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Section 13
Water Assessment Report

MASTER

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**13(c): Great Plains Gasification Project
Mercer County, North Dakota
December 1980**



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DEC 8 1980

Honorable Charles W. Duncan, Jr.
Secretary of Energy
1000 Independence Avenue, SW.
Room 7A257
Washington, DC 20500

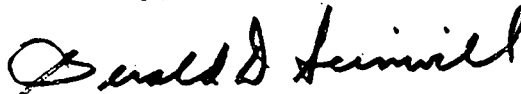
Dear Mr. Duncan:

The U.S. Water Resources Council has completed the water for energy assessment of the Great Plains Gasification Project in Mercer County, North Dakota, in response to the October 23, 1979, request by the U.S. Department of Energy. The report was prepared under the provisions of Section 13(c) of the Federal Nonnuclear Energy Research and Development Act of 1974 (P.L. 93-577, as amended). The report was published in the Federal Register on August 4, 1980, to permit a 90-day public review and comment period.

Enclosed is the final report on the assessment, the comments we have received during the review, and the Water Resources Council staff response to the comments. We have incorporated comments into the final report where appropriate and have addressed the other comments in the staff response.

The Water Resources Council will continue to cooperate with the Department of Energy.

Sincerely,



Gerald D. Seinwill
Acting Director

Enclosures

U.S. Water Resources Council

Section 13 (c) Water Assessment Report

GPGA Coal Gasification Plant Mercer County, North Dakota



December 1980

PREFACE

The U.S. Water Resources Council (WRC) has prepared this report on the Great Plains Gasification Associates Project in Mercer County, North Dakota, under the provisions of paragraph (c) of Section 13 of the Federal Nonnuclear Energy Research and Development Act of 1974, as amended.

This report assesses:

- (1) the availability of adequate water supplies to meet the water requirements of the project, supporting activities, and other development induced by the project; and
- (2) the changes in the water resources that will result from the project.

Under a memorandum of agreement with WRC, the Missouri River Basin Commission (MRBC) submitted a report entitled, "Section 13(c), Water Assessment for Great Plains Gasification Associates Project." The findings in the MRBC report are basis for this assessment.

Both the MRBC report and this report are based on existing information on the proposed gasification project and the water resources of Mercer County.

Publication of this report in the Federal Register is mandated by Section 13(c) of the Federal Nonnuclear Energy Act to provide for a 90-

day public review and comment period. Comments on the report are to be submitted to Gerald D. Seinwill, Deputy Director, U.S. Water Resources Council, 2120 L Street, N.W., Washington, DC 20037.

After the 90-day review period, the WRC staff will analyze the comments received and forward the comments, the WRC analysis, and the water assessment report to the Secretary of the Department of Energy.

FOREWORD

The Water Resources Council is completing a water assessment of synfuels development in the Upper Missouri River Basin. This is being done under Section 13(a) of the Federal Nonnuclear Energy Research and Development Act. The assessment area includes the coal deposits in the Mercer County project site. Levels of North Dakota coal gasification development that are several times the production level of the Great Plains gasification project are being examined.

Findings of the 13(a) assessment show that water supplies are physically available within the mainstem of the Missouri River in North Dakota to supply the requirements of the gasification facilities and the supporting activities -- mining and reclamation, electricity, and project-induced population increases. Results of the assessment will be published in the Federal Register.

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CHAPTER I. PRINCIPAL FINDINGS

A. Project Water Requirements

1. The coal gasification plant will require 12,800 acre-feet of water per year. Approximately 70 percent of this requirement is for cooling.
2. Electricity for the gasification plant will be provided by the adjacent powerplant of Basin Electric Power Cooperative. Powerplant water requirements to generate electricity for the gasification plant are estimated at 2,300 acre-feet/year.
3. Water requirements for mining activities to provide coal to the gasification plant are estimated to be 270 acre-feet/year.
4. Population growth and economic activity associated with employment at the gasification project and coal mines will increase local municipal water supply requirements by 410 acre-feet/year.

B. Water Supply Availability

1. Water supplies for the gasification plant and the adjacent powerplant will be provided through a diversion structure and pipeline

from Lake Sakakawea, which is formed by Garrison Dam on the Missouri River in North Dakota.

2. The U.S. Department of the Interior has a marketing agreement to supply the water requirements of the gasification plant and adjacent powerplant from Lake Sakakawea.
3. The State of North Dakota has granted a conditional water rights permit for the diversion from Lake Sakakawea.
4. The Missouri River below Garrison Dam presently has an average annual flow of 17 million acre-feet. Increase upstream depletions may reduce this flow to about 16 million acre-feet by the year 2000.
5. Present and projected flows in the Missouri River will be more than adequate to meet the requirements of the gasification project and adjacent powerplant. The active storage capacity of Lake Sakakawea is 17.7 million acre-feet, which is more than adequate to regulate the flows of the Missouri River during the dry season and longer drought cycles.
6. Groundwater resources at the project site are minimal but should be sufficient to meet the requirements of coal mining activities, adjacent municipal water supply systems, and rural domestic users. Groundwater for the direct project activities will not be used after the water supply line and pumping station are in operation.

8. The water quality of the Missouri River and Lake Sakakawea poses no major problem that may limit its use for gasification plant purposes.

C. Water Resources Impacts

1. Diversions of water for the gasification plant and supporting activities will reduce flow of the Missouri River at Garrison Dam and downstream by about 0.1 percent.
2. Runoff and sediment control features will reduce stormwater flows to minor tributaries that drain the project site and adjacent coalfields.
3. Shallow groundwater aquifers under the 19.5 square miles of the coalfield will be destroyed during mining. Land reclamation will restore some original characteristics, probably with increased recharge and transmissibility rates.
4. The project will not measurably affect surface water quality of the Missouri River.
5. Ash disposal in mine pits will deteriorate groundwater quality in reclaimed areas and possibly other adjacent areas.

D. Changes in Water Use

1. Flow depletion of the Missouri River at Garrison Dam and downstream will annually reduce hydroelectric power production by 7.4 million kilowatt hours (0.1 percent). The value of lost hydroelectric power generation is estimated at about \$300,000/ year (\$1979), which will be offset by revenues from sale of water for the project.
2. Flow depletion may also reduce navigation on the Missouri River below Sioux City, Iowa, but for an average of less than 1 day per year.
3. Rural domestic and stockwatering wells adjacent to reclaimed mine areas may deteriorate in quality below acceptable levels. The wells will be monitored. If unsafe deterioration occurs, the project developer has agreed to develop replacement water supplies.

CHAPTER II. PROJECT DESCRIPTION

A. Project Features

The coal gasification project of the Great Plains Gasification Association (GPGA) will be the first commercial-scale plant in the United States that produces synthetic pipeline gas from lignite coal. The 250 million cubic feet per day (MMcf/day) of gas planned for production will be piped east of the Mississippi River for consumption. This amount is equivalent to about 50,000 barrels of oil per day.

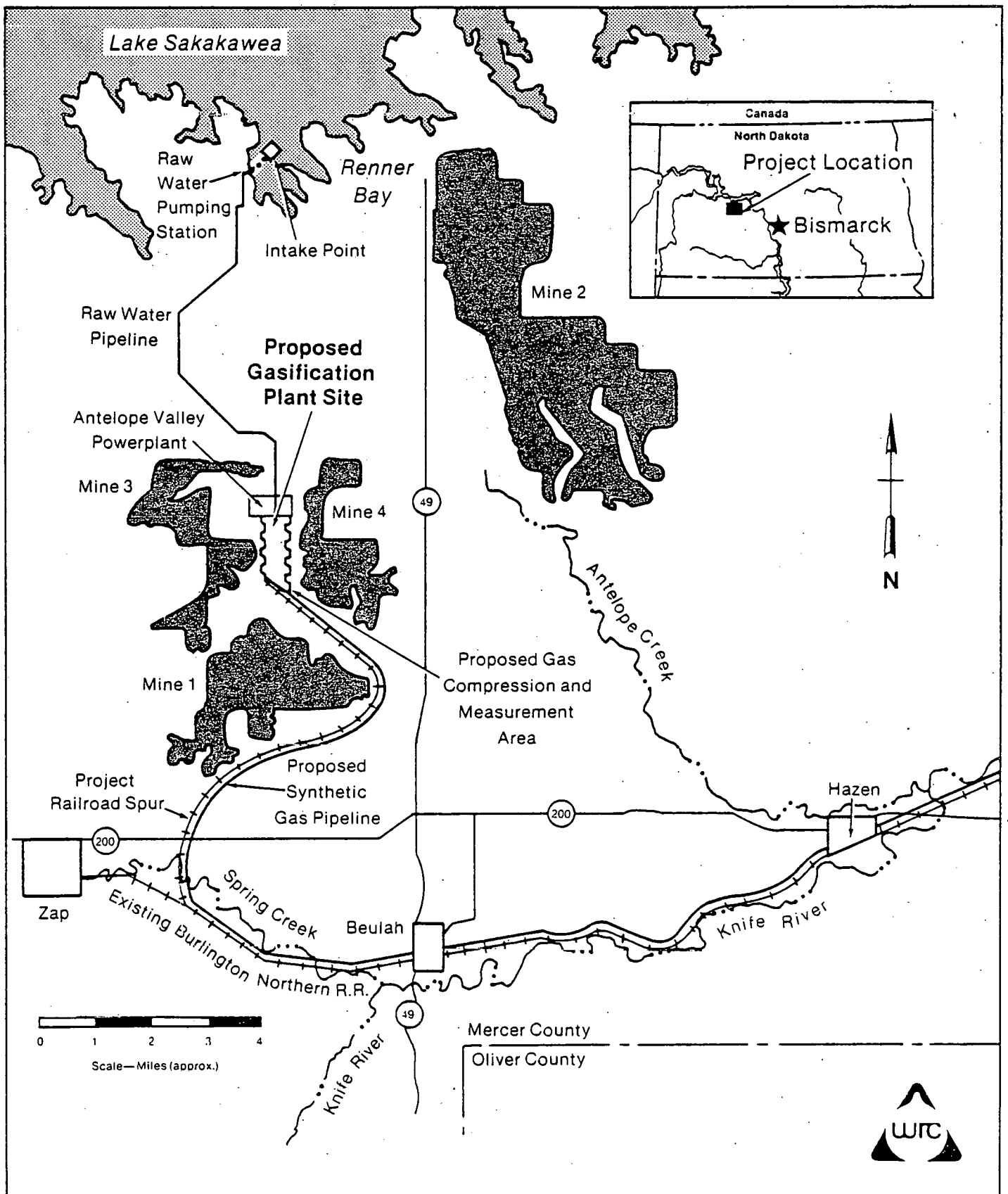
The gasification plant will be built in two phases, each with a production supply capacity of 125 MMcf/day for a 40-year expected life. This report, however, assesses the water requirements and supply availability and the consequent effects of constructing and operating the full 250 MMcf/day project.

The term "project" includes the gasification plant, part of the adjacent electric powerplant, the mining activities, and the increased population induced by the project construction and operation.

Project Location

The project is located in Mercer County, North Dakota; approximately 65 miles northwest of Bismarck in the area generally described as the Northern Great Plains (Figure 1). The gasification plant is about 6 miles

Figure 1 Project Area



south of Lake Sakakawea, which is formed by the Garrison Dam on the Missouri River. The 1975 estimated populations of nearby municipalities are: Zap, 278; Beulah, 1,949; and Hazen, 1,493.

Construction Schedule

Construction for phase I of the gasification plant is planned to begin in 1980, with plant operation scheduled for 1983. Construction of phase II will be deferred so that phase I construction and operation experience can be used to improve the second phase design. The second phase is tentatively scheduled to begin in 1985 and be completed by about 1989. Construction of the adjacent steam-electric powerplant and the water supply system has already begun.

B. Base Energy Resources

Coal

The gasification plant will require about 9.4 million tons of coal per year. The adjacent powerplant will also require about 5.2 million tons per year for its full capacity. Coteau Properties Company, a subsidiary of North American Coal Corporation, will surface mine the needed coal from four locations within the Beulah-Hazen coalfield surrounding the plant (Figure 1). Coteau has options on 1.5 billion tons of coal (947 million tons recoverable) in and around Mercer County. This amount is enough to supply the power and gasification plants for 65 years.

Electricity

The Basin Electric Power Cooperative Powerplant will have an 880-megawatt (MW) capacity when in full operation. Of this amount, the gasification plant will use about 160 MW and the water pumping station and project mines will require another 20 MW. The powerplant will also supply other customers in the area.

Water Supply

Lake Sakakawea, which has 17.7 million acre-feet of active storage, will be the primary source for the project water. During the construction period, groundwater can be used to support project activities until the water supply line and pumping station are in operation. The area has limited but adequate groundwater to support the increased population induced by the project.

C. Gasification Plant Description

The plant will use the Lurgi gasification process to produce pipeline-quality, high-Btu synthetic gas with a minimum heating value of 970 British thermal units per cubic foot.

In the Lurgi process, the carbon content of the low heat-producing, lignite coal is combined with the hydrogen extracted from the water to form a crude gas mixture. The methane in the crude gas is further

processed to produce a high-thermal gas (nearly 1,000 Btu/ft³) by shift conversion, purification, and methanation.

A detailed description of the gasification process is beyond the scope of this assessment; however, the major units for the gasification, water treatment, and byproduct recovery processes are:

- o gasification -- generation of raw low-Btu gas by heating lignite under pressure in the presence of oxygen and steam
- o shift conversion -- production of hydrogen by reaction of part of the generated gas with steam
- o gas cooling -- condensation of heavier hydrocarbons
- o rectisol -- removal of carbon dioxide, sulfur compounds, and other impurities from raw gas
- o methanation -- conversion of low-Btu gas to methane-rich, high-Btu gas
- o gas compression and drying -- drying and delivery of gas to pipeline system
- o gas-liquor separation -- separation of recoverable hydrocarbons
- o phenosolvan -- removal of phenols from process water after the gas-liquor separation
- o ammonia recovery -- absorption and recovery of ammonia and other usable material from process water

The plant will also have facilities for steam generation, power transmission, raw and wastewater treatment, pollution abatement, fire protection, coal storage and preparation, and transportation of raw materials, secondary products, and waste products for burial. A 20-inch pipeline will transport the product gas about 365 miles to Thief River Falls, Minnesota, where it will join existing pipelines.

D. Support Activities

Mining and Reclamation

Mining operations are designed to produce approximately 56,000 tons per working day, almost double the 25,750 tons per day required by the gasification plant. The coal will be surface mined from four locations of the Beulah-Hazen coalfield (Figure 1) and trucked to the nearby coal preparation facility. The overlying soil and rock will be removed, stockpiled, and replaced after mining. During mining and reclamation runoff and mine-pit water will be intercepted.

Water Supply System

Raw water will be piped from Lake Sakakawea through a submerged intake in Renner Bay. The intake will be located 72 feet below normal lake elevation to ensure a constant water supply, even at minimum lake elevation, and to reduce adverse environmental and esthetic effects.

Lake water will flow by gravity through the intake to an onshore pumping station with hydraulic capacity to deliver water at the peak usage rate of 22,500 gallons per minute or about 36,000 acre-feet per year. From the pumping station, the water will flow 7 miles through a 42-inch underground pipeline to a storage reservoir on the project site.

There the raw water will be clarified and softened for use in the powerplant and gasification operations. Basin Electric Power Cooperative is currently building and will maintain the water supply system.

Project-induced Population Growth

Construction and operation of the gasification plant and support activities will bring additional workers and their families into the area. An immigrant population peak of 5,125 will be reached during the construction period. The induced population will stabilize at about 2,730 after construction is completed.

E. Water Requirements

Although the project requires about 15,780 acre-feet/year (Table 1), the total amount will reduce releases from Lake Sakakawea by about 0.1 percent.

TABLE 1

Total Annual Water Requirements

<u>Requirements</u>	<u>Acre-feet</u>
Direct gasification plant purposes	12,800
Powerplant	2,300
Mining	270
Increased rural domestic and commercial consumption	<u>410</u>
Total annual water requirement	15,780

Gasification Plant

The cooling system will be the principal water-using component of the gasification plant. The plant will have two cooling towers: one reusing the process water and one using clarified fresh water. Both units are designed for a two-stage use of the circulating cooling water.

Rates of water use and loss vary by season. For example, in summer about 7,720 gallons per minute will be evaporated, but in the winter this amount will drop to 5,790 gallons per minute.

Electric Powerplant

The adjacent electric powerplant will require a total of about 11,200 acre-feet/year; of this amount, 2,300 acre-feet/year will be needed to generate electricity for the project purposes.

Mining and Reclamation

The mining operation will require about 450 acre-feet/year for dust control. This water, which will come from mine-site stormwater ponds and excess mine-pit water, is not included in the project water requirements. All other mining operation water (270 acre-feet/year) will be provided by the project water supply system as shown on Table 1. Extensive irrigation to establish reclamation growth should not be required, since the annual precipitation is generally adequate for regrowth.

Induced Development

The additional demand on domestic and commercial water supplies from project-induced population growth and related economic activity will average an estimated 410 acre-feet/year. Both central and non-central domestic and commercial supplies will come from groundwater supplies.

F. Wastewater Management

Design of the coal gasification facilities includes means for management of wastewaters from: the process, cooling tower blowdown, site runoff, solid wastes, and sewage.

Process Wastewater

The gasification process is designed to enable extensive recycling of process water. Wastewater from the process will be disposed of by deep-well injection into a highly brackish (about 200,000 parts/million of total dissolved solids) groundwater aquifer (Figure 2). Water quality characteristics of this wastewater are shown in Table 2. Some process wastewater will be disposed of with the solid wastes.

TABLE 2

Estimated Characteristics of Wastewater
for Deep-well Injection

<u>Parameter</u>	<u>Milligrams/liter</u>
CaSO ₄	540
MgSO ₄	460
Na ₂ SO ₄	6460
NaCl	2770
NaHCO ₃	110
CaCl ₂	860
MgCl ₂	730

Cooling Tower Blowdown

Blowdown from the cooling tower will be concentrated in a multi-effect evaporator. Evaporated water will be condensed and portions will be used as makeup water in the cooling tower. Concentrate from the evaporators (consisting of 92 percent water, 6 percent acetate, 1 percent phenols, and 1 percent inorganic salts), produced at a rate of 0.1 million gallons/day (mgd), will be incinerated. During extreme winter conditions the distillate will be disposed of in the deep well.

Site Runoff

Plant areas that may be a source of contaminated liquids will be paved with concrete. Drainage from these areas will be collected in sewers and transported to a retention pond, also concrete lined. Water that is not evaporated from the pond will be treated and the sludge will be buried in the mine pits.

Stormwater runoff from clean areas on the plant site will be collected in open ditches and routed into a 112 acre-foot retention pond. This pond is designed to handle a 25-year flood event.

The mining activities will have impoundments to intercept runoff and mine-pit water. The impoundments will be designed to control sediment, as required by surface mining regulations.

Solid Wastes

Four types of solid wastes will be generated at the plant:

1. Ash from the gasifiers and from the evaporator concentrate incinerator and fly ash from steam boilers
2. Sludge from surface water treatment
3. Sludge from biological treatment unit for sanitary sewage
4. Refuse (paper, cartons, rags, wood scraps, etc.).

The gasifier ash will be dewatered in the ash-handling facilities and buried at the mine. The total ash production will be about 720,000 tons per year. The fly ash collected by electrostatic precipitators will also be hauled to the mine for disposal, as will the sludge from raw water treatment. Sludge from the biological wastewater treatment

plant will be used as a soil conditioner. Combustible refuse will be burned in an incinerator. Solid waste disposal will comply with the Federal Resource Conservation and Recovery Act (Public Law 95-609) and subsequent regulations.

About 0.05 mgd of sewage will be processed in a package treatment unit. This unit will include facilities for biological oxidation, clarification, and chlorination. Solids accumulated in this unit will be used as a soil conditioner in the mine reclamation program. Effluent from the waste-treatment unit will be discharged to a stormwater pond, which will act as a polishing pond (tertiary treatment) prior to discharge. Chemical toilets will be installed to handle the larger sewage treatment load during the construction period.

CHAPTER III. WATER SUPPLY AVAILABILITY

A. Surface Water Resources

The principal surface water resources in the vicinity of the project site are:

- (1) the main stem of the Missouri River below Garrison Dam
- (2) Lake Sakakawea, a reservoir formed by Garrison Dam on the Missouri River
- (3) Knife River, which is a tributary of the Missouri River and drains an area of west-central North Dakota, including the project site
- (4) Antelope Creek, which is a minor tributary of the Knife River and drains the project site and some of the coal mines
- (5) Spring Creek, which is a tributary of the Knife River.

The drainage area above Garrison Dam is 180,000 square miles, including parts of Montana, Wyoming, and North Dakota, and the provinces of Alberta and Saskatchewan. The average annual flow of the Missouri River below the dam is about 17 million acre-feet (maf). Currently

about 2.5 maf are depleted annually, mostly for upstream crop and pasture irrigation. The depletions are projected to increase to 2.9 maf annually by 1985, and to 3.4 maf annually by 2000. Expansion of irrigated agriculture is the principal factor in the increases; energy development (coal mining, steam electric power, and possible synthetic fuel facilities) is a rapidly growing consumptive use of water, which may be a major factor in depletions by 2000. However, even with the increased depletions, annual flow will still be about 16 maf.

Lake Sakakawea has an active storage capacity of 17.7 maf. The lake is operated by the U.S. Army Corps of Engineers for several purposes, including hydroelectric power generation and water conservation. The U.S. Department of the Interior markets water from the reservoir and has allocated substantial quantities for municipal and industrial purposes. Inflow to the lake through the Missouri River is stabilized by the operation of Fort Peck Reservoir upstream in Montana.

The Knife River drains an area of about 2,250 square miles and enters the Missouri River a short distance downstream of Garrison Dam. It has an average annual flow of 130,000 acre-feet at Hazen, North Dakota, near the site. Most flow occurs during periods of spring snowmelt and heavy thunderstorms in the watershed. There are periods of no flow in the river. Reservoir storage would be needed if the river were to serve as a dependable source of supply for the project.

Antelope and Spring Creek flows are less dependable than those of the Knife River and are extremely limited as potential water supply sources.

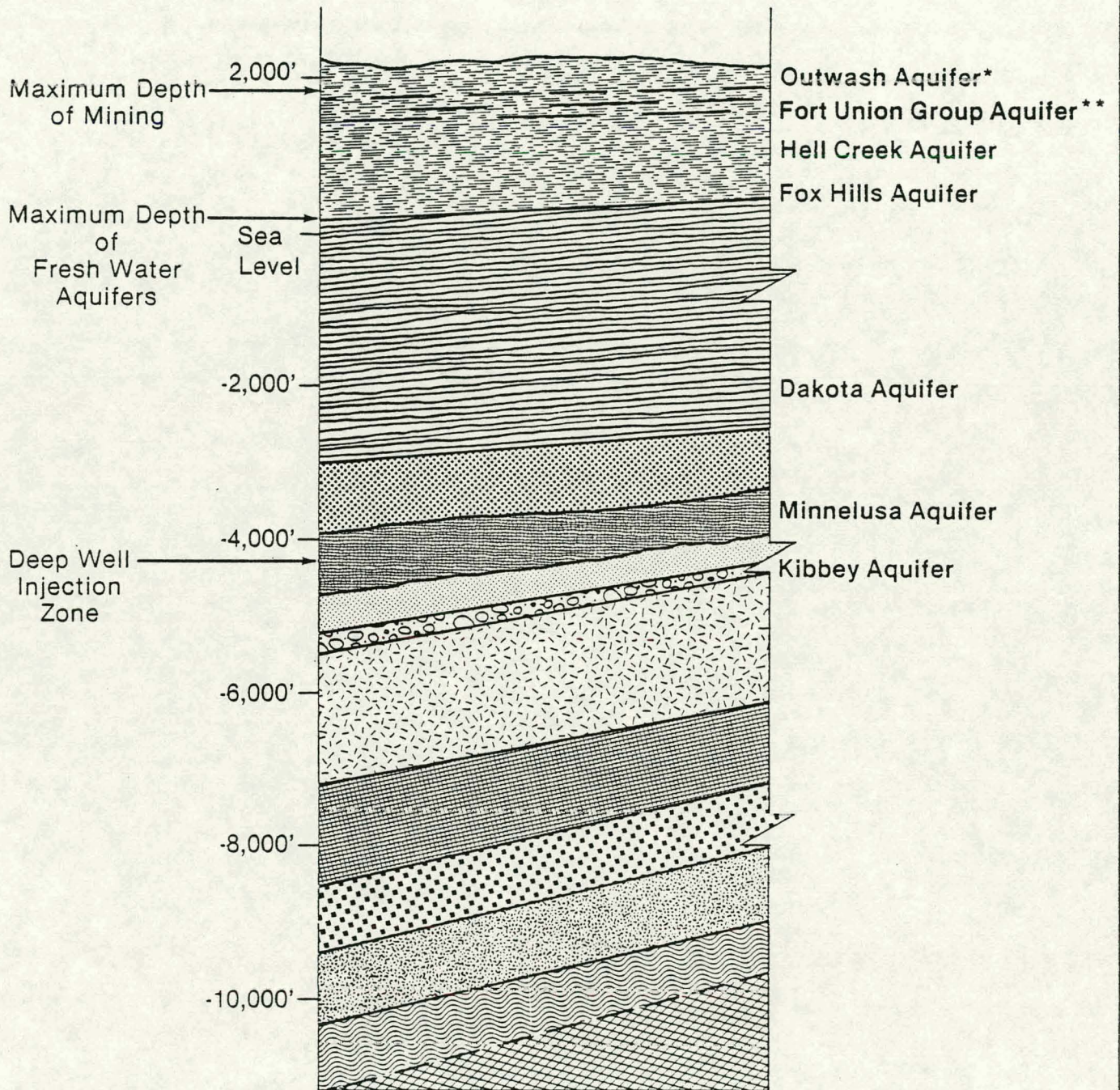
B. Groundwater Resources

Groundwater is present in limited quantities throughout the project area in the relatively shallow lignite and deeper sandstone aquifers. Aquifers in Mercer County include: the outwash deposits underlying the Knife River, Spring Creek, Antelope Creek (Renner Trench), and the West Fork Antelope Creek (Beulah Trench); the Fort Union Group of lignite and sandstone units; the Hell Creek and Fox Hills sandstones; the Dakota sandstones; the Minnelusa sandstones; and the Kibbey limestone (Figure 2).

Potentially the most prolific aquifers are the outwash deposits. They have not been explored or developed to a significant extent, but well yields over 100 gallons per minute (gpm) have been recorded, and a sustained yield on the order of 10,000 acre-feet/year may be possible in Mercer County.

The Fort Union Group comprises an aquifer with fractured and saturated lignite (or shale) or with sandstone lenses below the water table. The Beulah-Zap lignite bed constitutes the most consistent unit of this type. Where jointing and adequately saturated thicknesses exist, this aquifer can be developed to sustain farm or individual household needs (2 to 10 gpm). The Fort Union Group units produce hard water that is high in iron and often colored by organics.

Figure 2 Approximate Depths of Aquifers Mercer County



* Includes Knife River, Spring Creek, Antelope Creek (Renner Trench), and West Antelope Creek (Beulah Trench) Aquifer.

** Includes Beulah-Zap Aquifer.



The Fox Hills and Hell Creek sandstones are interconnected. They produce water that is developed for farm, household, domestic, and municipal purposes. The potential yield has not been exhausted, but data suggest that the recharge rate of this aquifer in Mercer County is less than 200 acre-feet/year. Water from the Fox Hills is soft, moderately mineralized, and relatively high in sodium bicarbonate.

Data on the deep aquifers (Dakota, Minnelusa, and Kibbey) in Mercer County is limited. Their main characteristics have been deduced from wells and other data in adjoining counties. The Kibbey and Minnelusa units contain brine with greater than 100,000 milligrams/liter (mg/l) of total dissolved solids (TDS). The Dakota sandstone contains brackish water (about 5,000 mg/l of TDS).

C. Competing Uses of Water

As the number of energy and related projects increases in this area, conflicts for water may arise in some localities. The principal competition for available Missouri River water supplies is between instream nonconsumptive water uses and offstream consumptive uses.

Most instream use in the Missouri River depends on main stem reservoir operations for the primary purpose of flood control, navigation, and hydropower functions. Releases at Garrison Dam are governed by detailed operating rules. To meet the downstream flow needed to maintain

water levels at municipal and industrial water supply intakes, the minimum flow release is generally 11,900 acre-feet/day during the ice-free navigation season and 7,900 acre-feet/day during the remaining time. Reservoir releases above the minimum are made for the most part to maximize hydropower generation from the main stem reservoir system.

Instream uses will continue to be affected by the increased depletions of Missouri River supplies upstream and downstream of Garrison Dam. The coal gasification project and further energy development in other areas of the Basin must be viewed in that context. Moreover, as depletions increase, competition among offstream users (e.g., energy development vs. agriculture) can be expected to increase.

D. Water Rights

In 1974, the North Dakota State Water Commission granted to the project sponsors a conditional permit for maximum withdrawal of 17,000 acre-feet/year from Lake Sakakawea. This permit was granted on the condition that the right be perfected by actual water use within 8 years and that the project activities comply with pertinent State codes and regulations. Time extensions can be granted.

Future legislation, administrative action, or court action could require that contracts be revised or renegotiated, but the principles of prior appropriation and beneficial use should ensure the project's rights.

The North Dakota State Water Commission (SWC) included a number of stipulations in the conditional water permit granted to the ANG Coal Gasification Company (ANGCGC) for the proposed gasification project. Among others, the conditions stipulate that ANCGC must: (1) use the most environmentally acceptable methods to minimize evaporation and other wasteful water uses; (2) consult, cooperate with, and secure all necessary permits from State agencies concerned with use of water and the facility's effects on the environment, economy, and State governmental units; (3) conform to SWC recommendations on protection of the groundwater supplies.

The Mercer County Board of Commissioners has also attached a number of stipulations that would allow for monitoring of the project to reduce adverse effects to water resources. Among these are that ANCGC must submit: (1) the project control plan to reduce runoff and retain natural vegetation; (2) a copy of the permit for construction of the deep-well waste disposal facility issued by the State Department of Health; (3) a detailed report on the proposed plant's effects on area groundwater quantity and quality.

CHAPTER IV. WATER QUALITY AND QUANTITY IMPACTS

In addition to the direct changes to water quality and quantity, the construction and operation of the project will also change the social, economic, and environmental conditions of Mercer County. Although these changes are an effect of the project, this assessment deals only with those changes directly related to project water use. Other studies listed in the selected references have analyzed the nonwater-related impacts.

The impacts related to water use or changes to water use are:

- o changes in water quantity
- o changes in water quality
- o changes in water uses.

In general, the construction and operation of the gasification plant, the support powerplant and mining operations, and the increased population induced by the project will not significantly affect the water resources in the area. The project's effects on quantity and quality of surface and groundwater are described below.

A. Surface Water Quantity

Missouri River

The direct gasification plant and support uses will deplete releases from Lake Sakakawea to the Missouri River by about 0.1 percent in a

normal year. The slight lowering of lake levels will also reduce evaporation losses from Lake Sakakawea and will increase circulation in Renner Bay. Hydropower generation at and below Garrison Dam will be decreased by 7.4 million kilowatt hours annually, which is about 0.1 percent of the 1979 total production. The navigation season below Sioux City, Iowa, will be reduced by an average of less than 1 day. The project should have no measurable effect on irrigation water supplies or flood control operations.

Project impacts during drought conditions have not been specifically evaluated. However, an analysis of the cumulative effects of energy conversion development on the Missouri River reservoirs indicates that the project will lower Lake Sakakawea levels less than 1 inch, even during drought conditions. Consequent effects on navigation should also be insignificant.

During construction of the water intake in Lake Sakakawea, turbidity may disturb fish and temporarily displace organisms living on or near the reservoir bottom. During periods of low water level (about 1 year in 8) the operation of the water intake will entrain some fish. There is also a possibility that some young cold water species could become entrained when the lake is at normal or near normal levels. Still the water intake inlet velocity of 0.5 feet/second should prevent serious losses.

Knife River

Downstream from the confluence of Antelope Creek with the Knife River, irrigation is a major use of the available streamflow. The

drainage area of the Knife River at this location is over 2,300 square miles. Since the area of the project site is only 4.7 square miles, the project will not significantly affect the streamflow characteristics in the remaining portion of the basin. The decreased flow in the Knife River at Hazen will be less than 1 percent.

Runoff control structures at the plant site will eliminate the natural runoff from 1000 acres. This will consequently reduce downstream flows in the Antelope Creek by about 14 percent. Runoff from active portions of the mine areas (about 2,000 acres) will also be confined, but runoff in excess of that required for dust control and other mining requirements will be pumped or released to the surface drainage system after settlement of sediment. These reductions in runoff have not been quantified, but are not considered significant.

B. Groundwater Quantity

Aquifer Destruction

Mining will destroy the existing Beulah-Zap lignite bed and shallower units of the Fort Union aquifer under an estimated 19.5 square miles of surface area. While only qualitative bases for prediction exist, current evidence indicates that the planned reclaimed materials will have recharge and transmissivity characteristics that are equal to or greater than the undisturbed formations. After reclamation, the hydrologic and hydraulic characteristics of the aquifers should return to near the premining conditions.

Water Level Changes

Construction dewatering for the project facilities will deplete groundwater storage by lowering the potentiometric surface of local aquifers. This effect will be temporary and will be confined to the project site.

Mining operations will lower water levels where the overburden or lignite is saturated. If the aquifers being mined are characterized by jointing or bed-continuity over significant distances, the water levels will be lowered in the immediate vicinity of the active mine pit. These effects will extend from about .5 to 2 miles from active pit and reclamation areas. The mining may temporarily stop or reduce flow from the springs and wells immediately adjacent to the mine.

Groundwater tables in reclaimed mining areas should recover within a few years since the storage capacity and permeability will increase. Moreover, since the premining water levels are not far above the base of the Beulah-Zap aquifer, stable water level conditions probably will be restored within a few years after reclamation. In perched water zones, however, the postrecovery water level may be lower.

Paving, reservoir lining, and lining of detention ponds will disrupt recharge to aquifers underlying the project facilities for the life of the project. Project water control facilities and possible future diversions during reclamation will also reduce runoff from areas that

are now sources of recharge to the Beulah Trench. Locally, underflow to the glacial outwash may be reduced by diversion to mine-pit seepage. Although these activities will reduce the groundwater in storage under the project area, offsite groundwater users should not be affected.

C. Surface Water Quality

Project construction and operation activities will comply with runoff control and other regulations and thereby should avoid serious sediment and erosion-related impacts on water quality. Process wastewater will be discharged to a deep, brackish aquifer, not to surface waters.

The most significant project-related impacts will be (1) destruction of overburden during mining and (2) placement of project ash and sludge into the mine. These wastes will mineralize groundwater resources that may reach the surface water system as baseflow to Antelope Creek. An unknown number of springs or channel pools sustained in dry periods by groundwater may also be affected.

Missouri River

The project will have little measurable effect on the water quality of Lake Sakakawea or the Missouri River. Water supply withdrawals for the project will slightly increase circulation within Renner Bay and will reduce the dilution capacity of the Missouri River for water quality management purposes. Neither of these impacts are considered significant,

probably not even measurable. Water intake features have been designed to minimize entrainment and impingement of aquatic life. The effects of constructing the intake structure and the connecting water supply conduit will be mitigated by isolating their construction from the lake water. The intake structure is being constructed in a caisson and the intake pipe will be constructed by tunneling.

Knife River

The quality of surface waters in the Knife River may be influenced by the dissolved solids increases that will accelerate from plant-site drainage, releases or overflows from runoff and sediment control structures, and from groundwater affected by ash burial and reclamation. Since the increased concentrations will be tolerable, they will not affect existing uses of the river.

D. Groundwater Quality

Both Federal and North Dakota State laws govern water quality impacts. The North Dakota State Water Quality Standards contain a policy that states: "Water whose existing quality is higher than the established standards will be maintained at the higher quality unless it can be affirmatively demonstrated that a change in quality is justifiable to provide necessary economic or social development and will not adversely affect the stated beneficial uses of the water. All exceptions must be supported by data."

Table 3 shows the general characteristics of the project area's groundwater sources.

TABLE 3
Groundwater Quality

<u>Aquifer</u>	<u>Dissolved solids</u>		<u>Hardness</u>		<u>Sulfates</u>	
	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>
Outwash	375	1,471	209	568	6	426
Fort Union	482	5,570	25	1,803	123	3,305
Fox Hills, Hell Creek	1,410	1,690	8	16	1	11
Dakota	5,000 ^{a/}	7,500 ^{a/}	na ^{b/}	na	na	na
Minnelusa	na	150,000 ^{a/}	na	na	na	na
Kibbey	na	150,000 ^{a/}	na	3,100	9,700	na

^{a/} as NaCl equivalent

^{b/} na - no data available

Three project activities may change these qualities:

- o leaching of ash disposed in the mine pits
- o percolation of water through reclamation overburden
- o migration of contaminants injected into the deep wells.

Some materials in the ash buried in the bottom of reclaimed mined areas, including sulfates and possibly other contaminants, will go into solution. The concentration of these dissolved materials could make

the groundwater unusable for domestic and livestock purposes. The entire area of the Beulah-Hazen mine will probably be affected.

The possibility of further contamination of groundwater resources by outflow from the mine area to adjacent aquifers has not been specifically evaluated. Such contamination will probably be constrained by the limited precipitation in the area and the slow rate of groundwater movement.

If compacted impervious materials are used, the groundwater contamination by burial of ash in the mine pits could be minimized. Ash could also be selectively isolated in structural depressions or pockets where groundwater movement would naturally be excluded or the amount minimized from the burial areas. The alternative of ash surface disposal rather than burial, however, would pose esthetic problems, require additional land areas, and potentially threaten ground and surface water quality to a greater degree.

Removal and replacement of overburden during mining activities will increase the surface areas of the overburden and thus expose more of the surfaces to air and water. The higher rates of mineral oxidation and salt solubility will increase concentrations of dissolved solids in groundwater in the mined area.

The deep-well injection of project wastewaters is not expected to affect the shallower, more useable aquifers. Safeguards during well

construction, and the impermeable beds separating the receiving aquifer from the shallow aquifers should prevent contamination of the shallow aquifers.

Highly mineralized water will migrate outward from reclaimed areas, probably as subsurface flow to outwash aquifers and adjacent streams. The extent and location of migration have not been estimated, but the limited area (19.5 square miles over the project lifetime), the low annual precipitation, and the recharge capacity of reclaimed lands suggest that the migration will be limited.

E. Rural Domestic and Municipal Systems

Adjacent communities have already substantially improved their water supply and wastewater treatment systems. For example, since the 1975 date shown in Table 4, Zap has upgraded its sewage system to serve a population of 700, instead of the 400 as shown. Other nearby communities have also expanded their systems to meet the increased demands.

TABLE 4
Water and Wastewater System Status

Community	1975	Population		Peak Pop. Year	System Capability (as population served)	
		1980	1989		Water	Wastewater
Beulah	1,949	3,897	3,803	5,849 (1982)	4,500	6,000
Golden Valley	239	346	392	448 (1982)	1,000	200
Hazen	1,493	2,746	3,775	4,046 (1983)	3,500	3,700 ^{a/}
Zap	278	429	602	684 (1982)	1,000	400

^{a/} 5,000 with added aeration.

Since the domestic and municipal systems use groundwater supplies and the project will primarily use surface water, the project should not affect the amount available for municipal purposes. Sources for domestic and municipal supplies are beyond the immediate project site, so impacts from the project should not significantly affect the quality of community supplies. However, local landowners who depend on individual wells near the project site may be affected by the mining as discussed under groundwater quality impacts. Under conditions of the Mercer County Rezoning permit, the ANG Coal Gasification Company is liable for valid claims of damage due to disrupted water supplies or deteriorated groundwater quantity or quality caused by the project activities and must restore the quantity and quality to the levels prior to construction.

F. Instream Uses

The reduction (about 0.1 percent) in releases from Lake Sakakawea will slightly lower the lake level with the accompanying reduction in evaporation losses and increased circulation in Renner Bay. This may affect aquatic life and recreation, but the slight amount would be difficult to measure.

The reduced flow from Garrison Dam will decrease hydropower generation by about 7.4 million kilowatt hours annually, or about a \$300,000 (\$1979) equivalent. The flow reduction will reduce navigation below Sioux City, Iowa, only by an average of less than one day. Flood control operations should not be measurably affected.

G. Changes to Wetlands

The product gas pipeline will cross an estimated 32 of the approximately 160 wetlands near the proposed pipeline route. The pipeline construction will temporarily upset the wetland habitat, but compliance with wetland/dredge spoil permit provisions and timing of construction will minimize disruption of wildlife reproductive and migratory peak seasons.

Wetlands also occupy about 50 acres (0.3 percent) of the mine site, but there are no wetlands on the gasification plant site. Due to their fertility and depth, the wetland soils will probably be reclaimed for agricultural use. However, impoundments to confine drainage to the mine area and final cuts (which are not filled) will probably hold water. Proper grading of these reclaimed areas to provide shallow water may establish wetlands. The replaced overburden would also settle unevenly over a long period of time, thereby creating shallow surface depressions that may form wetland areas.

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