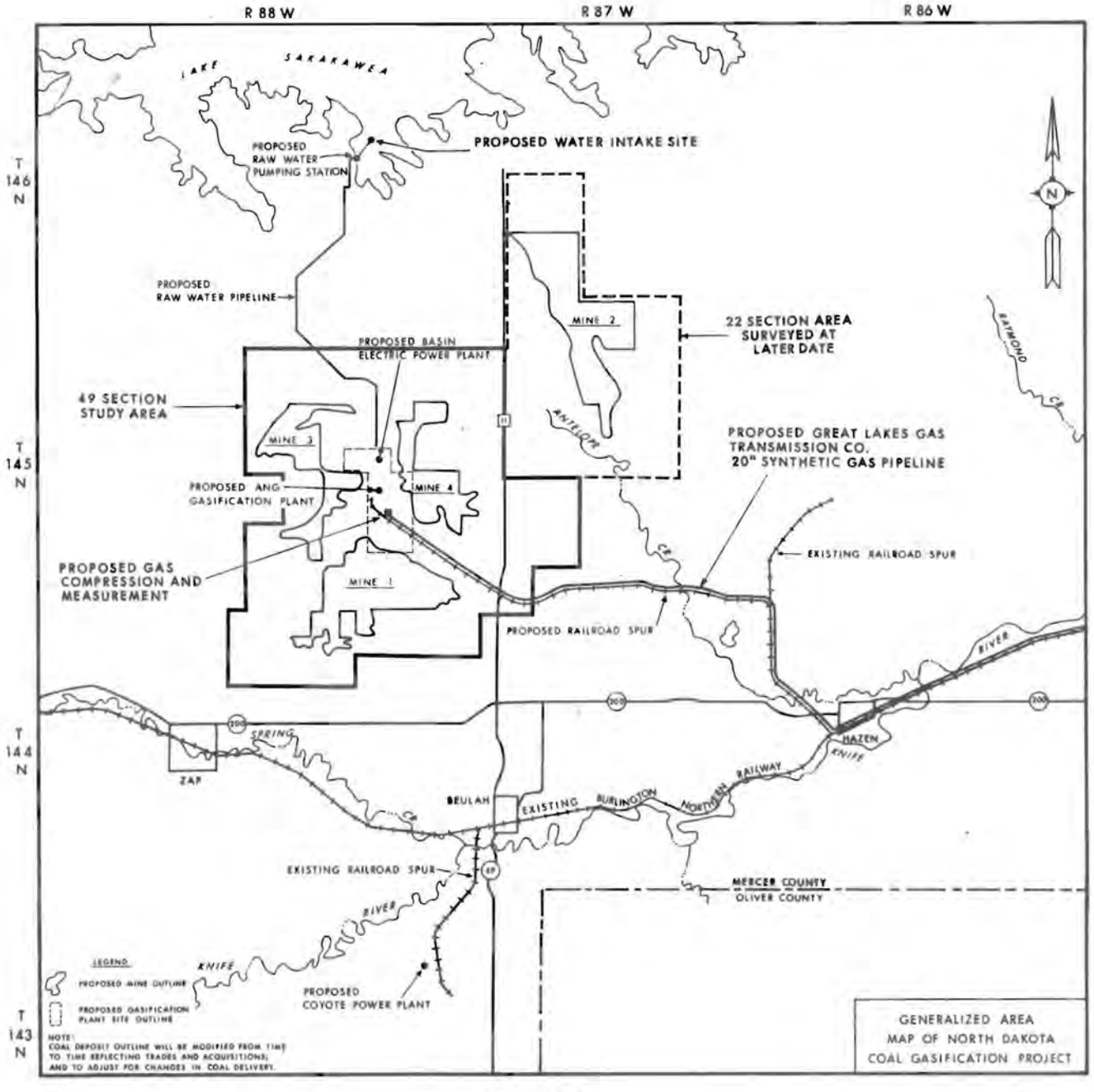


Figure 2-39

PROPOSED COAL GASIFICATION PLANT AND RELATED STRUCTURES IN RELATION TO SAMPLING AREAS

TABLE 2-15

Extent of Plant Communities Found Within a 49-Section Study Area Encompassing the ANGCGC Plant-Mine Site

Community and Habitat Type	Approximate Acreage 1/	% of Community
Agriculture (59%)		
Cropland	13,300	72
Domestic Hayland	4,800	26
Retired Cropland	100	1
Fencerow	100	1
Farmstead	300	1
	18,600	100
Prairie (40%)		
Subirrigated	100	1
Overflow	250	2
Saline Lowland	100	1
Closed Depression	100	1
Sandy	1,250	10
Silty	5,500	44
Clayey	250	2
Thin Upland	1,600	13
Shallow	2,250	22
Claypan	125	1
Shallow-Gravel	100	1
Very Shallow	125	1
Thin Claypan	500	4
	12,250	100
Wetland (0.3%)		
Wetmeadow Swale	15	14
Cropland Pond	1	1
Seasonal Ponds & Lakes	65	64
Semipermanent Ponds & Lakes	7	7
Stock Ponds	14	14
	102	100
Woodlands (0.7%)		
Natural	125	63
Tree Plantings	75	37
	200	100

1/ Approximate acreage based upon 15 quarter-section samples within the 49-section study area.

Source: Woodward-Envicon, Inc. 1974

wheatgrass, alfalfa, and yellow sweetclover. Coarse weed species are commonly associated with seeded grasses in retired cropland fields. The fields in the study area were utilized for hay in 1974.

d. Fence Rows, Section Lines, and Rights-of-Way

Narrow strips of weedy habitat often border croplands, hayfields, grazed prairie, fences, section lines, and rights-of-way. For nine sampled fence rows, three introduced grasses (smooth brome, Kentucky bluegrass, and crested wheatgrass) made up 60 percent of the total plant composition, native perennial grasses 14 percent, and annuals 19 percent (Appendix G). Many section lines and roadsides are planted in hay grasses and legumes, and are hayed annually. Fence rows adjacent to domestic hayfields contained mainly hay grasses; those adjacent to croplands contained a wide variety of annual weeds. The establishment of smooth brome generally resulted in a nearly pure stand of this species due to its early growth and its tendency toward dense stands.

e. Farmsteads

About 1 percent of the agricultural community was farmsteads. Abandoned farmsteads were about 15 percent of the total farmstead acreage. Grounds of these areas tend to become overgrown with weeds and brush and are important as wildlife habitat.

Product Pipeline: Agricultural land in the vicinity of the product pipeline is essentially of the same type as that of the plant-mine site. About 262 miles of the proposed route is bordered by cropland and 15 miles bordered by domestic hayland.

2.2.2.2 Prairie

Plant-Mine Site: Approximately 40 percent of the plant-mine study area consists of prairie. This community was further subdivided into 13 range-site categories based on soil type, field inspection, and vegetation sampling. These range sites represent a wide spectrum of pre- and post-climax plant communities resulting from local variations in soil, wetness, topography, etc. The range sites in the study area were: subirrigated, overflow, saline lowland, closed depression, sandy, silty, clayey, thin upland, shallow, claypan, shallow to gravel, very shallow, and thin claypan.

a. Subirrigated

This range site is present in the study area only as a part of other units. Its acreage is insignificant, but it represents a distinct community. Dominant plant species in a subirrigated plantsite in the study area were big bluestem, prairie cordgrass, and switchgrass (Appendix G).

b. Overflow

About 2 percent of the prairie in the study area was overflow range site. In two overflow range sites big bluestem was the dominant species; Pennsylvania sedge was second in abundance, and porcupine grass was third.

c. Saline Lowland

Less than 1 percent of prairie in the study area is saline lowland. Plant species tabulated on moderately well and poorly drained saline lowland sites are listed in Appendix G. Western wheatgrass, swollen bluegrass, and poverty weed dominated in the moderately well drained area whereas salt meadowgrass, saltgrass, hastate saltbush, western wheatgrass, and wild barley were the principal species where drainage was poorer.

d. Closed Depression

Less than 1 percent of the prairie in the study area is closed depression range site. Because this site is found in closed basins, the plant community is quite variable depending on recent weather conditions. Generally the dominant species is western wheatgrass, an upland species with high moisture tolerance. However, a succession of wet years may result in high percentages of northern reedgrass and sedges more characteristic of wet meadow sites.

e. Sandy

Sandy range is about 10 percent of the prairie in the study area. In two sandy range sites sampled, big sandgrass was the most abundant species, followed by prairie junegrass, blue grama, and needle-and-thread. Western wheatgrass was relatively low in importance.

f. Silty

The silty range site comprises about 44 percent of the prairie in the study area. Two silty range sites were sampled and both showed blue grama highest in relative abundance, with western wheatgrass and needle-and-thread second and third, respectively.

Blue grama is a short-grass understory species, and although abundant, it comprises a much smaller percentage of the stand by weight than the percent relative abundance indicates. Therefore, western wheatgrass was actually the dominant species.

g. Clayey

About 2 percent of the prairie of the study area is clayey range site. Examination of a clayey range site showed that western wheatgrass, green needlegrass, and blue grama were the dominant plant species.

h. Thin Upland

This range site was about 13 percent of the study area prairie. In two thin upland communities sampled, little bluestem was the most abundant species, followed by Pennsylvania sedge, porcupine grass, and big sandgrass.

i. Shallow

The shallow range site was about 22 percent of the prairie acreage. The dominant plant species of two sampling areas were little bluestem, threadleaf sedge, Pennsylvania sedge, and big sandgrass. The high occurrence of big sandgrass was due to the sandyness of the soil.

j. Claypan

Claypan was about 1 percent of the prairie of the study area. These sites are often characterized by shallow depressions where the underlying impervious subsoil is exposed by erosion. The vegetation of these depressions is sparse and many are almost barren. A claypan site in the study area was dominated by western wheatgrass, green needlegrass, and prairie junegrass.

k. Shallow to Gravel

The shallow to gravel range site was less than 1 percent of prairie acreage. One site in the study area was dominated by threadleaf sedge, blue grama, and fringed sage. Blue grama dominance was probably a result of heavy grazing.

l. Very Shallow

This range site was about 1 percent of the study area prairie. Plant communities on soils underlain by gravel are different than those on soils underlain by hard rock or clinker. In the study area, threadleaf sedge and needle-and-thread were the dominant

plants in areas underlain by gravel. Plains muhly, needle-and-thread, and little bluestem dominated over clinker areas whereas thickspike wheatgrass was the dominant grass over sandstone.

m. Thin Claypan

The thin claypan range site is about 4 percent of the prairie acreage. Examination of one site showed western wheatgrass as dominant. Significant percentages of blue grama, tumblegrass, gumweed, sandberg bluegrass, and buffalo grass were also present.

Product Pipeline: Typical plants of the various prairie regions along the proposed product pipeline route would include western wheatgrass, needle-and-thread, green needlegrass, big bluestem, little bluestem, Indian grass, and blue grama. The types of prairie (e.g., tall-grass, transitional, etc.) differ primarily in the species composition and/or densities of these species. Along almost all of the proposed route vegetation consists of brome, mixed grasses, and some shrub communities characteristic of idle lands along railroad rights-of-way. About 58 miles of the proposed route is bordered by natural prairie communities.

2.2.2.3 Wetland

Plant-Mine Site: Wetland communities occupy about 0.3 percent of the 49-section study area. Five different habitats are represented within this community: wet-meadow swales, cropland ponds, seasonal ponds and lakes, semipermanent ponds and lakes, and stock ponds.

a. Wet-Meadow Swales

Wet-meadow swales occur in shallow depressions that have not been cultivated and make up about 14 percent of study area wetlands. In two wet-meadow sites, smoothcone sedge, wild barley, and common spikerush were the most abundant plant species (Appendix G).

b. Cropland Ponds

Cropland ponds occur in basins where the soil is cultivated during dry years. Vegetation in noncrop years is dominated by pioneer species characteristic of early wet-meadow and shallow marsh successional stages. Cropland ponds are present, but were not sampled.

c. Seasonal (Pothole) Ponds and Lakes

About 65 percent of the wetlands in the study area were seasonal ponds and lakes. Two vegetative zones are generally present: a peripheral wetland range zone and a shallow marsh zone. Two

wetland range sites sampled were dominated by slough sedge and long-rooted smartweed. Other wetland range sites dominated by rivergrass were noted.

d. Semipermanent (Pothole) Ponds and Lakes

This habitat type was 7 percent of the wetlands in the study area. Two marshes were sampled, and burreed, long-rooted smartweed, broadleaved cattail, and river bulrush were the principal species. Hardstem and softstem bulrush were observed but were not represented in the sample.

e. Stock Ponds

Stock ponds comprised about 14 percent of wetland habitat in the study area. The edges of these ponds are usually trampled to the point that vegetation cannot grow, but occasionally small areas of marsh, wetland range, and/or wet-meadow vegetation are present.

Product Pipeline: About 19 miles of wetlands lie in close proximity to the proposed product pipeline route (Table 2-16). The pipeline would only be laid on one side of the railroad but whether the north or south side would be used is not known at this time; thus, Table 2-16 presents wetland data for both. Not all 155 or 162 wetlands would be crossed; as indicated on page 2-24, it is estimated that about 32 of these wetlands would be crossed by the pipeline. The wetlands occur primarily on the Missouri Couteau and portions of the Drift Prairie west of Pelican Lake (about 50 percent of the wetlands occur in Ramsey County alone). The vegetation associated with these wetlands would be essentially the same as that described above for the plant-mine site.

Table 2-16
INVENTORY OF WETLAND IMPOUNDMENTS ALONG PRODUCT PIPELINE ROUTE

	North Side of RR	South Side of RR
Number of wetlands encountered	155	162
Total acreage of wetlands	7,123	7,167
Acreage within 50 foot ROW	113	114
Linear miles of wetland	18.5	18.7

All of the wetlands along the proposed route (about 19 miles) are in North Dakota. The most important waterfowl habitat is in the Missouri Couteau and the Drift Prairie west of Pelican Lake. Intermittent ponds and marshes are more extensive than permanent waters by 4:1. The potholes on the Couteau are on higher ground, are visually more distinct, and tend to be fresher than potholes of the Drift Prairie. The latter, being at or below the surrounding water table, are subject to inflow seepage and tend to be more saline.

2.2.2.4 Woodlands

Plant-Mine Site: Natural wooded communities near the plant-mine site can best be classed as prairie thickets. Several tree plantings are also present. Only 0.7 percent of the study area is occupied by woody vegetation over 6 feet high.

a. Natural Communities

Natural wooded communities make up 63 percent of the woody cover present. Three types of natural woodlands are present in the study area. Species composition relates closely to moisture conditions - hydric (wet), mesic (moist), and xeric (dry). Woody species in each of these types are shown in Appendix G. It appears that the natural wooded communities are gradually increasing in extent, particularly on north slopes. This might be a result of protection from fire, perhaps in conjunction with heavy grazing.

b. Tree Plantings

Long narrow strips of native and exotic trees and shrubs (shelterbelts) account for about 37 percent of wooded habitat in the impact area. Two wildlife habitat improvement plantings have been established in the study area. These are block plantings of 3 to 5 acres designed to provide food and winter cover for wildlife. Exotic plant species, particularly Chinese and Siberian elms, caragana, and Russian olive were the most common trees in tree plantings, although in older plantings native species such as green ash and cottonwood were present.

Product Pipeline: Natural woodlands in the vicinity of the product pipeline route consist of stands of bottomland hardwoods along major drainages; notably the Knife River, Missouri River, Forest River (and its branches), Red River of the North, and Snake River. There are also some scattered stands of bur oak, green ash, and aspen around the Missouri Coteau and scattered in other areas of stronger relief throughout the Missouri Coteau and Drift Prairie. Woody shrubs are also found in coulees west of the Missouri. Stands consisting primarily of aspen and jack pine are found scattered on some beach ridges around the Red River Valley. Also, scattered woodlots and occasional areas of tamarack swamp occur along the route where it leaves the Soo Line ROW west of Vicking to link with the Thief River Falls Compressor Station. Overall the pipeline route traverses about 22.7 miles of woodland habitat.

2.2.3 Terrestrial Fauna

2.2.3.1 Birds

Field studies near the plant-mine site during 1974 indicated the presence of 75 bird species during the breeding season. An additional 32 species observed only during early spring and/or late summer and fall are considered to be migrants. Bird species observed in and about the 49-section study area are listed in Table 2-17.

a. Water Birds

Waterfowl were given special attention in field studies. Six species nested or attempted to nest in the plant-mine study area (Table 2-18). The estimated spring (May) duck population was about 250 birds, including 104 pairs and 42 unpaired drakes. A brood count the second week of July located 135 ducklings in 22 broods. Blue-winged teal and ruddy duck broods were not observed, thus the estimated 21 percent nesting success rate is probably low. Use of the area was heavy during early spring when seasonal ponds contained water. Use decreased in July as these ponds began to dry out and breeding activity declined. By September 3, only 36 ducks were counted.

Twenty-six species of water birds other than waterfowl were observed on or in the study area. Of these, eight were seen only on Lake Sakakawea. Only three species, the American coot, killdeer, and upland plover, were numerous enough to allow calculation of population estimates.

Water birds are of primary importance throughout the region of the proposed product pipeline and utilize the area extensively. The

TABLE 2-17

BIRD SPECIES OBSERVED ON AND IN THE VICINITY OF THE STUDY AREA

Species	Status[1]	Habitat[2]				Minimum[3] Breeding Population
		Agricultural	Prairie	Wetland	Wooded	
Waterbirds						
Common loon[4]	-			100		-
Western grebe[4]	-			100		-
Eared grebe	B			100		P
Pied-billed grebe	B			100		P
White pelican[4]	-			100		-
Double-crested cormorant[4]	-			100		-
Mallard	B			100		62
Pintail	B			100		12
Gadwall	B			100		19
American widgeon	M			100		-
Shoveler	B			100		70
Blue-winged teal	B			100		62
Green-winged teal	M			100		-
Redhead	M			100		-
Canvasback	M			100		-
Ring-necked duck	M			100		-
Lesser scaup	M			100		-
Ruddy duck	B			100		5
Great blue heron	M			100		-
American bittern	M			100		-
Sandhill crane	M			100		-
American coot	B			100		81
Sora	B			100		P
American avocet	M			100		-
Killdeer	B	8	64	28		10 ± 3/mi^2
Marbled godwit	M			100		-
Upland plover	B		91	9		6 ± 2/mi^2
Spotted sandpiper	M					-
Willet	B			100		P
Lesser yellowlegs	M			100		-
Long-billed dowicher	M			100		-
Semipalmated sandpiper[4]	-					
Wilson's phalarope	B			100		P
Common snipe	M			100		-
Herring gull[4]	-			100		-
Ring-billed gull[4]	-			100		-
Franklin's gull[4]	-			100		-
Black tern	B			100		P
Upland Gamebirds						
Sharp-tailed grouse	B	50	22		28	1.6/mi^2
Ring-necked pheasant	B	15	28		57	
Gray partridge	B	51	10		39	P
Raptors						
Turkey vulture	M	33	67			-
Cooper's hawk	B				100	2 pr
Sharp-shinned hawk	M				100	-
Marsh hawk	M	47	52	1		6 pr
Red-tailed hawk	M	45	55			-
Swainson's hawk	B	35	60		5	2 pr
Prairie falcon	M		80		20	-
Sparrow hawk	M	100				-
Screech owl	M	100				-
Great horned owl	B	6	13	13	68	3 pr
Burrowing owl	B	12	88			3 pr
Songbirds						
Rock dove	B	100				P
Mourning dove	B	11	28		61	7 ± 3/mi^2
Black-billed cuckoo	B				100	P
Common nighthawk	B	50	50			P
Belted kingfisher	B			100		P
Yellow-shafted flicker	B				100	P
Eastern kingbird	B	22	38	40		13 ± 3/mi^2
Western kingbird	B		33		67	P
Eastern phoebe	B				100	P
Traill's flycatcher	B				100	P
Least flycatcher	B				100	P
Horned lark	B	62	35	3		82 ± 19/mi^2
Barn swallow	B					P
Tree swallow	B					P
Bank swallow	B					P
Rough-winged swallow	B					P
Blue jay	B				100	P
Black-billed magpie	B				100	P
Common crow	B				100	P
Black-capped chickadee	M				100	-

(continues)

TABLE 2-17 (cont'd.-1)

Species	Status[1]	Habitat[2] Agricultural	Prairie	Wetland	Wooded	Minimum[3] Breeding Population
Rock wren	M		100			-
Long-billed marsh wren	M			100		-
Catbird	B				100	P
Brown thrasher	B		9	18	73	P
Robin	B		11		89	5 ± 2/mi^2
Loggerhead shrike	B		67		33	P
Starling	B	100				P
Philadelphia vireo	B	100				P
Yellow warbler	B				100	4 ± 2/mi^2
Myrtle warbler	M				100	-
Ovenbird	B				100	P
Yellowthroat	B	17			83	4 ± 2/mi^2
House sparrow	B		56		44	5 ± 3/mi^2
Bobolink	B	77	10	13		8 ± 6/mi^2
Western meadowlark	B	15	80		5	47 ± 6/mi^2
Yellow-headed blackbird	B	37		63		P
Red-winged blackbird	B	21	35	23	21	31 ± 7/mi^2
Brewer's blackbird	B	37	20	2	41	14 ± 8/mi^2
Common grackle	B		100			P
Brown-headed cowbird	B	30	52		18	42 ± 11/mi^2
Orchard oriole	B				100	P
Baltimore oriole	B				100	P
Rose-breasted grosbeak	B				100	P
American goldfinch	B				100	P
Dickcissel	B	100				P
Rufous-sided towhee	B				100	P
Grasshopper sparrow	B	28	68		4	7 ± 2/mi^2
Baird's sparrow	B		100			P
Lark bunting	B	60	39		1	93 ± 14/mi^2
Vesper sparrow	B	24	67	4	5	11 ± 2/mi^2
Clay-colored sparrow	B	2	2		96	14 ± 5/mi^2
Tree sparrow	M				100	-
Chipping sparrow	M				100	-
White-crowned sparrow	M				100	-
Song sparrow	B	37	13	37	13	P
McCown's longspur	B	100				P
Chestnut-collared longspur	B	27	72	1		114 ± 21/mi^2

[1]B = Breeding bird, M = migrating bird.

[2]Values indicate percentages of observations.

[3]P = Present in low numbers; breeding population less than four (4) per square mile. Whole numbers indicate the estimated number of breeding individuals on the 48 square mile study area in 1974; pr = breeding pairs.

[4]Observed only on Lake Sakakawea.

Source: Woodward-Envicon, Inc., Analysis, 1974.

TABLE 2-18

BREEDING POPULATIONS AND PRODUCTIVITY OF SIX SPECIES OF WATERFOWL ON THE STUDY AREA

Species	Estimated No. of Pairs	Unpaired Males	Spring Population	No. of Broods	No. of Young	Percent Nesting Success
Mallard	26	10	62	12	83	46
Pintail	13	6	32	4	20	31
Godwall	8	3	19	5	28	62
Shoveler	29	12	70	1	4	3
Blue-winged teal	26	10	62	0	0	0
Ruddy duck	2	1	5	0	0	0
Total	104	42	250	22	135	21

Source: Woodward-Envicon, Inc., Analysis, 1974.

prairie pothole region is especially important and is used heavily during breeding and migrations. Several species of ducks commonly nest in the area; blue-winged teal make up nearly one-fourth of the nesting ducks in the Dakotas, with pintails, mallards, and gadwalls comprising most of the rest (37). Coots, snipe, plovers, rails, and the American avocet breed on the shores of marshes and lakes. Sandhill cranes also use the area for feeding and resting during migration; the whopping crane and whistling swan are known to use the area for resting during migration.

b. Upland Game Birds

Three species of upland game birds inhabited the plant-mine study area--the sharp-tailed grouse, ring-necked pheasant, and gray partridge. The sharp-tailed grouse was present where ungrazed or lightly-grazed prairie, grain fields, and woody vegetation were in close proximity. These birds use ungrazed or lightly-grazed prairie for nesting (30); woody areas provide vital winter cover. During July and August the adult to juvenile ratio was 1:3.2, providing an estimated fall population of 6.7 birds/mi^2.

Spring surveys indicated a population of 0.8 male pheasant/mi^2. A male to female ratio of 1:2.0-3.3 (31) was used to estimate the breeding population of 2.4 birds/mi^2. Data on gray partridge were not sufficient to estimate populations.

Upland game birds along the proposed product pipeline route include ring-necked pheasant, gray partridge, sharp-tailed grouse, and greater prairie chicken.

c. Raptors

Eleven species of raptors were observed in the 49-section study area; six were present during the breeding season - Cooper's hawk, marsh hawk, Swainson's hawk, great-horned owl, and burrowing owl. Seven of the eight observations of burrowing owls were in prairie habitats where they nest in the abandoned burrows of various mammals; in the study area probably those of badgers.

d. Songbirds

In all, 57 species of songbirds (pigeons and doves, cuckoos, goatsuckers, swifts, kingfishers, woodpeckers, and perching birds) were observed in the plant-mine study area; 49 of these during the nesting season. Ten species, the chestnut-collared longspur, lark bunting, horned lark, western meadowlark, brown-headed cowbird, redwinged blackbird, clay-colored sparrow, Brewer's blackbird,

eastern kingbird, and vesper sparrow, accounted for over 85 percent of all songbird observations during the spring census. The first four of these species comprised over 60 percent of the observations. The widest variety of birds, 33 species, was observed where woody vegetation was present. Many prairie and wetland species use trees and shrubs for perches during territorial displays.

2.2.3.2 Mammals

a. Small Mammals

Small mammals include bats, shrews, and small rodents not of recreational or furbearing importance. Ten species were identified in the plant-mine study area (Table 2-19). Suitable habitat in agricultural areas was mainly in fence rows. Thirteen-lined ground squirrels and deer mice were the most abundant small mammals, as they were also in prairie habitat. Thirteen-lined ground squirrels and meadow jumping mice were the most common small mammals in wetland areas, whereas deer mice and meadow jumping mice were the most common in wooded areas.

b. Medium Mammals

Medium-sized mammals include small game mammals and furbearers. Eleven species were observed on the study area near the plant-mine site; sufficient data were gathered to calculate population estimates for five of these (Table 2-20). Raccoons were observed most often in agricultural areas, but tracks and droppings were often observed in wooded and wetland areas. Eight red fox dens were located in the spring, and two additional pairs were reported by a landowner.

The muskrat is probably the most abundant furbearing mammal in the region of the proposed product pipeline. Beaver, weasel, fox, mink, and raccoons are also taken for their fur. Predators such as coyotes, bobcats, skunks, and badgers are also often taken for their fur, or simply hunted as undesirable species. Tree squirrels, cottontail rabbits, and white-tailed jackrabbits are also present.

c. Large Mammals

Three species of large mammals were observed in the 49-section study area (Table 2-20). Only one mule deer was seen; white-tailed deer were not present in sufficient numbers to accurately estimate numbers, but at least 11 individuals were observed. Most observations of pronghorn were in the agricultural northeastern one-third of the study area. Four males had summer territories

Table 2-19

SMALL MAMMAL SPECIES CAPTURED ON THE STUDY AREA

Species	Spring and Summer 1/				Fall Population 2/	
	Agricultural	Prairie	Wetland	Wooded	Agricultural	Prairie
Small Mammals						
Masked shrew	--	--	--	3	6.4	--
Thirteen-lined ground squirrel	63	64	83	--	--	83.2
Northern pocket gopher	3	--	--	--	--	--
Wyoming pocket mouse	7	--	--	--	25.6	6.4
Deer mouse	24	36	--	51	812.8	710.4
Northern grasshopper mouse	--	--	--	--	57.6	25.6
Boreal redback vole	--	--	--	3	--	--
Prairie vole	1	--	--	--	--	--
House mouse	1	--	--	--	25.6	--
Meadow jumping mouse	1	--	17	43	--	--
Total	100	100	100	100	928.0	825.6

1/ Percent of small mammals captured within each habitat type.
2/ Animals per mi^2.

TABLE 2-20

MEDIUM-SIZED AND LARGE MAMMAL SPECIES OBSERVED IN THE STUDY AREA

Species	Habitat[1]				Minimum Fall Population[2]
	Agricultural	Prairie	Wetland	Wooded	
Raccoon	79	16		5	1.18 ± .88/mi^2
Long-tailed weasel	67	17		16	P
Mink	100				P
Badger	33	67			P
Striped skunk	83	14		3	1.82 ± .68/mi^2
Coyote	20	70		10	.22 ± .14/mi^2
Red fox	68	29		3	.64 ± .24/mi^2
Fox squirrel				100	P
Porcupine	50			50	P
White-tailed jackrabbit	57	42		1	1.92 ± .40/mi^2
Eastern cottontail				100	
Mule deer				100	P
White-tailed deer	40	20	7	33	11
Pronghorn	73	27			32

[1]Percent of observations.

[2]P = presence in low numbers or incidentally. Confidence limits about density estimates are equal to the standard error of the mean. Whole number indicates estimated numbers present on the 49 square-mile study area.

Source: Woodward-Envicon, Inc., Analysis, 1974.

within, or partly within, the study area; a bachelor herd of five males was also present. During two aerial surveys conducted in July and September, 65 and 37 pronghorn, respectively, were counted. The July survey revealed 11 males, 27 females, and 27 juveniles; the September survey showed 8 males, 15 females, and 14 juveniles. Reproductive success was excellent at 0.98 juveniles/female. A total of 32 pronghorns had their entire range within the study area; an additional 38 had ranges partly within the study area. Fall movements suggest a wintering area for a herd of about 21 pronghorn in Beulah Trench near the center of the study area.

The same large mammals occur in the vicinity of the product pipeline except that the pronghorn becomes less numerous east of the Missouri River.

2.2.3.3 Amphibians and Reptiles

Ten species of amphibians and reptiles were observed in the plant-mine study area (Table 2-21). Aside from the northern leopard frog, which was very common, the plains garter snake was the most commonly encountered species.

2.2.4 Aquatic Systems

2.2.4.1 Renner Bay (Lake Sakakawea)

a. Fish

Twenty-five species of fish were collected from Renner Bay during the field study (Table 2-22) by the use of gill nets, seines, and electroshocking. Species composition and measurements are shown in Appendix G. Goldeye was the most abundant species taken comprising 59.4 percent of the gill net catches. Other species were carp (11.2 percent), white sucker (8.0 percent), walleye (7.1 percent), sauger (3.4 percent), river carpsucker (3.3 percent), and yellow perch (3.0 percent). Electroshocking also indicated goldeye to be the most abundant species, followed by carp, walleye, yellow perch, and white sucker. Species composition of fish captured by seining differed from those captured by gill nets and electroshocking. Emerald shiners comprised 59 percent of the total catch, while yellow perch made up 32.8 percent.

Young-of-the-year emerald shiners, yellow perch, carp, white sucker, and white bass were collected in seine hauls. Carp were observed spawning from early June to mid-August. Eggs of another species (probably one of the shiners) were found attached to aquatic plants in shallow water.

b. Benthos

Eighteen macroinvertebrates of various taxonomic levels were collected from Renner Bay (Appendix G). Chironomidae were the most abundant with densities ranging from 33.3 to 1,095.2 larvae/m^2. There was no apparent difference in average midge densities among all benthic sample stations. Aquatic earthworms made up 20.2 percent and midge larvae 70 percent of all benthic macroinvertebrates collected.

c. Plankton

Plankton studies of Renner Bay indicate a low-standing crop and a highly mineralized environment. Most phytoplankton found (Appendix G)

TABLE 2-21

AMPHIBIANS AND REPTILES OBSERVED ON AND IN THE VICINITY OF THE STUDY AREA

Species	Habitat[1] Agricultural	Prairie	Wetland	Wooded	Total
Blotched tiger salamander	4	-	-	-	4
Great plains toad	-	1	-	-	1
Rocky Mountain toad[b]	-	-	-	1	1
Northern leopard frog[c]	-	-	-		
Western painted turtle	-	-	14	1	15
Plains garter snake	6	8	19	-	33
Red-sided garter snake	3	-	5	1	9
Western hog-nose snake	1	-	-	-	1
Yellow-bellied racer	5	8	-	-	13
Smooth green snake	-	2	-	1	3
Bull snake	5	-	-	-	5

[1]Number of observations in habitat.

[2]Observed only along the Knife River.

[3]Observations of the northern leopard frog were not recorded due to their extreme abundance in wetland areas.

Source: Woodward-Envicon, Inc., Analysis, 1974.

TABLE 2-22

FISH COLLECTED FROM AQUATIC ECOSYSTEMS IN MERCER COUNTY, NORTH DAKOTA, MAY THROUGH OCTOBER

Species	Lake Sakakawea	Knife River Drainage	Ponds
Shovelnose sturgeon	X		
Goldeye	X	X	
Coho salmon	X		
Rainbow trout	X		
Northern pike	X	X	
Lake chub		X	
Carp	X	X	
Brassy minnow		X	
Plains minnow	X		
Flathead chub		X	
Emerald shiner	X	X	
Sand shiner		X	
Northern redbelly dace	X	X	X
Fathead minnow	X	X	X
Blacknose dace		X	
Creek chub	X	X	
River carpsucker	X	X	
White sucker	X	X	
Smallmouth buffalo	X		
Bigmouth buffalo	X		
Shorthead redhorse	X	X	
Channel catfish	X	X	
Stonecat		X	
Black bullhead		X	
Burbot	X		
Brook stickleback			X
White bass	X		
Iowa darter	X	X	
Johnny darter *Etheostoma rigrum*	X	X	
Yellow perch	X		
Sauger	X	X	
Walleye	X	X	
Freshwater drum	X		
Total	25	22	3

Source: Woodward-Envicon, Inc., Analysis, 1974.

are either tolerant of a wide variety of conditions or are found specifically in highly mineralized environments. Most of the zooplankton, likewise, are known to occur in a wide variety of limnetic environments.

Twenty-eight zooplankton taxa were identified including 7 Copepoda, 6 Cladocera, 11 Rotifera, and 1 each of Protozoa, Chironomidae, Nemata, and Oligochaeta. Density was highest in late July (29.1 organisms/l) and lowest in September (16.6 organisms/l). Copepoda clearly predominated, comprising 59 to 91 percent of the total.

One hundred two phytoplankton taxa were found including 10 centric diatoms, 79 pennate diatoms, and 13 others (5 Chlorophyta, 3 Cyanophyta, 2 Pyrrophyta, 2 Chrysophyta, and 1 Euglenophyta). Phytoplankton density was highest in late June (240.8 cells/ml) and lowest in September (21.6 cells/ml). Pennate diatom density was 84 to 91 percent of total phytoplankton density throughout the study.

d. Rooted Aquatic Plants

Macrophytes were not abundant. The dominant submergent was sago pondweed. Very sparse growth of a broad-leaved pondweed was seen in portions of the bay. Smartweed was the most abundant subaquatic.

2.2.4.2 Knife River Basin

a. Fish

Twenty-two species of fish were collected from the Knife River and Spring Creek (Table 2-23). Measurements and numbers collected are presented in Appendix G. Minnows were 83.2 percent of the total fish collected, with sand shiners representing 70 percent of this total. Suckers accounted for 12.9 percent and gamefish less than 1.0 percent of the total. The carp, flathead chub, sand shiner, fathead minnow, blacknose dace, white sucker, shorthead redhorse, and Iowa darter were collected each month of the study. The walleye, stonecat, creek chub, and northern red belly dace were taken five of the six sample periods.

Young-of-the-year black bullheads were captured in drift nets. Young-of-the-year carp, sand shiner, river carpsucker, shorthead redhorse, white sucker, and channel catfish were also collected from the river drainage.

b. Benthos

Although siltation was evident, a diverse macroinvertebrate population was found in the Knife River drainage; 63 various taxonomic levels

TABLE 2-23

TOTAL NUMBER OF FISH FOR EACH SPECIES TAKEN FROM EACH AREA OF THE KNIFE RIVER DRAINAGE

Species	Spring Creek[1]		South Fork[2]	Lower Area[3]	
Goldeye			1		
Northern pike	4	2			
Lake chub			3		
Carp	32	86	21	13	21
Brassy minnow		1			
Flathead chub		8	76	48	9
Emerald shiner				1	
Sand shiner	811	602	940	1685	708
Northern redbelly dace	2	3	4		
Fathead minnow	2	24	73	243	50
Blacknose dace	8	69	16	18	3
Creek chub	1		30	8	10
River carpsucker			10	2	1
White sucker	203	258	79	30	27
Shorthead redhorse	28	64	45	57	71
Channel catfish				18	10
Stonecat		10	5	4	
Iowa darter	5	4	4		
Sauger				1	1
Walleye	2		3		2

[1] Stations 1 and 3
[2] Station 2
[3] Stations 4 and 6

Source: Woodward-Envicon, Inc., Analysis, 1974.

were identified (Appendix G), including 10 genera of mayfly nymphs, 11 genera of caddisfly larvae, and 16 genera of midge larvae. A unionoid clam and a crayfish were hand-collected from the drainage. Only minor differences in the species composition existed among six collection stations. Individual taxa varied in numbers between stations and among samples, but differences in habitats sampled and sampler selectivity may have contributed to these variations.

c. Ponds

Three ponds within the study area were surveyed for fish and aquatic macroinvertebrates. The brook stickleback, fathead minnow, and northern red belly dace were all collected from one pond (Table 2-22). Leeches, sideswimmers, dragonfly nymphs, damselfly nymphs, water boatmen, water striders, caddisfly larvae, predaceous diving beetles, crane fly larvae, soldier fly larvae, and a snail were collected from the three ponds.

2.2.4.3 Product Pipeline Route

There are two major types of aquatic ecosystems in the region of the proposed product pipeline: a standing-water (lentic) system, which includes lakes, impoundments, ponds, and wetlands, and a running-water (lotic) system, which includes springs, creeks, and rivers. In general, surface waters in the area undergo wide

seasonal temperature gradients and have relatively high concentrations of total dissolved solids. Most rivers have sluggish currents and are normally turbid. The major impoundments are adequate in respiratory gases and are less turbid than the rivers. Rivers normally have higher concentrations of respiratory gases, due to greater interface mixing.

a. North Dakota

The major standing-water ecosystems which border or are in the proposed pipeline route in North Dakota are Lake Sakakawea, Lake Audubon, and the lakes of the Devils Lake complex. Other lentic systems include many unnamed perennial potholes, lakes, ponds, and wetlands, plus numerous unnamed intermittent potholes and wetlands. Major running-water systems were listed in Table 2-7 and Figure 2-18.

The major fishing waters in North Dakota which may be affected by pipeline construction include:

1. The lower reaches of the Knife River supports an excellent sauger and walleye sports fishery. In the spring these waters are important as walleye, sauger, and forage fish spawning and nursery habitat.

2. The Missouri River near Washburn supports a commercial fishery (buffalo fish, bullhead, carp, etc.) and an important sports fishery for pike, walleye, and sauger. In addition, an experimental coho salmon stocking program is taking place at Garrison Fish Hatchery to establish a salmon sports fishery in the Missouri. The first generation of adult spawners is due in 1977.

3. Lakes Sakakawea and Audubon provide excellent habitat for both warm- and cold-water species, and thus support a sports fishery of national importance.

4. Devils Lake supports an excellent northern pike fishery, as well as a white bass and walleye sports fishery. Because of salinity problems, the fishery is managed on a put-and-take basis.

5. The Forest and Red Rivers provide a locally important sport fishery for warm-water species such as northern pike, sauger, walleye, largemouth bass, and smallmouth bass.

Tributaries of the aforementioned streams provide sports fishing of local value during spring runoff. They also provide spawning habitat for spring spawning fish.

b. Minnesota

Minnesota waters to be crossed by the proposed pipeline are the Red River of the North, Snake River, and a perennially flowing drainage canal which flows into the Middle River. The fishery of the Red River was outlined above and that of the Snake River is similar.

2.2.5 Unique Biological Resources

2.2.5.1 Unique Ecosystems

A unique community is one which is extremely limited in extent or occurrence and/or possesses attributes of special academic interest. One such community exists on a small flat-topped butte at T. 145 N., R. 88 W., 1.25 miles northwest of the proposed mine boundary. The flat top represents the level of a former geologic period, most of which has long since eroded away. The plant community is a rare, relict grassland stand which has escaped grazing and tillage. The butte top is roughly triangular with an area of about 0.5 acres. Western wheatgrass was the predominant plant species, comprising 90 percent of the stand. Green needlegrass, fringed sage, needle-and-thread, and plains reedgrass were present in small amounts. A uniform mulch layer of 1.5 inches is present with an additional 0.5 inch of humic mulch.

Wildlife areas that occur in close proximity or adjoin the proposed product pipeline route include the Lewis and Clark State Game Management Area (GMA), south of the route at the Missouri River crossing, the Wolf Creek GMA on the south side of Lake Sakakawea, and the De Trobriand GMA on the north side of Lake Sakakawea. Also, the route passes south of Lake Ardoch NWR in Walsh County and near the Marshall County State Game Refuge in Minnesota. The proposed route is on existing railroad ROW near all of these areas.

2.2.5.2 Endangered Species

The black-footed ferret is the only endangered mammal that might be found in the project area. It is closely associated with prairie dog towns and neither the ferret or any prairie dogs were observed near the plant-mine site. The area is also within the former range of the northern kit (swift) fox; however, the current (July 14, 1977; FR 42:135) List of Endangered and Threatened Wildlife and Plants describes this species as now restricted to Canada.

The project area is within the migratory range of the whooping crane. In fact, two confirmed sitings were recorded for Mercer County during the fall of 1975. The Eskimo curlew possibly migrates through the area if it is not already extinct. It is also possible that the arctic peregrine falcon could be found in the region during migration. No endangered species of fish, amphibians, and reptiles are known to occur in the study area. The product pipeline route has not been checked for the presence or absence of any of these species. However, ANGCGC is committed to a detailed biological survey of the proposed route before final alignment (99).

2.3 Socioeconomic Environment

2.3.1 Demography

Population: The region near the plant-mine site is a predominantly agricultural area with a low population density. The 1970 population in the eight counties within 75 miles of the site was 108,512 (Table 2-24). Mercer, Dunn, and Oliver Counties had a 1970 population of 13,392. Since 1970, however, coal-related developments at Stanton and Center have resulted in some increase in population in the area. A special census in Hazen in August of 1975 showed a population of 1,558; this was an increase of 318 persons over the 1970 population of 1,240 (79). Although special censuses have not been held in other area cities, it is probable that some may also have experienced a population increase (particularly Beulah and Center).

Local Work Force: In 1970, about 14,500 workers in relevant job categories lived within 75 miles of the plant-mine site; more than 6,200 were employed in construction or farming. About 7.2 percent of the civilian labor force in the three major impact counties (Mercer, Dunn, and Oliver) was unemployed as of June 1976 (78). This showed little change from the 1972 rate of 7.3 percent (39). Dunn County has the highest jobless rate (7.8 percent) and Mercer County has the lowest (6.4 percent); Oliver County currently has a 7.3 percent jobless rate.

The 1970 primary work force in construction and construction-related jobs is shown in Table 2-25; the overall secondary work force in related construction is listed in Table 2-26. Unions having membership in the area in 1974 are shown in Table 2-27. Technical workers needed for operation of the gasification plant are not available in the region; some of the maintenance workers could come from the existing blue collar work force.

2.3.2 Economy

Of the 38,262 workers living in the eight counties near the plant-mine site in 1970, nearly 32 percent were engaged in

TABLE 2-24

PROPOSED COAL GASIFICATION PROJECT AREA, U.S. CENSUS SUBDIVISION POPULATION

County	Minor Civil Division (MCD) Subdivision	Count of Persons (Population)	North Dakota City[1]	Count of Persons (Population)
Burleigh	Bismarck	35,496	Bismarck	34,703
	Northeast	788	Wing	223
	Northwest	1,315	Regan	74
			Wilton (P)	116
	Southeast	1,198		
	Southwest	1,917		
Dunn	Halliday	1,820	Dodge City	121
			Dunn Center	107
			Halliday	413
			Werner	21
	Killdeer	1,899	Killdeer	615
	South Dunn	1,176		
McLean	Dogden Butte	917	Benedict	72
			Butte	193
			Ruso	15
	Garrison	1,614	Garrison	1,614
	North Central	1,673	Max	301
	South Central	1,196	Wilton (P)	579
	Turtle Lake	1,541	Mercer	132
			Turtle Lake	712
	Underwood	1,971	Coleharbor	78
			Underwood	781
	Washburn	804	Washburn	804
	West McLean	1,535		
Mercer	Beulah	1,344	Beulah	1,344
	East Mercer	1,653	Pick City	119
			Stanton	517
	Hazen	1,240	Hazen	1,240
	West Mercer	1,938	Golden Valley	235
			Zap	271
Morton	Central Morton	1,105	Almont	109
	Flasher	1,113	Flasher	467
	Glen Ullin	1,070	Glen Ullin	1,070
	Hebron	1,103	Hebron	1,103
	Mandan	11,093	Mandan	11,093
	Mandan North	1,859		
	Mandan South	1,227		
	New Salem	943	New Salem	943
	West Morton	717		
Oliver	Center	1,604	Center	619
	West Oliver	718		
Sheridan	East	1,090	Goodrick	300
	North	828	Martin	120
	Southwest	1,314	McClusky	664
Stark	Belfield	1,130	Belfield	1,130
	Dickinson	13,089	Dickinson	12,405
	Dickinson North	1,154	Gladstone	222
	Dickinson South	841		
	East Stark	2,319	Richardton	799
			Taylor	162
	West Stark	1,080	South Heart	132
Regional Totals	40 MCD's	108,512	42 Cities	76,738

[1] Any incorporated place.

(P) = partial incorporation in U.S. Census subdivision.

Source: 1970 Census 1st count.

TABLE 2-25

CENSUS OF PRIMARY WORK FORCE IN RELATEDCONSTRUCTION JOBS, 1970

County	Work Force		
	Construction	Farmers	Farm Laborers
Burleigh	1,600	705	178
Dunn	60	833	163
Mercer	151	592	107
McLean	261	1,032	166
Morton	533	787	421
Oliver	42	441	49
Sheridan	76	481	114
Stark	330	841	259
Subtotal	3,061	5,714	1,459
Total for Construction			10,234

Source: Thomas K. Ostenson. 1972. North Dakota employment characteristics by counties. North Dakota Agricultural Experiment Station. Fargo, North Dakota.

TABLE 2-26

SECONDARY WORK FORCE AVAILABLE IN RELATED CONSTRUCTION JOBS, 1970

Counties	Craftsmen Foremen	Operatives	Laborers	All Farmers	Laborers	Transport
Burleigh	1,821	646	411	705	178	419
Dunn	95	18	27	833	163	30
McLean	334	86	84	1,032	166	83
Mercer	296	96	131	592	107	81
Morton	937	363	233	787	423	294
Oliver	78	11	18	441	49	0
Sheridan	92	18	517	483	114	25
Stark	638	356	231	841	313	223
Sub total	4,291	1,594	1,652	5,714	1,513	1,155
Total						15,905

Source: Thomas K. Ostenson. 1972. North Dakota employment characteristics by counties. North Dakota Agricultural Experiment Station. Fargo, North Dakota.

TABLE 2-27

CONSTRUCTION RELATED UNIONS IN NORTH DAKOTA, 1974

Union	Local No.	Address	Jurisdiction	Members	Journeymen Wage per Hour
Asbestos Workers	133	1641 N. 10th St., Fargo	N.D.	40	$7.69
Boilermakers	647	117 S.E. Forest St., Minneapolis	N.D., S.D., Minn.	2000	8.90
Bricklayers	4	Rt. 4, Box 9A, Mandan	SW part of N.D.	75	7.13
Carpenters	1091	1323 E. Front Ave., Bismarck	Parts of west N.D.	NA	6.55
Cement Masons and Plasterers	897	107-6th Ave., N.W., Mandan	Parts of west N.D.	29	6.07
IBEW	714	Hwy. 83 North, Minot	Western N.D.	274	7.30
Homeworkers	793	403-7th Ave. N., Fargo	N.D.	343	7.80
Laborers	580	P.O. Box 1602, Grand Forks	N.D.	900	5.67
Millwrights	1091	1323 E. Front Ave., Bismarck	Parts of west N.D.	NA	7.56
Operating Engineers	49	P.O. Box 686, Bismarck	N.D.	NA	5.85
Painters	1962	911 Curtis Ave., Bismarck	N.D.	NA	5.65
Plumbers and Pipefitters	795 & 627	1323 E. Front Ave., Bismarck	Western N.D.	246	7.45
Sheetmetal Workers	553	120-19th St., S.E., Minot	All N.D. exc. SE part	125	7.90
Teamsters	123	1323 E. Front Ave., Bismarck	SW part of N.D.	NA	4.92

NA - Not Available

Source: Bismarck-Mandan Building and Construction Trades Council, 1974.
(Compilation of data submitted by each union listed in table)

finance and service industries, 22 percent in wholesale and retail trade, and 19 percent in agriculture (Table 2-28). The work force had a well balanced occupational structure--42 percent were professional and other white collar workers; 40 percent were blue collar workers, farmers, or farm workers; and 15 percent were service workers (Table 2-29). The eight county area contained over 5,700 farmers or farm managers, about 1,500 farm workers, and 8,300 other blue collar workers.

Although Mercer, Dunn, and Oliver Counties are predominantly agricultural, 211 small industrial firms were operating within these counties in 1972 (Table 2-30). In 1969, nearly 40 percent of the 1,961 farms in these counties were over 1,000 acres (40).

The three major impact counties had a combined taxable real estate valuation of about $16.5 million in 1975 (Table 2-31). Taxable valuation is legally prescribed at 50 percent of the market value of real property. However, the Sales Ratio Study conducted in 1976 by the State Supervisor of Assessments for the purpose of comparing the 1975 assessed value of properties with their actual selling prices shows that assessments averaged only 11.7 percent of market value in Dunn County, 9.9 percent in Oliver County, and 8.9 percent in Mercer County. (The State average is 12.3 percent.)

The State may legally levy up to 4.00 mills annually on the taxable valuation of local property for the State Medical Center, but only 1.00 mill has been levied in recent years. Taxes levied on taxable property within the three impacted counties but outside of a municipal boundary include the State levy, county levy, unorganized township road and bridge levy, school district levy, and rural fire protection levy. Taxable property within a municipality is subject to the State and county levy, city levy, school district levy, a fire protection district levy, and often a park district levy. The State-wide average total property tax mill levy in 1975 was 183 mills.

The major source of revenues for the three counties in 1975 was from the general property tax levy and the special tax levy on any mobile homes, rural electric cooperatives, banks, trust companies, savings and loan associations, and mutual, cooperative, and small commercial telephone companies. Total revenues expected from property taxes levied in 1975 upon the various classes of property in each county were:

TABLE 2-28

EMPLOYMENT[1] BY INDUSTRY AND BY COUNTY, 1970

County	Agriculture	Mining	Construction	Manufacturing	Transportation, Communication, Pub. Utilities	Trade	Finance, Services	Government	Total	Percentage Agriculture	Percentage Trade Finance, Services
Burleigh	967	42	1,400	841	1,121	3,845	5,819	1,654	15,866	5.9	60.8
Dunn	998	5	88	0	31	198	297	95	1,690	58.9	29.3
McLean	1,226	13	261	41	135	650	1,013	157	3,514	34.8	47.9
Mercer	713	115	151	9	245	349	459	91	2,132	33.4	37.8
Oliver	495	9	42	7	62	44	87	33	779	63.5	16.8
Sheridan	583	0	82	9	31	171	213	29	1,118	52.0	34.4
Stark	1,336	167	330	764	385	1,632	2,434	194	6,642	17.1	61.3
Morton	1,249	7	311	496	627	1,580	1,741	226	6,521	19.1	50.1
Total	7,568	358	1,865	2,767	2,637	8,428	12,103	2,588	38,262	19.7	53.6

[1]Number of persons reported in 1970 Census.

Sources: 1970 Census Data, Fourth Count, File B, MCD Reports.

Department of Agricultural Economics, North Dakota State University, 1972. North Dakota Employment Characteristics by Counties.

TABLE 2-29

EMPLOYMENT[1] - OCCUPATION BREAKDOWN BY COUNTY, 1970

County	Professional and Management	%	Farmers and Farm Managers	%	Farm Workers	%	Other[2] Blue Collar	%	Other[2] White Collar	%	Services[2]	%	Total
Burleigh	4,795	30.2	705	4.4	178	1.1	3,297	20.8	4,407	27.8	2,484	15.7	15,866
Dunn	220	13.0	833	49.3	163	9.6	170	10.1	168	9.9	136	8.0	1,690
McLean	747	21.3	1,032	29.4	166	4.7	587	16.7	460	13.1	522	14.9	3,514
Mercer	348	16.2	592	27.8	107	5.0	604	28.3	210	9.8	273	11.8	2,132
Oliver	59	7.6	441	56.6	49	6.3	107	13.7	66	8.5	57	7.3	779
Sheridan	152	13.6	483	43.2	114	10.2	169	15.1	131	11.7	69	6.2	1,118
Stark	1,467	22.1	841	12.7	259	3.9	1,490	22.4	1,422	21.4	1,163	7.5	6,642
Morton	1,314	20.2	707	12.1	423	6.5	1,827	28.0	1,120	17.2	1,050	16.1	6,521
Total	7,917	20.7	5,714	14.9	1,459	3.8	8,251	21.6	7,984	20.9	5,754	15.0	38,262

[1]Number of persons reported in 1970 Census.

[2]Categories listed in table are composed of the following occupations: Other White Collar - sales and clerical workers; Other Blue Collar - craftsmen and foremen, all operatives and non-farm laborers; Service - all service and private household workers.

Source: 1970 Census Data, Fourth Count, File B, MCD Reports.

Department of Agricultural Economics, North Dakota State University, 1972. North Dakota Employment Characteristics by Counties.

TABLE 2-30

NUMBER AND TYPES OF INDUSTRIES IN THE THREE-COUNTY AREA, 1972

Industry	Dunn	Mercer	Oliver
Agricultural Services	0	0	0
Mining	0	3	1
Construction	4	9	1
Manufacturing	1	3	0
Transportation, Communications, Public Utilities	2	10	2
Wholesale Trade	12	12	2
Retail Trade	31	45	8
Finance	1	8	0
Services	14	35	3
Total[1]	68	126	17

[1]Includes firms in miscellaneous categories.

Source: U.S. Bureau of the Census, 1973. County Business Patterns, 1972: North Dakota CBP-72-36. Washington, D.C. U.S. Government Printing Office.

County	Total Property Tax Revenues*
Dunn	$1,080,453
Oliver	572,564
Mercer	1,157,685

*Total collections might be somewhat less than this figure since not all projected revenues are collected.

Primary State revenues in North Dakota are derived from the 4 percent sales and use tax and the personal and corporate income tax. Sales and use tax revenues generated from the three counties in 1975 were:

County	Total Sales	Taxable Sales	Tax Paid
Dunn	$10,139,601	$ 4,100,826	$163,783
Oliver	1,611,941	793,451	27,172
Mercer	37,143,692	21,721,426	866,577

Table 2-31

TAXABLE VALUATION OF PROPERTY SUBJECT TO GENERAL PROPERTY TAX IN 1975

Taxable Valuation	Dunn	Oliver	Mercer
Total Acres	1,066,420.10	441,556.00	603,991.20
Farm Lands	$5,611,103.00	$2,948,171.00	$3,877,177.00
Other Real Estate	557,566.00	208,387.00	1,913,288.00
Total Real Estate	$6,168,669.00	$3,156,558.00	$5,790,405.00
Personal Property	-0-	-0-	-0-
Railroad and Utility Property	$ 484,254.00	$ 241,635.00	$ 647,596.00
Grand Total	$6,652,923.00	$3,398,193.00	$6,438,001.00

Source: 1976 Statistical Report, 1975 Property Taxes Levied and 1976 Property Tax Valuation, North Dakota Tax Department

The North Dakota coal severance tax on existing mines effective July 1, 1977, was $0.65/ton escalated on the basis of $0.01/ton for each one-point increase in the wholesale price index. The revenues received from the severance tax are allocated to the State Coal Development Fund. This fund is divided as follows:

a. 35 percent to a special fund for distribution to taxing districts impacted by coal development;

b. 15 percent held in perpetual trust, the income from which goes to the State's General Fund;

c. 20 percent allocated to the coal producing counties in proportion to the coal removed from the county; and

d. 30 percent to the State's General Fund.

The 20 percent of the severance tax allocated to the counties is further allocated 40 percent to the county, 30 percent to school districts within the county, and 30 percent to the cities. Loans can be made from the State Trust Fund as a last resort to impacted counties, cities, and school districts for services and facilities at a maximum 6 percent interest rate; the loans would be paid back out of future severance taxes the various entities would receive. The old severance tax was $0.50/ton escalated $0.01/ton for each three-point rise in the wholesale price index; allocation was 35 percent to the special fund, 30 percent in trust, 5 percent to the counties, and 30 percent to the General Fund. The first distribution under the new formula will take place in October 1977.

North Dakota also has a coal conversion tax of $0.10/mcf (or 2.5 percent of gross receipts whichever is greater) that would apply to the proposed gasification plant once it started operation. The tax would be allocated 65 percent to the State and 35 percent to the County; the allocation formula for the monies going to the County would be the same as for the severance tax.

About 38.5 percent of the families in the three county major impact area earned $8,000 or more in 1969 (Table 2-32); 18.5 percent of the families earned incomes below the 1969 governmentally defined poverty level. The effective buying income of residents in the three counties was estimated to be $30 million in 1972 (42). Estimated retail sales by this same source was $15 million.

The economic base of the 14 counties traversed by the proposed product pipeline is primarily agricultural. Table 2-33 presents comparative earnings for seven categories: manufacturing, wholesale trade, retail trade, services, local government, agriculture, and mining for the counties affected by the pipeline in each State. Data on earnings of manufacturing do not represent sale of manufactured goods, but rather the value added as a result of manufacturing.

Wholesale and retail sales are the economic leaders in the area near the pipeline; North Dakota pipeline impact area wholesale

TABLE 2-32

FAMILY INCOME DISTRIBUTION IN THE THREE-COUNTY AREA, 1969

County	Number and Percentage of Families						Families Below Poverty Level		
	0-$3,999	%	$4,000-7,999	%	$8,000+	%	Total	Number	%
Dunn	300	26.5	409	36.1	423	37.4	1,132	226	20.0
Mercer	429	26.3	541	33.2	659	40.5	1,629	289	17.7
Oliver	147	24.6	240	40.2	210	35.2	597	109	18.3
Total	876	26.1	1,190	35.4	1,292	38.5	3,358	624	18.6

Source: 1970 Census Data, Fourth Count, File B, MCD Reports. Department of Agricultural Economics, North Dakota State University, 1972. North Dakota Income Characteristics by Counties.

Table 2-33

EMPLOYMENT BY COUNTIES AND STATES FOR NORTH DAKOTA AND MINNESOTA*

	UNEMPLOYMENT 1970 PERCENT	MEDIUM FAMILY INCOME 1969 DOLLARS	MANUFACTURING 1967 (1,000)	WHOLESALE 1967 (1,000)	RETAIL 1967 (1,000)	SERVICES 1967 (1,000)	GOVERNMENT LOCAL 1967	GOVERNMENT FEDERAL 1970	FARMING 1969 (1,000)	MINERAL INDUSTRY 1967 (1,000)
MERCER	3.6	6,710	(D)	52	193	41	200	37	1,330	200
OLIVER	1.8	6,529	(D)	(D)	19	(D)	92	10	1,052	NA
MC LEAN	6.2	7,092	(Z)	106	360	59	384	239	3,227	NA
WARD	4.9	8,370	.6	894	3,076	844	1,328	959	3,230	NA
MC HENRY	5.7	6,890	(Z)	82	250	21	306	76	2,404	NA
SHERIDAN	2.7	6,278	(D)	18	71	6	98	37	1,404	-
PIERCE	3.3	7,144	(D)	44	280	39	150	46	1,428	- -
BENSON	9.2	6,318	(Z)	75	151	15	286	117	2,238	-
RAMSEY	4.5	8,179	.1	189	964	142	329	151	2,134	-
NELSON	4.7	6,318	(D)	81	229	49	262	44	1,868	NA
GRAND FORKS	4.3	8,458	.9	731	3,585	935	1,371	843	4,533	NA
WALSH	4.3	7,440	.2	282	757	118	489	92	6,455	NA
TOTAL	4.6	7,444	1.8	2,554	9,925	2,286	5 294	2,650	30,103	200
STATE OF N.D.	4.7	7,836	7.5	10,681	28,821	6,547	16,896	8,051	106,837	1.9
MARSHALL	12.2	6,244	(Z)	148	1,335	31	416	80	4,398	NA
POLK	5.8	7,677	1.0	504	1,400	97	992	144	8,929	NA
STATE TOTAL	9.0	6,961	--	652	2,735	128	1,408	224	13,327	NA
STATE OF MINN.	4.2	9,961	299.8	71,174	189,338	57,372	100 736	29 286	251,065	12.9

*ADAPTED FROM: U.S. DEPT. COMMERCE, COUNTY AND CITY DATA BOOK, A STATISTICAL ABSTRACT SUPPLEMENT, 1972.

LEGEND

- — REPRESENTS ZERO
- (D) WITHHELD TO AVOID DISCLOSURE
- (Z) LESS THAN 1,000 PERSONS
- NA NOT AVAILABLE

earnings totaled $307 million and retail earnings totaled $311 million in 1967, compared to $190 million for agriculture. For the Minnesota pipeline impact area, wholesale earnings totaled $67 million and retail totaled $58 million, while agriculture produced $64 million in earnings. A significant portion of retail and wholesale trade, however, is in support of agricultural activities.

Income and employment statistics for the product pipeline impact area show the North Dakota median family income to be $7,444 (1969) with the largest employment in farming (Table 2-33). Similarly, median family income in the two county Minnesota area was $6,961 with farming also the largest employer.

2.3.3 Community Services

Education: Each of the nine towns near the plant-mine site is represented by a different school district. These districts operate independently under the direction of the superintendent of schools in their district. Enrollment figures for the school years 1972-73 and 1975-76 are shown in Table 2-34. Enrollments have increased in the Beulah, Hazen, Center, and Dodge districts and have remained about the same or decreased in the Juzeler, Pick City, Stanton, Zap, and Halliday districts. The average annual education expense per pupil in 1975-76 was $901.73.

No colleges, technical, vocational, or trade schools are present within Mercer, Dunn, or Oliver Counties. The closest post-secondary public schools are Bismarck Junior College (Bismarck) and Dickinson State College (Dickinson). Current total enrollment is 4,304 students. This was an increase of 33 percent between 1973 and 1976. Mary College, a private 4-year college, is also located in Bismarck.

Police Services: Mercer County law enforcement is accomplished through a county sheriff and five deputies; one deputy each in Stanton, Beulah, and Hazen, one shared by Stanton and Pick City, and one shared by Golden Valley and Zap. In addition, Beulah, Hazen, and Stanton each have one full-time city policeman and Hazen has a State Highway Patrol officer.

For other area cities, Center has a full-time city policeman and Dodge and Halliday have part-time city policemen. This is in addition to two sheriff's deputies located at Center.

Fire Services: The volunteer fire department program in the project area is divided into city fire districts and rural protection districts (Table 2-35). Fire protection classification ratings range from 10 to 1; a score of 10 represents no fire protection. This does not mean, however, that no fire protection is available. A community with a score of 10 may have a truck with a small tank, a pressure tank type of water system, or other tools useful in fire protection; but the tools may not be sufficient for a significant risk reduction by insurance underwriters. A score of 9 or less represents a recognized level of fire protection.

Table 2-34

SUMMARY OF EDUCATIONAL INFORMATION FOR SELECTED SCHOOL DISTRICTS IN THE WEST RIVER COAL IMPACT AREA

School District	Total Enrollment 1972-73	Total Enrollment 1975-76	1975-1976 Pupil/Teacher Ratio Elementary	1975-1976 Pupil/Teacher Ratio Secondary	1974-75 Average Cost Per Pupil
Beulah	508	529	20.88	15.00	825.18
Hazen	487	515	17.12	18.70	817.69
Golden Valley	130	118	19.25	9.11	838.44
Pick City	252	239	18.80	12.25	1035.16
Stanton	251	244	17.20	16.60	726.49
Zap	121	93	10.33	8.45	1061.15
Center	451	460	18.65	16.29	809.48
Dodge	102	113	14.17	8.25	996.08
Halliday	252	223	13.11	15.00	1005.86

Community Water and Sewer Facilities: In the impact region, the wastewater treatment systems are predominantly waste stabilization lagoons (Table 2-36). The water systems are predominantly small well systems with a treatment plant.

Recreation: Recreation in the three county impact area is primarily outdoor oriented. Lake Sakakawea provides water-oriented recreation such as swimming, boating, hunting, fishing, and picnicking. Local picnic and boating access is available at Beaver Creek Bay, about 11 miles north of Zap; Beulah Bay, 15 miles north of Beulah; and the Hazen Recreation Area 15 miles north of Hazen. Lake Sakakawea State Park, already badly overcrowded during periods of peak use, provides access to the lake at Pick City.

TABLE 2-35
PROJECT IMPACT REGION FIRE DEPARTMENT STATUS AND FIRE PROTECTION CLASSIFICATION AS OF NOVEMBER 1, 1973

County	City	Fire Department[1]	Fire Protection Classification[2]
Dunn	Dodge	No	10
	Dunn Center	Yes	9
	Halliday	Yes	8B
	Killdeer	Yes	8
	Manning	No	10
	Marshall	No	10
	New Hradec	No	10
	Werner	No	10
	Hebron[4]	Yes	8
	Gladstone[4]	Yes	9
Mercer	Beulah	Yes	8B
	Beulah Protection District	Yes	B
	Golden Valley	Yes	9B
	Hazen	Yes	8B
	Hazen Protection District	Yes	B
	Pick City	No	NA[3]
	Stanton	Yes	9
	Stanton Protection District	Yes	9
	Zap	Yes	9
	Glen Ullin[4]	Yes	8
	Halliday[4]	Yes	8
	Hebron	Yes	8
Oliver	Center	Yes	8B
	Fort Clark	No	10
	Hannover	No	10
	Hensler	No	10
	Price	No	NA
	Sanger	No	10
	New Salem[4]	Yes	8
	Stanton[4]	Yes	9

[1] Arneson, Vance. Fifty-fifth Report of the State Fire Marshal of the State of North Dakota. July 1, 1972 - June 30, 1973.

[2] The fire protection classification is the rating established by the Staff of Insurance Services Office, 12 South Sixth St., Rm. 1229, Minneapolis, Minn. The classification used in establishing the rating is a composite weighted score based on water supply, fire department, alarm systems, and fire ordinance characteristics. The higher the classification score the lower the level of protection. Scores range from 10 to 1. Rural districts are classified on an ABC system. See text for detailed description of scoring.

[3] NA indicates data not available.

[4] City is not located in the county but served a portion of the county.

Source: WEI analysis 1974.

Other area recreation facilities include municipal parks, State Game Management areas, country clubs, and a small golf course. The Theodore Roosevelt National Park and Little Missouri Grasslands are about 100 miles west of the impact area. Private recreation facilities (including indoor facilities) have been largely unfeasible because of the limited population in the area.

Table 2-36

COMMUNITY WATER AND SEWER FACILITIES

City	Water Production Rate (gpm)	Water Treatment	Water Treatment Capacity (gpm)	Annual Water Allocation (acre-ft)	Storage Capacity (gpm)
Beulah	600	lime softening chlorination, fluoridation	400	226	680,000
Hazen	1,500	iron removal, chlorination, fluoridation	600	420	400,000
Golden Valley	75	chlorination	75	101	50,000
Zap	80	chlorination	80	112	50,000
Pick City	40	chlorination	40		
Stanton	private wells				

Medical and Social Services: Within Mercer, Dunn, and Oliver Counties there is only one hospital. It is located at Hazen, has a capacity of 39 beds, and is staffed by three physicians (Table 2-37). The current utilization rate is about 7 beds/1,000 residents and the current occupancy rate is 69.2 percent. Although hospitals exist at Turtle Lake, Garrison, Richardton, and Dickinson, the facilities used most often by area residents are those in Hazen and the two hospitals at Bismarck.

Nursing and retirement home facilities are available in Mercer County and the Bismarck-Mandan and Dickinson areas. The facilities outside of Mercer County are not heavily utilized by area residents.

Health clinics in Beulah and Hazen are staffed by three physicians, a general practitioner-surgeon and two general practitioners. These physicians serve about 6,222 persons, a ratio of 1 to 2,074; the U.S. average is about 1 to 700. Presently, one Beulah physician is approaching retirement age, an event that would place area residents in a critical situation. When specialized types of treatment are necessary, area residents visit Bismarck-Mandan physicians. However, care availability on an outpatient basis is limited by distance. No chiropractors, four dentists, one optometrist, and 19 registered nurses comprise the remaining medical personnel in Mercer, Oliver, and Dunn Counties.

The majority of mental health care services are provided to area residents by the Memorial Health Care Center at Mandan and an outreach worker located at Hazen. The center accepts cases primarily by referral and is an outpatient clinic. The outreach worker deals primarily with child welfare. At present both facilities are working at maximum capacity.

The total welfare funds expended in the three major impact counties during fiscal year 1975 were:

Mercer	$334,435
Dunn	432,267
Oliver	89,758

Included are all categories of Federal, State, and county funding. The figures do not necessarily reflect county welfare costs because funds expended in one county often serve individuals from adjacent counties; e.g., the nursing home located in Mercer County serves Oliver and Dunn Counties as well.

Product Pipeline: The proposed product pipeline route passes through, or runs adjacent to, 45 incorporated or unincorporated

TABLE 2-37

MEDICAL FACILITIES IN THE INVOLVED COUNTIES

County	Hospitals		Nursing Homes		Retirement or Custodial		Clinics		Ambulance Firms
	Number	Beds	Number	Beds	Number	Beds	Number	Physicians	
Burleigh	2	453	3	241	1	126	3	68	2
Dunn	0	0	0	0	0	0	0	0	2
Mercer	1	39	1	40	2	58	2	3	2
McLean	2	78	2	135	2	45	1	3	4
Oliver	0	0	0	0	0	0	0	0	1
Sheridan	0	0	0	0	1	34	0	0	2
Stark	2	151	2	162	1	106	4	17	3
Morton	2	113	1	80	1	60	1	1	6
Total	9	834	9	658	8	429	10	92	22

Source: North Dakota Department of Health. 1973. Summary of Health Facilities and Manpower in North Dakota, Bismarck, N. D.

Fedje, Thomas, P., 1973. Emergency Medical Services in North Dakota: A Plan for North Dakota, Bismarck, N. D.

North Dakota South Central Health Plannings Council. 1974. (Unpublished).

communities in North Dakota and Minnesota (Figure 2-40). Eighteen incorporated cities are affected in North Dakota and two in Minnesota. Data regarding these cities and community services that may be impacted are summarized in Table 2-38.

2.4 Sociocultural Environment

2.4.1 Indian Culture

The proposed plant-mine site is located about 8 miles southeast of the 420,718-acre Fort Berthold Reservation. The water to be marketed would be drawn from Lake Sakakawea, which is bordered by the reservation. The Indians have claimed treaty rights to reservoir water on the reservation and are actively pursuing greater definition and quantification of those rights. They are concerned that sufficient quantities of reservoir water be reserved for all of their present and future needs.

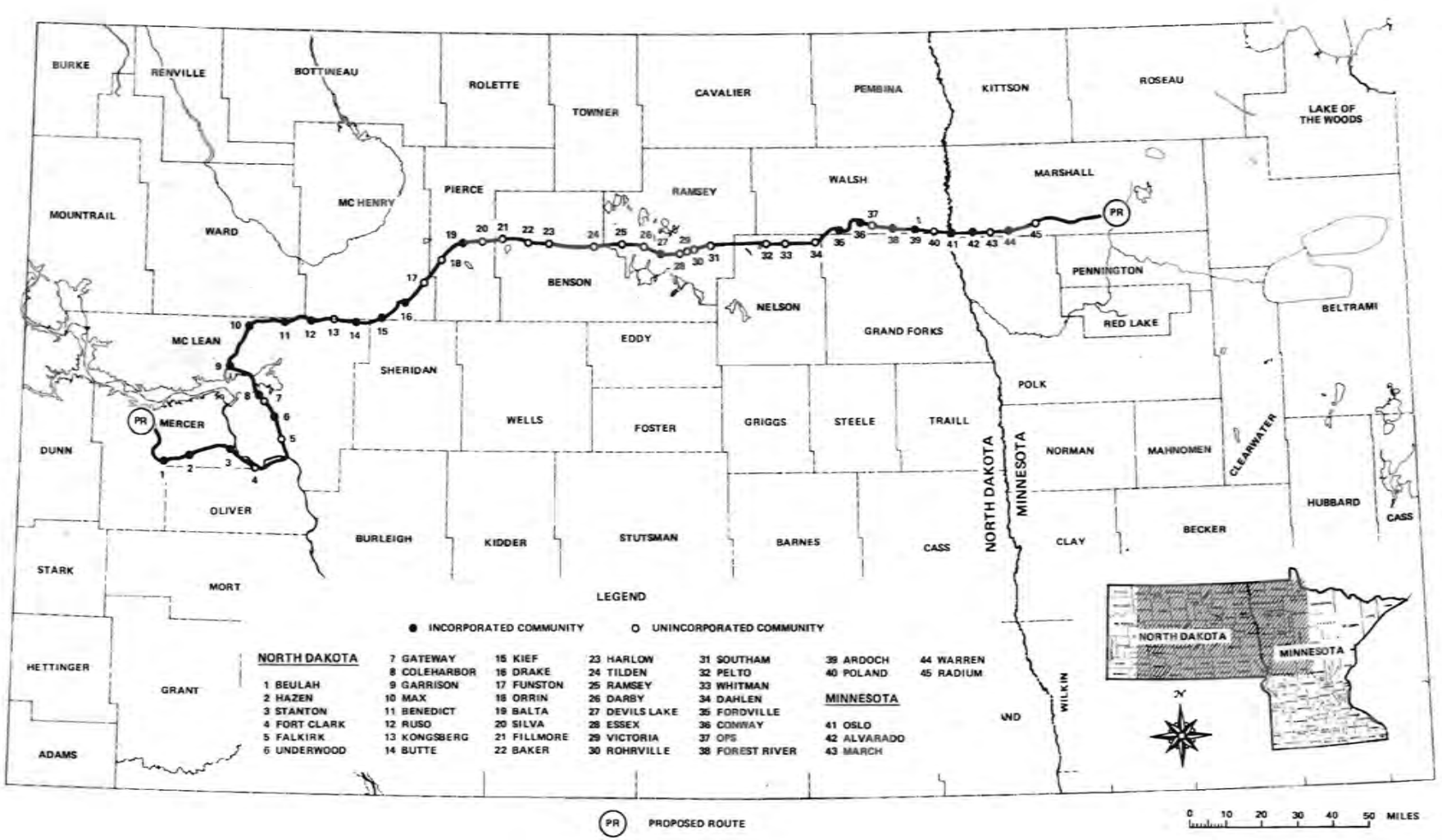


Figure 2-40 COMMUNITIES ALONG THE PROPOSED ROUTE

TABLE 2-38
INCORPORATED COMMUNITIES AFFECTED BY THE PROPOSED PRODUCT PIPELINE

City	County	Population (1970)	Pipeline Route	Other
North Dakota				
Beulah	Mercer	1,344	Through town	-
Hazen	"	1,240	Edge of town	Hospital Adjacent to ROW
Stanton	"	517	"	-
Falkirk	McLean	12	"	-
Underwood	"	781	Through town	Nursing Home 366 ft. from ROW
Coleharbor	"	78	Edge of town	-
Garrison	"	1,614	"	-
Max	"	301	"	-
Benedict	"	72	"	-
Ruso	"	15	"	-
Butte	"	193	Through town	-
Kief	McHenry	46	Edge of town	-
Drake	"	636	"	-
Balta	Pierce	165	"	-
Devils Lake	Ramsey	6,299	N. Edge of town	-
Fordville	Walsh	361	Edge of town	-
Conway	"	57	"	-
Forest River	"	169	"	-
Ardoch	"	70	"	-
Minnesota				
Oslo	Marshall	417	Edge of town	-
Warren	"	1,999	Through town	Hospital 100 ft. N. of ROW
Alvarado	"	302	"	-

Indians of three affiliated tribes (Mandan, Hidatsa, and Arikara) live on or near the Fort Berthold reservation. Reservation leaders have expressed great concern to many State and Federal agencies about the cultural and environmental issues accompanying coal development. The Tribal Council, which is composed of 11 elected members, has placed a moratorium on leasing and other mineral activity affecting the 4 to 20 billion tons of lignite reserves on the reservation (84).

As of May 1976, the Indian population of the Fort Berthold reservation was 3,226, with 3,051 living on the reservation and 175 in close proximity. Unemployment at the same time was 38 percent. Agriculture is the main reservation industry and wages and salaries income for area Indians is derived mainly from a small amount of local industry and the various tribal, Federal, and State agencies providing local services on the reservation.

2.4.2 Non-Indian Culture

The existing non-Indian culture in the three county major impact area might be described as predominantly white (primarily German-Russian), rural, and generally conservative. Many area residents enjoy the rural life style and have become self-reliant and independent. Most of their information on world and national affairs is obtained through television, radio, and newspapers. Because few indoor means of recreation exist in the immediate area and because of the limited merchantile base, area residents often make trips to the Bismarck-Mandan area for these purposes.

2.4.3 Historic and Archaeological Features

No national landmark or historic site is listed in the U.S. Federal Register for the plant-mine area as of February 1977.

Because of the long lead time for construction of the plant and mine and uncertainties about exact pipeline siting, detailed archaeological surveys have not been done in all of the areas to be disturbed by the proposed project. However, ANGCGC and Great Lakes have committed themselves to providing detailed surveys in accordance with the requirements of the National Historic Preservation Act and the State Historical Society of North Dakota (SHS) far enough in advance of construction to allow for proper mitigation (104, 105). Also, the North Dakota Public Service Commission (PSC) requires detailed surveys as part of ANGCGC's application for a Certificate of Site Compatibility under the North Dakota Energy Conversion and Transmission Facility Siting Act (Chap. 28-32 and 49-22, NDCC).

The present status of the required studies is as follows:

1. Plantsite: Detailed survey completed in June 1974.

2. Minesite: Preliminary survey completed in June 1974. Mine 2 is presently being studied by SHS under contract with Basin Electric. Results should be available in REA's EIS. Mine 4 will be studied in early 1977 through an ANGCGC contract; mines 1 and 3 may not be opened for up to 10 years.

3. Water System and Railroad Spur: ANGCGC is to contract for a detailed survey beginning in early 1977.

4. Product Pipeline: Literature search conducted in 1974. Detailed survey to be done prior to construction.

The archaeological surveys of the plant-mine site located eight archaeological sites. Four of the sites consist of tepee rings; the other sites consist of single examples of boulder effigies, burial sites, petroglyphs, and temporary campsites. Two of these sites lie near the plantsite:

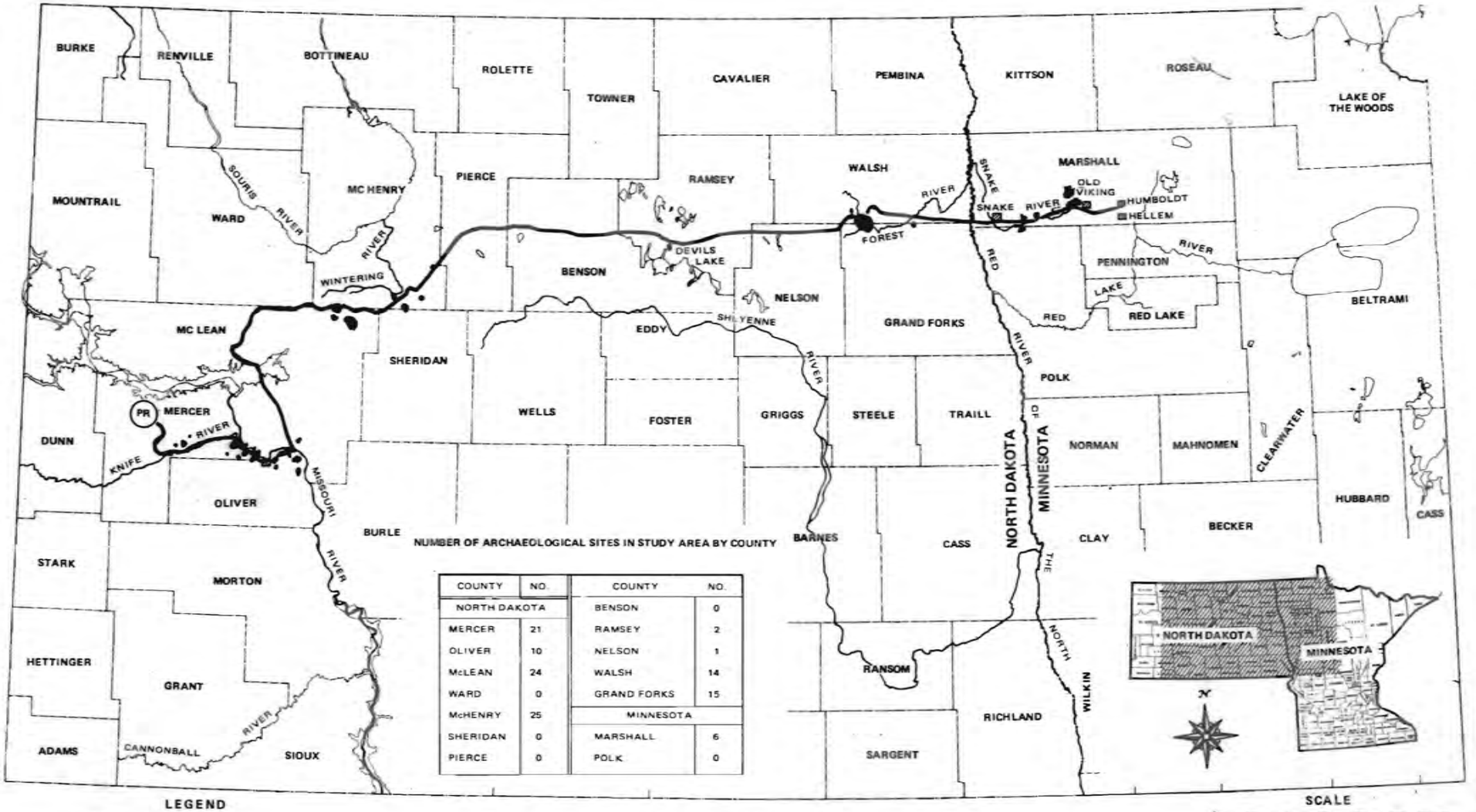
1. The Adam Keller Site comprises 10 to 15 acres which served as a temporary prehistoric Indian camp site near a spring; and

2. The August Keller Site was identified in the 1930's as containing teepee rings and Indian burial remains.

The remaining six sites are located in the potential mine area. Of particular interest is a turtle effigy. Turtle effigies, with their outlines formed of prairie boulders, are scarce in the Northern Great Plains. This turtle effigy is one of only two known with its carapace filled with stones. The Voegele Petroglyph Site contains a late prehistoric carving of four deep parallel grooves in a slab of sandstone on top of a high conical hill. Petroglyphs are moderately rare in the region.

In addition to the eight sites of archaeological significance, two cemeteries (Boeckel and Saron) border the mine area. Also, two German-Russian mud houses, one on the plantsite and one in the mine area, are of possible historical significance.

A survey of the available literature indicates that the railroad ROW's utilized for the proposed product pipeline currently cross 5 archaeological or historical sites in North Dakota and that 19 more may be in close proximity (Figure 2-41; Table 2-39). These sites all are located in 4 counties and include 4 mound



NUMBER OF ARCHAEOLOGICAL SITES IN STUDY AREA BY COUNTY

COUNTY	NO.	COUNTY	NO.
NORTH DAKOTA		BENSON	0
MERCER	21	RAMSEY	2
OLIVER	10	NELSON	1
McLEAN	24	WALSH	14
WARD	0	GRAND FORKS	15
McHENRY	25	MINNESOTA	
SHERIDAN	0	MARSHALL	6
PIERCE	0	POLK	0

Figure 2-41 LOCATIONS OF KNOWN ARCHAEOLOGICAL AND HISTORICAL SITES NEAR THE PROPOSED ROUTE

Table 2-39

ARCHAEOLOGICAL SITES ALONG THE PROPOSED ROUTE

	Site Designation		Type	Potential Impact (If Disturbed)
*	32ME2	Fort Clark	Early Historic Forts, Village Site, and Indian Cemetery	Major - State Historic Site
*	32ME7	White Buffalo Robe	Early Village Site	Major - High Research Potential
	320L20	Connelly Site	Early Village Site	Major - High Research Potential
	320L21	Mandan Lake	Multi-Component Village	Major - High Research Potential
	320L22	Mahhaha	Multi-Component Village	Major - High Research Potential
*	32WA1 1/	Fordville Mound Group	77 Mound Group	Major - High Research Potential
	320L19	Dennison	Village Site	Medium - Medium Research Potential
	320L18	Hensler	Village Site	Medium - Medium Research Potential
+	32ME4	Alderin Creek Site	Village Site	Medium - Medium Research Potential
+		Lyman Aldren Site	Village Site	Medium - Medium Research Potential
	32ME5	Deapolis	1804 Mandan Village	Medium - Medium Research Potential
*+		Earthlodge Village	Village Site	Unknown - Insufficient Data
+			Village and Cemetery	Unknown - Insufficient Data
+		Boller	Village Site	Medium - Medium Research Potential
	32ME202		Village Site	Medium - Medium Research Potential
+			Mounds	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data

* Sites Crossed by Railroad

\+ Unassigned

1/ Nominated to the National Register of Historic Places.

sites, 4 camp sites, 15 earthlodge village sites, some of which are historic, and an early fort (Ft. Clark) with an adjacent Indian burial ground.

In Mercer County proximal sites which may be affected by the proposed project include six village sites and one mound site. All six sites in Oliver County are village sites; as are four small sites in McHenry County. Toward the eastern end of the proposed route in Walsh County there is one mound site which may be within the proposed route.

Of the five sites presently crossed by the railroad, three are on the west bank of the Missouri: 1) White Buffalo Robe Site, an 18th century village; 2) another earthlodge village; and 3) Fort Clark, a State historic site. In addition, the Fordville Mound Group (Walsh County), consisting of 77 mounds, is traversed by the railroad.

Six known archaeological sites lie near the proposed pipeline route in Marshall County, Minnesota. One mound site on the Cambell Beach was built by members of the Arvilla culture; the cultural affiliation of another mound site is unknown. Three of the sites are habitation areas: one Archaic, one Blackduck focus, and one of unknown culture. The sixth site is in a gravel pit area.

2.5 Future Environment Without the Proposed Project

Even without the proposed project it is probable that some coal-related development would take place in the area near the plant-mine site. It is probable that the Coyote powerplant south of Beulah would be built and that the proposed Basin Electric powerplant would also be built. Because NACCO has the lease options on the lignite to be used for the proposed project, the coal may still be mined for other uses if the proposed gasification plant were not built—perhaps by Basin Electric.

The results of such development would be a rapid population increase in local communities for the forseeable future, disturbance of land for strip mining, and a reduction in local air quality in the three county region.