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DRAFT ENVIRONMENTAL IMPACT STATEMENT

NORTHERN STATES POWER COMPANY'S PROPOSED UNITS 3 AND 4 SHERCO STEAM ELECTRIC STATION

JULY, 1977

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Minnesota Pollution Control Agency

July 26, 1977

TO WHOM IT MAY CONCERN:

On December 13, 1976 the Minnesota Pollution Control Agency (MPCA) and our consultant Environmental Research and Technology, Incorporated (ERT), actively initiated preparation of a draft environmental impact statement (EIS) for Northern States Power Company's proposed SHERCO Units 3 and 4 electric generating facility to be located near Becker, Minnesota. This document was completed July 26, 1977 and is now being made available to you along with a formal Draft EIS Completion Notice (attached). Written comments regarding this document should be sent to:

Dale E. McMichael
Office of Environmental Analysis
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

In providing comments, it is important to note that a Certificate of Need was issued by the Minnesota Energy Agency on April 12, 1976 and a Certificate of Site Compatibility was issued by the Minnesota Environmental Quality Board (EQB) on November 10, 1976. Therefore, the need and alternative sites for the proposed SHERCO Units 3 and 4 facility were not considered in the Draft EIS. An EIS preparation notice for this proposal was issued by the Minnesota Environmental Quality Board on April 2, 1976.

Several actions remain regarding the SHERCO Units 3 and 4 proposal. A public hearing will be held after the Draft EIS has been distributed and ample time provided the public for review of this document. Following the public hearing, the MPCA Board will accept, modify or reject the hearing officer's findings and conclusions regarding the adequacy

- over -

of the EIS. After the public hearing, the MPCA must prepare a Final EIS which will be sent to the MEQB. The MEQB can elect to review the Final EIS. In any case, the ultimate determination regarding adequacy of the Final EIS rests with the MEQB. As provided in the MEQB Rules and Regulations (MEQC 33, 1973), the Final EIS will consist of a supplement to the Draft EIS containing public comments, or summaries of public comments (including public meetings or hearings held on the EIS), and a response of the MPCA to the significant issues raised in the consultation, comment and review process. Final decisions including issuance of permits follows the preparation of a Final EIS.

I hope that the Draft EIS addresses your interests and concerns in this matter.

Yours truly,

Sandra S. Gardebring

Sandra S. Gardebring
Executive Director

SSG:es
Attachments

DRAFT ENVIRONMENTAL IMPACT STATEMENT

NORTHERN STATES POWER COMPANY'S PROPOSED UNITS 3 AND 4 SHERCO STEAM ELECTRIC STATION

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1. EXECUTIVE SUMMARY

1.1 Introduction

Northern States Power Company (NSP) has proposed the addition of two units to its existing SHERCO steam electric generating facility in Sherburne County. Each of the proposed units is to have a gross generating capacity of 860 megawatts (Mw.). This will more than double the existing capacity of the plant. A plant of this size is considered a Large Electric Power Generating Plant (LEPGP), as defined by the Minnesota Environmental Quality Council (MEQC). By Minnesota state law any new proposed LEPGP must be developed in accordance with a prescribed set of environmental review procedures. This Environmental Impact Statement (EIS) has been compiled by the Minnesota Pollution Control Agency (MPCA) as part of the envirommental review process. It is the purpose of this EIS to provide information for agencies and private persons to evaluate the environmental consequences of the proposed power plant expansion. It will be used as a guide in issuing, amending or denying permits for SHERCO Units 3 and 4.

1.2 Background

On November 1, 1974, NSP applied to MEQC for a Certificate of Site Compatability for the expansion of its SHERCO plant. The company proposed the alternate development of two units of similar capacity at its Sibley County (SIBCO) site. MEQC appointed a Site Evaluation Committee to compare the relative merits of the proposed sites. The committee issued a report in which it concluded that SHERCO was the preferred site. MEQC subsequently issued a Certificate of Site Compatibility on November 10, 1975.

On October 14, 1975 NSP filed an application for a Certificate of Need with the Minnesota Energy Agency (MEA). After reviewing NSP projections for electric power demand MEA concluded that NSP projections were reasonable and that additional power generating facilities would be needed in the NSP service area in the early 1980s. Accordingly, a Certificate of Need was granted by MEA April 12, 1976.

Upon issuing the Certificate of Site Compatibility, MEQC formally determined that an EIS should be prepared. The Minnesota Pollution

Control Agency (MPCA) was designated as the agency responsible for the preparation of the document. On February 10, 1976 NSP submitted to MPCA a report titled Sherburne County Generating Plant, Units 3 and 4, Environmental Report, Volumes 1 and 2. At that time MPCA began its review of the environmental and design data supplied by the utility company. In December 1976, a Consultant Task Force (CTF) was retained by MPCA to assist in reviewing the accuracy and adequacy of data supplied by NSP, and to help provide other information deemed necessary by MPCA. Using the best available information, MPCA and its consultants prepared this EIS.

1.3 Proposed Plant

SHERCO Units 3 and 4 will share the site currently occupied by SHERCO Units 1 and 2. The site is located in South Central Sherburne County, adjacent to the City of Becker, between Minneapolis and St. Cloud, on the Mississippi River. Accommodation of Units 3 and 4 will entail expanding the existing site from 1700 acres to 2020 acres.

The proposed facility is comprised of two coal-fired steam generating units. Each unit is rated at a gross generating capacity of 860 Mw. Support systems for the plant include two-stage scrubbers, mechanical draft cooling towers, settling ponds and coal handling facilities. NSP proposes commencing commercial operation of Unit 3 in 1981. Unit 4 will follow in 1983. Construction of the two units would be more or less continuous between 1977 and 1983 with separate peak activity periods for each unit.

1.4 Environmental Impacts

Land Use

The development of Units 3 and 4 is compatible with local land use regulations and ordinances. Becker has zoned the existing and proposed site areas as an industrial power generation district. The visual impact of the project will not be significant given the existence of Units 1 and 2. No historical or archaeological resources exist within the area to be affected by plant construction.

Transportation

During construction there will be increased traffic volumes due to the movement of construction equipment, truck deliveries and worker commutation. Because of the relatively low levels of traffic on adjacent roadways, impact will not be significant. Local impacts on U.S. 10, however, may require temporary traffic control, as was done with Units 1 and 2 to facilitate flow of peak construction volumes.

The delivery of coal to the site will continue in the same manner presently used for Units 1 and 2 by 100-car unit trains, each about 1.25 miles long, traveling at a maximum speed of 50 mph. The combined four units at SHERCO will require an average of 5.5 unit coal trains (incoming and outgoing) per day, an increase of about three per day.

The increase of three train trips per day will cause a total of about nine minutes more delay, including queue dispersal. At present traffic rates, about 60 vehicles will be affected if all trips occur during the peak hours (this is unlikely). By 1990, the number of coal trains is expected to be 15 per day. Thus, about 25% of the projected increase on the Burlington Northern line will be due SHERCO operations.

There will also be increases in truck deliveries of limestone, fuel oil, gasoline and some other materials necessary for plant operation. However, as previously noted, the number of such trips is too small to have an appreciable impact on local traffic.

Socio-Economic Issues

The peak of construction (1980) is expected to require 435 nonlocal workers, who are likely to be accompanied by 609 dependents. Becker City and Becker Township are the only localities that should experience an increase of more than 2.5% over their current populations as a result of this in-migration. Together these two communities are projected to account for over 20% of the construction-related population growth.

The proposed construction will have a positive impact on the local and regional economy by providing new jobs. The construction program will also indirectly result in the creation of other jobs in the service and trade sectors.

The construction and operation of the proposed plant will not have a measurable effect on the available community services. The construction of Units 3 and 4 on this 320-acre site will provide substantial property tax benefits to those local governmental units to be affected, namely, the City of Becker, School District 726, Sherburne County and the Big Lake-Monticello Hospital District. Housing demand, however, will exceed existing stock in the SHERCO area. There may be significant housing impacts in three of the four communities where project-related housing demand is expected to be greatest. A large disparity exists between employee demand and the potentially available housing supply in Becker Township, Clear Lake Township and Becker City. In the case of St. Cloud, the estimated available supply far exceeds estimated NSP employee demand by a factor of over 12.

Air Quality

Operation of SHERCO Units 3 and 4 may contribute to violations of the state 3-hour standard for sulfur dioxide (SO_2) concentrations and to violations of both the state and federal standards for total suspended particulates (TSP). Likewise it is possible that coal handling facilities will release fugitive dust emissions that exacerbate TSP standards. Since the predictive techniques used to calculate the potential air quality problems involve large margins of error, additional monitoring of SO_2 and TSP should be undertaken to more accurately assess the potential for significant impacts.

Measures that could be taken to reduce short-term ambient SO_2 impact include combustion of lower sulfur coal, increased SO_2 removal prior to emission and increased effective height of release. If monitoring indicates that the short-term SO_2 standard will be exceeded, these mitigation measures might be used to decrease the impact.

The SHERCO facility reportedly will use a number of control measures for coal handling and storage operations. Additional control options for those phases of the handling and storage operations that have controls are not readily available. Enclosure of the conveyor transfer equipment would effectively reduce a significant contributor to the fugitive dust emission burden. The addition of venting and particulate removal equipment to the stacker/reclaimer for Units 1 and 2 and the radial stacker for Units 3 and 4 would also effectively reduce fugitive dust emissions.

Water Quality

Based upon available plant discharge estimates and baseline water quality data from the Mississippi River, normal operation of SHERCO Units 3 and 4 is projected to result in violations of existing water quality standards for the proposed uses of the Mississippi River beyond the allowable discharge mixing zone under critical conditions (low river flow and maximum waste discharge rate). After waste discharges are totally mixed with the Mississippi River, it is projected that water quality standards will not be exceeded. Despite substantial percentage increases in sulfates, hardness, total dissolved solids (TDS) and nitrates expected to occur as a result of the SHERCO facility expansion, the concentrations of these components in river water downstream of the mixing zone will not preclude water uses such as drinking water, irrigation, livestock, and cooling, even under low river flow and high plant discharge conditions. However, Minnesota Water Quality Standards specify that no more than 25% of river flow be used for dilution of effluent. Under worst conditions, 76% and 26%, respectively, of available river flow will be required to dilute the total hardness and TDS concentrations of the effluent. Based on the results of the bioassay conducted by ERT effluent standards are projected tp be violated for unspecified toxic or corrosive substances.

Noise Levels

The proposed expansion of the SHERCO facility to four units will involve additional noise sources similar to those employed in SHERCO Units 1 and 2. Units 3 and 4 will have induced draft fans feeding a new stack, roof ventilation fans and cooling towers.

Normal operation of the proposed four-unit SHERCO facility will result in small (2 to 3 dBA) noise level increases at most noise sensitive receptors in the vicinity of the plant. The largest increases are about 5 dBA which occur at nearest receptor locations. The baseline measurements for one-unit operating conditions, however, indicated that there are certain existing violations of NPC-2 state noise regulations, and several other cases in which observed noise levels would be borderline in terms of compliance. As a result, these 2-5 dBA increases become more significant. Approximately 10 to 12 residences fall within

the area in which noise standards will likely be exceeded with all four units in operation. Furthermore an additional 1600 acres of land adjacent to the site will be subjected to noise levels above the state standards. The extent of the exceedances depends on the success of various design efforts currently in progress. These potentially mitigating measures for Units 3 and 4 are: improved ID fan system, improved ventilation fans and two speed fans for cooling towers. Should the improved design of Units 3 and 4 prove to comply with the NPC-2 noise regulations, it is possible that Units 1 and 2 could be retrofitted with similar control measures to bring the entire SHERCO operation within specified noise levels. In addition, construction noise levels associated with purging steam lines and with earthwork will cause short-term violations of noise standards.

With more operating experience it is conceivable that plant control systems could be optimized to reduce the frequency steam relief noise occurrences. If this is not possible, another standard approach is to employ multiple relief valves with differing trip pressures. Likewise, the unmuffled steam relief valves could be located in semi-open chambers in which noise was reduced without hampering the necessary steam relief at specified pressure.

Geology/Hydrology

At this time, there has been no request from NSP for additional groundwater withdrawals to satisfy cooling water requirements for the expanded facility. Additional groundwater will be appropriated for service water. Studies by R. W. Beck and Layne Minnesota Co. indicate that current groundwater withdrawal for Units 1 and 2 has had a minimal effect on the water levels in surrounding agricultural and residential wells. Existing SHERCO wells currently withdraw a maximum of 950 gpm of groundwater. It is unlikely that additional withdrawals of a similar magnitude would have any significant adverse impact on wells surrounding SHERCO. It is recommended, however, that if additional groundwater withdrawals are requested for purposes of suppling cooling water under critical low flow conditions in the Mississippi River, pumping tests be conducted and analyzed to document the effect on nearby levels.

Solid Waste

A total of approximately 360 additional acres of storage area will be required to accommodate solid waste for the life of the expanded plant. A portion of this required area will be located on property added to the original Units 1 and 2 site. The effects of the conversion of this area from its present land use is not considered a significant adverse impact.

Terrestrial Ecology

The proposed project will preclude potential agricultural production on 240 acres for the life of the project. The abandonment of agricultural and grazing practices will allow natural revegetation to continue in the area. Natural revegetation should enhance vegetative diversity on the site.

Preoperational studies of the impact of air pollutants on vegetation indicate possible ozone damage. Soybean leaves at a site 1.0 miles north of the SHERCO plant have shown stress, likely induced by ozone. This effect is considered the result of pollution from the Minneapolis-St. Paul area. This finding is significant since the SO_2 emissions expected to be produced by SHERCO Units 1 through 4 combined with the high background levels of ozone may have a negative impact on vegetation. Exposures of 0.1 ppm SO_2 and 1.0 ppm ozone for six hours per day over five days have been observed to cause a significant decrease in top and reed weights of soybean plants.

The deposition of TSP on leaf surfaces could also have a potential adverse impact on vegetation. Particulate emissions from the power plant stacks and coal piles, combined with the high background levels of particulates that have been recorded in the vicinity (see Section 5.4) could have a negative effect.

Field surveys and local literature indicate that no endangered or threatened species of flora or fauna inhabit the SHERCO site or the immediate area. The literature does suggest that several endangered or threatened bird species may migrate along the Mississippi River in the vicinity of the SHERCO site. The peregrin falcon, bald eagle, whooping crane and greater sandhill crane have the potential for using any of the

habitats at or near the SHERCO site. The impacts of operation upon these species is not known at this time.

Aquatic Ecology

Surface water use at SHERCO may produce water quality changes by altering the solubility of dissolved gases by varying the rate of biological processes that affect water quality and by the addition of substances used in plant operatins. Drainage or leachate from ash storage areas at SHERCO may reach the Mississippi River. In addition, water used for cooling will be discharged with increased concentrations of water quality components due to evaporation in the cooling towers. Chemicals used for slime and corrosion control and air pollutants scrubbed from the atmosphere may also be discharged. Bioassay testing of the existing SHERCO discharge has documented the acute toxic effects of the existing plant on aquatic organisms. Additional testing for chronic toxicity of SHERCO effluents appears necessary to more completely assess the potential impacts of the proposed project.

1.5 Alternatives to the Proposed Design

Alternatives to several of the plant systems have been considered. In several cases there are reasonable alternatives to the proposed system. Some of these are as follows:

Power Plant Cooling

A number of methods could be used for power plant condenser cooling. The magnitude of the potential impacts of the cooling method emphasizes the need to evaluate carefully the available technology and the environmental effects of each alternative. Alternatives considered feasible are: natural-draft wet cooling tower, mechanical-drift dry cooling towers, a cooling pond, and mechanical-draft wet-dry cooling towers.

While a cooling pond used jointly for water storage would eliminate the potential impacts of the water use restrictions on plant operations, the extremely large land requirement would likely pose serious siting and acquisition problems. The natural-draft wet cooling towers would eliminate fogging, but would generate significant visual and aesthetic

impacts due to their height as well as requiring $20 million more for construction. Dry cooling towers, while they would virtually eliminate water consumption, have a capital cost over two times greater than the proposed cooling method. Wet-dry towers would reduce water consumption, decrease ground level fogging and cost more than the proposed cooling method.

Air Pollution Abatement Systems

A number of possible air pollution abatement systems are available that would provide compliance with applicable regulations and standards. Evaluation of these alternatives determined that only electrostatic precipitators are a reasonable alternative. Electrostatic precipitators (ESPs) are the most commonly used method of high-efficiency particulate removal. As such, they represent a reasonable alternative to the proposed use of wet scrubbers. When properly designed precipitators can provide in excess of 99.5% removal efficiency. The technical advantages of the hot-side electrostatic precipitator when compared to the proposed wet scrubber system are: (1) less corrosion and fouling problems (less maintenance), (2) lower power requirements and (3) more commonly used with low sulfur coal.

The wet scrubber, however, has one significant advantage with respect to resource use when used in combination with a line/limestone slurry (for SO_2 removal) as proposed. The fly ash entrained in the wet particulate scrubber would reduce limestone requirements by 120,000 tons per year (NSP 1976). This saving is partially offset by the higher energy consumption of the wet scrubber, i.e., approximately 6700 more tones of coal per year are required.

The most important factor favoring the proposed wet scrubber system is its lower economic cost when compared with the electrostatic precipitator. The differential present worth of annual operating cost is about $34 million less for the wet particulate SO_2 scrubber system as compared to the electrostatic precipitator SO_2 scrubber system.

Fuel Sources and Processing

NSP has proposed using western sub-bituminous, low-sulfur coal for SHERCO Units 3 and 4 from the Colstrip and Sarpy Creek fields in Montana,

the same source of supply used for Units 1 and 2. There are a number of other possible sources of coal. Only one reasonable alternative is available, however, and that is the Powder River Coal Basin in northeastern Wyoming. While the proportion of sulfur in this coal is comparable to the proposed source, its Btu content is higher.

Wyoming coals have good potential for meeting air emission requirements without the use of an SO_2 scrubbing system. However, even though approximately 50% of the coal reserves have sulfur content of less than 0.7%, it would probably be necessary to use coal beneficiation to remove conventional pyritic sulfur. Coal beneficiation refers to treatment of the coal to enhance its characteristics as a fuel and remove undesirable materials such as noncombustibles and pyritic sulfur. NSP has concluded that beneficiation of the coal supply currently being used for the existing SHERCO units (Montana coal) cannot be expected to reliably produce a fuel that would not require flue gas SO_2 treatment for Units 3 and 4. However, this process may be a reasonable alternative if Wyoming sub-bituminous coal were used.

Solid Waste Disposal

The three major types of solid waste generated by plant operation will be SO_2 scrubber sludge, fly ash and bottom ash. Alternatives are related to joint disposal of these wastes, use of wet vs. dry disposal methods, processing wastes to improve their potential for reclamation and on-site vs. offsite disposal. There is one reasonable alternative.

Fixation of scrubber sludge and fly ash (by addition of certain chemicals) offers the possibility of significant benefits with respect to the physical properties of the sludge/fly ash, its pollution potential and the reclamation potential of the disposal site. The end result of fixation processes is production of a material having physical properties ranging from soil-like to those of low-strength concrete, depending upon the process used and the degree of fixation desired. The fixed material has a low permeability and may act to promote chemical bonding of heavy metals in the sludge, thus reducing the pollution potential of any leachate that may be produced.

Water Supply and Management

Surface water (the Mississippi River) is the proposed source of supply for Units 3 and 4. However, the Minnesota Department of Natural Resources (DNR) has proposed restricting water withdrawals from the Mississippi River when river flows fall below 2,000 cfs. The river flow will be below the proposed limit about 12% of the time (Beck 1977d). This could curtail operation of Units 3 and 4 unless there are some alternative water sources or supplies. Alternatives include underground and surface storage as well as use of groundwater.

The topography of the area in the site vicinity makes it very unlikely that a natural dam and reservoir site exists in the area. Some type of diked structure would have to be constructed to store the water.

A water storage reservoir constructed on site can also be used to provide condenser cooling for the power plant, thus making joint use of the reservoir and possibly resulting in overall savings in the capital and operating costs of the plant. Land requirements for the pond (1,600 acres) is a major constraint to its development unless NSP is able to purchase suitable additional property for this purpose.

Construction of a large well field may be feasible, depending upon aquifer characteristics. An intensive groundwater testing program would have to be started, and this alternative would have to be compared with water storage options.

The important advantage of groundwater use is that it presumably would not be affected by water withdrawal restrictions proposed by DNR. However, the construction and operation of such a system would probably not be cost competitive with the proposed surface supply approach.

2. INTRODUCTION

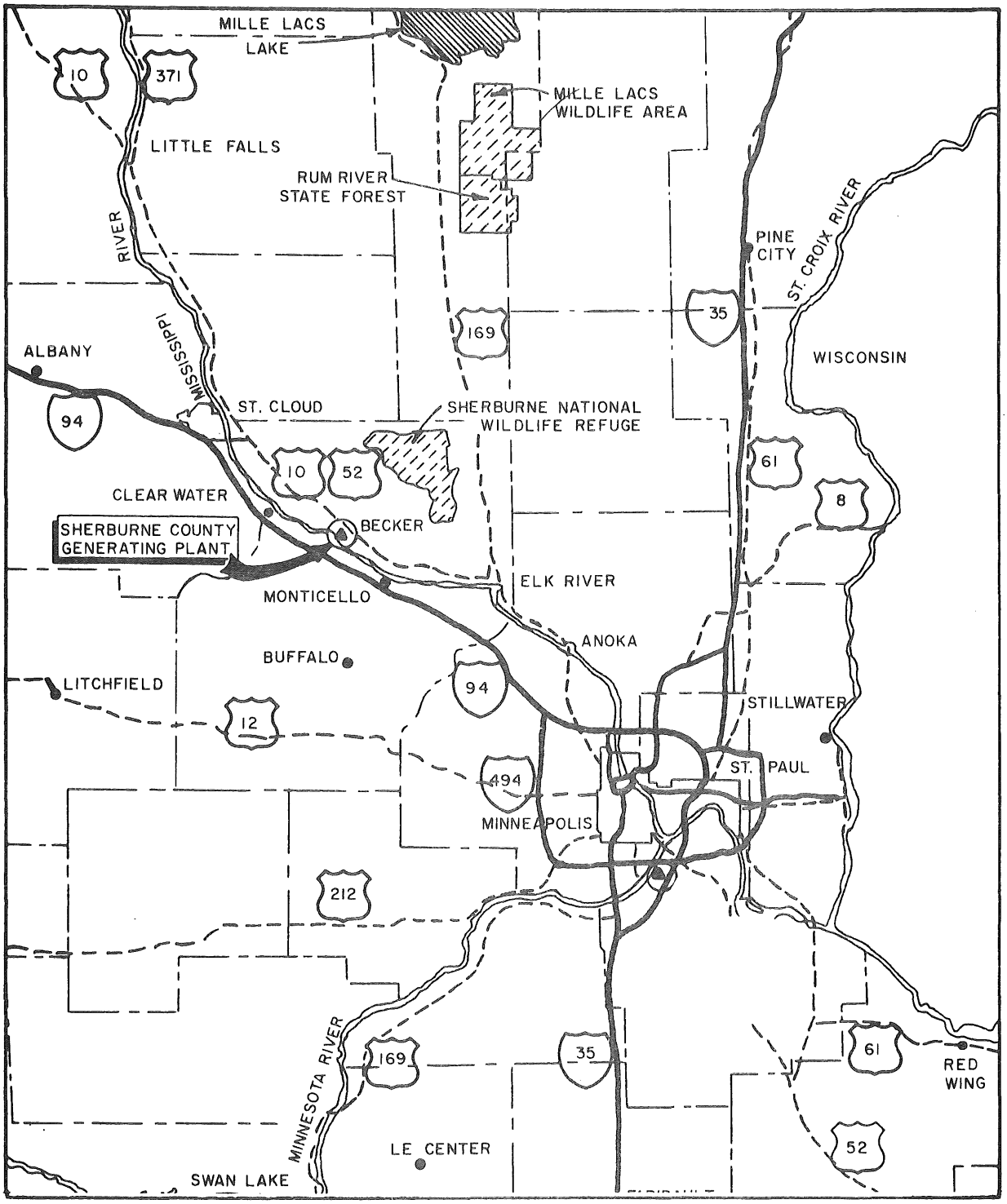
2.1 Proposal to Build SHERCO Units 3 and 4

NSP currently owns and operates the SHERCO Steam Electric Power Station in Becker, Minnesota. The station consists of two coal-fired steam generating units. Each of these units has a maximum gross generating capacity of 745 Mw. In addition to the generating units themselves, the station houses the major ancillary equipment required to operate a large-scale coal-fired generating plant. This equipment includes raw materials, handling equipment for coal, chemicals and supplies, cooling water systems, solid waste disposal systems and pollution emission and effluent control systems.

NSP has more recently proposed the expansion of the SHERCO facility to include an additional pair of generating units together with additional ancillary facilities. Units 3 and 4 are each designed to provide a maximum gross generating capacity of 860 Mw each. Ancillary facilities include additional cooling water systems, additional pollution control systems, additional raw materials handling equipment and an expansion of the solid waste disposal area.

The first unit at SHERCO began commercial operation in May 1976. Unit 2 was synchronized in January 1977. It began commercial operation in April of this year. NSP proposes to provide power on a commercial operating basis from Unit 3 in May of 1981 and from Unit 4 in May of 1983. The proposed schedule for commercial operation of Units 3 and 4 is predicated upon commencing earthwork and foundation construction in 1977, followed by the erection of buildings and installment of equipment in 1978. This optimistic scheduling presumes completion of the environmental review process in the fairly near future.

The plant site is located in a rural area of south central Sherburne County, approximately 1-1/2 miles southwest of Becker, approximately 19 miles southeast of St. Cloud and approximately 42 miles northwest of Minneapolis. The site is bounded on the southwest by the Mississippi River. Figure 2.1-1 shows the regional site location including major cities, major highways and major wildlife and forest areas (NSP 1976).



5 0 5 10 15

SCALE MILES

INTERSTATE HIGHWAY

U.S. HIGHWAY

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 2.1-1 Regional Site Location

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The current site covers approximately 1,700 acres. Some 320 acres will be acquired for the addition of Units 3 and 4, which will result in a total plant site area of approximately 2,020 acres 3.2 square miles.

NSP proposes to build SHERCO Units 3 and 4 in response to its forecasts for electrical power demand in its service area. NSP feels that existing generating facilities will meet projected customer demands through 1979. By the summer of 1980 NSP projects a generating deficiency of about 470 Mw. In the short-term, this deficiency will be offset by summer power purchases from Manitoba Hydro. Even with the purchased power, however, NSP projects system capacity deficiencies of 400 Mw. beginning in 1981 with increasing deficiencies yearly. Since NSP feels that other utilities will not be in a position to sell large blocks of power on a contractual basis, the company believes the construction of additional generating facilities is required to meet consumer demands for service (NSP 1975).

2.2 Environmental Review Process

The State of Minnesota has developed a set of laws and regulations for the development of LEPGP and high voltage transmission lines (HVTL). The Minnesota Environmental Policy Act, the Minnesota Power Plant Siting Act and the Minnesota Energy Act, in combination, require a sequential review of proposed energy facilities. In its simplest form, this process consists of four major steps that are to be followed in the environmental review process for new generating facilities.

First the power company must demonstrate that the proposed generating capacity is required by its customers. The utility does this by filing an application for a Certificate of Need with the MEA. Upon reviewing the application, MEA has the sole authority to certify that the service area of the utility will, in fact, require increased generating capacity according to best available power demand forecasts. In establishing the need for a new generating facility, the power company must determine only the basic capacity and general design of required power units. No detailed designs are required, nor is the power company required to investigate specific environmental consequences of additional generation capacity.

Second, after establishing the need for a new generating facility within its service area, the power company must propose a site at which the new facility may be located. This process is initiated by filing an application for a Certificate of Site Compatibility with MEQC (recently renamed the Minnesota Environmental Quality Board). Such an application includes descriptions of the proposed sites, alternative sites at which the power facilities could be built and the rationale for selecting the preferred site. More detailed information for the proposed facility may be expected during this second step to certify the compatibility of a proposed facility with a specific site. Designs and environmental consequences are considered only to the extent possible, given the conceptual plans available at this stage.

After designation of a "compatible site", the third major step is the compilation of an EIS for a LEPGP. A state agency is designated by MEQC as the "Responsible Agency". That agency is charged with preparing a document that discusses the anticipated environmental effects associated with specific development plans for a power facility at the designated site. Preparation of this document requires a knowledge of the specific components and operating parameters associated with the proposed facility. The EIS is intended to be a statement of the potential impacts associated with the selected designs. It also serves as a vehicle for discussing design alternatives and means for minimizing potential environmental impacts. The EIS is intended to provide information necessary for decision-making. The EIS is not intended to make decisions. Alternative sites, the need for the facility and other issues previously determined by MEA and MEQC are not considered in the EIS (25 MEQC 1977).

After the EIS is compiled, circulated and reviewed, it may be approved by MEQC. Following MEQC approval of the EIS, the power company may apply to the various state agencies for construction and operation permits for the proposed facility. Environmental permits are normally required for proposed discharges to air and water as well as for disposal of solid wastes. In addition, noise levels must be within specified levels and various building and safety codes must be attained in project plans. Obtaining the various permits constitutes the fourth and final step in the pre-operational environmental review process.

Note that the decision-making process in regard to SHERCO Units 3 and 4 has not followed the specific sequential steps just described. The siting decision by MEQC preceded the MEA determination of need. These first two sequential steps were reversed because the initial NSP proposals predate the Energy Act [Minnesota Statutes § 116H.01 et seq.] (Attorney General Office Memorandum 1976). The review process, however, is now at the third stage. This document constitutes the draft EIS compiled for public review and comment.

2.3 Certification of Need

The Certificate of Need process is intended to be the initial phase of the decision-making process for a LEGPG. The purpose is to determine the necessity of constructing a new power facility in consideration of energy demands, but without major regard to environmental effects. The MEA has promulgated criteria for the assessment of need [Minnesota Statute § 116H.13 subd. 1 (1975)].* In short, law requires that an application is to be granted if

1) it is determined that the probable result of denial of the application will be an unacceptable level of reliability of electric service to ultimate consumers in Minnesota or in neighboring states; or

2) if a determination is made that the socially beneficial uses of the output of the proposed facility, including its uses to protect or enhance environmental quality, are deemed significant enough to justify the need for the facility.

At this phase decisions are normally made on the basis of a conceptual plant at a hypothetical site since no further specifics are available. This was not the case with SHERCO Units 3 and 4, as previously noted, since the SHERCO siting decisions preceded the enactment of the certificate of need requirements.

*Note that NSP applications predate the legislation.

On October 14, 1975, NSP filed an application for a Certificate of Need for a large electric generating facility consisting of two 800 Mw. coal-fired units. The application specified initial operation of the first unit in 1981 and operation of the second unit in 1983. NSP explained in its application that its preferred site would involve expanding the existing SHERCO site in Becker, Minnesota. It also noted that an alternative site in Sibley County had been presented to MEQC in its application for a Certificate of Site Compatibility then under consideration by MEQC.

Six days of public hearings were held in Minneapolis during which NSP, potential intervenors and staff from several Minnesota agencies provided oral and written evidence pertinent to the need for the proposed facilities. Upon reviewing the evidence presented, MEQC found that: NSP forecasts for future electricity requirements in the service area were reasonable; NSP could probably pick up some power from existing facilities not requiring a Certificate of Need; there is virtually no chance that 1,600 or even 800 Mw could be obtained from these facilities on a continuing basis; current and planned facilities are insufficient to meet the projected demands for the period from 1981 through 1983; economic, technological and other considerations make it extremely unlikely that NSP could find a reasonable alternative to the proposed facility for supplying 800 Mw of power by 1981 and 1,600 Mw by 1983; the size, type and timing of the proposed facility should be appropriate to the energy supply and demand projections for the NSP system. The socially beneficial uses of the output of the proposed facility were found to include providing electric service to residential, farm, commercial and industrial customers. The electricity will provide a broad range of services including lighting, heating, cooling, venting, driving household appliances and powering commercial and industrial processes and control mechanisms. The uses include many functions that protect or enhance environmental quality, such as the powering and controlling of antipollution devices and providing a clean end-use energy resource in densely populated urban areas. Based on these findings the Certificate of Need was granted by the Director of MEA on April 12, 1976. No findings of fact or conclusions were made with respect to the environmental effects of the proposed SHERCO units 3 and 4.

2.4 Certification of Site Compatibility

In May of 1973 the Governor signed into law the Minnesota Power Plant Siting Act. In August of 1974 MEQC promulgated Minnesota Regulations MEQC 71-75, "Rules and Regulations for Power Plant Siting and Transmission Line Routing", pursuant to the Act. Together the Act and the regulations have established the framework for the LEPGP siting process. The purpose of this process is to determine whether a conceptual facility at a specific site is environmentally compatible.

The site selection process is initiated by the application of a utilities to MEQC for designation of a specific site or corridor for a specific size and type of facility. When it receives the application, MEQC is required to compile a Site Environmental Report. In this report the MEQC evaluates the compatibility with respect to three sets of criteria:

> "(1) Exclusion Criteria.
>
> (aa) No LEPGP shall be sited in violation of any federal or state law or regulation. No area shall be considered in which a LEPGP is not licensable by all appropriate state and federal government agencies.
>
> (bb) The following land areas shall be excluded: national parks; national historic sites and landmarks; national historic districts; national monuments; national wilderness areas; national wildlife refuges; national, wild, scenic, and recreational riverways; state wild, scenic, and recreational rivers and their land use districts; state parks; Nature Conservancy preserves; state scientific and natural areas; state wilderness areas; and any area designated a LEPGP exclusion area by the Council.
>
> (cc) No area shall be considered which does not have reasonable access to a proven water supply sufficient for plant operation. No use of ground water shall be permitted where mining of ground water resources will result. "Mining" as used herein shall mean the removal of ground water that results in material adverse effects on ground water in and adjacent to the area, as determined in each case.
>
> (dd) No water shall be transferred between the four major drainage basins within the state: that is, the Missouri River drainage basin, the Mississippi River drainage basin, the Lake Superior drainage basin, and the Red-Rainy River drainage basin.

(ee) Water intake structures and water pipelines shall not necessarily be prohibited from land areas excluded for power plant sites.

(2) LEPGP Avoidance Areas.

(aa) In addition to exclusion areas, the following land use areas shall not be approved for LEPGP sites when feasible and prudent alternatives with lesser adverse human and environmental effect exist. Economic considerations alone shall not justify approval of avoidance areas. Any approval of such areas shall include all possible planning to minimize harm to these areas. LEPGP avoidance areas are: state registered historic sites; state historic districts; state wildlife management areas (except in cases where the plant cooling water is to be used for wildlife management purposes); county parks; metropolitan parks; designated state and federal recreational trails; designated trout streams; and the rivers identified in Minn. Stat. § 85.32, subd. 1 (1971); and any other area designated a LEPGP avoidance area by the Council.

(bb) LEPGP avoidance areas also apply to new transportation access routes and storage facilities associated with the plant in addition to the plant itself. Water intake structures and water pipelines shall not necessarily be prohibited from LEPGP avoidance areas.

(cc) No transfer of water between sub-basins within each of the four major drainage basins shall be permitted except where it can be clearly demonstrated that the transfer will not have an adverse effect on water supplies or water quality in the areas involved.

(dd) The use of ground water for high consumption purposes, such as cooling, shall be avoided if feasible and prudent surface water alternatives less harmful to the environment exist. Ground water use to supplement available surface water shall be permitted if the cumulative impact minimizes environmental harm.

(3) Site Selection Criteria. The following criteria shall be applied in the selection of sites:

(aa) Prefered sites require the minimum population displacement and disruption of local communities and institutions.

(bb) Preferred sites minimize adverse health effects on human population.

(cc) Preferred sites do not require the destruction or major alteration of land forms, vegetative types, or wildlife habitat which are rare, unique, or of unusual importance to the surrounding area.

(dd) Preferred sites minimize the visual and audible impingement on waterways, parks, or other existing and proposed public recreation areas.

(ee) Preferred sites minimize the removal of valuable and productive land and water from other necessary uses and minimize conflicts among water users.

(ff) Preferred sites maximize reliability with respect to climate and geology.

(gg) Preferred sites permit significant conservation of energy or utilization of by-products.

(hh) Preferred sites are located near large load centers.

(ii) Preferred sites maximize the use of already existing operating sites and transportation systems.

(jj) Preferred sites allow for larger rather than smaller generating capacity." (74 MEQC)

A "Site Evaluation Committee' is appointed to assist the MEQC in the evaluation of plant sites that are being considered for designation. MEQC is required to provide a charge to the committee and a date by which the committee is to complete its evaluation. The committee is to be comprised of as many persons as may be designated by MEQC, but includes at least one representative from each of the following: a public or municipally owned utility; a private investor-owned utility; a cooperatively owned utility; and each regional development commission, county and municipal corporation in which a LEPGP site or HVTL corridor is proposed to be located. A majority of the members are public representatives (75 MEQC).

The report provides an evaluation of each site that is considered for designation. The report is precluded from considering the "need" issue or any other issues not related to differentiating site impacts (25 MEQC).

After evaluating the site proposed by the utility, as well as alternative sites, MEQC designates a suitable site for a specific size and type of facility and issues a Certificate of Site Compatibility.

NSP submitted its application for a Certificate of Site Compatibility on November 1, 1974. The application requested certification for SHERCO Units 3 and 4 with scheduled completion dates of 1982 and 1984, respectively.

The company proposed the alternative development of two units of similar capacity at its Sibley County (SIBCO) site (NSP 1974). The application was accepted by MEQC on November 12, 1974. A Site Evaluation Committee was appointed to review the application and to make a recommendation to MEQC (NSP 1976). In addition, an independent hearing officer was appointed and a series of five hearings were scheduled from May to September, 1975. In June of 1975, MEQC issued its Draft Environmental Report on siting issues. This report was made available for public review and comment. In August the Environmental Report was issued in final form. Shortly thereafter, the Site Evaluation Committee issued its Final Report (NSP 1975).

With 19 of its 23 members present, the Committee voted SHERCO 1, its preferred site by a count of 14 to 5.

> The major factors which influenced the Committee's selection of SHERCO were criterion (aa) regarding the displacement of people and criterion (ee) regarding the removal of valuable and productive land. The SHERCO site would not displace any people and it would remove only 320 acres of marginal agricultural land from production. On the other hand, the SIBCO site would displace 61 persons and use 3,480 acres of fertile and productive land, of which 2,800 acres are currently under cultivation. (NSP-P-1, 1975)

On October 13, 1975, NSP notified the hearing officer that the proposed 1982-1984 completion schedule for the two new units, as referenced in the application, was to be advanced to 1981-1983 in the Certificate of Need application. This schedule advancement did not alter information already presented in connection with NSP's application to the MEQC (NSP 1976).

The hearing officer filed Findings of Fact, Conclusions and Recommendations with the MEQC on October 23, 1975. The major conclusions cited by the hearing officer were:

> 1. The site designated by the applicant as the SHERCO site, is a suitable site upon which to locate, construct and operate two fossil fuel-fired steam electric power generating units each of which will have an approximate net generating capacity of 800 megawatts of electric power for transmission and distribution.
>
> 2. Based upon the design concepts set forth in the application and other presently-available information, the proposed LEPGP is licensable by the State agencies authorized by law to issue permits or certificates required for the construction and operation of such facilities.

3. The adverse human and environmental impacts of the proposed LEPGP and associated facilities to be constructed and operated will be the least at the site recommended by the Hearing Officer, the SHERCO site, and greater at the SIBCO site.

4. In order to insure that appropriate environmental consideration will be given to significant alterations of the proposed LEPGP and associated facilities as may be required by other State agencies as a prerequisite to the issuance of required permits and licenses, conditions should be included in the Certificate of Site Compatibility to be issued by the Minnesota Environmental Quality Council in the language set forth in the form of the Certificate recommended by the Hearing Officer.

Based upon the Site Evaluation Committee Report and the Hearing Officer's findings, the MEQC issued a Certificate of Site Compatibility for SHERCO Units 3 and 4 on November 10, 1975.

2.5 Environmental Impact Statement Process

The requirement for an EIS is a provision of the 1973 Minnesota Environmental Policy Act.

> The purpose of an Environmental Impact Statement is to provide information for agencies and private persons to evaluate proposed actions which have the potential for significant environmental effects, to consider alternatives to the proposed actions, and to institute methods for reducing adverse environmental effects. An Environmental Impact Statement is not a document to justify an action, nor shall indications of adverse environmental effects necessarily require that an action be disapproved. It is to be utilized as a guide in issuing, amending, and denying permits and carrying out the other responsibilities of public agencies to avoid or minimize adverse environmental effects and to restore or enhance environmental quality consistent with the Act. (21B MEQC 1977)

MEQC, the principal agency responsible for administration of the Environmental Policy Act, has established regulations for determining how and whether an EIS is to be prepared. An EIS is generally required whenever it is determined that an action is major and has the potential for significant environmental effects (25 MEQC 1977). In the case of LEPGPs an EIS is mandated by the construction of an electric power generating plant at a single site, with a capacity of 200 or more megawatts (24 MEQC 1977). Upon determining whether an EIS shall be required, MEQC selects the "Responsible Agency" for preparing the EIS. In doing so,

the MEQC considers which public agency has the greatest responsibility for supervising the entire action and which agency has special expertise in the topics to be addressed by the EIS. For an LEPGP, the Minnesota Pollution Control Agency is normally designated the Responsible Agency (256 MEQC 1977).

On November 10, 1975, MEQC formally determined that the preparation of an EIS for SHERCO Units 3 and 4 would be required. MEQC also designated MPCA as the Responsible Agency. MEQC further ordered that the mailing of the EIS Preparation Notice, which commences the preparation of the draft EIS, would occur upon submission by NSP to MPCA a report detailing information required to compile the EIS.* On February 10, 1976, NSP submitted a report entitled Sherburne County Generating Plant, Units 3 and 4, Environmental Report, Volumes 1 and 2. In February, 1976, MPCA staff began their review of the Environmental Report (ER) submitted by NSP. On March 22, 1976, MPCA staff, in a letter to the Chairman of MEQC, identified major problems regarding the ER and proposal, provided detailed comments regarding the Environmental Report and recommended issuance of the Preparation Notice (MPCA Memo, July 27, 1976).

The size and potential for significant impact associated with the proposed SHERCO Units 3 and 4, combined with lack of staff resources concerned MPCA. Accordingly, in order that the proper level of examination could be given the SHERCO proposal, MPCA decided to retain a consultant team to participate in the process of compiling an EIS. In April of 1976, requests for proposals to provide the required assistance were issued. Several proposals were received by the end of May, 1977. In July, 1976 the Agency Board of the MPCA approved the MPCA staff's selection of ERT to help prepare the SHERCO 3 and 4 EIS.

In December a Consultant Task Force (CTF) comprised of Environmental Research & Technology, Inc. (ERT) and R. W. Beck and Associates was contracted to supply the auxiliary services required to MPCA in the preparation of the EIS. The CTF was instructed to:

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*"When environmental documents are required on an action subject to governmental permit, the proposer shall supply in the prescribed manner any unprivileged data or information reasonably requested by the Responsible Agency" (24C MEQC)

1) review and evaluate the NSP ER and other available information;

2) identify additional needed information;

3) collect additional field data as appropriate;

4) compile a series of technical work papers describing the proposed project, its design alternatives and potential impacts of SHERCO Units 3 and 4;

5) assist MPCA with the preparation and production of the EIS; and

6) participate in public hearings and meetings.

The technical work papers cited as Task #4 above are the informational basis for this draft EIS. The series of technical work papers are as follows:

#1 - Description of Proposed Project

#2 - Description of Reasonable Alternatives to the Proposed Action

#3 - Assessment of Air Quality Impact

#4 - Assessment of Water Quality Impact

#5 - Assessment of Aquatic Ecology Impact

#6 - Assessment of Terrestrial Ecology Impact

#7 - Assessment of Noise Impact

#8 - Assessment of Land Use and Aesthetic Impact

#9 - Assessment of Transportation Impact

#10 - Assessment of Socio-Economic Impact

#11 - Solid Waste System Engineering Evaluation

#12 - Geology/Hydrology Impact

#13 - Energy Analysis for the Existing and Proposed Units

#14 - Assessment of Alternative Fuels and Fuel Transportation

#15 - Documentation of Bioassay Study Results

Using the best information available to MPCA, these papers discuss in technical detail potential impacts associated with SHERCO Units 3 and 4. The papers also point out where the existing data base is questionable, the technical tools and assumptions incorporated in the environmental analysis and potential for mitigating impacts associated with Units 3 and 4 as proposed. Subsequent sections of the draft EIS are abridged findings based upon these more exhaustive studies. The reader interested in more technical information is advised to review the series of technical work papers as well as the EIS.

As prescribed by MEQC (30 D) the draft EIS contains the following information:

1. Summary. A summary sheet which describes the action, major environmental impacts (adverse and beneficial), reasonable alternatives, and the federal, state, and local permits outstanding shall be included. Also, federal, state, or local agencies, other organizations, and private individuals consulted in the preparation of the EIS shall be identified.

2. Description. A description of the action, including type, size and location, and the environmental setting of the action. A regional and site-specific map should be included to assist in identification of the project.

3. Environmental impact of the proposed action. All phases of an action shall be considered when evaluating an action: planning, acquisition, construction, implementation, development, operation, and conclusion of operation. Special consideration shall be given to pollution, impairment, or destruction of the air, water, land, or other natural resources located within the State resulting from the proposed action, without limitation by the definitions of "action" and "environment" in these Rules. This discussion shall also include a description of all resources in the area and how they will be affected by the action, with emphasis placed on resources that are rare or unique to the region or that possess important historical, cultural, natural, ecological, or aesthetic values, without limitation by the definitions of "action" and "environment" in these Rules.

4. Any direct or indirect environmental, economic, energy, and employment effects that cannot be avoided if the proposed actions is implemented. This discussion shall describe the adverse and beneficial environmental, economic, energy, and employment effects that will result directly from the action, as well as the effects that may be reasonably expected to result from the action. Mitigation measures that have been or may be incorporated into the action to reduce or minimize significant adverse environmental, economic, energy, and employment effects shall be discussed.

5. Any irreversible and irretrievable commitments of resources that would be involved in the proposed action if it is implemented. This discussion shall include the proposed use of non-renewable resources, long term or irreversible commitments of resources to a particular use and any irreversible and irretrievable damage that may result from the action.

6. The relationship between local short term uses of the environment and the maintenance and enchancement of long term productivity, including the environmental impact of predictable increased future development of an area if the action is implemented. This discussion shall include the extent that the proposed action involves trade-offs between short term environmental gains or losses versus long term gains or losses, including potential risks to health and safety, and the extent that the proposed action forecloses future options. The impact of predictable increased future development in the area that may be stimulated, directly or indirectly, by the proposed action shall be discussed.

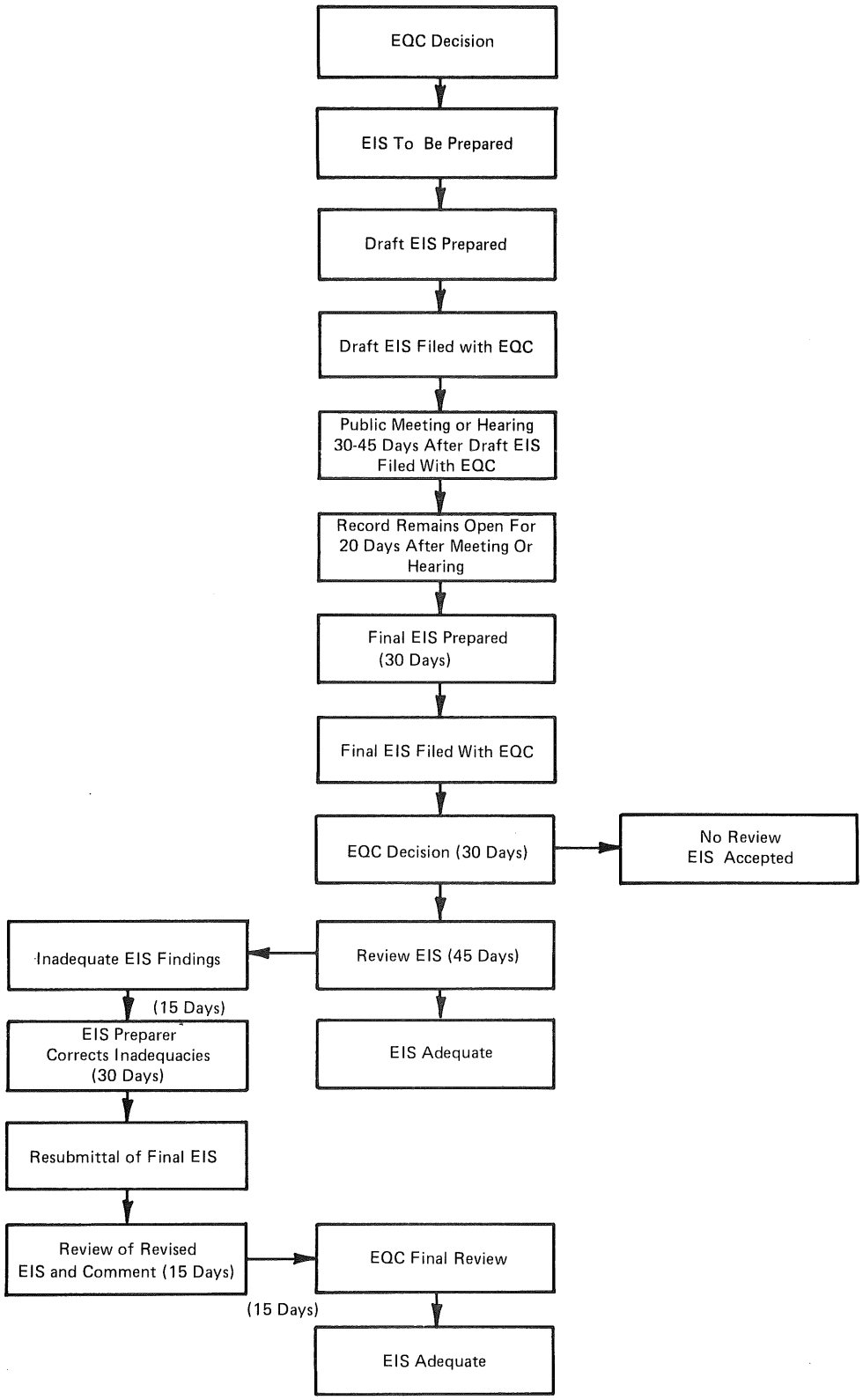
7. Alternatives to the Proposed Action. An objective evaluation of all reasonable alternatives to the action and the environmental impact of each and the reasons for their rejection in favor of the recommended choice shall be made. Reasonable modifications of the proposed action that may avoid or reduce adverse environmental effects shall be discussed, including the expected benefits, costs, and effects on the objective of the proposed action.

8. The impact on state government of any federal controls associated with the proposed action. Federal actions pending which may affect the final outcome of the project should be discussed, including those actions which may result in the expenditure of additional state funds.

9. The multi-state responsibilities associated with the proposed action. Impacts of the proposed action upon multi-state responsibilities shall be discussed, including the environmental effects of the action upon adjacent states.

The EIS process is shown in simplified form in Figure 2.1-2. Between 30 and 45 days after the draft EIS is filed, public hearings are scheduled. A transcript of the hearings is made and the public record remains open for 20 days after the last day of hearings to allow the submission of additional information. The Responsible Agency has 30 days from the close of the public record to prepare and file the final EIS.* The final EIS consists of the draft EIS, comments or summaries of comments received during public hearings and reviews and MPCA responses to the comments. MEQC may review the final EIS to ensure that its EIS

*MEQC may extend the time limitation upon written request showing good cause.



MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 2.1-2

EIS Process

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rules have been complied with. If MEQC determines that the final EIS is inadequate, the Responsible Agency has 30 days to undertake required revisions, with an additional 15-day review period. Once the MEQC has determined that the EIS is adequate, the EIS process is concluded.

2.6 Permitting Process

One major purpose of the EIS process is the generation of environmental information required by government agencies in determining whether a new facility, such as SHERCO, should be constructed. During the permitting process the various agencies review the major effects and design of the proposed facility to determine whether the facility meets applicable environmental and safety standards. In the course of permitting, public comment is solicited through public hearings. If the agencies determine that the proposed facility meets the requirements of the environmental regulations and standards then NSP will be given construction and eventually operating permits. If one or more of the permitting agencies determines that its regulations will be violated, permits are denied and NSP must either redesign to attain compliance or abandon its proposal.

The MEQC Hearing Officer has determined that NSP must ultimately obtain some 26 permits from nine government bodies. Table 2.1-1 , abstracted from MEQC Power Plant Siting Findings of Fact, Conclusions and Recommendations for SHERCO, enumerates the permits that must be obtained for SHERCO Units 3 and 4.

TABLE 2.1.1

SHERCO PERMITS

Agency		Description	Applicable Regulation
Minnesota Pollution Control Agency	1.	Liquid Waste Disposal Permit (plant blowdown and basin drainage including holdup pond and coal storage basins)	WPC 20, 15, 22
	2.	Certificate of Compliance (assurance of meeting water quality standards)	WPC 15
	3.	Gaseous Waste Disposal Permits (gaseous waste installation permit and gaseous waste operating permit)	APC 1, 3, 4
	4.	Burning Permit (construction and operating waste incineration)	APC 7, 8
	5.	Solid Waste Disposal Permit (ash storage)	SW 6
	6.	Solid Waste Disposal Permit (construction wastes - landfill)	SW 6
	7.	Liquid Storage Permit (oil and chemical storage)	WPC 4
	8.	NPDES Discharge Permit	40 CFR Part 425, WPC 36 40 CFR Part 423, Effluent 40 CFR Part 402, Cooling Water
Minnesota Department of Natural Resources	9.	Surface Water Appropriation (river water for plant operation)	
	10.	Ground Water Appropriation (dewatering wells)	
	11.	Ground Water Appropriation (batch plant well)	

TABLE 2.1-1 (Continued)

Agency		Description	Applicable Regulation
Minnesota Department of Natural Resources	12.	Ground Water Appropriation (domestic, service water, and plant makeup wells)	
Minnesota Department of Health	13.	Approval of Sewage Disposal Plans (temporary sanitary sewage disposal system)	
	14.	Approval of Sewage Disposal Plans (plant sanitary sewage disposal system)	
	15.	Approval of Plumbing Plans (temporary building plumbing)	
	16.	Approval of Plumbing Plans (permanent plant plumbing)	
	17.	Approval of Potable Water Plans (wells and water supply plumbing)	
Minnesota Department of Labor and Industry	18.	Certification of National Board Acceptance (auxiliary boiler)	
	19.	Certification of National Board Acceptance (power boiler)	
	20.	Approval of Plans (access to chimney lighting balconies)	
State Fire Marshal	21.	Approval of Plans (flammable liquid storage)	
Environmental Protection Agency	22.	Plant Discharges (NPDES)	(Taken over by MPCA as of 6/30/74)
	23.	Operation Notification (boiler operation)	40 CFR 60.8

TABLE 2.1-1 (Continued)

Agency		Description	Applicable Regulation
Federal Aviation Administration	24.	Notice of Proposed Construction or Alteration (chimney and powerhouse elevation authorization lighting and marking requirements)	14 CFR Part 77
Sherburne County	25.	Approval of Plans (flammable liquid storage)	
Becker, MN	26.	Burning Permit (site preparation clearing)	

In addition to these permits cited by the MEQC Hearing Officer, the U.S. Environmental Protection Agency (EPA) must review the plant for complinace with both New Source Performance Standards, (NSPS), which specify maximum air pollutant emissions for Units 3 and 4, and Significant Deterioration Standards, (SDS), which specify the maximum allowable degradation of ambient air quality attributable to the new units.

With the obtainment of these permits NSP may build and operate SHERCO Units 3 and 4, subject to the permit conditions.

2.7 LIST OF REFERENCES

1. Attorney General Office Memorandum, August 10, 1976, Marlene Sehechal to William Donahue.

2. Findings of Fact, Conclusions and Recommendations, NSP Application for Certificate of Site Compatibility, October 23, 1975.

3. Minnesota Statute 116H.13, subd. 1, 1975.

4. Northern States Power Company (NSP) Application for a Certificate of Site Compatibility for a Large Electric Power Generating Plant, November 1, 1974.

5. Northern States Power Company (NSP) Certificate of Need Application for a 1,600 Megawatt Electric Generating Facility, October, 1975.

6. Northern States Power Company (NSP) Environmental Report (ER), 1976.

7. NSP-P-1 Final Report, Site Evaluation Committee, August 29, 1975.

8. Rules of Minnesota Environmental Quality Council (MEQC) Environmental Review Program, 1977.

3. DESCRIPTION OF THE PROPOSED PROJECT

3.1 Existing SHERCO Plant

The existing SHERCO facility consists of two coal-fired steam generating units. Its general location and boundaries are shown in Figure 3.1-1. The general plant arrangement is shown in Figure 3.1-2.

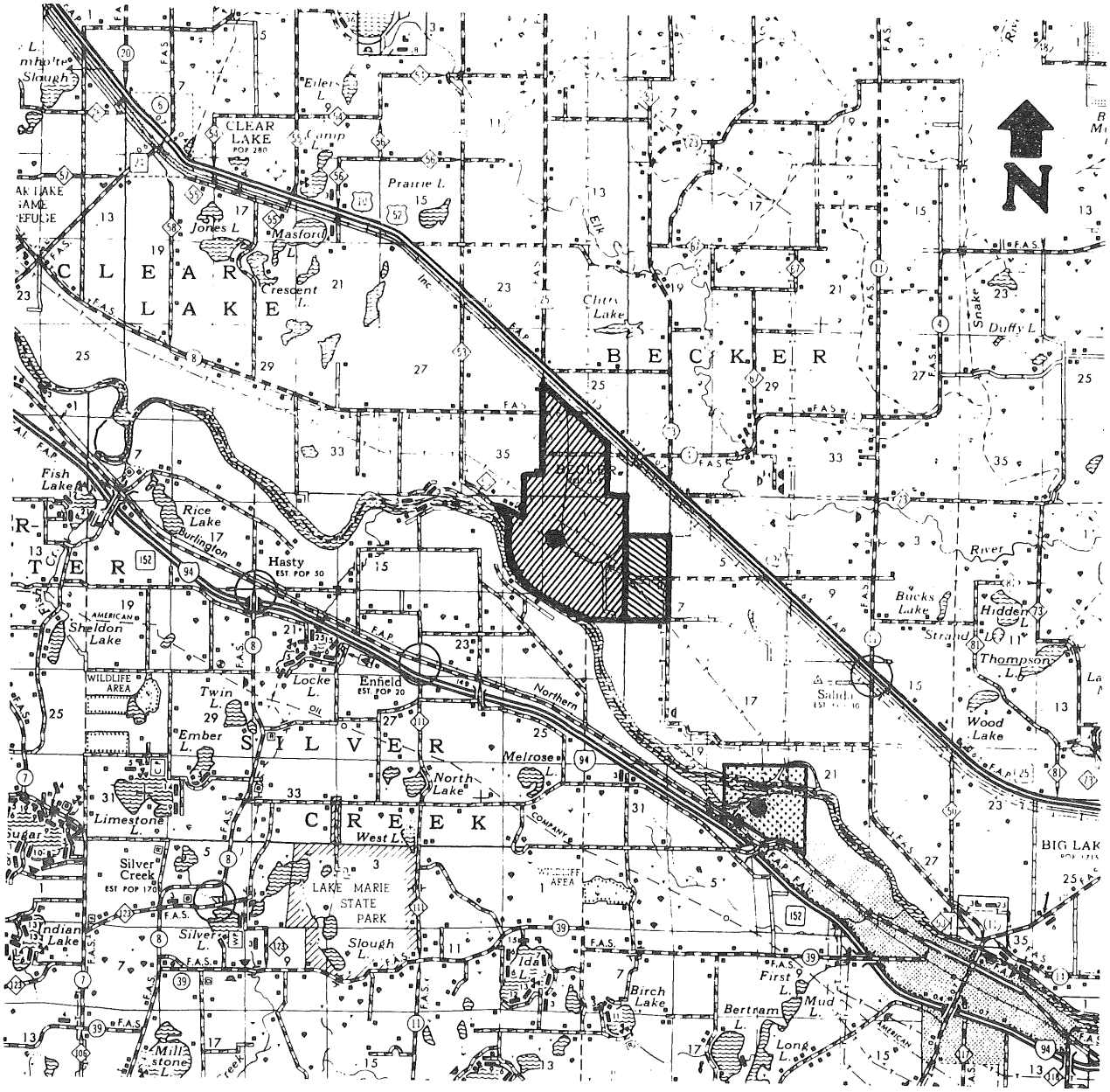
The first generating unit at the SHERCO plant, which began commercial operation in May 1976, has a maximum gross generating capacity of 745 Mw (698 Mw net). Generating Unit 2 was first synchronized in January 1977, and is a duplicate of the first unit (Gordon 1977).

The existing plant is comprised of five major systems. First, the power generation cycle system has three major elements: the two steam generators, which are coal-fired, water-cooled furnace, balance draft, single drum units; the steam turbines and the steam condensers and circulating water equipment, which includes the two banks of mechanical draft cooling towers.

The second major system's raw components include rail delivery sidings for coal, a rotary coal car unloader, coal transfer equipment (including a stacker-reclaimer conveyor), storage areas, a coal crusher and a coal pulverizer. In addition, the plant includes storage areas and a stacker-reclaimer for limestone, a wet limestone pulverizer, chemical storage tanks and petroleum storage tanks.

Third is the water system for Units 1 and 2, which is comprised of several subsystems. Plant water is drawn from the Mississippi River through the intake structure on the east bank of the river. A recirculating cooling water system dissipates waste heat from the steam condensers. Cooling is accomplished by the two banks of four mechanical draft cooling towers. Makeup water for the boilers is provided by a separate boiler water system supplied by well water and treated by a demineralizing system. Additional water is needed for miscellaneous plant uses, such as auxiliary cooling, plant service water and equipment cleaning. Waste waters are circulated through a recycle basin, settling ponds and a holding basin prior to discharge into the river.

The air quality control system is the fourth major system. Its major elements are two-stage limestone wet scrubbers for control of sulfur dioxide (SO_2) and total suspended particulate (TSP) emissions.



SHERCO 1 & 2 PLANT SITE

ADDITIONAL AREA REQ'D FOR UNITS 3 & 4

MONTICELLO PLANT SITE

MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 3.1-1

General Location of Plant Site

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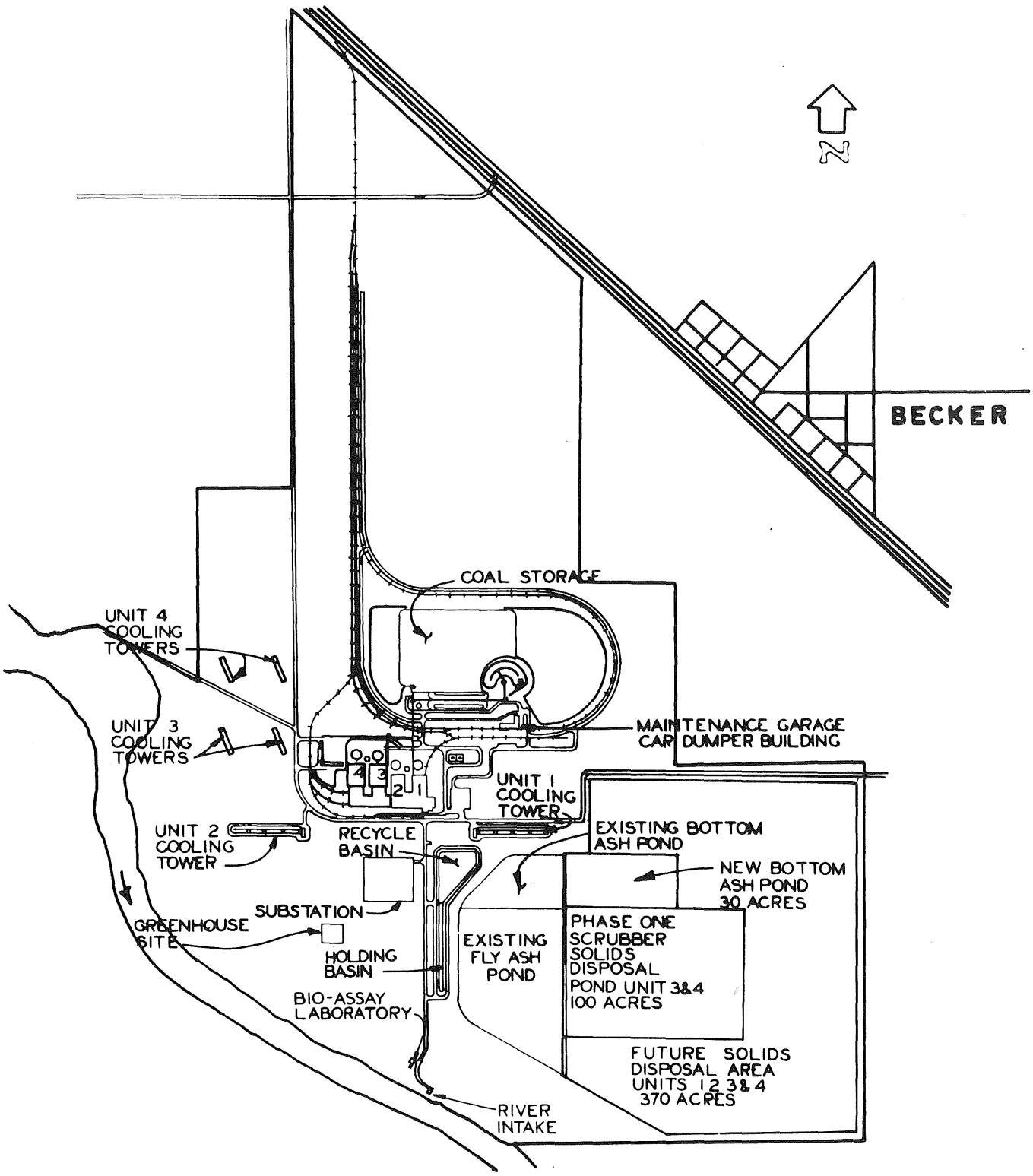

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 3.1-2 SHERCO Site Layout

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NO_x emissions are controlled by the use of overfire air with a tangentially fired burner system. Products of combustion from Units 1 and 2 are reheated from approxiately 131°F to 171°F and discharged from a common 650-ft stack with an inside diameter of 21.4 ft.

The fifth major system, solid waste, handles the by-products of the coal combustion. Solids from the scrubber are conveyed to one of two thickeners. Bottom ash is sluiced from bottom ash hoppers to the bottom ash pond, a diked earthen 20-acre reservoir. Scrubber wastes are collected in a separate scrubber solids pond.

3.2 General Description of the Proposed Plant

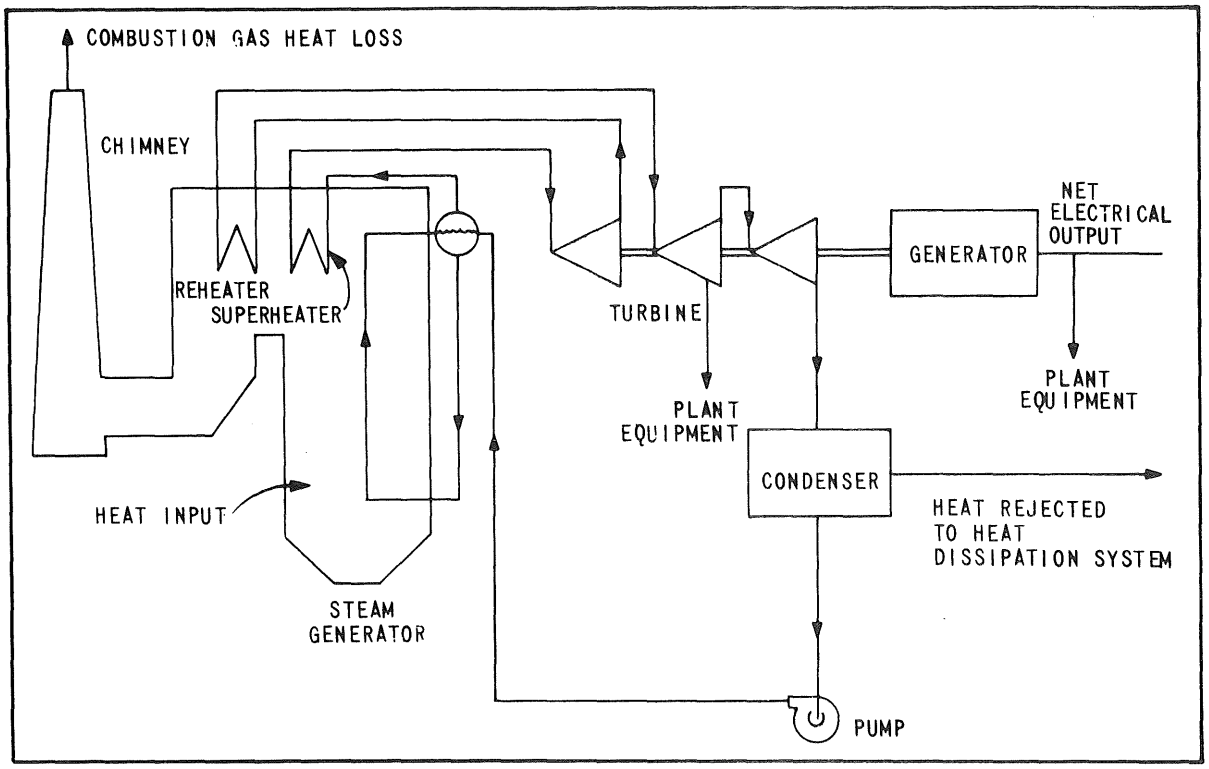
The proposed addition to the SHERCO plant, Units 3 and 4, will be located immediately west of the existing units. Commercial operation of Units 3 and 4 is planned for May 1, 1981 and May 1, 1983, respectively. The current SHERCO site covers approximately 1,700 acres. Approximately 320 acres will be acquired for the addition of Units 3 and 4.

Units 3 and 4 will each have a maximum gross generating capacity of 860 Mw and a corresponding net generating capacity of 800 Mw (NSP). The units will be operated in order to satisfy NSP's electrical energy and demand requirements. NSP has indicated that the levelized capacity factor* for Units 3 and 4 is projected to be approximately 57% over their 35-year life. (It should be noted that both the anticipated capacity and the plant life may vary according to future circumstances with regard to energy planning and policy.)

3.3 Description of Proposed Units 3 and 4

The representative schematic shown in Figure 3.3-1 describes the thermodynamic cycle and components of a typical modern coal-fired electric power plant. The major components shown are described below as they apply to the proposed plant.

*Levelized capacity factor = capacity factor averaged over the life of the plant.



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 3.3-1 Steam Electric System

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3.3.1 Power Generation Cycle

Steam Generators

The steam generators for Units 3 and 4 will be designed to produce approximately 6,150,000 pounds of steam per hour at a pressure of 2,640 psig with a superheater inlet temperature of 1,007°F and to reheat the steam to 1,005°F after partial expansion through the turbine. The boilers are indoor, water-cooled furnace, balanced-draft, single-drum units. They are pulverized coal-fired units of the dry-bottom type.

Steam Turbine-Generators

These units are predicted by the manufacturer to have a maximum gross generation capacity of 860 Mw when operating with the control valves wide open at an inlet pressure 5% greater than design and at rated temperature at the inlet and reheater readmission point. This highest predicted gross generation capacity of 860 Mw is the expected maximum used for this environmental impact statement. The corresponding expected net generation capacity is 800 Mw.

Condensers and Circulating Water Systems

The steam surface condensers for Units 3 and 4 are two-shell dual-pressure units. The two shells have a combined surface area of approximately 480,000 square feet for condensing the turbine exhaust steam. The condensers are designed to maintain a turbine exhaust pressure of 3.5 inches Hg when receiving the steam turbine exhaust at maximum output, while also receiving adequate circulating water to absorb that heat of condensation.

3.3.2 Raw Materials Handling

Quality and Quantity of Coal

The SHERCO Plant presently burns and will continue to burn a western sub-bituminous, low-sulfur coal. This coal is obtained principally from the Colstrip and Sarpy Creek fields of Montana.

Tables 3.3-1 through 3.3-3 summarize Sarpy Creek coal characteristics.

TABLE 3.3-1

ANALYSIS FOR SARPY CREEK TRACT II COAL

Proximate Analysis (as received)	Statistical Average	Lower Limit	Upper Limit
Moisture (%)	24.84	21.61	27.01
Ash (%)	11.12	6.54	15.0*
Volatile (%)	28.40	25.54	31.13
Fixed Carbon (%)	38.59	34.46	41.20
Sulfur (%)	0.86	0.40	1.3
Heating Value (Btu/#)	8,252	7,600*	8,836
Ultimate Analysis (%) (as received)			
Moisture	24.84	21.61	27.01
Carbon	51.02	46.36	53.21
Hydrogen	3.30	3.07	3.57
Nitrogen	0.76	0.65	0.90
Chlorine	0.03	0.00	0.06
Sulfur	0.86	0.40	1.3
Ash	11.12	6.54	15.0*
Oxygen (by diff)	11.05	9.43	11.75
Standard Mineral Analysis of Ash (%)			
P_2O_5	0.52	0.15	0.96
SiO_2	35.35	28.66	44.84
Fe_2O_3	6.88	3.59	12.34
Al_2O_3	17.16	12.93	19.60
TiO_2	0.67	0.51	0.78
CaO	17.35	6.03	26.92
MgO	4.30	2.19	5.98
SO_3	15.24	7.87	19.78
K_2O	0.37	0.12	0.50
Na_2O	1.46	0.24	4.18
Undetermined	0.65	0.10	1.10

*Corrected based on experience with other coals of differences between core analyses and mining results.

TABLE 3.3-2

TRACE ELEMENT ANALYSES, SARPY CREEK TRACT II COAL IN PPM

	Statistical Average	Minimum	Maximum
Antimony, Sb	0.85	0.53	1.5
Arsenic, As	2.2	1.4	5.2
Barium, Ba	310	150	440
Beryllium, Be	0.88	0.33	2.9
Boron, B	31	25	36
Cadmium, Cd	0.10	0.09	0.20
Chlorine, Cl	845	240	2,000
Chromium, Cr	5.1	3.1	9.7
Copper, Cu	9.2	6.3	16
Fluorine, F	60	11	100
Germanium, Ge	2.1	0.10	6.1
Lead, Pb	5.1	1.3	9.0
Manganese, Mn	102	22	170
Mercury, Hg	0.13	0.09	0.16
Molybdenum, Mo	2.3	1.7	3.6
Nickel, Ni	10	7.1	13
Selenium, Se	1.2	0.83	1.5
Silver, Ag	0.06	0.02	0.11
Uranium, U	1.9	1.1	2.9
Vanadium, V	7.8	5.0	11
Zinc, Zn	14	4.6	29

TABLE 3.3-3

RADIOACTIVITY ANALYSIS OF SARPY CREEK TRACT II COAL

Nuclide	Activity in Coal Sample (pCi/gm dry)	Activity in Ash Sample (pCi/gm dry)
Gross Alpha	<4.0	0.13 ± 0.06
Gross Beta	4.0 ± 1.2	0.22 ± 0.02
Be- 7	<0.4	<0.9
K- 40	1.00 ± 0.78	0.128 ± 0.013
Mn- 54	<0.03	<0.07
Co- 58	<0.04	<0.09
Co- 60	<0.03	<0.07
Zr- 95	<0.07	<0.2
Ru-103	<0.05	<0.1
Ru-106	<0.3	<0.7
Cs-134	<0.03	<0.09
Cs-137	<0.03	<0.08
Ba-140	<0.6	<1.0
Ce-141	<0.1	<0.2
Ce-144	<0.2	<0.4
Ra-226	<0.6	6.23 ± 1.37
Th-228	0.293 ± 0.088	2.94 ± 0.29

The following data have been used to calculate the quantity of fuel required:

Coal Characteristics	
Higher Heating Value	8,300 Btu per lb
Ash	10.8 percent by weight
Sulfur	0.9 percent by weight
Net Unit Capacity	
Unit 3	800 Mw
Unit 4	800 Mw
Net Plant Heat Rate	
Unit 3	10,400 Btu
Unit 4	10,400 Btu
Capacity Factor - Units 3 and 4 (NSP)	
0 - 15 years	65%
16 - 20 years	55%
21 - 35 years	50%

Retirement at the end of 35 years' service.

Based upon these values, the following quantities of coal were calculated:

	Unit 3	Unit 4	Total
	Short Tons	Short Tons	Short Tons
Average hourly consumption based on the above initial capacity factors	325.8	325.8	651.6
Maximum hourly consumption	501.2	501.2	1,002.4
Average annual consumption based on the above initial capacity factors	2,854,000	2,854,000	5,708,000
Maximum annual consumption	4,391,000	4,391,000	8,782,000
Total consumption based on remaining unit life and the above capacity factors.	87,811,000	87,811,000	175,622,000

Method of Coal Movement

Coal is transported to the SHERCO site by unit train. The rail cars are automatically unloaded in an enclosed shed by a rotary unloader. The rotary unloader is capable of unloading 105 cars of approximately 100 short tons net coal capacity each in four hours.

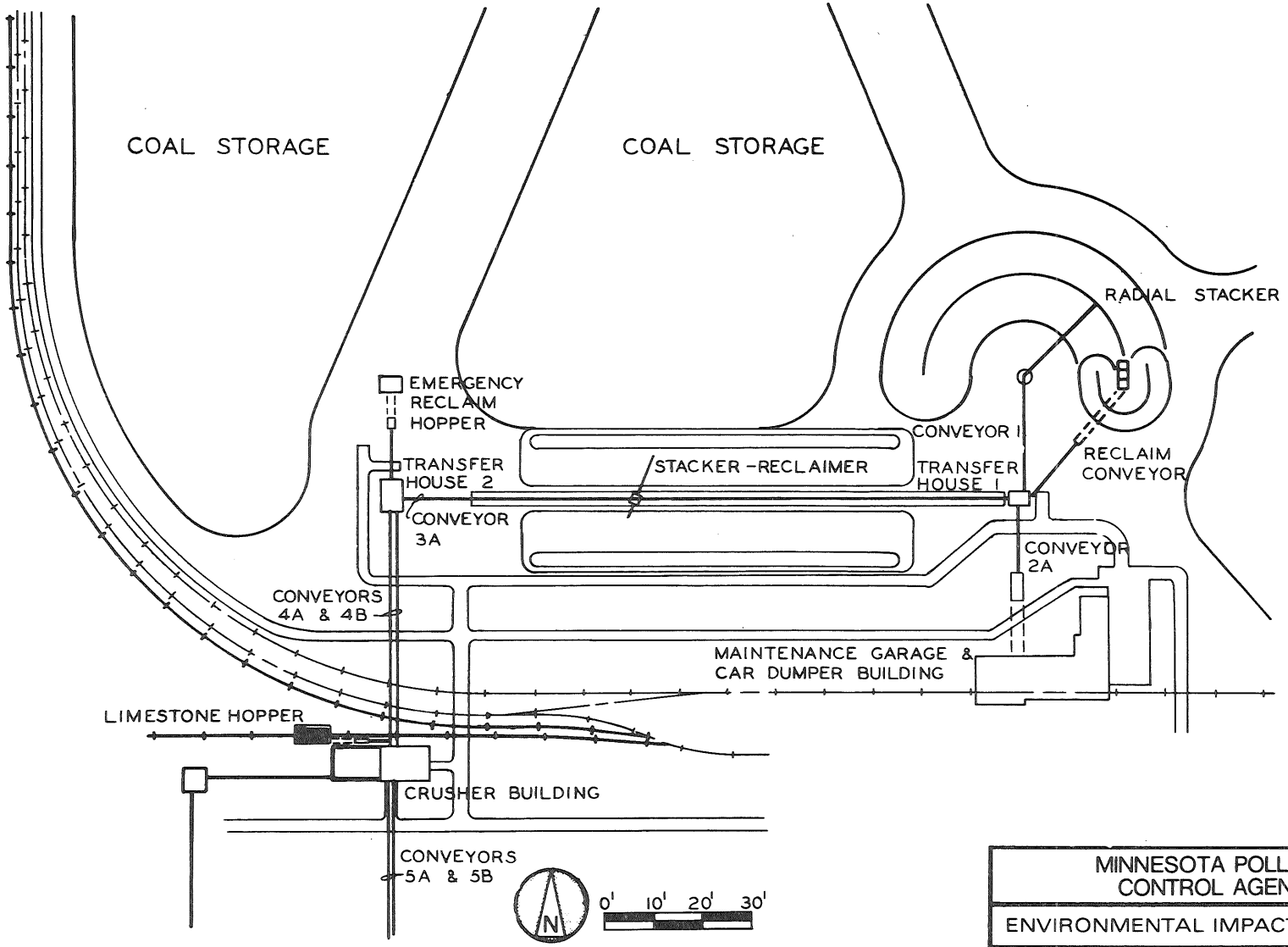
Coal from the unloading facility is conveyed by an inclined belt conveyor to Transfer House 1 (see Figure 3.3-2), from which it may be delivered to the stacker-reclaimer conveyor or stocked out. The coal delivered to the stacker-reclaimer conveyor may be passed through to Transfer House 2 or placed in a ready storage pile on either side of the stacker-reclaimer conveyor. The coal which was stacked out from Transfer House 1 may be fed to the reclaim conveyor by bulldozer or hauled by rubber-tired scrapers to the inactive storage pile.

Transfer House 2 may receive coal from either the emergency reclaim hopper (a point to which coal may be delivered by rubber-tired scrapers from inactive storage) or from the stacker-reclaimer conveyor. Transfer House 2 delivers coal to the crusher house by means of an inclined belt conveyor. The coal is crushed in the crusher house to a size suitable for introduction into the fuel pulverizers, then sent by inclined belt conveyor to the in-plant cascade conveyors. The trippers on the cascade conveyor fill the in-plant coal bunkers. These coal bunkers are the active fuel storage for the plant.

The active storage consists of seven 400-ton coal bunkers for each unit. The ready storage at the stacker-reclaimer is of sufficient size to store 90,000 tons of coal. The inactive storage pile for Units 1 and 2 is sized to store approximately 1,100,000 tons - equivalent to about 54 days' supply at maximum load.

In addition to increasing the amount of inactive storage required, when the proposed plant is constructed, NSP will add a radial stacking out conveyor so that coal can be stored over a greater area, significantly increasing the ready storage supply. The proposed plant will also include the following:

1) a third unit-train track parallel to the existing tracks to increase unit-train capacity on-site;



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 3.3-2 Coal Handling Facilities Layout

2) an additional coal conveyor parallel to the existing stacker-reclaimer;

3) additional coal-crushing capability;

4) an addition to the coal conveyor system and transfer equipment to supply coal to Units 3 and 4 and

5) additional active storage at each unit.

Limestone, Chemicals and Petroleum

Crushed limestone is currently delivered to the existing plant in dump trucks, which dump it at a point accessible by the stocker-reclaimer. The stacker-reclaimer loads the limestone onto a conveyor for transport to the crusher house, where it is fed into the wet pulverizer, from which it enters the SO_2 scrubber slurry system.

NSP has not yet contracted for the supply of lime or limestone to be used for the Units 3 and 4 SO_2 flue gas scrubbers. Inasmuch as the form of material is not yet certain, the method for handling that material has not been determined.

Chemicals are normally delivered to the plant in trucks. Acid is delivered by bulk tank truck and stored in an above-ground tank, while compressed hydrogen and carbon dioxide gas are delivered in bottles. The dry chemicals are delivered in bags. Sodium hydroxide, for demineralizer regeneration, is delivered by truck in bulk form and stored in a lined indoor storage tank. Anhydrous ammonia is stored in an outdoor storage tank. No new facilities for handling process chemicals have been proposed to date.

Fuel is required for coal ignition in each of the steam generators. Two 200,000-gallon tanks provide storage for No. 2 fuel oil used for Units 1 and 2. In addition, a single 15,000-gallon tank provides storage for diesel fuel, which is needed to power the emergency generating units and large mobile ground equipment. Gasoline is required by maintenance and personnel transportation vehicles. These fuels are brought to the plant by bulk tank truck and stored in tanks. Units 3 and 4 will require more frequent deliveries, but no new facilities.

Delivery of Coal and Equipment

The coal used as fuel for SHERCO Units 1 and 2 is mined in Montana at the Sarpy Creek and Colstrip coal fields. Increased quantities of coal will be required to fuel Units 3 and 4. This coal is delivered to the plant by unit train over existing railroads. Figure 3.3-3 shows the coal delivery route.

The unit trains used for coal delivery are made up of approximately 110 cars each having a capacity of 100 short tons. The calculated average additional consumption of coal during the initial years of operation is 5,708,000 short tons annually for Units 3 and 4 combined. This consumption requires approximately 519 more unit train deliveries per year, or 10 additional deliveries per week.

The combined coal requirement of Units 1 through 4 is 10,688,000 short tons per year during the initial years of operation. This requires an average of 18.7 unit trains per week, or about 2.7 trains per day. These trains are scheduled on an average-consumption basis to levelize the requirement for mining and transportation during the year.

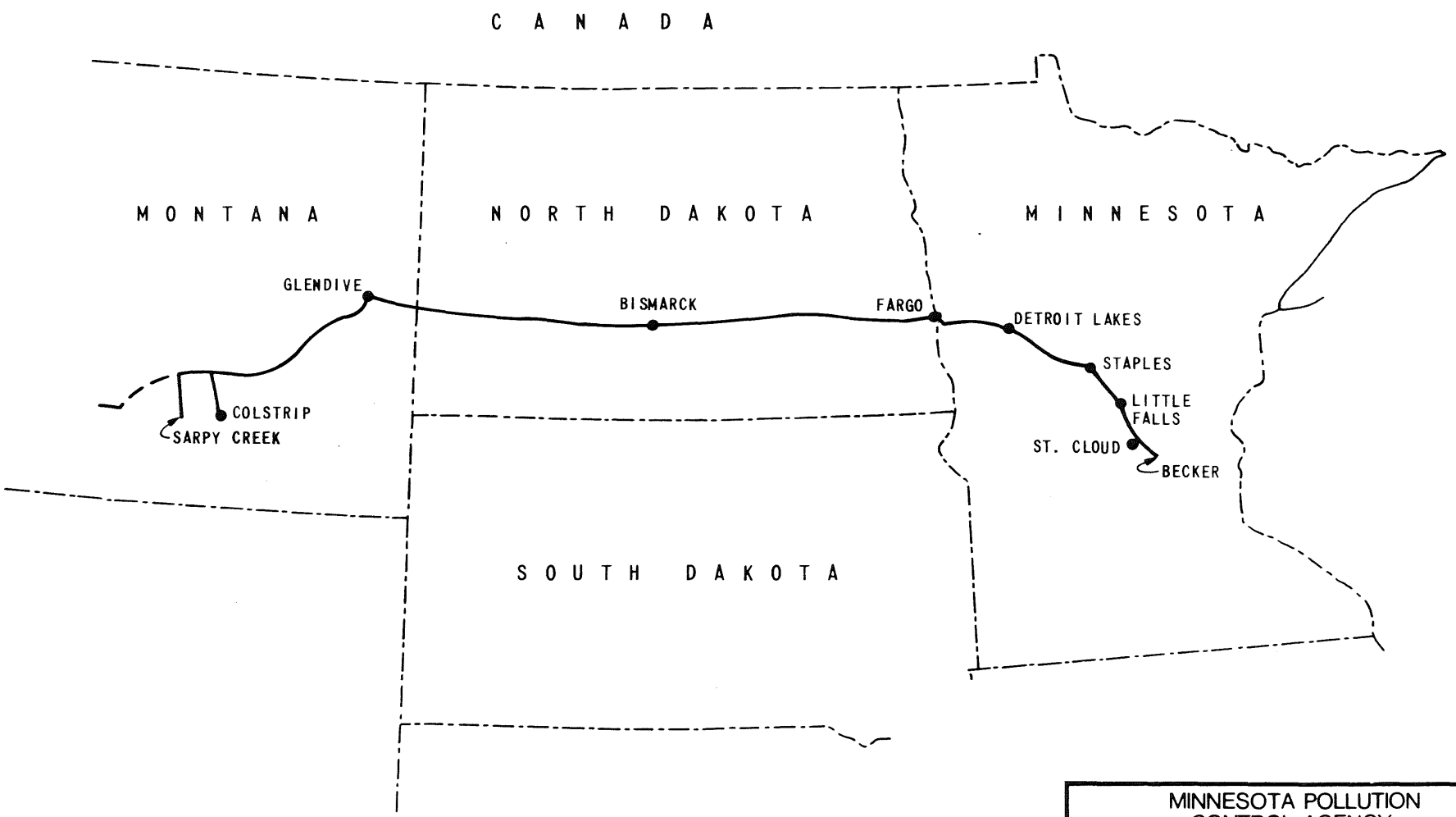
3.3.3 Units 3 and 4 Water Systems

Figure 3.3-4 is a schematic diagram of water and wastewater flows for all four units of SHERCO.

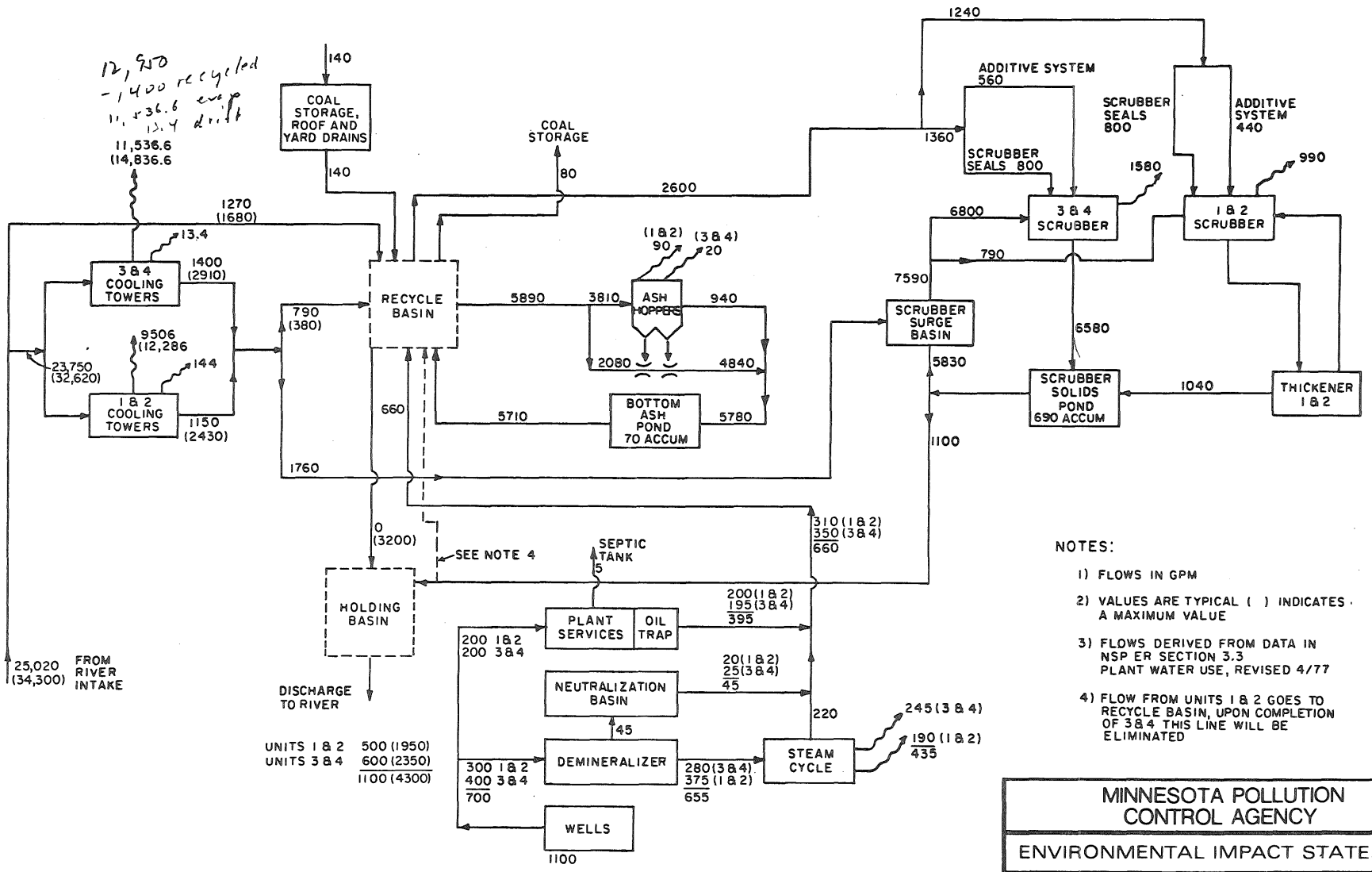
Intake System

The existing intake structure for Units 1 and 2, shown in Figure 3.3-5, will also serve Units 3 and 4. No additional construction will be required, although one 20,000 gpm pump will be added to the existing pump in each of the two intake bays. Four-unit operation will require an average inflow of 25,020 gpm and a maximum of 34,300 gpm.

Typical and maximum operation will require that only one pump be running in each bay at one time. The second pump will serve as backup. When the intake plate of one bay requires backwashing, both pumps in the other bay will be operated to supply the plant needs and the



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 3.3-3 Coal Transportation Route



NOTES:

1) FLOWS IN GPM
2) VALUES ARE TYPICAL ( ) INDICATES A MAXIMUM VALUE
3) FLOWS DERIVED FROM DATA IN NSP ER SECTION 3.3 PLANT WATER USE, REVISED 4/77
4) FLOW FROM UNITS 1 & 2 GOES TO RECYCLE BASIN, UPON COMPLETION OF 3&4 THIS LINE WILL BE ELIMINATED

MINNESOTA POLLUTION CONTROL AGENCY

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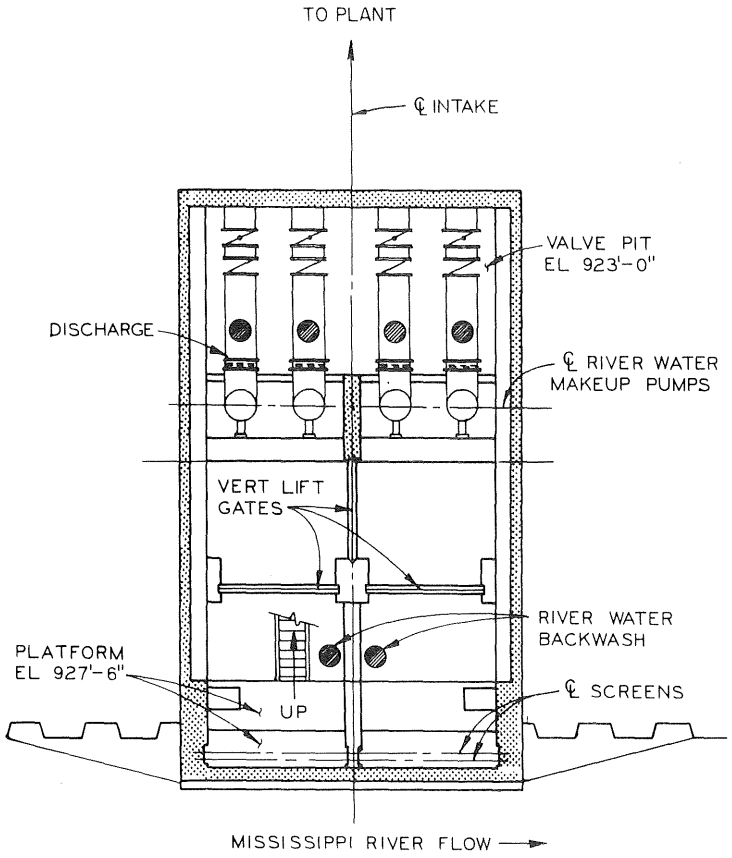
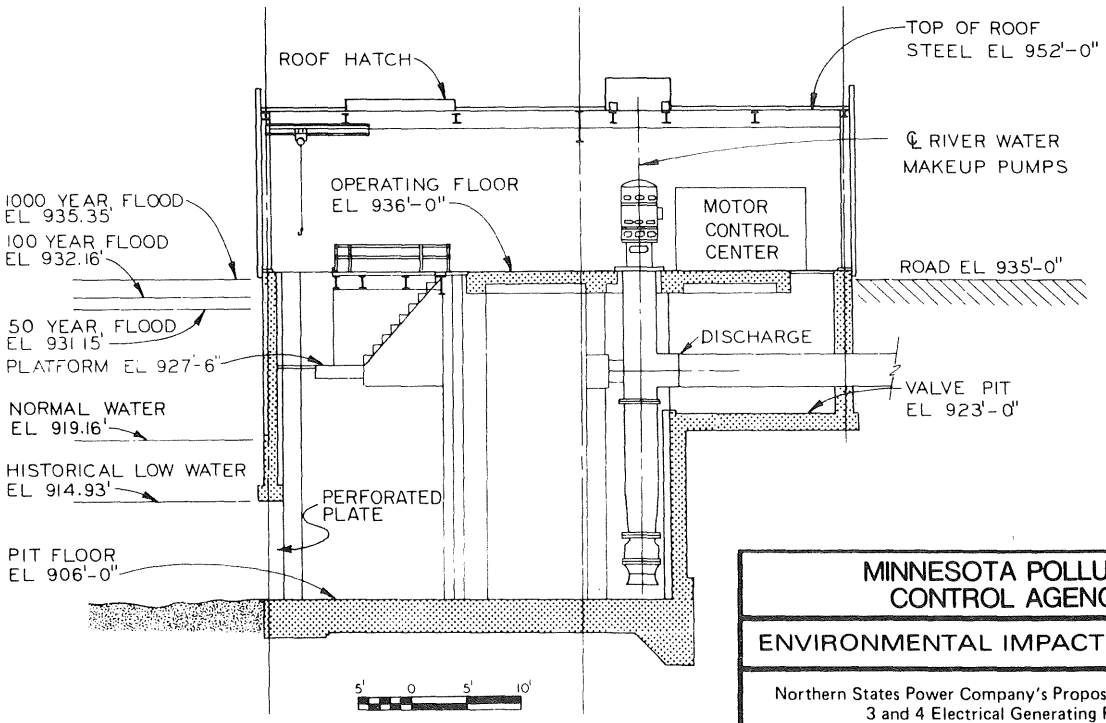
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 3.3-4

Power Plant Water Flow Diagram





MINNESOTA POLLUTION CONTROL AGENCY
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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 3.3-5 Cooling Water Intake Structure Profile

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excess will be used to provide backwash flow. Maximum flow into one bay will be less than 40,000 gpm. Approach velocities are tabulated as follows:

Flow into Bay	Approach Velocity
20,000 gpm	0.4 ft per second
40,000 gpm (two pumps in one bay)	0.8 ft per second

Approach velocity will occur within 1/2 foot of plate face.

Condenser Cooling Water System

Both Units 3 and 4 use a recirculating water system to convey waste heat from each steam condenser to its respective cooling tower. Makeup water to replace that lost by evaporation and drift is supplied via the river water intake structure. Blowdown is withdrawn from the recirculating water flow and discharged to the recycle pond.

Maximum recirculating water flow for each generating unit is 340,000 gpm. Total cooling tower blowdown for both Units 3 and 4 is typically 1,400 gpm with a maximum of 2,910 gpm. Drift from the cooling towers is specified to be 50 gpm per unit. This is less than 0.02% of the recirculating water flow rate and is consistent with generally accepted values for drift. Total evaporation is typically 11,500 gpm, with a maximum of 14,800 gpm.

Values for evaporation, drift and blowdown are based on an 100% generating rate, with typical and maximum values reflecting variations due to meteorological conditions. The plant capacity factor will be 56%, not 100%, and actual water use will vary as the capacity factor varies. However, it will be somewhat higher than 56% of the value at 100% generation.

The value for cycles of concentration for the Units 3 and 4 cooling towers at maximum generation is calculated to be 8.9.

Boiler Makeup Source and Treatment

Well water from the on-site system will supply the demineralizer system for Units 3 and 4, which supplies boiler makeup water for those units. The well water requirement is 400 gpm at maximum generation. Of this amount, 245 gpm goes to replace water lost in the steam cycle and 25 gpm is discharged as wastewater from the demineralizers. This wastewater goes to a neutralization basin and then to the recycle basin. Quantities of chemicals used to regnerate the demineralizers are tabulated as follows:

	Amount Per Regeneration (lb)	Regenerations Per Year	Amount Per Year (lb)
Acid (93% H_2SO_4)			
Primary Cations	2,052	210	430,920
Secondary Cation	1,072	7	7,504
Polishing Cation	1,072	4	4,288
Total Acid			442,712
Caustic (100% NaOH)			
Primary Anions	510	104	53,040
Secondary Anion	730	104	75,920
Polishing Anion	730	4	2,920
Total Caustic			131,880

Demineralized water is further purified by routing it through condensate polishers before adding it to the boiler steam cycle. The condensate polisher resins will be recharged about every two weeks and 580 lbs. of spent resin will be discharged to the recylce basin.

Boiler Blowdown

Chemicals added to the boiler water include sodium phosphate, ammonia and hydrazine. Boiler blowdown, amounting to 220 gpm, will have the following chemical characteristics: pH - 9.0 to 10.0; ammonia - 2 mg/l and phosphorus as P - 5 to 10 mg/l.

Bottom Ash Handling System

About 20% of the total coal ash resulting from coal combustion in the existing units is bottom ash. Water is used to transport (sluice) this from the ash hoppers to the bottom ash pond. Sluice water is returned to the recycle basin from the bottom ash pond.

The sluice water systems for Units 1, 2, 3 and 4 will be combined bottom ash is sluiced intermittently, usually at 5,890 gpm for all four units, of which a total of 110 gpm is lost by evaporation. A total of 5710 gpm is returned to the recycle basin from the bottom ash pond.

Fly Ash Handling and Scrubber System

Particulate material is removed in the first stage of the two-stage scrubber system, where a water spray is injected into the gas stream as the gas passes through a venturi. The liquid and entrained particulate material drop out of the flue gas stream as it leaves the venturi and collect in the limestone slurry. Fly ash that is not collected by the first stage is collected in the second stage, where SO_2 removal takes place. Some of the water that is used to scrub the particulates and SO_2 remains in the flue gas stream and is discharged out the stack. Some of the SO_2 scrubber sludge, containing particulate and SO_2 removed from the flue gas, must be removed as blowdown from the system. This blowdown is pumped to a thickener and then to the scrubber solids pond, where the solids settle. Water that is chemically and physically bound with the scrubber sludge will accumulate in the scrubber solids pond. Some of the supernatant is returned to the scrubber surge basin for re-use in the scrubber. The remainder goes to the holding pond for discharge to the river.

Since the scrubber system is a net user of water, it requires makeup. Makeup water for all four units will be taken from the recycle basin.

NSP has begun a monitoring program to determine the chemical characteristics at four points within the scrubber system of Units 1 and 2 in addition to the discharge from the holding pond. Results and sampling points are summarized as follows:

Sample Date March 16, 1977

	Discharge to Holding Basin	Thickener Overflow	Thickener Inlet	Thickener Underflow	Discharge to River
pH	6.6	6.7	6.2	7.25	7.7
Conductivity, Specific	3,870	6,180	6,120	529.0	3,710
Dissolved Solids, ppm	5,888	9,939	9,504	9,139	5,414
Suspended Solids	16.0 ppm	92.9 ppm	4.22% by wt.	18.06% by wt.	11.9 ppm
Nitrate, ppm	15.5	22.3	19.8	21	12.5
Sulfate, ppm	1,736	2,305	3,492	1,871	1,464
Fluoride, ppm	4.9	4.0	3.4	5.9	3.5
Temperature, °F	41	91	90	82	46
Magnesium as Mg^{++}, ppm	611.7	1,205.1	1,169	1,102	569.3

Miscellaneous Water Uses

Wells will provide service water for Units 3 and 4. Plant service water is used for such purposes as potable water; equipment and floor washing and cleaning of equipment water seals, coal car crusher and dumper building. Approximately 200 gpm will be used for Units 3 and 4, of which 5 gpm is disposed of in the septic system. The remainder is returned to the recycle basin after passing through an oil trap.

Equipment Cleaning Wastes

Power plant air preheaters, boiler fireside and economizers are usually cleaned periodically by water washing to remove built-up fly ash, sulfur contaminants and other contaminants which interfere with equipment operation and efficiency. Cleaning is usually done when a unit is shut down. Boiler chemical cleaning wastes result from cleaning the insides of boiler tubes to remove built-up scale. Typically, this is done about once every five years. The resulting waste contains pollutants which may include copper, iron, hardness, phosphates and suspended solids. These wastes are routed to the scrubber system for processing prior to discharge to the scrubber solids pond. Table 3.3-4 shows the quantities of chemicals used in various cleaning processes.

TABLE 3.3-4

EQUIPMENT CLEANING WASTES

	Concentrations of Cleaning Solutions	Quantities of Cleaning Chemicals	
		Pre Operational Cleaning (lb)	Maintenance Cleaning (lb)
ALKALINE CLEANING OF THE CONDENSATE-FEEDWATER SYSTEM			
Disodium Phosphate, as Anhydrous	1,000 mg/l	1,477	
Trisodium Phosphate, as Anhydrous	2,000 mg/l	2,955	
Non-foaming Wetting Agent	As Required		
Foam Inhibitor	As Required		
ACID CLEANING OF THE CONDENSATE-FEEDWATER SYSTEM			
Hydroxyacetic Acid	2.0%	21,697	
Formic Acid	1.0%	10,849	
Foam Inhibitor and Wetting Agent	As Required		
ALKALINE CLEANING OF THE STEAM GENERATOR			
Trisodium Phosphate, as $Na_3PO_4 \cdot 12H_2O$	2,500 mg/l	4,807	
Caustic Soda	2,500 mg/l	4,807	
ACID CLEANING OF THE STEAM GENERATOR			
Inhibited Hydrochloric Acid	5.0%	95,918	95,918
Ammonia Biflouride	0.25%	4,807	4,807
NEUTRALIZING BOIL OF STEAM GENERATOR			
Soda Ash	1.0%	19,184	

Rainfall runoff from plant roofs, the yard area, and the coal pile will be collected and routed to the recycle basin.

River Discharge System

The discharge from the holding pond flows by gravity through the effluent monitoring house and thence to the river via a 24-in. (61-cm) diameter pipe.

The discharge point is about 26 ft downstream of the river intake and the pipe elevation is 915 ft msl, which corresponds to the historic low river elevation at that point. Thus the discharge will be submerged at most river stages. The velocity of the discharge will range from 0.8 ft per second (fps) at 1,100 gpm to 3 fps at 4,300 gpm.

Although the typical predicted TDS levels in the plant discharge are 12,010 mg per liter, the dilution in the river is very rapid.

3.3.4 Air Quality Control Systems (AQCS)

Units 3 and 4 will be equipped with an emission control system in order to reduce stack gas emissions to within regulatory limits. The steam generators for Units 3 and 4 will be equipped with two-stage wet scrubbers which remove both particulates and SO_2. The additive for SO_2 removal will be either lime or limestone.

The wet scrubber specification requires that eight scrubber modules be provided for each unit, with full load operation being possible using any seven of the eight modules in service.

The first stage of a scrubber module is a venturi section which is designed to remove particulates. The second stage will employ a spray tower to remove SO_2. As the flue gas passes through the spray tower it is contacted with the slurry by means of spray nozzles in the gas stream. The SO_2 is absorbed by the spray water and reacts primarily with the additive and secondarily with the lime in the fly ash to form either calcium sulfite or calcium sulfate. The spray water with the absorbed SO_2 drains into the reaction tank, where the chemical reactions are allowed to go to completion before the slurry is recirculated to the spray tower. As the flue gas passes out of the spray tower, mist eliminators separate entrained moisture from the gas before it enters the reheater.

Design criteria in pounds per hour for the wet scrubber were provided as follows (NSP 1976):

	Entering Scrubber (lb/hr)	Leaving Scrubber
CO_2	1,829,000	1,829,000
O_2	466,000	466,000
N_2	6,479,000	6,479,000
NO_x (as NO_2)	5,800	5,800
Cl_2	300	300
SO_2	18,100	10,000
H_2O	638,000	980,000
Particulate	86,700	830
TOTAL	9,522,900	9,767,930

*Based on 20% excess air at 60% relative humidity and 80 F dry bulb (0.013 lb moisture per lb dry air). An allowance for a preheater leakage has also been included.

The schematic drawing of the Units 3 and 4 wet scrubber system is shown in Figure 3.3-6.

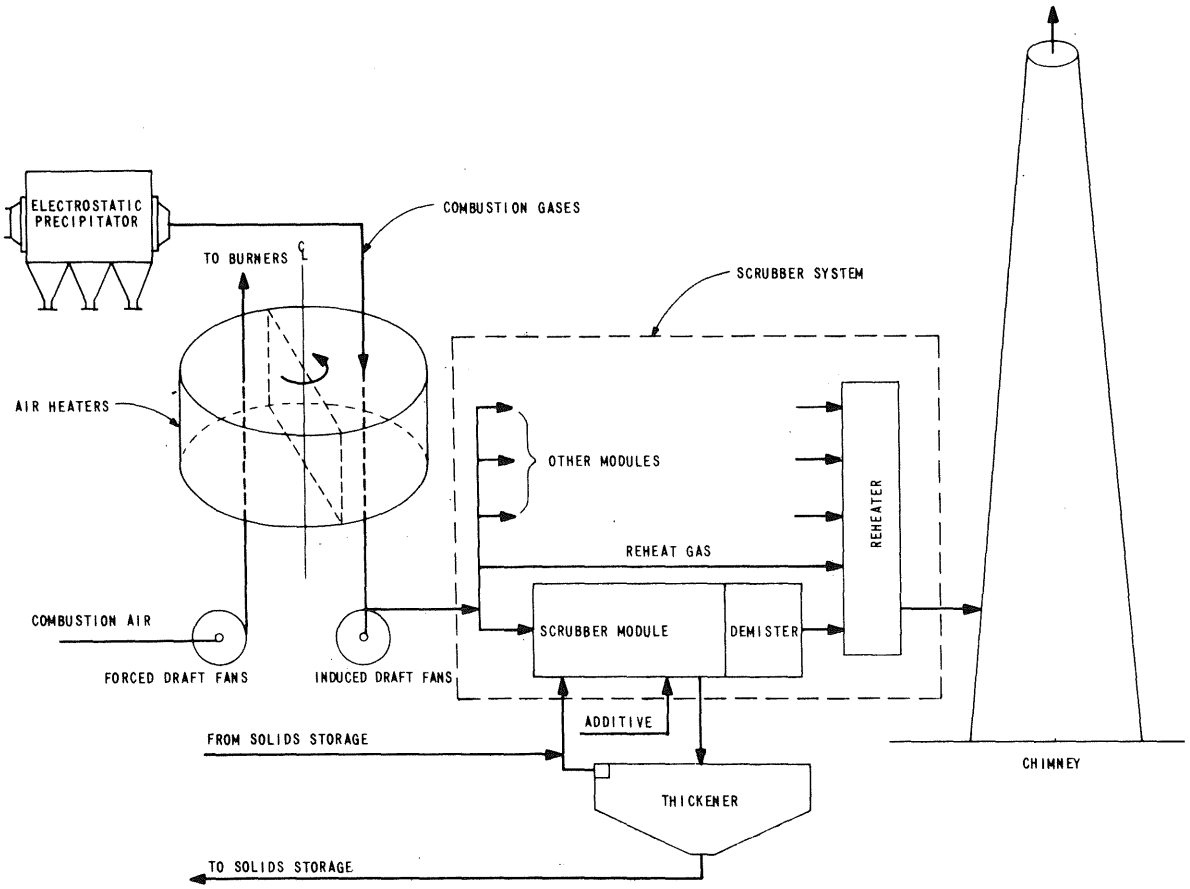
NO_x emissions will be controlled by incorporating dual-register burners (staged combustion), compartmented windbox for improved air distribution, and reduced furnace temperature into the steam generator design.

Products of combustion from Units 3 and 4 will be reheated from approximately 130°F to 170°F and discharged from a common 650 ft stack with an inside diameter of 35.4 ft.

3.3.5 Solid Waste Disposal System

Solid Waste Sources

The major sources of solid waste from Units 3 and 4 will originate as byproducts from the combustion of coal. One of the sources of solid waste will be the bottom ash, which is composed of heavy ash and slag which fall from the boiler furnace to a water-filled bottom ash hopper. This ash will be sluiced to the bottom ash pond by water from the recycle basin.



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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 3.3-6 Combustion Gas Cleaning System

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The rest of the ash, the fly ash, makes up about 80% of the total ash. The fly ash and the SO_2 formed during the combustion of sulfur in the coal will be entrained in the combustion stack gases. These constituents will be removed by a two-stage limestone scrubber. Scrubber solids and fly ash removed from the stack gas stream are pumped to the scrubber pond. The solids accumulate there and the supernatant is returned to the recycle pond. Some water becomes chemically and physically bound with scrubber sludge and fly ash, and is, therefore, retained in the scrubber pond.

Solid Waste Quantities

Units 3 and 4 will burn approximately 1,000 tons of coal per hour. Based on an average ash content of 11%, 110 tons of ash will be generated hourly. At a capacity factor of 57 percent, this is 1,500 tpd. Of the ash, 110,000 tpd (20%) will be bottom ash and 440,000 tpd (80%) will be fly ash. Since the removal efficiency of the two-stage scrubber is in the range of 99%, virtually all of the ash will require disposal.

The sulfur content of the coal will likely range from 0.4 to 1.3% with the average being 0.9%. Based on a complete conversion from sulfur to SO_2 during combustion, the average SO_2 produced hourly from each unit is 18,000 lb. The range would be 8,000 to 26,000 lb per unit. The New Source Performance Standards (NSPS) emissions limitation for sulfur is 1.2 lb per 10^6 Btu. Therefore, a maximum of 10,000 lb per hour can be discharged from the unit and an average of at least 8,000 lb per hour will be collected. This results in a total of 16,000 lb per hour from both units.

Limestone requirements, based on a 150% stoichiometric feed rate and a purity of 90%, would be approximately 42,000 lb per hour. At a 57% load factor, this would be 105,000 tpy. Scrubber sludge and fly ash quantities generated from emissions control are shown in Table 3.3-5, which also estimates the composition of scrubber wastes. The actual composition will depend on coal characteristics, scrubber design, operating characteristics and efficiency obtained.

TABLE 3.3-5

BASIC DATA FOR SOLID WASTE QUANTITY CALCULATION, UNITS 3 AND 4

Coal Characteristics	
Ash Content	10.8%
Bottom Ash Percentage	20%
Fly Ash Percentage	80%
Sulfur Content	0.9%
Plant Characteristics	
Generating Capacity	800 Mw per unit
Net Heat	10,400 Btu/kwh (5,780 kg-cal per kwh)
Capacity Factor	65% (first 15 years)
	55% (next 5 years)
	50% (last 15 years)
Particulate Removal Efficiency	99%
Sulfur Dioxide Removal	Not to exceed 1.2 lb per 10^6 Btu (2.2 kg per 10^6 kg-cal heat input)
Solid Waste Quantities	
Bottom Ash	
Hourly Rate	22 tph (20 mtph)
Annual Rate	123,000 tpy (112,000 mtpy)[a]
Life of Plant	3.8 x 10^6 tons (3.4 x 10^6 mt)[b]
Scrubber Sludge (includes fly ash)[c]	
Hourly Rate	117 tph (106 mtph)
Annual Rate	664,000 tpy (602,000 mtpy)[a]
Life of Plant	20.4 x 10^6 tons (18.5 x 10^6 mt)[b]
Volume over Life of Plant	2.54 x 10^7 yd^3 (1.95 x 10^7 m^3)[b,d]

[a]Based on 65% capacity factor.

[b]Based on levelized capacity of 57% for 35 years.

[c]Based on production of 3.1 pounds of SO_2 sludge per pound of SO_2 removed.[1]

[d]Calculated average density of 59.4 lb/ft^3 (951 kg/m^3)

[1]Twin City Testing Inc., July 18, 1975, Northern States Power Company Black Dog Plant Fly Ash Lagoon, St. Paul, Minnesota.

Disposal Method

The bottom ash from all units is disposed of in the bottom ash pond after being sluiced from the bottom ash hoppers by water from the recycle basin. The bottom ash remains in the pond and the clarified supernatant is pumped back to the recycle basin. The bottom ash pond is approximately 20 acres in size and has an 18-inch clay liner. This pond has sufficient capacity to provide storage through 1983. Additional storage will be constructed adjacent to the existing pond. This pond, which will be 60 acres in size, will provide bottom ash storage for the life of all four units.

The scrubber sludge from Units 3 and 4 is sluiced from the scrubber to the scrubber solids pond. The sluice water for this operation is continuously recycled between the pond and the scrubber.

Effluents from Disposal Site

The scrubber sludge and bottom ash from Units 3 and 4 are to be disposed of with the solid waste from Units 1 and 2 in large disposal ponds adjacent to the plant. These ponds also have an 18-inch clay liner on the bottom and embankments with central clay cores.

3.4 Emission, Effluents and Waste Production

3.4.1 Air Emissions*

Air emission sources associated with Units 3 and 4 include the combustion process, operation of the cooling towers, transfer of coal and venting processes.

Units 3 and 4 Stack Emissions

Particulate emissions from Units 3 and 4 will be limited by MPCA regulations to 0.1 lb per million Btu, NO_x emissions to 0.7 lb per

*In calculating emissions, effluents and solid waste rates a levelized capacity factor of 57% over a 35-year life was assumed unless otherwise noted.

million Btu and SO_2 emissions to 1.2 lb per million Btu. State emission limitations for particulates, NO_x and SO_2 are identical to the New Source Performance Standards promulgated by the EPA. Also, the federal regulations mentioned above limit opacity to 20% for new sources, except for periods of start-up, soot blowing and malfunctions, during which up to 40% opacity is allowed for two minutes during any 60-minute period.

Particulate, SO_2 and NO_x stack emissions from Units 3 and 4 have been estimated in Table 3.4-1. Sulfate and heavy metals emissions are not presently regulated. However, emission estimates for these items are shown in Table 3.4-2. Compliance with the opacity regulations has been a problem with Units 1 and 2 and may be a problem with Units 3 and 4 due to the similarity in design.

Cooling Tower Emissions

There are no existing MPCA regulations limiting emissions from the cooling towers. However, cooling towers contribute three principal emissions (in addition to heat) to the atmosphere. They are water vapor, drift (mist) and salts. Based on a TDS level of 2,075 mg per liter in the circulating water flow for all four cooling towers, calculated quantities of salt drift from each tower are shown in Table 3.4-3.

TABLE 3.4-3

CALCULATED WATER AND SALT DRIFT - UNITS 1-4 COOLING TOWERS

	Water Drift		Salt Drift
	gpm	lb per hr	lb per hr
Unit 1	72	36,048	74.8
Unit 2	72	36,048	74.8
Unit 3	6.7	3,342	6.9
Unit 4	6.7	3,342	6.9

TABLE 3.4-1

POWER PLANT EMISSIONS

	Unit 1 or 2 (Per Unit)	Total for Units 1 & 2	Unit 3 or 4 (Per Unit)	Total for Units 3 & 4
Full load electrical output, gross Mw/net Mw	756/698[1]	1,490/1,396	860/800	1,720/1,600
Heat input rate, Btu per hr x 10^6[2]	7,259	14,518	8,320	16,640
Fuel consumption rate, lb per hr[3]	875,000	1,750,000	1,002,400	2,004,800
Products of combustion to scrubber:				
Mass flow rate, lb per hr[4]	7,998,000	15,996,000	9,162,000	18,324,000
Volume flow rate, Acfm	2,410,000	4,820,000	2,761,000	5,522,000
Temperature, °F.	265	265	265	265
From scrubber:				
Mass flow rate, lb per hr	8,294,000	16,588,000	9,500,000	19,000,000
Volume flow rate, Acfm	2,267,000	4,534,000	2,625,000	5,250,000
Temperature, °F.	163	163	170	170
Emissions at full load:				
Particulate, lb per hr	632[8]	1,264	832[5]	1,664
SO_2, lb per hr	7,017[9]	14,034	9,984[6]	19,968
NO_x, lb per hr	7,767[10]	15,534	5,824[7]	11,648

Footnotes:

(1) Maximum summer rating.
(2) Assumes 10,400 Btu per kWh net plant heat rate.
(3) Fuel consumption rate based on 8,300 Btu per lb.
(4) Assumed products of combustion per lb of fuel ratio in 9.14 (approximately 20% excess air plus 5% air heater leakage).
(5) Based on MPCA maximum allowable emission rate of 0.1 lb per million Btu.
(6) Based on MPCA maximum allowable emission rate of 1.2 lb per million Btu.
(7) Based on MPCA maximum allowable emission rate of 0.7 lb per million Btu.
(8) Based on permit requirement of 0.08766 per million Btu - confirmed by test.
(9) Based on permit requirement of 0.9666 per million Btu - confirmed by test.
(10) No permit requirement except for unit to be equipped with overfire air. Assume uncontrolled NO_x emission rate of 1.07 lb per 10^6 Btu. No final test run to date but preliminary test showed actual emissions in 0.7 to 0.8 lb per million Btu range.

TABLE 3.4-2

MAXIMUM ESTIMATED ATMOSPHERIC EMISSIONS OF TRACE ELEMENTS AND SULFATES FROM EXISTING AND PROPOSED UNITS

(pounds per hour)

Trace Element	Maximum Atmospheric Emissions	
	Units 1 or 2	Units 3 or 4
Antimony	0.26	0.30
Arsenic	0.88	1.03
Barium	18.53	21.80
Beryllium	0.12	0.14
Boron	0.51	1.78
Cadmium	0.07	0.08
Chlorine	1515.94	1783.46
Chromium	1.63	1.92
Copper	1.35	1.59
Fluorine	42.11	49.54
Germanium	2.06	2.42
Lead	3.07	3.61
Manganese	14.31	16.84
Mercury	0.12	0.14
Molybdenum	0.60	0.71
Nickel	1.10	1.29
Selenium	0.63	0.74
Silver	0.010	0.011
Sulfates*	10.54**	12.40**
Uranium	0.12	0.14
Vanadium	1.85	2.18
Zinc	9.77	11.49

*Based on emission factor of 0.5 times fuel % Sulfur = lbs of SO_3 per ton coal burned. Maximum fuel sulfur of 1% assumed.
**50% of emission should be non-acid sulfates due to scrubber.

Note: Emissions based on a maximum boiler heat input, a minimum coal heating value of 8397 Btu per lb, maximum trace element concentrations, and application of trace element concentration factors, and reduced control efficiencies. Percent collection control was assumed to be 95% for trace metals, 10% for gases (Chlorine and Mercury), and 50% for those trace elements released as part gas, part mist (Fluorine and Selenium). If trace metals are attached to flue gas fly ash, used the scrubber total particulate efficiency of 99 percent for trace metals.

Other Emission Sources

Potential sources of fugitive dust at the SHERCO site are the coal handling system, traffic on unpaved roads, land areas without vegetative cover and the coal storage area. A number of problems have been cited by MPCA with respect to fugitive dust. The potential for fugitive dust emissions will increase as a result of the addition of Units 3 and 4. In addition, construction of Units 3 and 4 could cause an increase in fugitive dust emissions.

3.4.2 Wastewater Effluent

The addition of Units 3 and 4 will result in a slight modification to the wastewater flow diagram. All makeup water will be taken from the recycle basin instead of the holding basin as at present. The discharge flow and quantities of chemicals will increase proportionally, although there are significant differences in water use between the existing and proposed units. It is important to note that the information in NSP's Environmental Report on water consumption was based on 100% generation. The capacity factor for the initial years of plant operation is projected to be 65%. The processes in the plant which use water and generate wastewater are directly affected by plant generating rate. A reduction in generation will generally result in lower water consumption and generation of less wastewater. A reasonable estimate would be to use 75% of the water wastewater values for a 100% generation rate when the actual generation rate is 65% of maximum. Table 3.4-4 includes estimated discharge levels for plant operation at a 65% capacity factor.

The validity of the projected concentrations of parameters can best be established by analyses of effluent from the existing units, combined with consideration of any characteristics of the proposed new units. Available monitoring results do not include all the parameters listed in Table 3.4-4. However, they do include sulfates/sulfites and TDS. Considering that the monitoring was done when only one unit was operational, the measured quantities of chemicals in the discharge should be one-fourth the projected values for all four units.

Numbers for other parameters are not available. However, TDS values are significant since they are the sum of all dissolved constituents in the discharge.

TABLE 3.4-4

ESTIMATED EFFLUENT CHARACTERISTICS -- UNITS 1-4

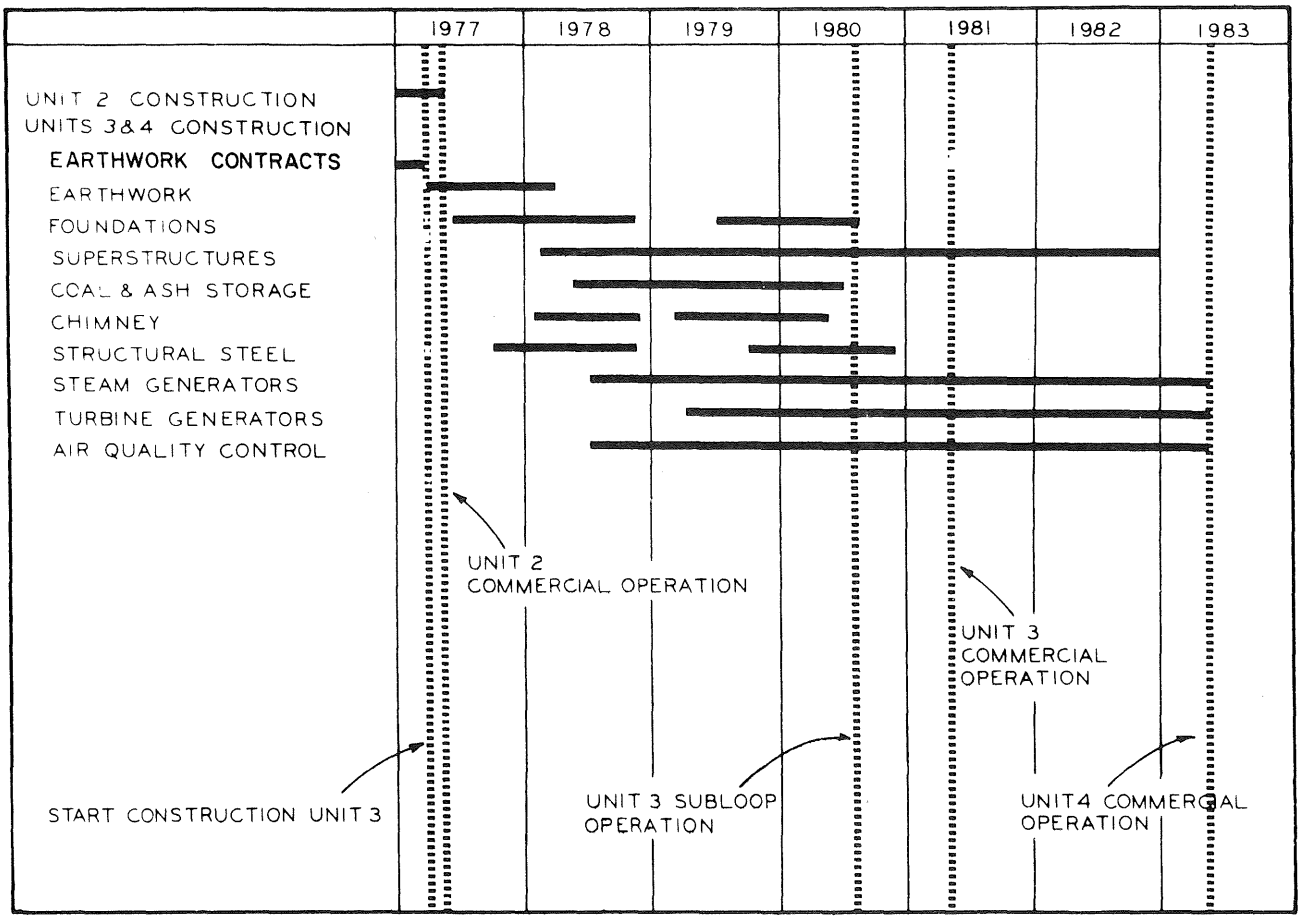
Parameter	Concentration (mg/l), Typical Effluent Discharge	100% Generation lb/day	100% Generation kg/day	65% Generation[1] lb/day	65% Generation[1] kg/day	Concentration (mg/l), Maximum Effluent Discharge	100% Generation lb/day	100% Generation kg/day
Calcium (Ca)	500	6,610	3,000	4,960	2,250	396	20,470	9,280
Magnesium (Mg)	1,960	25,920	11,750	19,440	8,810	607	31,370	14,230
Sodium (Na)	160	2,120	960	1,590	720	75	3,880	1,760
Bicarbonate (HCO_3)	30	400	180	300	135	156	8,060	3,660
Sulfate (SO_4)	9,040	119,520	54,200	89,640	40,650	3,221	166,480	75,500
Chloride (Cl)	100	1,320	600	990	450	52	2,690	1,220
Nitrate (NO_3)	60	790	360	590	270	38	1,960	890
Silia (SiO_2)	160	2,120	960	1,590	720	78	4,030	1,830
Total Dissolved Solids	12,010	158,790	73,010	119,090	54,010	4,623	238,940	108,360
SHERCO Discharge	1,100 gpm (69.40 l/sec)					4,300 gpm (271.29 l/sec)		

[1]Values are 75% of typical values at 100% generation.

3.5 Units 3 and 4 Construction

The proposed plant is scheduled to provide power on a commercial operating basis from Unit 3 in May of 1981 and from Unit 4 in May of 1983. Figure 3.5-1 indicates the general schedule of construction activities proposed by NSP. This schedule calls for commencement of earthwork and foundations early in 1977, with building construction beginning early in 1978, and major equipment construction beginning in mid-1978.

The schedule requires construction manpower and equipment at the site beginning in early 1977, continuing through the commencement of commercial operation of Unit 4 in 1983. Manpower required at the site will peak during the completion of equipment erection and installation of the piping and wiring. A separate construction peak is expected for each of the two units.



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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 3.5-1 Schedule of Major Construction Activities - SHERCO Units 3 and 4

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3.9 List of References

Gordon, L.P., Northern States Power Company, to G. L. Bird, R.W. Beck and Associates, February 2, 1977, private communication.

NSP (Northern States Power Company), Load Model for Sherburne County Unit 3.

NSP (Northern States Power Company), 1976. Sherburne County Generating Plant Units 3 and 4 Environmental Report.

4. DESCRIPTION OF ENVIRONMENT

4.1 Land Use

4.1.1 Existing Land Uses

Site and Adjacent Area

Existing land use conditions within five miles of the stack location proposed for SHERCO Units 3 and 4 are depicted in Figure 4.1-1. Land uses were identified through interpretation of aerial photographs taken by Mark Hurd Aerial Surveys, Inc. (Minneapolis) in May 1975. Data verification, or the establishment of "ground truth," was accomplished through field checks conducted on February 8-10, 1977. Table 4.1-1 shows the distribution of land uses by activity category for both the SHERCO site and the adjacent area. The land use category, "Agriculture," refers to actively cultivated land, as well as land lying fallow either for nutrient regeneration or for soil banking purposes.

The land use map outlines the existing SHERCO site as well as the additional land area required for Units 3 and 4. The existing site occupies approximately 1,700 acres, 630 of which are devoted to the physical plant facilities and ancillary activities. The remaining 1,070 acres are predominantly agricultural, though little is actively cultivated at present. A small portion of the site along the river is forest land.

Most of the equipment required for the proposed additional generating units is to be placed within the confines of the existing plant site. Approximately 320 additional acres will be required to accommodate the plant's waste disposal. The map indicates that this 320-acre expansion area is agricultural land. According to NSP officials, the northern half of this proposed expansion area is actively farmed and irrigated, while the southern half lies fallow. With the addition of this expansion area to the existing plant site, the total site land area will be approximately 2,020 acres, or 3.2 square miles.

Although the SHERCO site is located within the political jurisdiction of the City of Becker, the plant's power block and stack would be about three-quarters to one mile away from the majority of the city's

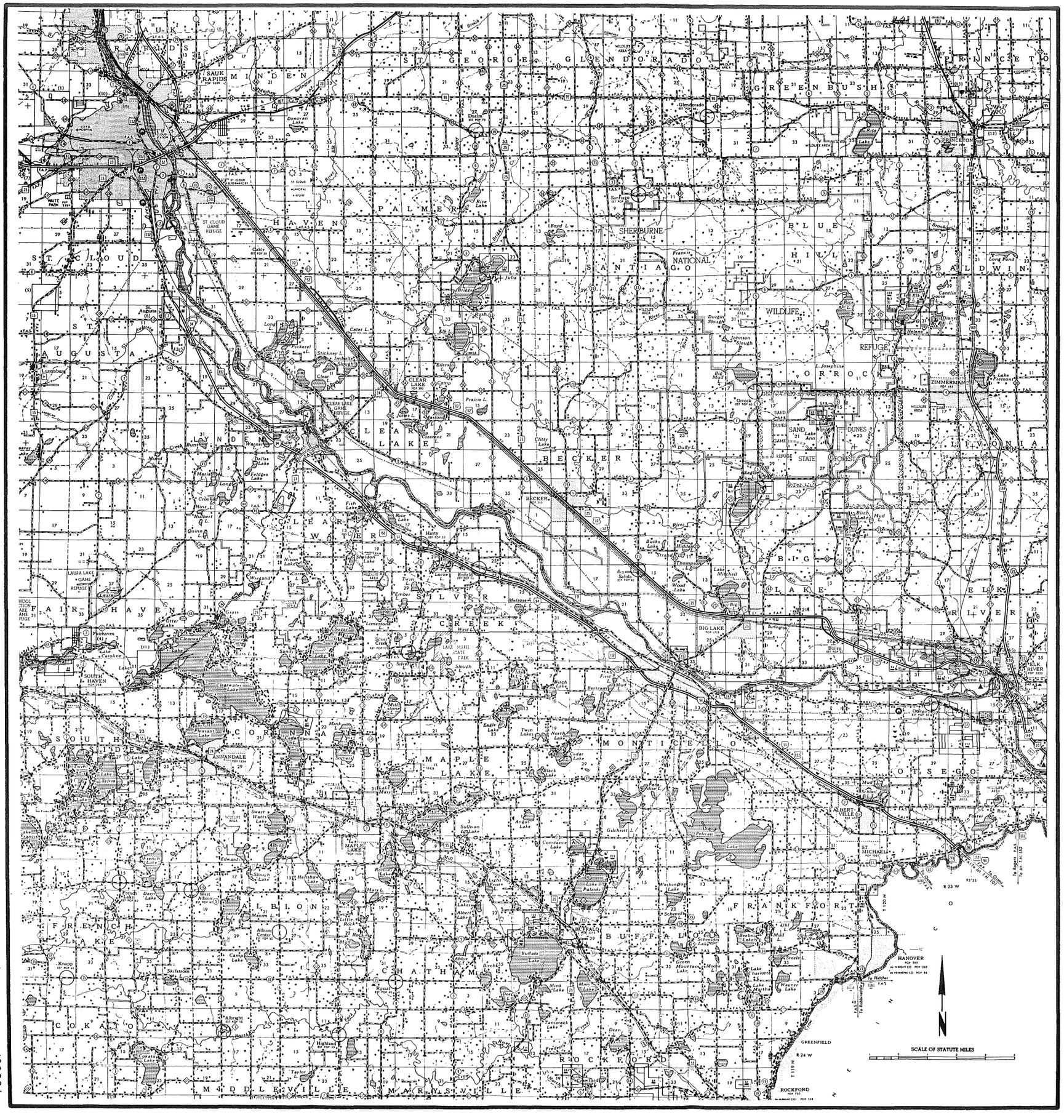

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Figure 4.1-1 General Land Use Map

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TABLE 4.1-1

SITE AND ADJACENT LAND USES, 0-5 MILES

	Site Area						Adjacent Area					
	Existing Site		Site Addition		Total Site		Sherburne Co.		Wright Co.		Adjacent Total	
Land Use	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Forest Land	175	10.3	0	0.0	175	8.7	6,943	23.3	5,905	32.0	12,848	26.6
Agriculture	895	52.6	320	100.0	1,215	60.1	19,763	66.3	8,995	48.8	28,758	59.6
Fields & Grassland	0	0.0	0	0.0	0	0.0	1,108	3.7	977	5.3	2,085	4.3
Water	0	0.0	0	0.0	0	0.0	1,414	4.7	1,583	8.6	2,997	6.2
Wetlands	0	0.0	0	0.0	0	0.0	46	0.2	40	0.2	86	0.2
Rural Settlement	0	0.0	0	0.0	0	0.0	130	0.4	80	0.4	210	0.4
Commercial	0	0.0	0	0.0	0	0.0	25	0.1	0	0.0	25	0.1
Industrial	630	37.1	0	0.0	630	31.2	36	0.1	95	0.5	131	0.3
Extractive	0	0.0	0	0.0	0	0.0	0	0.0	23	0.1	23	0.1
Recreation	0	0.0	0	0.0	0	0.0	0	0.0	58	0.3	58	0.1
Transportation	0	0.0	0	0.0	0	0.0	355	1.2	669	3.6	1,024	2.1
Total	1,700	100.0	320	100.0	2,020	100.0	29,820	100.0	18,425	100.0	48,245	100.0

SOURCE: Interpretation of May 1975 aerial photographs taken by Murk Hurd Aerial Surveys, Inc., Minneapolis, Minnesota.

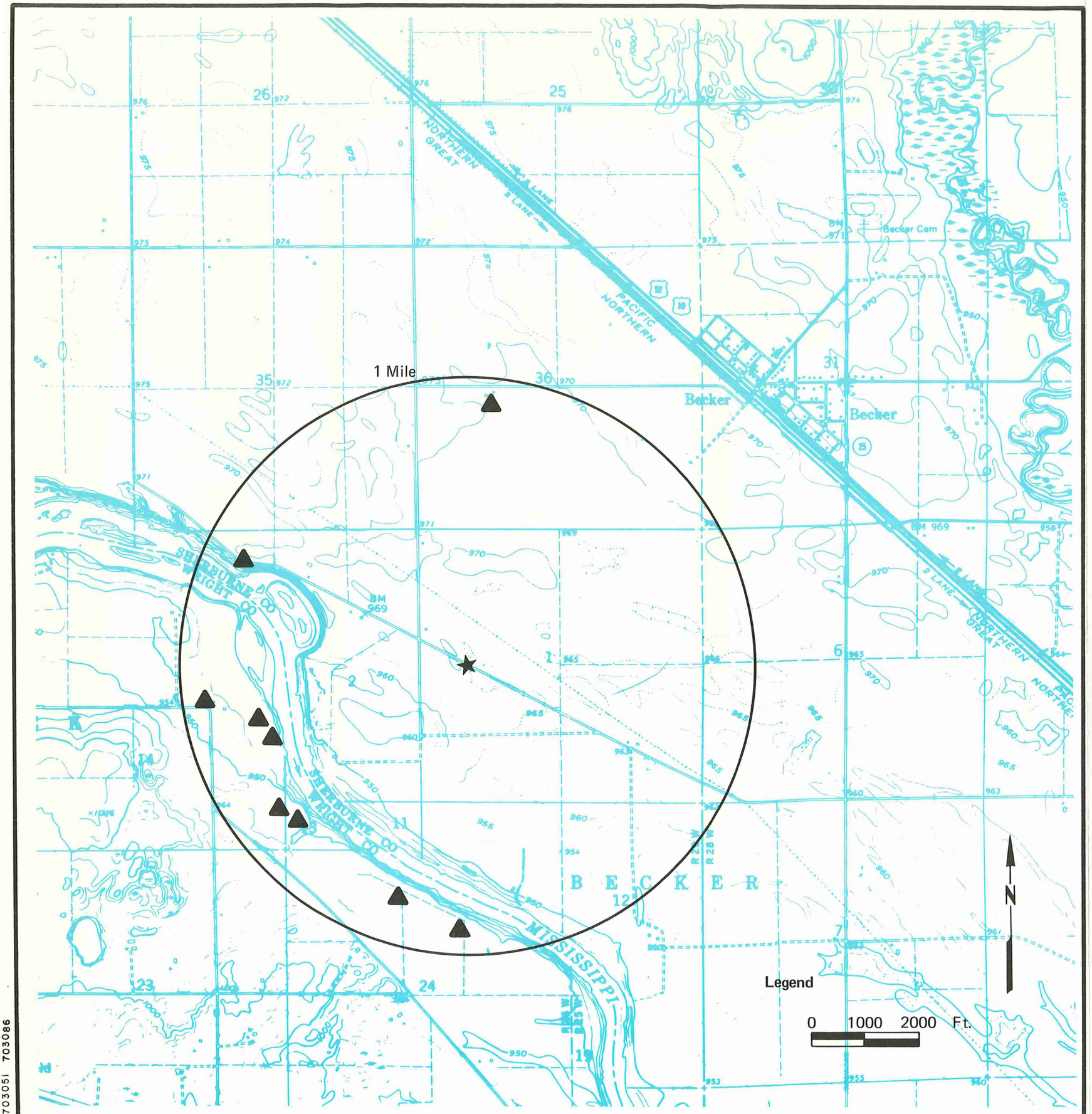
residences and businesses. A strip commercial district, which includes an auto dealership, gas stations, liquor stores, cafes, a laundromat, a fruit stand and a propane distributorship is situated along the north side of U.S. Highway 10. Beyond the commercial district lies the interior of the city. Residential dwellings predominate in this latter area with limited institutional, commercial and governmental activities situated along Main Street (ERT Field Summary 1977).

An inventory was also conducted of residences within one mile of the proposed stack location. Figure 4.1-2 illustrates this one-mile area and indicates the location of the nine houses, found through field surveys conducted on February 9 and March 11, 1977. There are two occupied dwellings in the Sherburne County portion of the one-mile area (one in Becker Township and one in Becker City) and seven in Wright County (all in Silver Creek Township). Based on average occupancy rates for the city and town of Becker (3.15 and 3.98 persons per dwelling unit, respectively) and for the township of Silver Creek (2.57 persons per dwelling unit) (U.S. Bureau of Census 1970), there is an estimated population of 25 persons residing within one mile of the proposed stack location.

The other lands within five miles of the site include portions of both Wright and Sherburne Counties. Nearly half of the adjacent area in Wright County is dedicated to agriculture; an additional 32% is forest land. Only 1% of this land area is in residential, commercial or industrial use. The majority (62%) of the adjacent land area is located in Sherburne County. The distribution of land uses in this county are similar to those found in neighboring Wright County, with the predominant uses being agriculture (66%) and forest land (23%). According to county officials, the primary agricultural crops grown in the Becker area are potatoes, corn, alfalfa and rye (Harju 1977, and Matz 1977).

Regional Land Use

Two published land use maps were reviewed to establish the general character of land use in the larger region. The Central Minnesota Regional Development Commission (CMRDC) recently prepared a map entitled, "Central Minnesota Area Generalized Land Use (1976)." The Central



Dwelling Unit
SHERCO Site Center

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.1-2

Residences within one mile of Proposed Stack Location

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Minnesota region consists of Sherburne, Wright, Stearns and Benton Counties. This land use map indicates that the predominant activity in the region is agriculture, with urban settlements and public recreation and open space scattered throughout the area.

A more detailed statistical examination of existing land uses is found in a 1969 map entitled, "State of Minnesota Land Use," prepared by the University of Minnesota's Minnesota Land Management Information System (MLMIS). The MLMIS data indicates a pattern of regional land use similar to the conditions depicted in the more recent CMRDC map. The data show that intensive agricultural activities (cultivated) occupy nearly 50% of the 2,983 square mile region, with less intensive agricultural use (pasture and open fields) taking place on nearly 30% of the region's land area. Approximately 13% of the region is forest land and less than 4% of the region's land is devoted to residential, industrial, commercial and transportation activities.

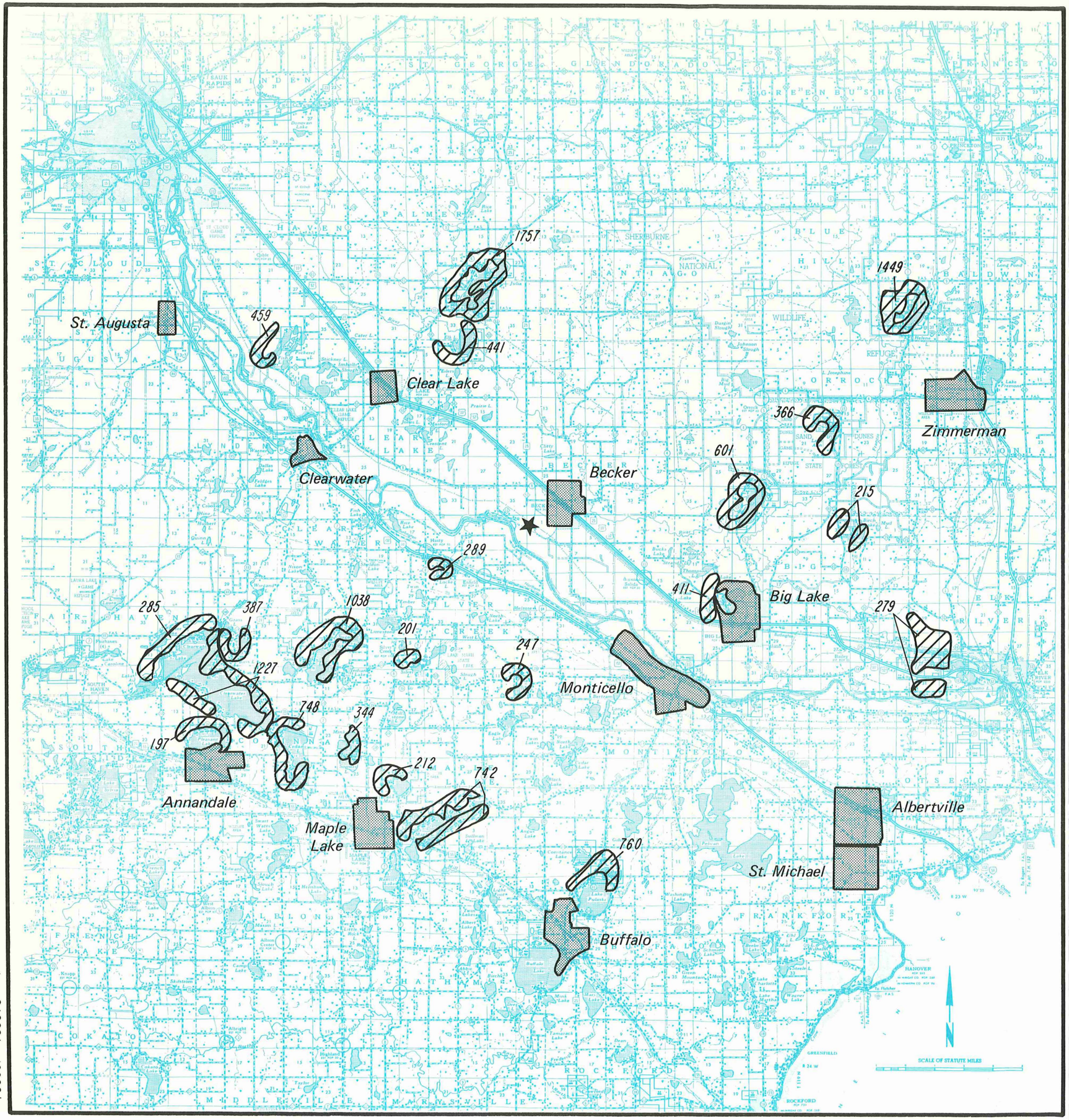
4.1.2 Regional Population Centers and Concentrations

The major population centers within 15 miles of the SHERCO site are identified in Figure 4.1-3, along with other areas having significant population concentrations. This latter group primarily consists of populations situated along various lakeshores in the region.

Twelve regional population centers are located within the study region. These cities range in size from approximately 244 persons (St. Augusta in Stearns County) to over 4,000 (Buffalo in Wright County). These regional centers have an estimated total population of nearly 14,700.

The nearest population center to the proposed stack location is the City of Becker. Although the NSP site is situated within the incorporated boundaries of Becker, the majority of the city's population reside on the opposite side of U.S. Highway 10 and 52, approximately 3/4 mile east-northeast of the stack location. Becker has an estimated current population of 517 (Alfords 1977).

Other population concentrations are found throughout the study region, though primarily along the shores of the various lakes in the area. The identification of these lakeshore populations were derived



Population Centers
(xxx) Estimated Populations

Becker (517)
Clear Lake (316)
Big Lake (2043)
Zimmerman (675)
Monticello (1786)
Clearwater (298)
St. Augusta (244)
Annandale (1465)
Maple Lake (1258)
Buffalo (4092)
Albertville (531)
St. Michael (1416)

Other Population Concentrations
(xx) Estimated Peak Population

SHERCO Site Center

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.1-3

Regional Population Coordinate

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from 1970 dwelling unit estimates developed by the University of Minnesota in its study entitled, Minnesota's Lakeshore (Borchert 1970). For the most part, the population concentrations around the lakes in the region are seasonal. The 22 lake areas identified support a total seasonal population of over 9,500 and a year-round population of a little more than 3,100. Together, the peak population along these lakes during the summer months is in the vicinity of 12,600. The lakeshore population concentration nearest to the proposed stack location is situated along Locke Lake in Wright County, approximately three miles to the west-southwest.

4.1.3 Applicable Land Use Plans and Ordinances

Interviews with public officials and a review of various public documents indicated that there are two land use plans and one zoning ordinance applicable to the project site: (1) Minnesota Regulation NR 2400 (Scenic and Recreational Land Use Districts); (2) The City of Becker Comprehensive Plan and (3) The City of Becker Zoning Ordinance. In addition, a portion of the expansion area is considered "unique farmland" by the U.S. Soil Conservation Service (Diedrick 1977). There is no applicable state or regional land use plan (Yaeger 1977). The Sherburne County Comprehensive Plan and Zoning Ordinance does not apply to the SHERCO site since it is situated within the corporate boundaries of Becker (Alfords 1977). A review of the state's Outdoor Recreation Plan revealed that there are no recreation facilities proposed for the planned expansion area (Minnesota State Comprehensive Outdoor Recreation Plan 1974).

Minnesota Regulation NR 2400

A portion of the SHERCO site has been designated by the Commissioner of Natural Resources as constituting protected land under the State's Wild, Scenic, and Recreational Rivers System Management Program (Minn. Reg. NR 2400). Although the state has ruled that power generation facilities at the NSP site are permitted within this land use district, certain restrictions are still applicable as they relate to the "preservation, protection, and management of the river." These standards are

enumerated in Minn. Reg. 78 and include dimensional and siting restrictions, vegetative cutting provisions and specifications regarding transmission line crossings.

City of Becker Comprehensive Plan and Zoning Ordinance

The city's comprehensive plan delineates the area north of U.S. Highway 10 as the location where residential and related support services will take place, while the land area south of this roadway is designated industrial and agricultural (Sanger 1977). The SHERCO site, including the proposed 320-acre expansion area to the east, is designated heavy industrial (Sanger 1977). The City of Becker's new zoning ordinance classifies the entire SHERCO site, including the 320-acre expansion area as "industrial power generation" (Sanger 1977).

Unique Farmland Designation

According to Mr. Raymond Diedrick, Soils Specialist with the U.S. Soil Conservation Service, none of the SHERCO expansion area is considered "prime" farmland (1977). However, the northern half of this 320-acre area is considered "unique" farmland since it is composed of soils currently used to grow specialty crops through irrigation (Soil Survey: Sherburne County, Minnesota 1968). If irrigation were not employed, the farmland would not be classified as unique due to the general limitations associated with agricultural use of these soils. In Minnesota "unique farmland" identifies agricultural areas where the management of the land overrides the inherent soil limitations (Diedrick 1977).

4.1.4 Baseline Aesthetic Conditions

General Visual Quality of the Area

The visual quality of the area around the SHERCO site is influenced by the topographic conditions that characterize this region of Minnesota, as well as by the obvious man-made modifications to this area's landscape. For the most part, the land around the SHERCO site is flat to gently rolling with topographic relief at a minimum. Furthermore, the

majority of the land is used for agriculture. As a result, the landscape around Becker generally affords panoramic views; there are few features to block views of background objects.

Since the landscape in the region may be characterized as generally open, and since topographic relief is at a minimum, large scale man-made modifications are difficult to integrate into the landscape. Such is the case with the existing SHERCO facilities. The inherent physical characteristics of SHERCO Units 1 and 2 (or for that matter any large electrical generating station), particularly in terms of scale, provide a strong visual image on the surrounding landscape, which is noticeable from several miles away.

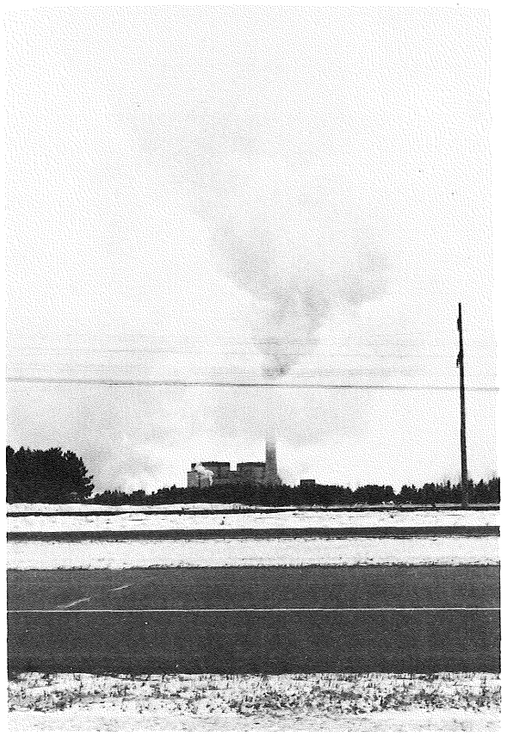
Views to the Site

Figure 4.1-4 presents representative views of the existing SHERCO facilities from nearby locations. These photographs were taken from between 3/4 and 1-3/4 miles away. Within about 2 miles of the plant facilities, there is a maximum discernment of detail, scale and color.

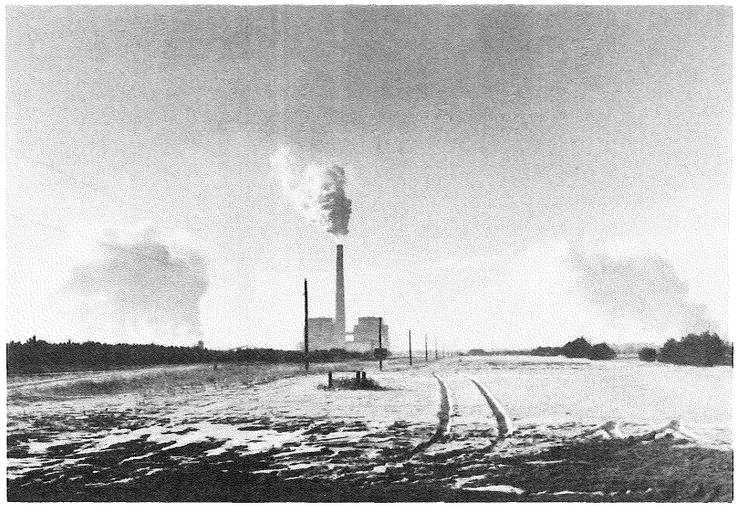
Figure 4.1-5 shows photographs taken from between three and five miles away. From these distances, the only visible parts of the existing facility are the stack and vapor plumes. The lower physical structures are not generally indentifiable. From these middle distances, the existing power plant becomes less obtrusive upon the regional landscape, as the difference in scale between the power plant and the surrounding area is diminished. At distances beyond seven miles, the plant stack and vapor plume tend to blend into the background pattern of the landscape. The shape of the vapor plume and stack become simplified outlines with no apparent texture or detail. During warmer weather when the vapor plume is less dense, the plant stack may not be readily discernable at these longer distances.

Visually Sensitive Land Uses

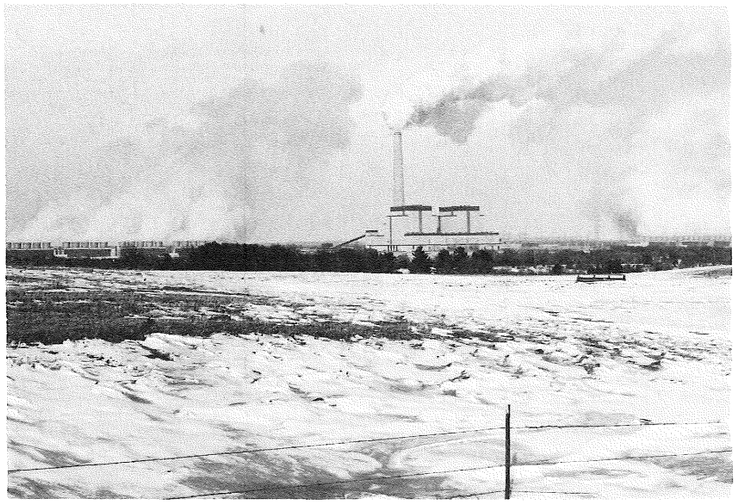
An inventory was conducted of visually sensitive land uses within a 15-mile radius of the proposed stack location for SHERCO Units 3 and 4. Subsequent field investigations showed that the plant's viewshed, or the



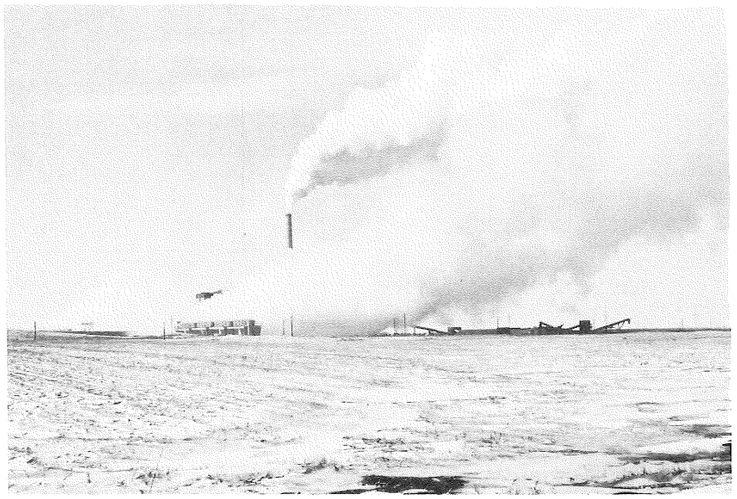
Photograph No. 1



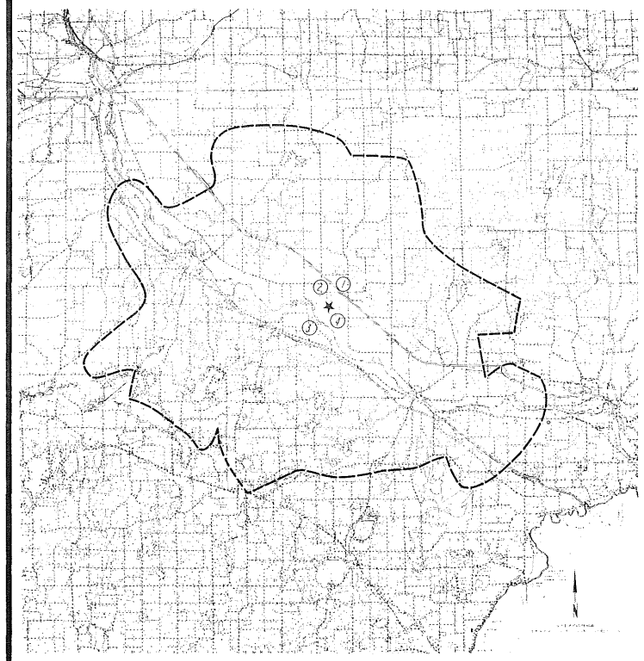
Photograph No. 2



Photograph No. 3



Photograph No. 4



Photograph No. 1	1 1/3 miles NE
Photograph No. 2	1 1/2 miles N
Photograph No. 3	1 3/4 miles SW
Photograph No. 4	3/4 miles SSE

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Figure 4.1-4

Views to the Site

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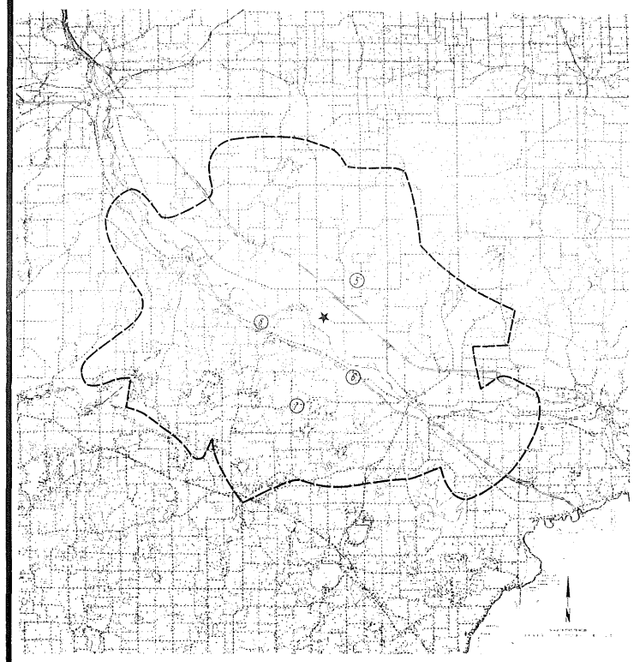
Photograph No. 5

Photograph No. 6

Photograph No. 7

Photograph No. 8



Photograph No. 5	3 miles NE
Photograph No. 6	3 3/4 miles SE
Photograph No. 7	5 1/4 miles SSW
Photograph No. 8	3 3/4 miles W

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.1-5

Views to the Site

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area within which there is a view of the existing generating station, is in fact well within the 15-mile limit ranging from 9.5 miles to the north to 10.5 miles to the east and west (ERT Field Survey 1977). Nearly 70 recreational sites were found within the 15-mile radius. These sites comprised more than 57,500 acres. The closest recreational area to the proposed stack location is the Harry Larsen County Park (Wright County), located approximately 3-1/4 miles to the south-southwest. Other areas in close proximity to the proposed stack location include: Riverwood Campland, a camp area situated about 4 miles to the north; Marcus C. Brunnen County Park (4 miles to the west-southwest); Lake Maria State Park (4-1/4 miles to the south-southwest); Kelly-Meyer Wildlife Management Area (4-1/4 miles to the south) and Silver Creek Golf Course Country Club (5 miles to the south-southeast).

In addition to the more conventional recreational facilities previously identified, there are a number of other recreational resources located in the 15-mile region. Three rivers are of recreational importance. The Missisippi River, which flows adjacent to the southerly boundary of the SHERCO site, has been designated by the state as a Wild, Scenic and Recreational River between St. Cloud and the City of Anoka (Knoke 1977). In addition, the Bureau of Outdoor Recreation (BOR), U.S. Department of the Interior, has recently completed a study of the Upper Mississippi River (1977). One conclusion of this federal study was that the "53 river miles between St. Cloud and Anoka...meet the criteria for inclusion in the National System [Wild and Scenic River System] of which 11.9 channel miles qualify as scenic, and 41.1 miles qualify as recreational." The Mississippi River is also a state-designated Canoe and Boating River (Minnesota State Planning Agency 1976). The Elk and Francis Rivers are both classified as recreational rivers by Sherburne County (Alfords 1977). The former waterway runs in a northwest/southeast direction, with the nearest segment being approximately two miles east-northeast of the proposed stack location. The Francis River runs in a more north-south direction with the closest river segment situated about 7-1/4 miles to the east.

U.S. Highway 10, which runs almost adjacent to the northern most edge of the SHERCO site, is considered a visually sensitive land use due to the number of motorists who use this roadway. (See Section 4.2,

"Transportation.") A portion of the Route 10 corridor between county roads 25 and 65 has been designated by the Minnesota Department of Transportation as a scenic area (Jeffers 1977). Another state-designated scenic highway situated within the study region is the Great River Road. This road runs within about 2-1/4 miles of the proposed stack location for SHERCO Units 3 and 4 (Jeffers 1977).

Four other outstanding natural features identified within the study region include the sand dunes situated in the Sand Dunes State Forest (11-1/4 miles east-northeast); the Duelm Cone Kame (a natural land feature) in Benton County (14-1/2 miles north-northwest); Monticello Mountain in Wright County (9-3/4 miles northeast) and a stand of sugar maples also in Wright County (15 miles south-southeast). The first three features constitute outstanding landforms, while the sugar maples constitute a natural area noted for its "scenic timber" resources (Minnesota Department of Natural Resources, Bureau of Planning, 1971, and Adelman 1977*).

Finally, 33 lakes with public access have been identified in the 15-mile study region. These lakes range in size from the 83-acre Camp Lake (5 miles northwest) to the 3,704-acre Clearwater Lake (11 miles southwest). All of the lakes are located at least 5 miles away from the proposed stack location.

4.1.5 Historical and Archaeological Resources

Fourteen historical sites were identified within the study area. There are no historical sites on the SHERCO property and the nearest historical resource is located 6-1/2 miles away. The majority of the sites are located in and around the City of Monticello (Wright County). One of the sites in Wright County, the Tobias G. Mealy house, is listed on the National Register of Historic Places. There are also two sites currently being proposed for nomination to the National Register of Historic Places: St. Marks Episcopal Church near Clearwater Lake (Wright County) and the Clearwater Historic District in the Village of Clearwater (Wright County) Jameson 1977). The remaining 11 sites in

*Adelman identified significance and location of Duelm Cone Kame in Benton County.

the study area are all included in the Minnesota Inventory of Historic and Prehistoric Places (Minnesota Historical Society 1975) and are located between 6-1/2 and 13-3/4 miles away from the proposed stack location.

There are nearly 50 known archaeological sites in the 15-mile study area. None are within the immediate vicinity of the SHERCO site, although several are found in the nearby townships of Clear Lake, Big Lake and Silver Creek. Many of these archaeological sites date back to the Indian occupation of the region, while others related to early settlement days.

4.2 Transportation

The area surrounding the SHERCO site is characterized by low population densities and little transportation network development. Major transportation links are situated in a northwest-southeasterly direction connecting to Elk River (and ultimately Minneapolis) to the southeast and St. Cloud to the northwest. The only two modes of significance in the region are highway and railroad. Each is discussed below.

4.2.1 Highways

The primary highway impact area is delineated in Figure 4.2-1. It is comprised of a circle roughly five miles in radius from the SHERCO site. While secondary impacts could theoretically occur over a wider area due to the independence of transportation facilities, it is expected that such effects will barely be measurable due to the current low traffic densities. Measurable impacts are most likely to occur at or near the site.

U.S. 10 and 52 (oriented towards the metropolitan areas of St. Cloud and Minneapolis), prior to the opening of I-94, was the heaviest carrier of traffic in the area. It is a four-lane arterial with partial control of access. It has lost much of its traffic to the interstate facility since the latter's opening in 1974. Access to the plant is obtained directly from this roadway; therefore, traffic impacts from the SHERCO site will be felt most heavily on U.S. 10 and 52 (see Figure 4.2-2). In the vicinity of the plant, 1976 average daily traffic volume on this road was 8,830 vehicles (see Figure 4.2-3).

Running almost parallel to U.S. 10 and 52 is I-94, located across the Mississippi River in Wright County. This highway is of less importance to plant-related traffic, since the SHERCO site is not located close to either Routes 24 and 25 which cross the river (see Figure 4.2-1). In 1976, I-94 carried 10,520 vehicles daily,* which is not a large number for a major limited access facility. However, there is evidence

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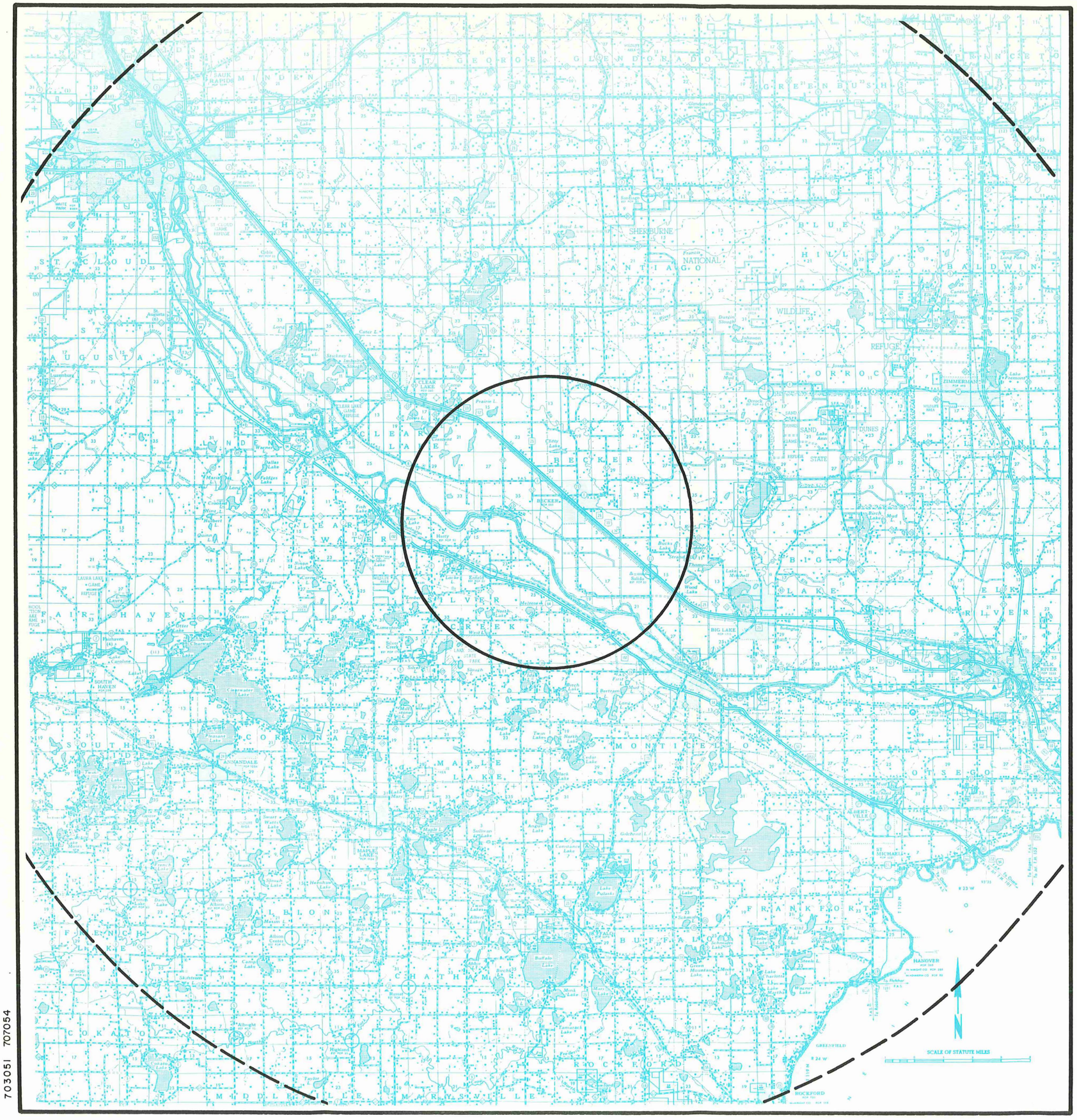
*This and all subsequent traffic counts derived from traffic maps of the Minnesota Department of Highways. Some 1976 figures were obtained from a conversation with Mr. Warren Gerber, April 25, 1977.



MINNESOTA POLLUTION CONTROL AGENCY

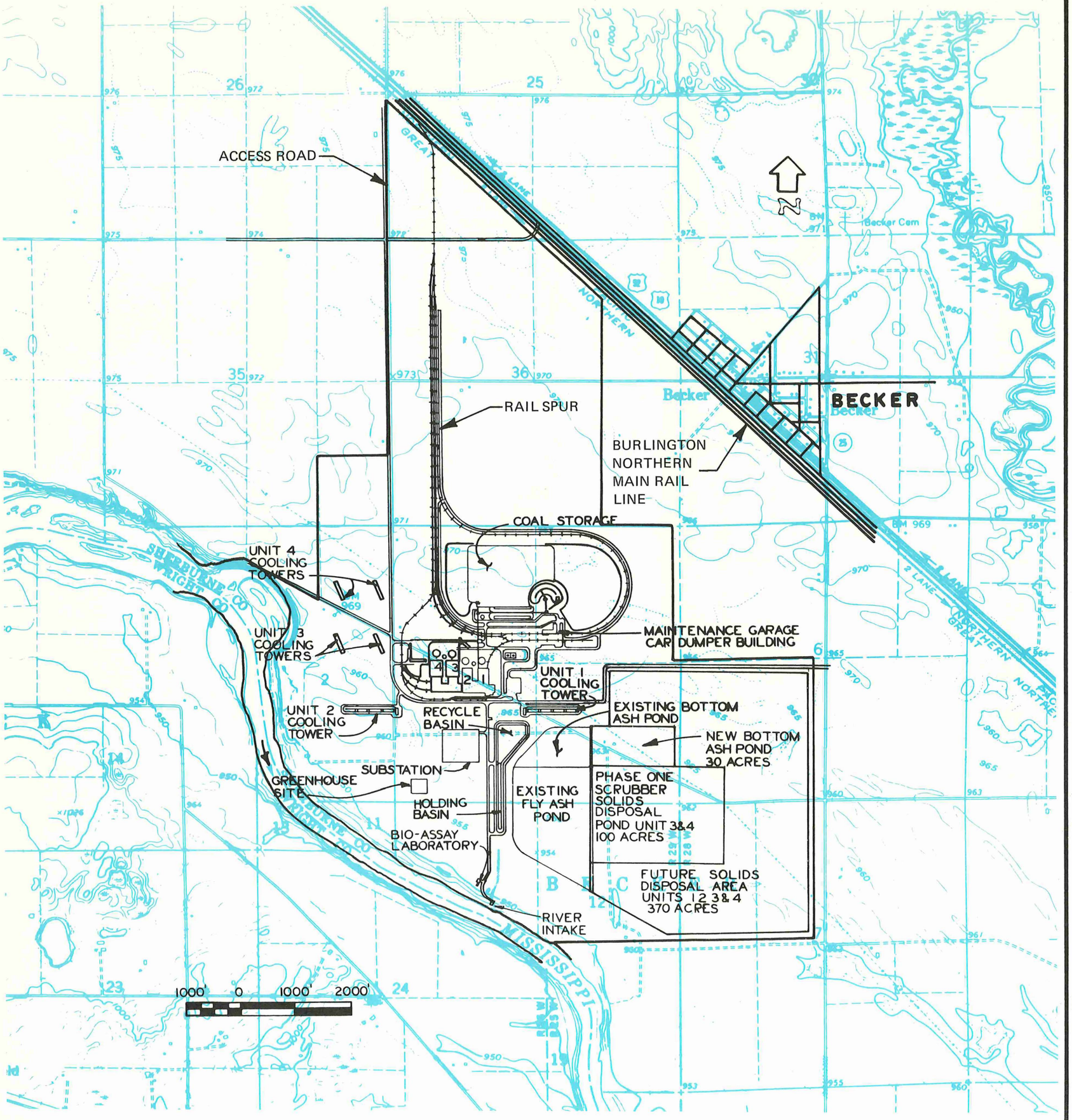
ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.2-1

Primary Impact Area Transporation

703227 703051 707054



703051 707055

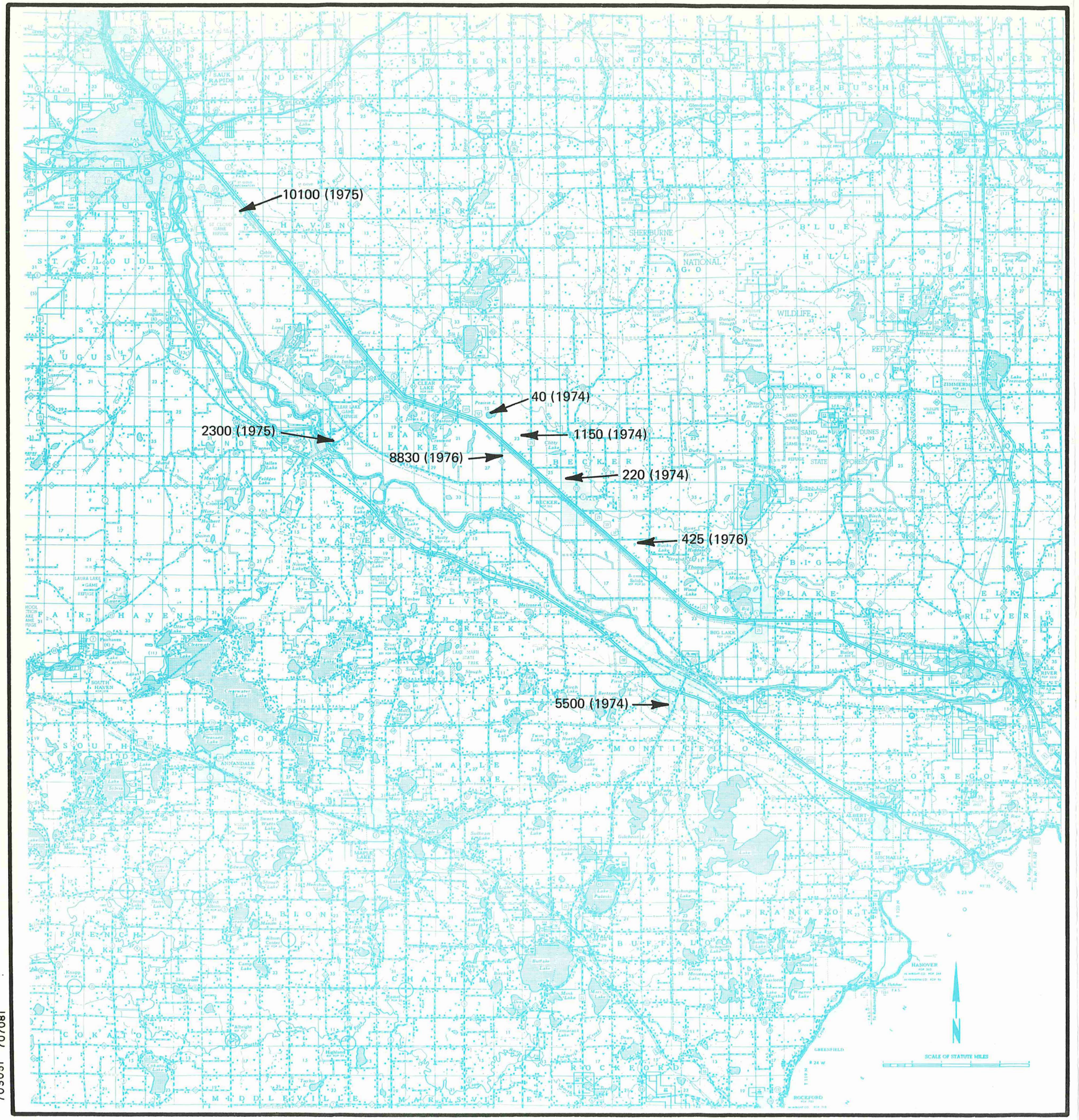
MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.2-2

Transportation Access to the Site



xxx Vehicles per Day

(yyyy) Year of Count

MINNESOTA POLLUTION CONTROL AGENCY

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.2-3

Average Daily Traffic

705051 707081

that the road has not yet realized its full potential volume given current population, due to its relatively recent opening (1974). Route 152 coincides with I-94 for a portion of the study area and was formerly the major parallel route south of the river.

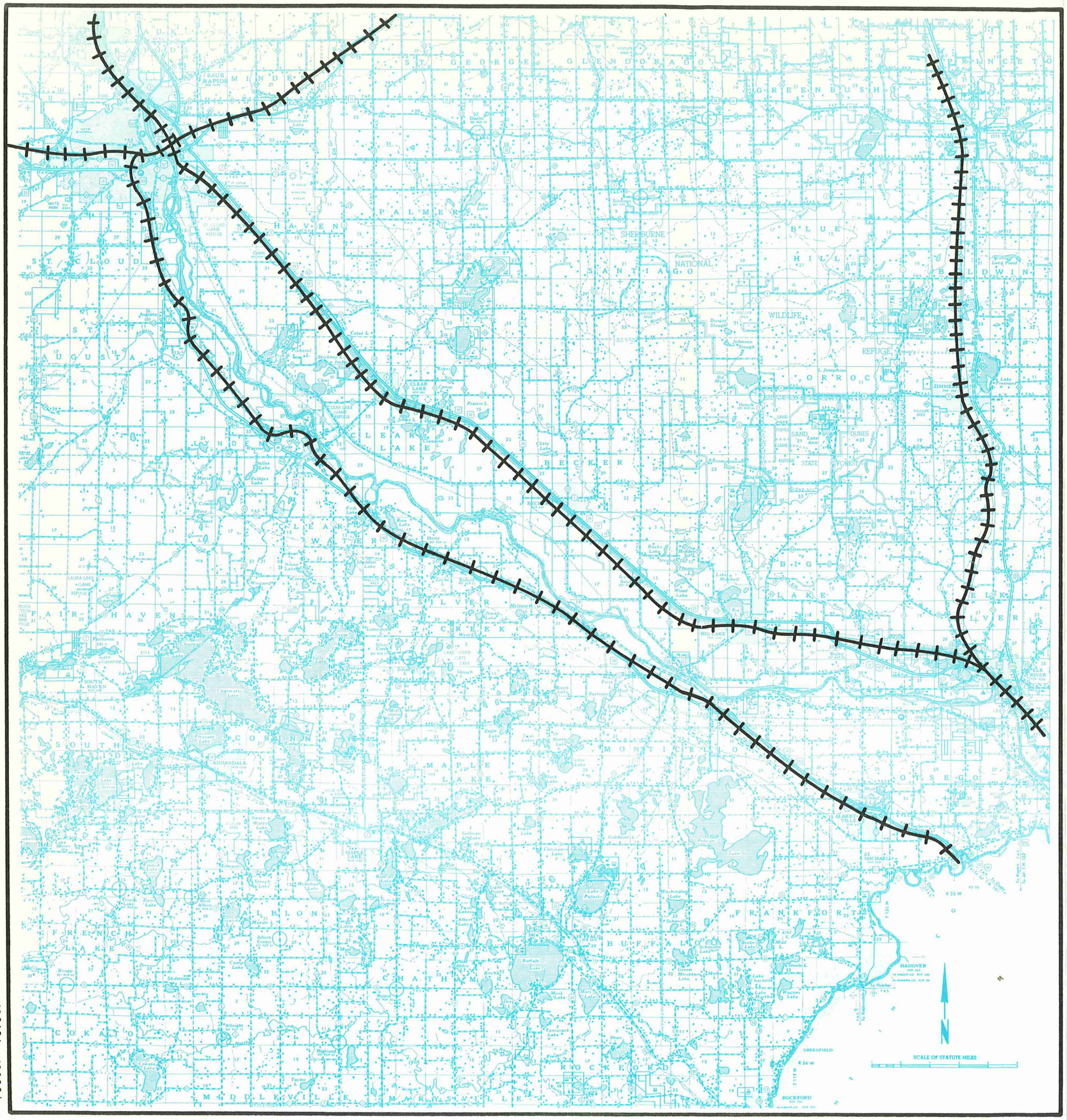
There are a number of north-south roadways in the region, most being characterized by two lanes, few lateral and horizontal curves, and relatively unobstructed flow (see Figure 4.2-1). The most important of these, within the primary impact area, follow:

- State Route 25, which enters as a concurrent route with U.S. 10 after having crossed the Mississippi River southeast of the site. Route 25 branches northward at Becker.
- County Route 11, which originates at Route 25 at the county line and proceeds northward, parallel to and east of Route 25.
- County Route 23, lying between the above two roads (of less importance in terms of volume).

Traffic volumes within the impact area are generally light relative to other roads of comparable capacity. Although volumes are expected to increase along major truck routes, in some cases dramatically, locally generated as well as through traffic remain less of an influence on the roadways, due to the relatively low population levels. Traffic counts for selected roadways within the impact area are shown in Figure 4.2-3.

4.2.2 Railroads

The other mode of significance to the SHERCO facilities is rail. The operator of virtually every line in the impact area is the Burlington Northern Railroad. Major trunk lines run northwesterly to southeasterly in the same corridor as that formed by U.S. 10 and I-94. Main lines, and some branches, are shown in Figure 4.2-4. Burlington Northern estimates its current traffic on the Becker line to be about 23 trains per day, of which two are coal trains (MPCA 1977). According to Burlington Northern, this number is considerably below capacity, and it is not expected to increase to capacity within the next 25 years.



Rail Line

MINNESOTA POLLUTION CONTROL AGENCY

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.2-4

Railroads Serving the Area

703227
703051 707091

4.2.3 Other Modes

While the area is served by a variety of other modes, none carries a significant amount of traffic. (Trucks and buses are included in total vehicular movements previously documented.) The Mississippi River, adjacent to the SHERCO site, is not commercially navigable in the vicinity of the SHERCO site.

4.2.4 Current SHERCO Activity

Two units, SHERCO 1 and 2, are already in operation on the site. Together, they employ almost 170 people on a permanent basis. Assuming a typical automobile capacity of 1.1,* employees generate about 310 one-way trips per day by automobile. This represents about 3.5% of all traffic on U.S. 10 and 52, the route that provides access to the site. Secondary trips by employees during the day and service trips to the plant provide a relatively low level of additional trips.

The major transportation activity related to current plant operation is coal train delivery. An average of 2.5 trains (MPCA 1977) per day either deliver coal or run empty to and from the plant. These are unit trains of about 100 cars in length, which travel at a maximum speed of 50 mph. There are numerous at-grade crossings with local roads along the length of track, at which delays of almost two minutes occur when trains pass. Most of these intersections are outside the primary impact area (ERT 1977g).

SHERCO Units 1 and 2 currently receive between 160 and 170 deliveries per month of limestone, on a continuous basis (Beck 1977f). Based upon six days per week of operation, this is a bit more than six deliveries, or 12 one-way trips per day. In addition, there are smaller numbers of truck deliveries of various materials for plant operation, such as gasoline for emergency generating units and mobile ground equipment, and No. 2 fuel oil.

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*In the absence of any quantitative data, this figure was used and is a conservative one. That is, it implies the maximum number of possible vehicles.

4.3 Socio-Economics

4.3.1 General Definition of Study Area

Three geographical areas are examined in the socio-economic baseline study: the Central Minnesota Region (CMR); the Primary Study Area (PSA) and the Secondary Study Area (SSA). Figure 4.3.1 delineates each of these study areas. The CMR provides a broad perspective of the larger area within which the SHERCO site is located. PSA constitutes the area within which the majority of the socio-economic impacts are likely to occur based upon projected construction worker and permanent employee settlement patterns (ERT 1977h). SSA is adjacent to the PSA and encompasses a larger region, including portions of Sherburne, Wright, Stearns and Benton counties.

4.3.2 General Population Trend

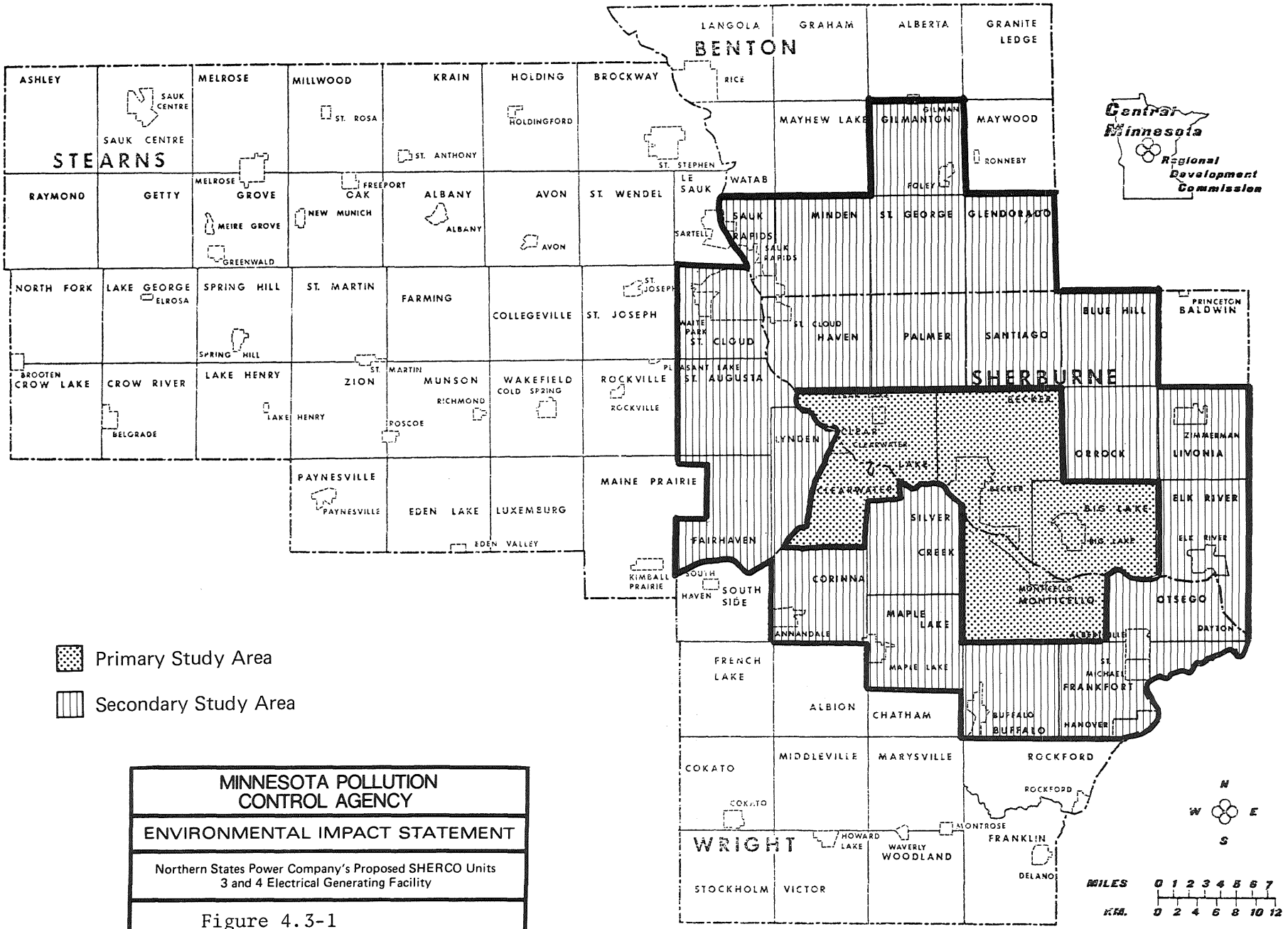
Central Minnesota Region

The regional population has displayed an increasing rate of growth during the period 1940-1970. From 1940 to 1970, the region has expanded from a little over 121,000 persons to over 173,000. Table 4.3-1 presents more recent data showing the components of population change during the period 1970-1975.

The statistics indicate that in-migration was the major factor responsible for the moderate population gains in this five-year period. This was especially true in the case of Sherburne County which grew 43.4% or by 8,000 people in this five-year period, with 85% of the growth attributable to in-migration. Furthermore, on a percentage basis, Sherburne was the fastest growing county in Minnesota from 1970 to 1975 (Office of the State Demographer 1976).

Secondary Study Area

The SSA had a 1970 population of nearly 87,000. The population in the SSA increased by 27% from 1960 to 1970. Since the last census (1970), communities in Wright and Sherburne Counties have each shown substantial population growth (see Table 4.3-2).



Primary Study Area

Secondary Study Area

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.3-1 Central Minnesota Area

TABLE 4.3-1

ESTIMATED COMPONENTS OF POPULATION CHANGE

1970-1975

County	1970 Population	Births	Deaths	Net Migration	Estimated 1975 Population	Change
Benton	20,841	2,300	900	-100	22,141	1,300
Sherburne	18,344	1,900	800	+6,800	26,344	8,000
Stearns	95,400	8,300	3,600	+2,100	102,200	6,800
Wright	38,933	4,400	2,000	+5,400	46,633	7,700
Region	173,518	16,900	7,300	14,200	197,318	23,800

Source: Office of State Demographer, State Planning Agency, Population Estimates for Minnesota Counties 1975, September 1976.

TABLE 4.3-2

RECENT POPULATION TRENDS IN THE SECONDARY STUDY AREA

	1970	Current Estimate*	Percent Change
In Benton County			
Foley City	1,271	1,179	-7.2
Gilmanton TWP	906	897	-1.0
Gilmanton City (part)	39	a	a
Glendorado TWP	726	749	3.2
Minden TWP	1,307	1,461	11.8
St. Cloud City (part)	4,180	a	a
St. George TWP	888	919	3.5
Sauk Rapids TWP	6,115	6,675	9.2
Sauk Rapids City	5,051	5,093	0.8
In Sherburne County			
Blue Hill TWP	495	715	44.4
Elk River City	2,252	3,132	39.1
Elk River TWP	1,846	3,146	70.4
Haven TWP	1,049	1,593	51.9
Livonia TWP	705	1,209	71.5
Orrock TWP	502	998	98.8
Palmer TWP	663	1,111	67.6
Santiago TWP	541	693	28.1
St. Cloud City (part)	3,918	4,390	12.0
Zimmerman City	495	675	36.4
In Stearns County			
Fairhaven TWP	818	857	4.8
Lynden TWP	511	542	6.1
St. Augusta TWP	1,584	1,815	14.6
St. Cloud City (part)	31,593	a	a
St. Cloud TWP	6,807	4,885	-28.2
Waite Park City	2,824	3,030	7.3
In Wright County			
Albertville City	451	531	17.7
Annandale City	1,234	1,476	19.4
Buffalo City	3,275	4,092	24.9
Buffalo TWP	1,236	1,555	25.8
Corrina TWP	1,109	1,609	45.1
Dayton City (part)	48	48	-
Frankfort TWP	2,393	3,127	30.7
St. Michael City	1,021	1,416	38.7
Hanover City (part)	269	389	44.6
Maple Lake City	1,124	1,258	11.9
Maple Lake TWP	1,226	1,542	25.8
Otsego TWP	1,526	3,343	119.1
Silver Creek TWP	1,102	1,415	28.4

*Most up-to-date estimate for Sherburne County is for 1976, for Wright County, 1974; for Benton and Stearns, 1973.

(a) Source presents total city only

Sources: Alford, Harvey, Zoning Administrator, Sherburne County, "Sherburne County 1976 Population Statistics," mimeographed paper, no date.

Wright County Planning and Zoning Department, "Wright County Population Estimates," mimeographed sheet, no date.

U.S. Department of the Treasury, Office of Revenue Sharing, State & Local Data Elements, Entitlement Period 7 and Entitlement Period 8, U.S. Government Printing Office, February 1977

Primary Study Area

The PSA had a 1970 population of approximately 9,804. The population of the PSA increased by nearly 50% from 1960 to 1970. Since 1970, all the communities in the PSA have shown still further gains in population (see Table 4.3.3). This was especially true in Big Lake City, where the population increased by 101.3% between 1970 and 1976. Becker's population rose to 517, a 41.6% gain. Some portion of this is attributable to expansion of the city limits, which occurred in 1973, and some to the development of SHERCO Units 1 and 2. The PSA as a whole has more than doubled in population size since 1960.

4.3.3 Demographic Characteristics of Population

In the previous discussion of population trends, very recent figures were used. However, to gain an understanding of the basic composition of these populations, 1970 census data must be relied upon because of the level of detail it provides. The paragraphs that follow discuss social and economic characteristics of the PSA as a whole and the City of Becker in particular.

Primary Study Area

The PSA had a 1970 population of 9,804, 99.6% of whom were white. Approximately 11% of the population was in each of the dependent age cohorts (under 5 years and over 65 years). Nearly 90% (88.8%) of the population had parents who were born in this country. Of the others, most were from Scandinavia, Germany and Canada. Less than half the people over five (48.6%) lived in the same house in 1970 that they had lived in in 1965. This suggests that many of the residents of the PSA were newcomers. The data on level of education attainments in the PSA show that 53.4% of the adults had graduated from high school and 16.2% went on to complete some college.

The labor force participation rate in the PSA was 94.6%. A plurality of the workers (43.2%) were in blue-collar occupations, especially operative positions. In terms of industry, wholesale and retail trade accounted for the largest number of jobs. Manufacturing

TABLE 4.3-3

RECENT POPULATION TRENDS IN THE PRIMARY STUDY AREA

	1970	Current Estimate*	Percent Change
Becker City	365	517	41.6
Becker TWP	799	1,263	58.1
Big Lake City	1,015	2,043	101.3
Big Lake TWP	1,708	2,092	22.5
Clear Lake City	280	316	12.9
Clear Lake TWP	612	912	49.0
Clearwater City	282	298	5.7
Clearwater TWP	867	923	6.5
Monticello City	1,636	1,786	9.2
Monticello TWP	2,240	3,442	53.7

*Most up-to-date estimate for Sherburne County is for 1976; for Wright County, 1974.

Sources: Alford, Harvey, Zoning Administrator, Sherburne County, "Sherburne County 1976 Population Statistics," mimeographed paper, no date.

Wright County Planning and Zoning Department, "Wright County Population Estimates," mimeographed sheet, no date.

U.S. Bureau of the Census, Census of the Population: 1970, General Population Characteristics, U.S. Government Printing Office, Washington, D.C., 1972.

was the source of employment for 16.7% of the labor force and construction for another 14.0%. The agricultural sector employed 11.5% of the workers. These occupations and industries brought the families in the PSA a mean family income of $9,956. The average individual income was $2,680.

City of Becker

The 1970 population of Becker was 365. As shown in Table 4.3-4, its age distribution reflects an even higher dependency ratio than that of the PSA. Only 44.4% of the people were in the 18 to 64 age group.

More than three quarters of the population (76.1%) were of native-borne parents. No one was foreign born; but, of those whose parents were, over half came from the Scandinavian countries and another third came from Germany. The population was extremely stable. Nearly 80% of those five years old and over lived in the same house in 1970 as in 1965 and another 16.5% were still residing in the same country. Over half the residents 25 years of age or older did not complete high school, and less than 7% had any formal schooling beyond the twelfth grade.

Only 91.2% of the civilian labor force in Becker was employed. Over half of these people (57.0%) had blue-collar jobs, especially as laborers. Wholesale and retail trade was the dominant employment sector accounting for 42.2% of all jobs. The public utilities and construction sectors were also of substantial importance, employing 17.8% and 14.1% of the workers, respectively. Nearly half (49.4%) of the families in Becker had incomes of $8,000 to $12,000. The average family income was $9,660, slightly lower than that of the PSA. The average individual income was $3,332.

4.3.4 Economic Characteristics of Central Minnesota Region

Historical Development

Agriculture has long been the dominant industry in the region's economy. In 1940, agriculture accounted for 17,616 jobs, making it the major employer. By 1970, with 7,746 workers, agriculture fell from its

TABLE 4.3-4

SELECTED SOCIO-ECONOMIC CHARACTERISTICS OF THE CITY OF BECKER

(1970)

	Number	Percent
Total Population	365	
Under 5	41	11.2
5-17	111	30.4
18-64	162	44.4
65 and over	51	14.0
White	364	99.7
Other	1	0.3
In families	334	91.5
Primary individual	25	6.9
In group quarters	6	1.6
Native*		
of native parents	280	76.1
of foreign born or mixed parentage	88	23.9
German	29	7.9
Scandinavian	48	13.1
Canadian	6	1.6
Other (ins. not reported)	5	1.3
Foreign born*	-	-
Total Population, 5 years old and over	339	
Same house in 1965	271	79.9
Different house, same county in 1965	56	16.5
Different county, same state	6	1.8
Other	6	1.8
Total Population, 25 years old and over	188	
No school completed	-	-
1-11 years completed	98	52.1
High school completed	77	41.0
More than 12 years completed	13	6.9
Civilian Labor Force, 16 years old and over	148	
Employed	135	91.2
Unemployed	13	8.8

*Fourth count data. Approximates, but is not equal to, first count data above.

TABLE 4.3-4 (Continued)

SELECTED SOCIO-ECONOMIC CHARACTERISTICS OF THE CITY OF BECKER

(1970)

	Number	Percent
Employed persons, 16 years old and over	135	
Occupation		
Professional, Technical, etc.	-	-
Managers and administrators	19	14.1
Sales work	24	17.8
Clerical, etc.	-	-
Craftsmen, foremen, etc.	26	19.2
Operatives	36	26.7
Laborers	15	11.1
Farm workers	-	-
Service workers	15	11.1
Industry		
Agriculture, forestry and fisheries	4	3.0
Mining	-	-
Construction	19	14.1
Manufacturing	11	8.1
Transportation, communication and other public utilities	24	17.8
Wholesale and retail trade	57	42.2
Finance; insurance and real estate	-	-
Business & repair services	-	-
Personal services	3	2.2
Entertainment & recreation services	-	-
Professional & related services	12	8.9
Public administration	5	3.7
Count of families by income	83	
Under $4,000	12	14.5
$4,000-7,999	20	24.1
$8,000-11,999	41	49.4
$12,000-14,999	5	6.0
$15,000-24,999	-	-
$25,000 and over	5	6.0
Mean family income ($)	9,660	
Mean individual income ($)	3,332	

Source: U. S. Department of Commerce, Bureau of the Census, First and Fourth Count, 1970 Census, as generated by Minnesota Analysis and Planning System of the University of Minnesota

rank as primary employer. Providing jobs to 12.7% of the labor force, it became the fourth largest employer. It was, however, still considered the single most important industry in the region and the relative value of production (especially dairy products and livestock) had increased (Central Minnesota Regional Development Commission 1976). The food processing industry accounts, at least in part, for this apparent contradiction. This sector more than doubled its number of employees from 1940 to 1970 (752 to 1,701).

As agriculture lessened in importance, employment in manufacturing and trade industries increased. In 1940, these sectors employed 2,763 and 4,938 workers, respectively; but by 1970 they accounted for 12,349 and 13,355 jobs. "Other services," which includes members of the health and education professions, had become the most significant employment sector by 1970.

While their relative ranking has varied, agriculture, manufacturing, wholesale and retail trade and the service industries have consistently accounted for 80% of regional employment. This diversification due to the proximity of St. Cloud and the Twin Cities (to which numbers of residents commute) has afforded a certain amount of economic stability in the past.

Recent Trends in Employment

The regional labor force continues to expand in numbers. Employment in utilities has increased sharply with the development of the Monticello and Becker power plants (Central Minnesota Regional Development Commission 1976). The decline in agricultural employment may have reached a plateau. New technology has permitted intensive irrigation of land in Sherburne County and similar development is feasible in Benton County (Central Minnesota Regional Development Commission 1976). This could mean extended agricultural production and employment.

Information from the Minnesota Department of Economic Development indicates that 134 new jobs were created in 1975 as a result of industrial investment. The $33 million in Municipal Industrial Development Bonds issued for pollution control at NSP's SHERCO plant was the second largest investment in Minnesota in 1975.

Wages

Table 4.3-5 presents 1975 wages by industrial sector for the four counties in the CMR. The figures do not include the self-employed or elected public officials. The industry that paid the highest wages was the construction sector, particularly in Sherburne County. In general, services and trade were the sectors that paid the lowest wages. Average monthly wages for all industries were highest in Stearns County ($692 per month) and lowest in Wright County ($591 per month).

Unemployment

Regional residents had an aggregate employment rate of 4.5% in 1970. The individual rates were 3.8% in Benton County, 4.6% in Sherburne, 4.7% in Stearns and 4.5% in Wright. Thus, in 1970, Benton had the lowest unemployment rate of the four counties; Stearns, the highest. Most of the experienced unemployed were blue-collar workers.

More recently, unemployment has risen, though, with the exception of Wright County, not as sharply as on a national basis. The region's 1975 unemployment rate was 6.2% with Benton County still the lowest (4.5%). Wright County, at 9.2%, had the highest unemployment.

4.3.5 Property Taxes Applicable to SHERCO Site

The general property tax is the major tax imposed by local government and school districts in Minnesota (State of Minnesota 1977). The property tax is ad valorem. The amount of tax levied on a parcel of property is based on the market value of the property, the assessed value of property (in the taxing jurisdiction having authority to levy a tax) and the budget requirements of the taxing districts.

Taxing Jurisdictions

There are four local taxing jurisdictions which have the power to impose property taxes on the SHERCO site: Sherburne County, Becker School District No. 726, the City of Becker and the Monticello-Big Lake Hospital District. The county and city taxes affect households and

TABLE 4.3-5

AVERAGE MONTHLY WAGES BY INDUSTRIAL SECTOR FOR THE FOUR COUNTIES IN THE CENTRAL MINNESOTA REGION, 1975

Industry	Average Monthly Wages ($) Benton County	Sherburne County	Stearns County	Wright County
Agriculture, Forestry and Fisheries	x	341	656	635
Mining	x	x	x	x
Construction	909	1,001	964	821
Manufacturing	751	x	734	625
Transportation, Communication and Utilities	672	968	945	660
Trade	500	454	472	460
Finance, Insurance and Real Estate	697	671	760	699
Service	400	366	601	375
Government	742	836	827	732
Total (including undisclosed industries)	627	674	692	591

(x) Too few employers to allow publication in accordance with Minnesota's nondisclosure laws.

Source: Minnesota Department of Employment Services, Minnesota Employment Wage Data by County (First Quarter 1975), July 1976; (Second Quarter 1975), October 1976; (Third Quarter 1975), December 1976; (Fourth Quarter 1975), January 1977.

activities within their respective corporate boundaries. The Becker School District and the Monticello-Big Lake Hospital District, on the other hand, each affect persons in several cities and townships.

Tax Rates

The property tax bill of a typical City of Becker property owner is composed of four major components: the county tax, school district tax, city tax and hospital district tax. There has been a substantial variation in tax rates during the past five years, primarily in terms of municipal and school district rates. During the period 1973-1977, the municipal mill (tax) rate ranged from $6.44 (1976) to $57.82 (1974). The school district mill rate showed a similar degree of variation during this same time period, while the county tax rate has remained relatively constant.

The fluctuating mill rate for the City of Becker and for Becker School District No. 726 is attributable to a number of factors. According to the Becker Village Clerk, municipal rates have reflected the revenue requirements for adding new water and sewage facilities and to a lesser extent, for expanding fire protection services (Boettcher 1977). The recent increased school district mill rates are attributable to the fact that a new $6.5 million junior/senior high school is currently being constructed in the City of Becker (Boettcher 1977). Available data also reveal that school district and county tax payments account for the majority of an individual's total property tax liability.

Real Property Valuations

Market and assessed valuations for Sherburne County, School District No. 726 and the City of Becker are presented in Table 4.3-6 for the tax years 1973 through 1976. The data show rapid gains in the market and assessed valuations of the City of Becker and School District No. 726, with a significant though less substantial increase noted in Sherburne County as a whole. The City of Becker increased its assessed valuation from approximately $300,000 in the tax year 1973 to $25.4 million in 1976. In 1973, the assessed value of the City of Becker represented less than 1% of the valuation of the entire county whereas by 1976, the

TABLE 4.3-6

REAL PROPERTY MARKET AND ASSESSED VALUATIONS

1973-1976

Taxing Jurisdiction Tax Year*	Market Valuation** ($ million)	Assessed Valuation ($ million)
Sherburne County		
1976	$224.7	$74.8
1975	154.3	50.6
1974	127.7	41.1
1973	112.7	36.0
%Δ 1973-1976	99.4%	107.8%
School District 726		
1976	89.2	30.6
1975	28.1	9.8
1974	10.9	3.3
1973	8.5	2.5
%Δ 1973-1976	949.4%	1,124%
City of Becker		
1976	72.8	25.4
1975	18.7	7.0
1974	1.0	0.3
1973	1.0	0.3
%Δ 1973-1976	7,189%	8,366.7%

*Refers to year payable. 1976 tax year equivalent to 1975 calendar year.

**After limitations.

Source: State of Minnesota, Department of Taxation, Abstract of Assessment of Real Property, 1973-1976.

city's share constituted nearly 34% of the county's total assessed valuation. Sherburne County's tax base increased from $36 million to $74.8 million during the period 1973-1976. Becker School District No. 726 also enjoyed a substantial expansion of its tax base during the recent period. In 1973, its total assessed valuation was approximately $2.5 million. Three years later, this tax base was valued at over $30 million. The sizeable expansion of assessed valuation in the school district and City of Becker was primarily due to the construction of SHERCO Units 1 and 2.

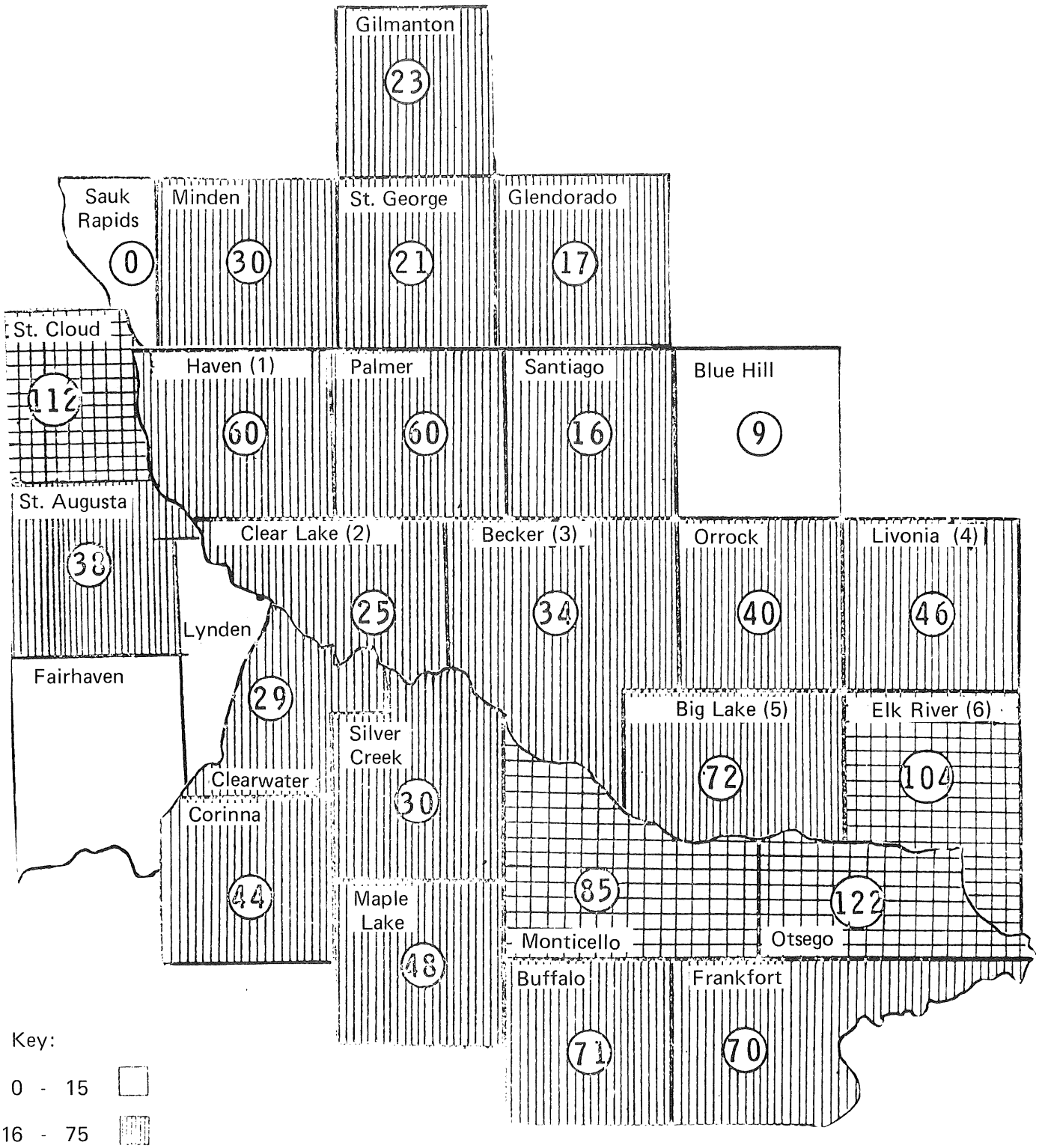
4.3.6 Community Facilities and Services

Housing

As shown in Table 4.3-7, the primary and secondary study areas had 27,593 year-round housing units in 1970. Nearly three-quarters of them (73.4%) were owner occupied, 22.5% were renter occupied and 4.1% were vacant. There were 2,854 seasonal units representing 9.4% of the grand total. Of the owner-occupied units for which a value was tabulated, 69% were valued at less than $20,000; 27% at between $20,000 and $35,000; with only 4% at $35,000 or more. The mean value was $17,646. Rentals averaged $104 per month.

The occupancy status of housing in the City of Becker was quite similar to that of the larger study area. In other respects, however, it was quite different. The portion of units lacking some or all plumbing facilities was nearly twice as high (11.2% vs. 5.7%) and a higher percentage of units had 1.01 or more persons per room. There were no seasonal units. Home values were substantially lower, with 97.1% tabulated at less than $20,000 and a mean value of only $10,485. Average rents were also a good bit lower ($70 vs. $104).

Figure 4.3-2 shows the number of residential building permits issued in 1975 and 1976 within the study area. It is a composite of maps presented in Update on Population, Residential Development and Cropland for Benton, Sherburne, Stearns and Wright Counties (Hanson and Fricke 1977). To derive the numbers, the authors of this study adjusted



(1) East St. Cloud 71 (houses and apts.)
(2) City of Clear Lake 1
(3) City of Becker 30 (houses and apts.)
(4) City of Zimmerman 31
(5) City of Big Lake 55 (houses and apts.)
(6) City of Elk River 73 (houses and apts.)

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.3-2 Residential Building permits 1975 and 1976 per standard 36 square mile township

707094

TABLE 4.3-7

SELECTED HOUSING CHARACTERISTICS (1970)

	Study Area		Becker	
	Number	Percent	Number	Percent
Total Year-Round Housing Units	27,593		116	
Owner occupied	20,262	73.4	83	71.6
Renter occupied	6,206	22.5	28	24.1
Vacant	1,125	4.1	5	4.3
For rent	227	0.8	4	3.4
For sale	202	0.8	-	-
Other	696	2.5	1	0.9
With all plumbing facilities	26,017	94.3	103	88.8
Lacking some or all plumbing facilities	1,576	5.7	13	11.2
Total Seasonal Units	2,854	-	-	-
Total Occupied Year-Round Housing Units	26,468		111	
1.00 or less persons per room	23,470	88.7	95	85.6
1.01 or more persons per room	2,998	11.3	16	14.4
Value of Owner Occupied Units for which Value was Tabulated	14,634		68	
Less than $10,000	2,622	17.9	32	47.1
$10,000 - 19,999	7,473	51.1	34	50.0
$20,000 - $34,999	3,948	27.0	2	2.9
$35,000 or more	591	4.0	-	-
Mean value ($)	17,646		10,485	
Contract Rent of Occupied Units for which Rent was Tabulated	5,726		28	
Less than $60	805	14.1	8	28.6
$60 - 79	906	15.8	7	25.0
$80 - 149	3,006	52.5	6	21.4
$150 or more	651	11.4	-	-
No cash rent	358	6.2	7	25.0
Mean rent ($)	104		70	

Source: U.S. Department of Commerce, Bureau of the Census, U.S. Census of Population and Housing, Special tabulations prepared by the University of Minnesota, Minnesota Analysis and Planning System.

residential permits and septic tank installations to a 36-square mile township. The encircled numbers indicate the specific number of permits in each township. The cities in Sherburne County are also displayed.

Consistent with population trends, it is apparent that with very few exceptions the study area is experiencing substantial gains in housing. This is particularly true in St. Cloud Township at the northwest corner of the area and in Otsego, Elk River and Monticello Townships in the southeast near the Twin Cities.

Domestic Water

Domestic water in the study area is drawn primarily from ground supplies. Fourteen of the cities are served by community water supply systems. The other cities and unincorporated areas of townships are served by private domestic wells rather than municipal systems.

All of the community water supply systems function at less than rated well pump capacities with most systems having substantial reserve capacity (ERT 1977h). In addition, all of the systems have stored reserves for emergencies. No information was available regarding the reserve capacity of the private domestic wells which serve the other communities in the study area.

Sewage Treatment

The majority of the communities in the study area (virtually all unincorporated areas in the townships and most of the small cities) do not have municipal sanitary sewer systems. These areas rely primarily on septic tank systems or cesspools for disposal of wastewater. It should be noted that Clearwater City (Wright County) and Clear Lake City (Sherburne County) plan to jointly construct a sewage treatment system (Jesh 1977).

Ten of the cities in Sherburne and Wright Counties have municipal wastewater treatment facilities. In addition, the cities of Sauk Rapids and Waite Park are served by treatment facilities in St. Cloud. Almost all of the systems are presently functioning below design capacity (ERT 1977h). However, several of the treatment plants are discharging effluents which do not comply with MPCA interim or final effluent limits.

Solid Waste Disposal

Most of the communities in the study area rely upon private contractors for collection of solid wastes. Exceptions are several cities, including St. Cloud, Sauk Rapids, Buffalo and St. Michael which have municipal pick-up for private residences. The cities and townships in the study area are served by seven landfill sites. All of these sites, with the exception of the Elk River Landfill, the largest in the study area, and the Little Falls Landfill, have remaining useful lives of only 2 to 5 years. The Elk River site, which serves Becker and a number of other municipalities in Sherburne County, has a useful life of at least 15 years.

Fire Protection

Fire protection in the study area is provided by 21 municipal departments. It should be noted that those communities without their own fire department contract with one or more departments in nearby communities for firefighting services. Most of the departments are served by volunteers, with smaller staffs than recommended by insurance industry standards (ERT 1977h).

Police Protection

Twelve of the incorporated cities in the study area have their own police departments. These cities and the remaining communities in the study area are served by four county sheriff's departments. Discounting the city policemen, the region has only 0.42 officers per thousand population; a figure far below the national standard of 1.4 for a minimal level of protection (ERT 1977h). Over 160 full-time officers provide police protection to the study area.

Health Care

Three hospitals (Big Lake Memorial, Buffalo Memorial and St. Cloud Hospital) and 11 nursing homes and other long-term facilities are located within the study area. The three hospitals have an average occupancy rate of nearly 72%. Of the 468 existing beds, 336 are typically in use;

132 are vacant and available on any given day. The occupancy rate in the nursing homes and other long-term facilities, however, is about 95%. Of the 1,022 beds, 976 are in use with 46 vacant. It is estimated that in 1973 there were 115 physicians in the four-county region. Assuming the same number were in practice in 1975, each doctor provided primary care to 1,716 people.

Education

The study area is served by 13 school districts and a regional vocational center. School district boundaries have no relationship to community borders. Children from the township of Becker, for example, may attend schools in one of four districts.

Fifty-six elementary and secondary public schools are in the area. They have a combined current enrollment of 35,036. This is approximately 96% of the existing capacity (ERT 1977h). Several districts, however, have future expansion plans.

4.4 Air Quality and Meteorology

4.4.1 Regional Climatology

Most information on regional climatology has been derived from climatic atlases and summaries published by the U.S. Weather Service (1955 a,b, 1959, 1963, 1964 a,b, 1969, 1974). Data are available from first-order weather stations at Minneapolis and St. Cloud, as well as from a number of climatological stations that take less extensive measurements. In addition, information has been obtained from special studies and technical reports as referenced in the text. There are an adequate number of weather stations in Minnesota, and the climate is sufficiently uniform that representative statistics for the SHERCO site region are available.

The site region has a definite continental-type climate, characterized by marked extremes of temperature, relatively light winter precipitation and strong seasonal weather changes. It is subject to frequent outbreaks of continental polar air throughout much of the year, but also occasionally experiences prolonged heat in summer as warm, moist air from the Gulf of Mexico reaches the area. Storms originating in the western United States migrate eastward or northeastward through Minnesota, followed by colder polar air masses from the northwest (Strub 1959).

Average temperature range from approximately 12°F in January to 72°F in July. Annual precipitation in the site region averages 24 to 28 inches, about 60% of which falls during the May-September growing season. Snowfall is highly variable from year-to-year, but averages approximately 40 inches per year. Most of the spring and summer precipitation occurs as rain from thunderstorms, which are occasionally heavy.

Relative humidity is moderate, averaging 71% for the year with little seasonal variation. Prevailing winds are from the northwest in winter and from the south to southeast in summer. Annual average wind speed is 11 miles per hour.

Severe weather is infrequent but can occur, usually in the form of thunderstorms, or more rarely as tornadoes or ice storms. There is an average of about 35 days per year with thunderstorms, and an average of 0.6 tornadoes per year has been recorded in the one degree latitude-longitude square including the site.

Weather Extremes

The highest temperature recorded in the region was 107°F at St. Cloud in July 1936; the minimum in the same period was -42°F, also at St. Cloud in January, 1904. Maximum monthly rainfall was 12.81 inches in July, 1897 at St. Cloud, and several months over the years have recorded no precipitation in the region. Maximum 24-hour rainfall has been 7.80 inches at Minneapolis in July, 1892.

The maximum seasonal snowfall was 89 inches at Minneapolis in 1950-51. In the month of March, 1965, St. Cloud recorded 51.7 inches of snow. The estimated maximum possible snow load is 50 lbs/sq ft. (HHFA 1952).

Maximum rainfall amounts for short periods have been tabulated by the U.S. Weather Bureau (1963) and in Technical Paper No. 25 (1955) for first order weather stations in Minnesota. Maximum rainfall rates are 1.29 inches in five minutes, 2.68 inches in 30 minutes, 3.11 inches in one hour, and 7.80 inches in 24 hours. These values are the highest from among records for Minneapolis, St.Cloud and St. Paul, and should represent likely extremes for the site area.

Freezing rain (ice) storms occur on the average about once per year. According to a U.S. Army study (1959), a severe freezing rain storm can be expected to deposit 0.5 inches of ice once every two years, and 0.75 inches once every three years.

As previously stated, tornadoes occurred with a frequency of 0.6 per year in the one-degree square enclosing the site during the period 1953-62 (Thom 1963). This square covers approximately 3,350 square miles. Using Thom's method and average tornado path area, this implies a probability of a tornado striking a given point of 0.00051, or once in 1980 years. Further statistics on tornadoes are given in U.S. Weather Bureau Technical Paper No. 20 (1960). During the period 1953-58,

there were two tornadoes in Sherburne County, both of which originated in Wright County and crossed the Mississippi and both of which occurred in the month of May.

Highest wind speeds (except for tornadoes) at Minneapolis are 73 miles per hour in October 1949 and 63 miles per hour in June 1939. A 92-mph wind in July 1951 was associated with a nearby tornado. According to Thom (1968), there is less than a 1% chance that wind speed at a height of 30 feet will exceed 87 miles per hour in a 100-year period.

Holzworth (1972) gives data on occurrence of severe air pollution potential as defined by persistent conditions of light wind, low inversion and poor mixing. His results, for the five-year period 1960-64, show no occurrence of the most severe episode conditions for the site area. Moderate episodes lasting at least two days (with mixing height less than 1,000 meters and wind less than 4 m/sec) occurred once, as compared to frequencies from zero to 200 times for other portions of the U.S. Thus, extreme conditions leading to poor dispersion and stagnation are rare in the site region.

Local Meteorology

The local meteorology of the SHERCO plant site has been established from three sources: the Minneapolis and St. Cloud stations of the U.S. Weather Service and NSP's meteorological tower at the Monticello nuclear generating plant. Minneapolis airport is approximately 50 miles southeast of the SHERCO site, the St. Cloud weather station is approximately 20 miles northwest and the Monticello plant is four miles southeast of SHERCO. The Monticello data are clearly preferable from the standpoint of proximity, but all weather elements are not observed at the tower, and more importantly, only a relatively short period of data (two years) is available from that location. Because of the year-to-year variability of weather conditions, a longer record is preferable. Minneapolis provides the longest and most complete weather record for the area.

Accordingly, data from all three sources have been utilized to characterize site meteorology and define atmospheric impacts. Wind and stability measurements from the Monticello tower have been applied to

define atmospheric dispersion, to show the change of wind with height and to confirm that there are no significant differences in wind climatology between SHERCO and Minneapolis. St. Cloud and Minneapolis data have been used to define those weather elements not measured at Monticello, and to provide representative long-term statistics for prediction of plant impacts.

Temperature, Relative Humidity and Precipitation

Average temperature and relative humidity data for St. Cloud, based on 1931-1960 normals, are shown in Tables 4.4-1 and 4.4-2, respectively. These data can be taken as representative of the SHERCO plant site area.

Annual precipitation at the site averages approximately 26 inches. Table 4.4-3 gives 30-year precipitation normals and extremes for St. Cloud and shows that the heaviest precipitation (both average and extreme) occurs in the thunderstorm season, April through October.

Wind

Mean wind speeds, prevailing direction and highest speeds for Minneapolis are tabulated in Table 4.4-4. For St. Cloud, only mean speed and prevailing direction information is available. The annual mean speed at St. Cloud is 8.1 mph, considerably lower than the mean speed of 11.2 mph at Minneapolis. The difference may be largely due to different exposure of the instruments at the two stations.

Prevailing wind direction during winter in St. Cloud is west-northwest as compared to the northwest at Minneapolis. During July and August, St. Cloud shows a prevailing southerly wind compared to southeasterly for Minneapolis.

Wind roses for Minneapolis and the Monticello meteorological tower are shown in Figures 4.4-1 through 4.4-3. The Monticello 1974 wind rose for 10m (33 ft.) height agrees quite closely with the Minneapolis 1958-72 wind rose. This implies both that Minneapolis and site wind distributions are similar, and that 1974 was a typical and representative year. The much lower percentage of CALM conditions observed at Monticello is due to the sensitive micrometeorological wind sensors in use on the tower; their low threshold makes possible the measurement of very light air motions.

TABLE 4.4-1

AVERAGE TEMPERATURE FOR ST. CLOUD, MINNESOTA, 1931-1960

(degrees F)

Month	Daily Maximum	Daily Minimum	Monthly Mean
Jan	20.4	-0.2	10.1
Feb	24.3	2.5	13.4
Mar	35.3	15.8	25.6
Apr	53.6	31.9	42.8
May	67.4	43.7	55.6
Jun	76.6	53.8	65.2
Jul	83.1	58.9	71.0
Aug	80.5	56.7	68.6
Sep	70.7	46.9	58.8
Oct	58.9	35.6	47.3
Nov	38.1	20.8	29.5
Dec	25.7	7.4	16.6
Year	52.9	31.2	42.0

TABLE 4.4-2

AVERAGE RELATIVE HUMIDITY, ST, CLOUD, MINNESOTA, 20-YEAR RECORD*

(Percent)

Month	Midnight	6 A.M.	Noon	6 P.M.
Jan	76	76	68	71
Feb	76	77	65	69
Mar	78	80	63	66
Apr	75	81	54	54
May	74	79	50	49
Jun	82	84	56	55
Jul	85	87	55	56
Aug	85	90	57	58
Sep	85	89	58	64
Oct	79	85	57	63
Nov	80	82	66	72
Dec	79	80	72	75
Year	79	82	60	63

*Source: U.S. Environmental Science Services Admin. 1969. Local Climatological Data - Annual Summary, St. Cloud, Minnesota.

TABLE 4.4-3

SUMMARY OF PRECIPITATION STATISTICS - ST. CLOUD

(30 year normals 1931-1960)

Month	Normal Precip (in)	Max Monthly	Min Monthly	Max 24-hr	No. of days .01 in or more	No. of days 1.0 in or more snow
Jan	0.72	2.52	0.02	0.99	8	3
Feb	0.80	2.76	0.04	1.83	7	2
Mar	1.28	3.43	0.10	1.81	9	3
Apr	2.02	5.31	0.34	3.15	9	1
May	3.51	8.01	0.32	3.24	11	0
Jun	4.49	9.34	1.30	3.33	12	0
Jul	3.26	8.00	0.59	2.26	10	0
Aug	3.73	7.55	0.46	4.62	9	0
Sep	2.41	5.02	0.07	2.72	8	1/2
Oct	1.64	5.80	0.07	3.24	7	1/2
Nov	1.33	3.14	0.01	1.25	8	2
Dec	0.73	2.04	0.01	1.05	9	3
Year	25.92	9.34	0.01	4.62	108	13

TABLE 4.4-4

CLIMATOLOGICAL WIND STATISTICS FOR MINNEAPOLIS*

Month	Mean hourly[a] speed (mph)	Prevailing[a][b] Direction	Fastest Mile[c] Speed	Direction
Jan	11.2	NW	47	NW
Feb	11.4	SE	52	NW
Mar	12.2	NW	56	SW
Apr	12.6	WNW	58	N
May	11.8	SE	56	NW
Jun	10.6	SE	63	NW
Jul	9.7	SSE	92	W
Aug	9.7	SE	57	NW
Sep	10.9	SSE	50	NW
Oct	11.4	NNW	73	S
Nov	11.6	NW	47	NW
Dec	11.1	W	52	W
Year	11.2	SE	92	W

*Source: U.S. Weather Bureau, 1955a. Local Climatological Data, Minneapolis - St. Paul, Minnesota.

[a] based on 64 years of record.

[b] prevailing direction is the direction from which the wind blows during the greatest number of hours during the given time period.

[c] based on 44 years of record.

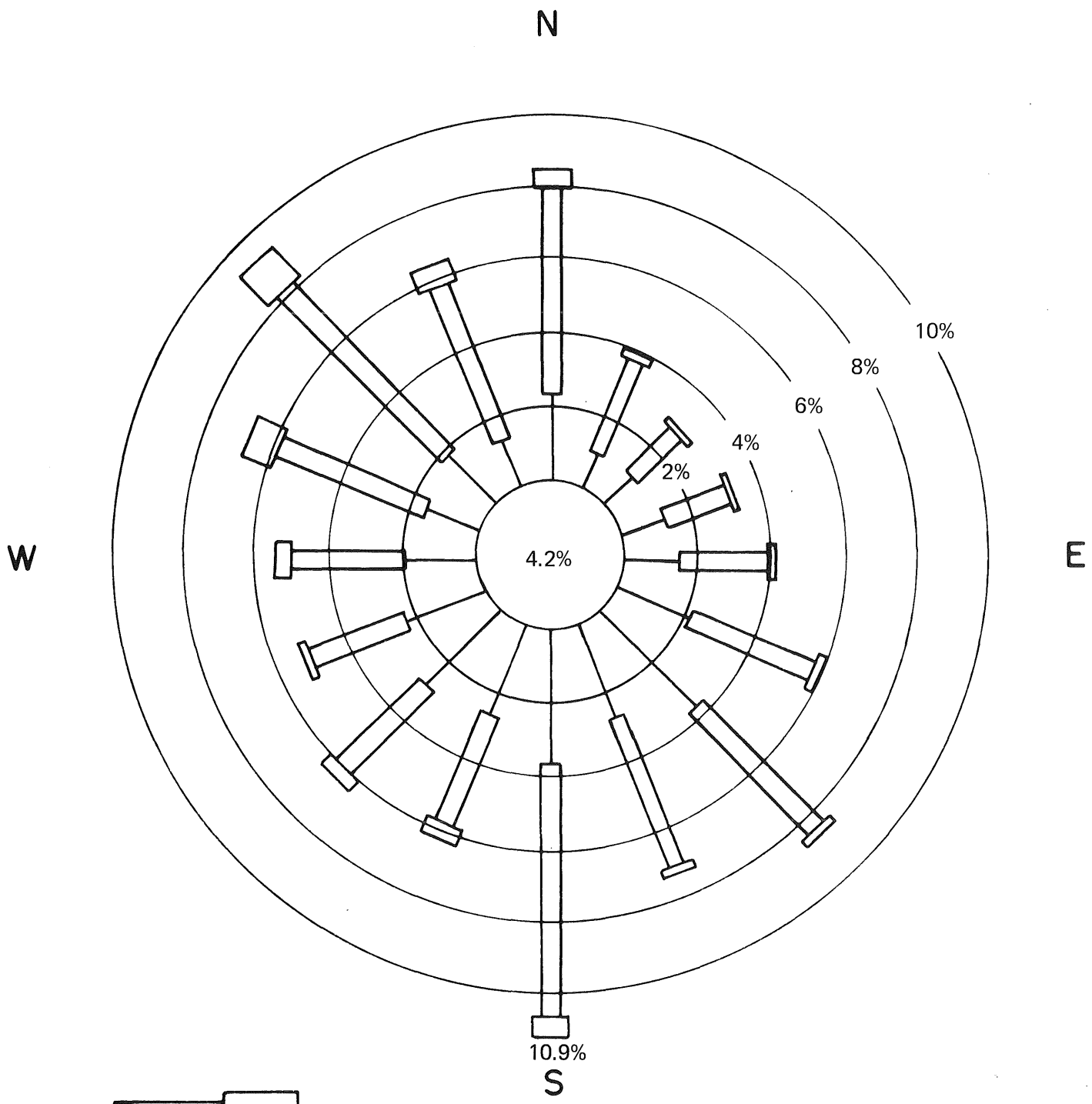

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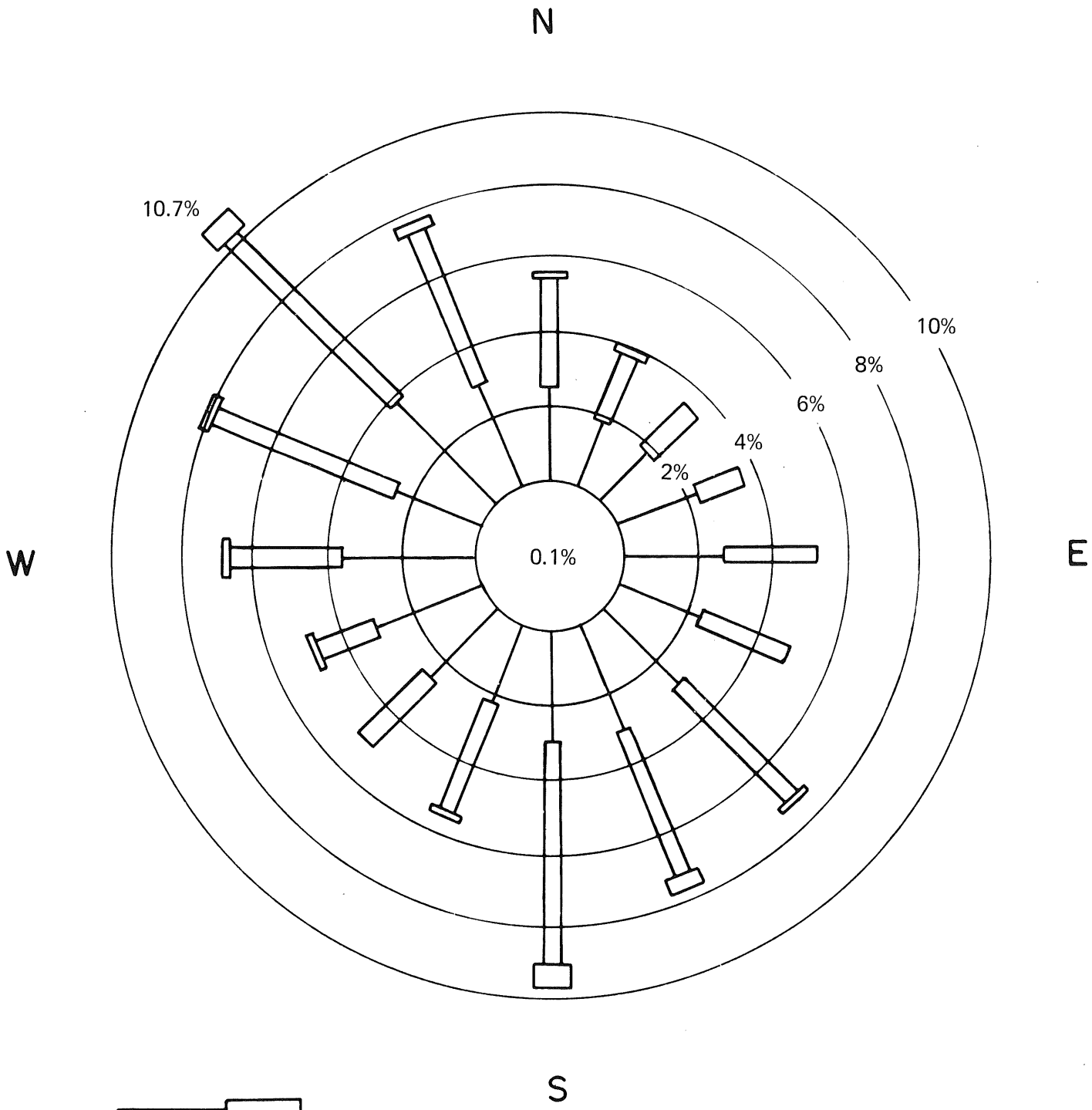
Figure 4.4-1 Minneapolis Annual Wind Rose 1958 - 1972

707041



MINNESOTA POLLUTION CONTROL AGENCY
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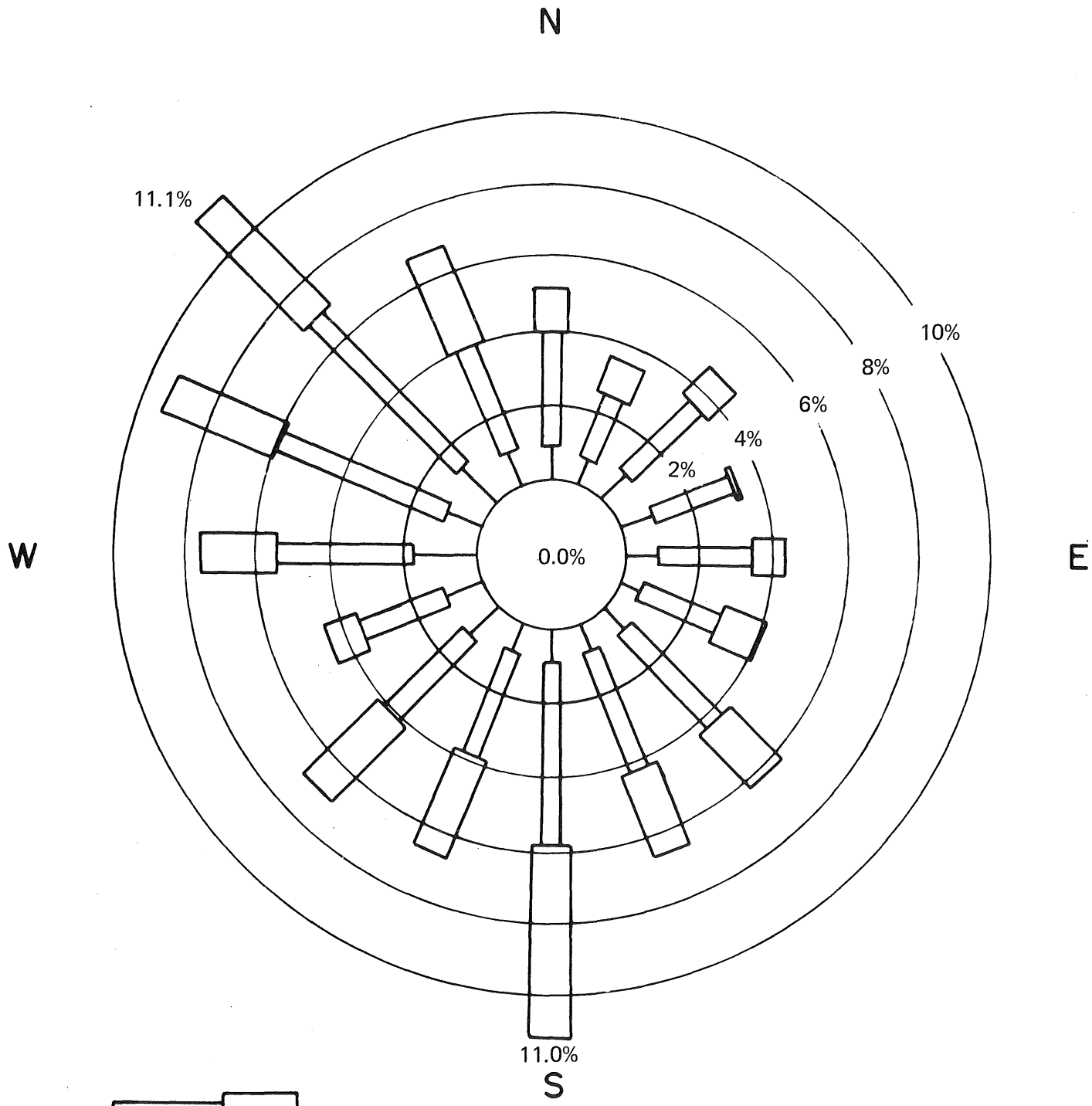
Figure 4.4-2 Monticello Annual Wind Rose 10 m (33 ft) 1974

707097



MINNESOTA POLLUTION CONTROL AGENCY
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Figure 4.4-3 Monticello Annual Wind Rose 100 m (328 ft) 1974

707096

The Monticello 100m (328-foot) wind rose illustrates the small change in wind direction occurring with increased height and, of course, the higher wind speed at that altitude. The average wind speeds for the three data samples considered are:

Minneapolis (1958-1972)	10.3 mph
Monticello 10m height (1974)	8.8 mph
Monticello 100m height (1974)	15.0 mph

Seasonal wind changes are illustrated in Figures 4.4-4 through 4.4-7, which show 15-year (1958-1972) Minneapolis wind distributions for each season.

Joint Wind, Temperature Humidity Statistics

To determine the characteristics and impact of cooling tower plumes, it is necessary to know the probability of various combinations of wind, temperature, and relative humidity. Such data are tabulated for Minneapolis only, and are given by the U.S. Weather Service (1963). Table 4.4-5 shows the annual joint distribution of these three variables for the 10-year period 1951-60. Monthly distributions are also available in the original reference.

Occurrence of Clouds, Fog, and Thunderstorms

The average cloudiness (percentage of the sky covered by cloud) in the site area is 60%. Table 4.4-6 gives data on daytime cloudiness for St. Cloud and Minneapolis. Cloud conditions are relatively uniform throughout the year, with a slight maximum in winter and early spring.

The occurrence of fog can be defined either in terms of "heavy fog" (visibility reduced to one-fourth mile or less) or any observation of fog regardless of visibility. Peace (1969) and Court and Gerston (1966) have published maps showing the distribution of "heavy fog" over the United States. Both sets of results indicate frequencies of 18 and 16 days per year, respectively, for the SHERCO site region. The most recent 16 years of record at St. Cloud gives a mean heavy fog occurrence of 23 days per year and 63 years of observations at Minneapolis average only eight days per year. Fog is a localized phenomenon that can depend

TABLE 4.4-5

ANNUAL JOINT DISTRIBUTION OF WIND, TEMPERATURE AND RELATIVE HUMIDITY-MINNEAPOLIS (1951-1960)

WIND	0-4 MPH						5-14 MPH						15-24 MPH						25 MPH and OVER						
Rel Humid / Temp °F	Under 30	30-49%	50-69%	70-79%	80-89%	90-100%	Under 30	30-49%	50-69%	70-79%	80-89%	90-100%	Under 30	30-49%	50-69%	70-79%	80-89%	90-100%	Under 30	30-49%	50-69%	70-79%	80-89%	90-100%	TOTAL OBS
104/100														+											+
99/ 95							1	2	1				1	3	1					+					8
94/ 90		1					3	16	10				1	15	8	+			+	1	+				54
89/ 85	+	3	3	+			5	43	39	1	+		3	27	20	1			+	1	1				147
84/ 80	1	6	8	3	1		9	76	79	21	3		8	41	31	5	1		1	2	1	+	+		295
79/ 75	2	7	13	8	5	1	15	90	117	50	26	4	10	49	44	14	6	1	1	4	3	+	+		468
74/ 70	1	8	24	14	13	9	14	82	133	71	68	35	9	53	42	19	13	5	1	4	2	1	1	+	621
69/ 65	2	7	18	20	25	23	16	69	126	82	86	66	10	42	44	18	16	14	3	2	2	1	+	1	690
64/ 60	1	8	21	18	30	30	13	65	114	80	82	69	10	40	44	22	19	15	2	5	3	1	1	1	695
59/ 55	1	8	17	18	24	22	8	56	98	67	80	52	7	32	41	21	24	17	1	4	3	1	1	1	602
54/ 50	1	7	16	13	22	19	7	51	92	52	61	54	7	32	40	20	17	18	1	3	5	1	1	1	538
49/ 45	1	5	17	10	16	18	4	38	93	51	49	45	3	30	46	18	16	14	1	2	4	1	+	1	482
44/ 40	+	3	15	13	13	13	2	34	98	59	53	41	1	21	52	27	22	20	+	3	6	3	2	2	500
39/ 35		3	12	14	18	11	+	22	94	76	73	56	+	11	55	43	33	25		1	6	4	2	1	560
34/ 30	+	1	11	11	19	26		10	87	86	101	87		8	49	47	36	33		1	5	6	3	5	632
29/ 25		2	11	13	23	17	+	7	81	99	115	81		5	40	43	38	22		1	3	3	4	2	609
24/ 20		1	7	13	22	16		7	62	85	115	48		4	38	32	36	16		1	2	3	3	5	514
19/ 15		1	7	12	17	12		8	63	72	71	18		5	37	32	19	3		+	1	3	2	1	383
14/ 10			9	12	22	6		10	61	65	57	5		5	29	21	7	+		+	2	1	1		311
09/ 05		2	9	12	17	1		10	62	53	26	+		5	30	14	3			+	1	1	+		246
04/ 00		1	10	14	9	1		7	57	38	8			6	28	6	+			+	1				186
-01/-05			5	10	6	+		5	43	25	3			4	15	2				+	+				119
-06/-10			5	8	2			3	24	10	1			2	6	1				+	+				62
-11/-15			4	6		+		2	9	5				1	3	+					+				31
-16/-20			1	1				1	4	2					1	+									10
-21/-25			+	+					2	1															4
-26/-30				+					+	1															2
TOTAL	10	71	243	245	302	224	94	713	1649	1149	1077	660	67	438	744	407	304	202	11	35	52	28	22	21	8767

TABLE 4.4-6

NUMBER OF DAYS OF CLEAR, PARTLY CLOUDY, AND CLOUDY WEATHER

	Minneapolis[a] (65 years of record)			St. Cloud[b] (30 years of record)		
Month	Clear	Partly Cloudy	Cloudy	Clear	Partly Cloudy	Cloudy
Jan	8	9	14	10	8	13
Feb	8	8	12	10	8	10
Mar	8	9	14	9	9	13
Apr	8	8	14	10	8	12
May	8	10	13	10	9	12
Jun	7	12	11	10	9	11
Jul	11	12	8	13	10	8
Aug	11	12	8	12	10	9
Sep	11	9	10	12	7	11
Oct	11	8	12	11	7	13
Nov	7	8	15	8	7	15
Dec	7	8	16	9	7	15
Year	105	113	147	124	99	142

*Sky cover is expressed in a range of 0 for no clouds to 10 for complete overcast. The number of clear days is based on average cloudiness 0-3, partly cloudy days 4-7, and cloudy days 8-10.

[a]Source: U.S. Weather Bureau, 1955a. Local Climatological Data, Minneapolis - St. Paul, Minnesota.

[b]Source: U.S. Environmental Science Services Admin, 1969. Local Climatological Data - Annual Summary, St. Cloud, Minnesota.

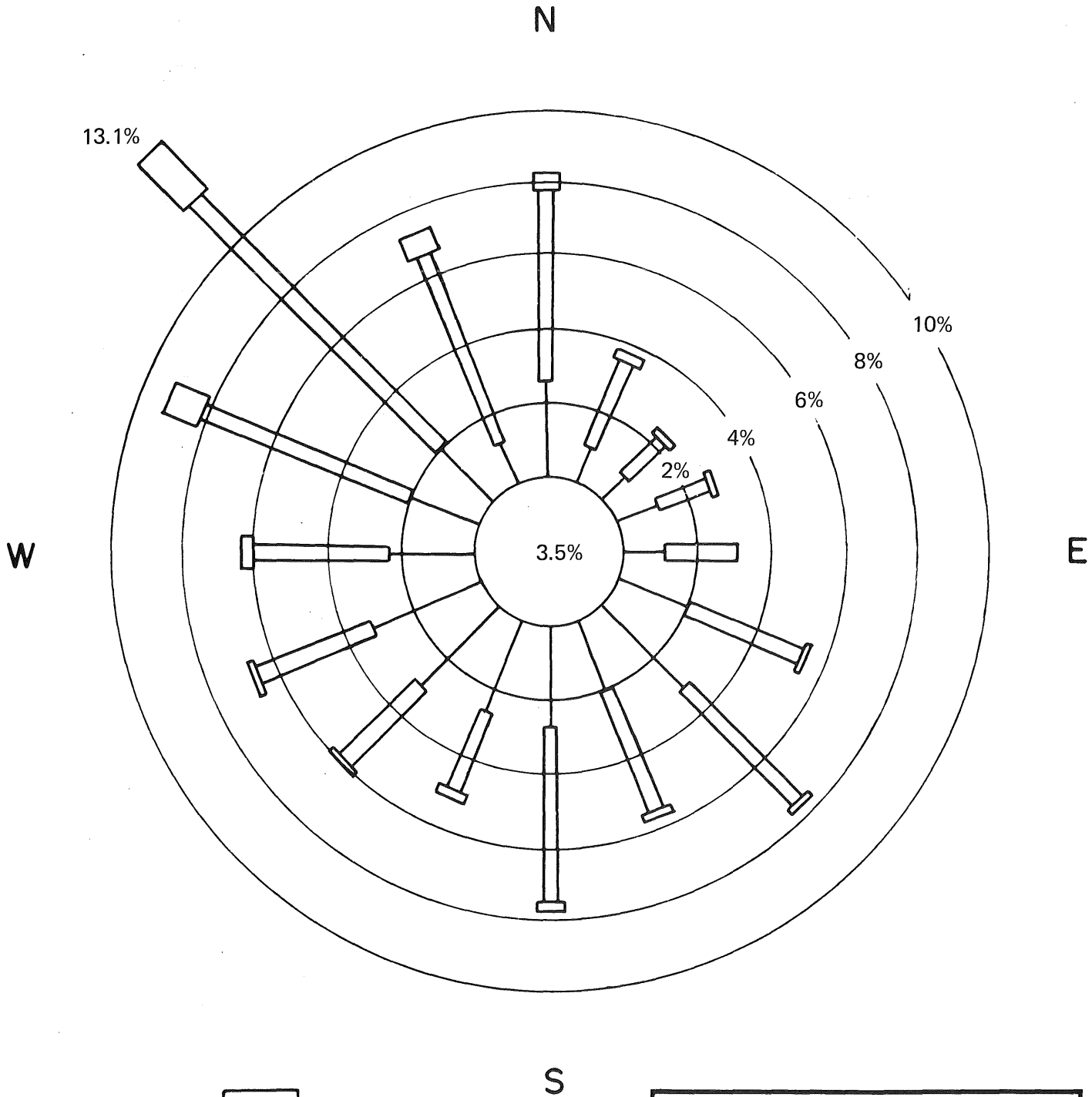

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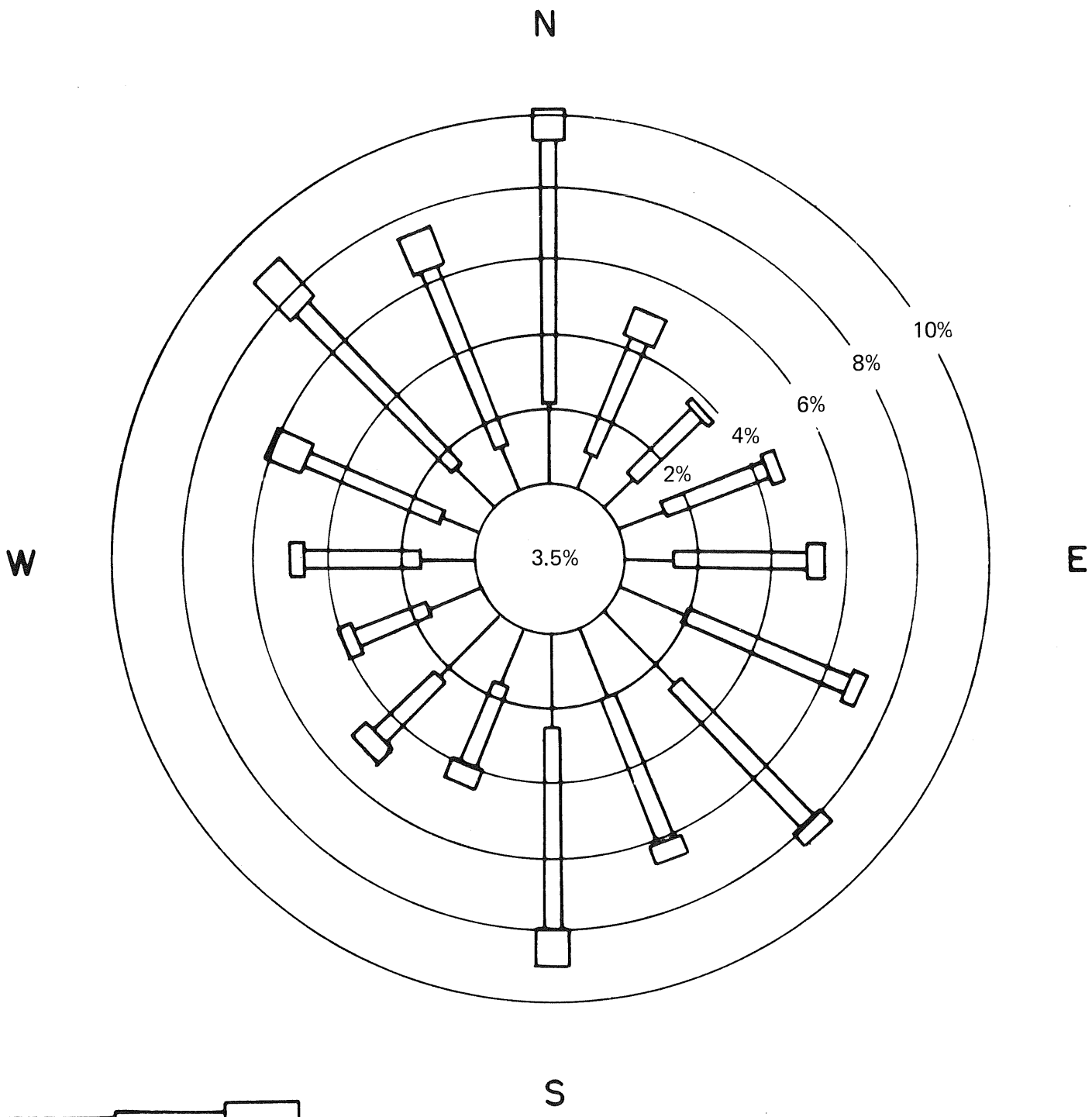
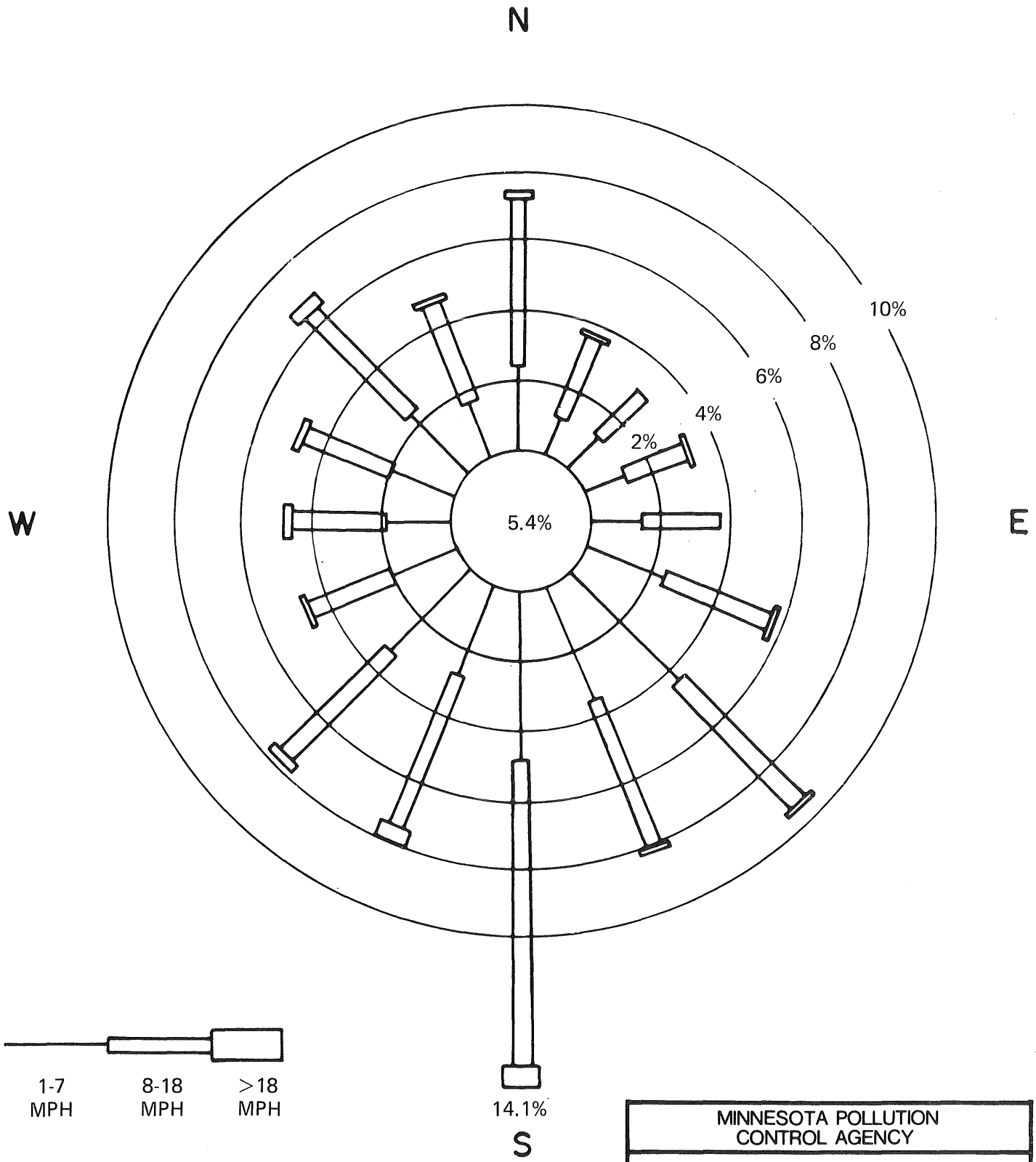
Figure 4.4-4 Minneapolis Winter Wind Rose (Dec, Jan, Feb) 1958 - 1972

707100



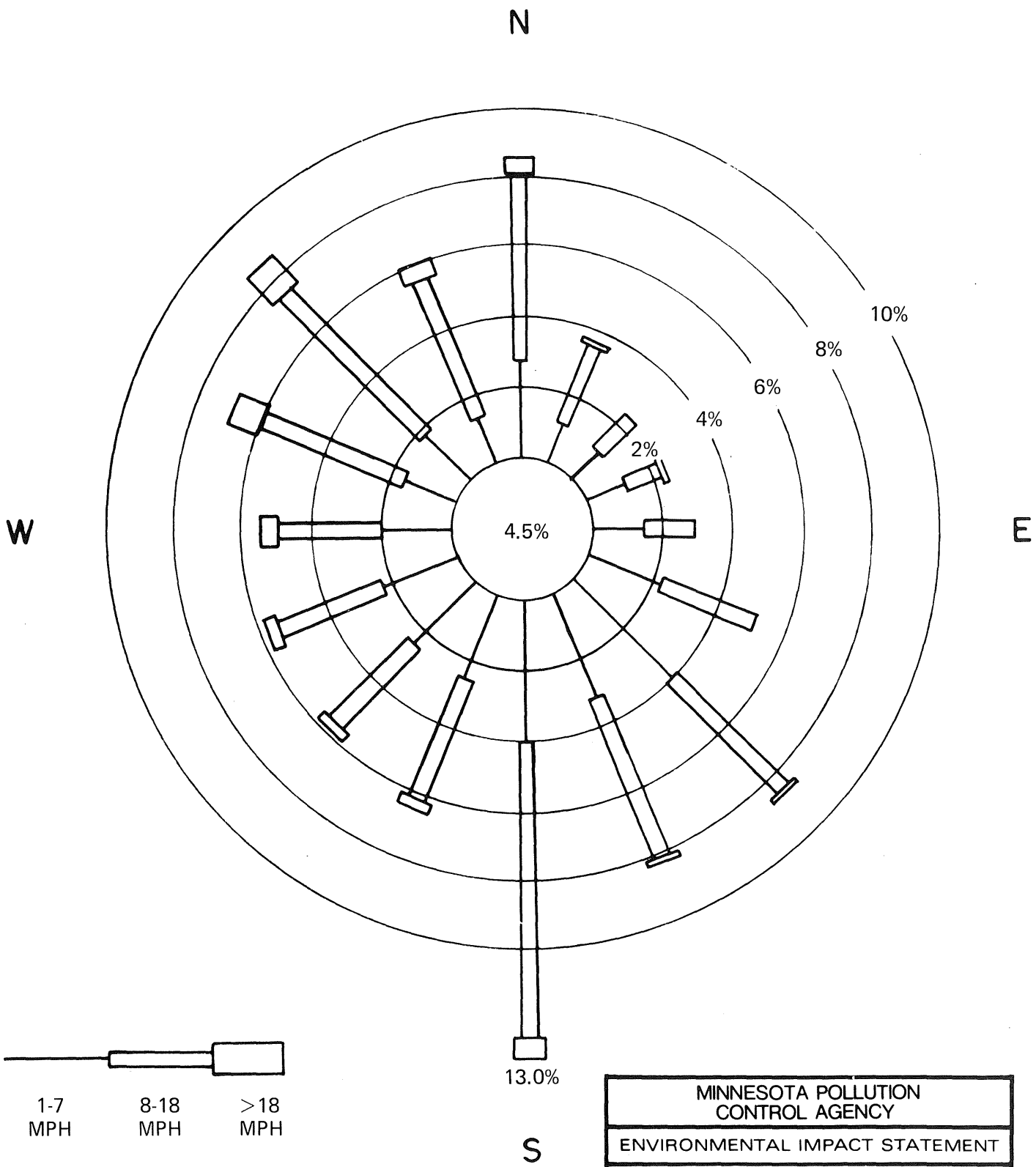
MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.4-5 Minneapolis Spring Wind Rose (Mar, Apr, May) 1958 - 1972

707101



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.4-6 Minneapolis Summer Wind Rose (Jun, Jul, Aug) 1958 - 1972

707098



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.4-7 Minneapolis Fall Wind Rose (Sept, Oct, Nov) 1958 - 1972

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heavily of local topography, presence of bodies of water and nighttime air flow patterns on cold nights. Therefore, fog frequency often varies substantially over short distances. No data are available from the SHERCO plant site, but in the absence of local features that would tend to promote fog formation, it is estimated that heavy fog occurs there from 15 to 20 days per year.

At Minneapolis, horizontal visibility is reduced to less than seven miles 11.5% of the time or about 1,000 hours per year. Visibility reduction is often caused by fog, but also results from smoke and haze, precipitation and blowing dust and snow. It is estimated that fog of any intensity occurs at the SHERCO site for approximately 250 hours per year. Fog is most likely in the early morning hours (5-9 AM), in late summer, fall and winter.

Thunderstorms occur on an average of 35 days per year at St. Cloud and 38 days at Minneapolis. They are most likely from May through September.

Atmospheric Dispersion Data

Prediction of atmospheric dispersion for plant emissions requires joint frequency data on wind speed, wind direction, and stability. Stability is a measure of the extent of turbulent mixing in the atmospheric boundary layer, and it can be inferred either from the vertical gradient of temperature, or by empirical relationships to conventional surface weather parameters.

Another important parameter for modeling of atmospheric dispersion is the mixing depth - the altitude to which pollutants emitted at or near the ground may be expected to be mixed. Mixing depth is determined largely by the existence of stable layers or inversions that limit vertical turbulence at some height above the ground. Daily maximum and minimum mixing depths are calculated by the U.S. Weather Service.

Topographic Description

The topography in the vicinity of the SHERCO plant site is flat to gently rolling and there are no marked topographic features in the area. The Mississippi River is at an elevation of approximately 920 feet msl,

plant grade elevation will be about 968 feet, and the highest terrain within five miles in any direction reaches 11,050 feet (to the southwest).

Because of the level terrain, there are no significant effects on local meteorology. The Mississippi River probably produces slight increases in humidity and fog frequency in its immediate vicinity, and there will be weak drainage of cold air into the river valley during calm winter nights. The shallowness of the valley, its distance from the plant facilities and the very small magnitude of these influences prevent any significant effect on site meteorology.

4.4.2 Air Quality Regulations

The construction and operation of a large coal-fired steam electric power generating plant, like the SHERCO facility, presents several means for affecting air quality. Pollutant emissions from three distinguishable areas of plant activity are directly responsible for all large scale air quality impacts associated with such a plant. First, the combustion of the coal used to fuel the plant results in significant emissions of pollutants from the power plant stack. Stack emissions consist of combustion gases and particulate matter released during the oxidation of the coal. The particulate matter often includes small quantities of heavy metals which are toxic. Second, the cooling towers associated with a large power plant may emit salts into the vapor of the cooling tower plume. The mositure of the cooling tower plume itself may be a problem as well in that potential for local fog and icing conditions may be enhanced. Lastly, the coal handling facilities of large power plant create the potential for generating significant quantities of airborne fugitive dust.

New and modified electric generating facilities are required to meet the appropriate federal and state air pollution regulations for both rate of emission release and resulting ambient air quality impact.

The NSPS restrict stack gas emissions in terms of pounds per day or pounds per Btu. In particular the emissions of SO_2, TSP and NO_2 are restricted to 1.2, 0.1 and 0.7 pounds per million Btu of heat input, respectively. As a result, stack emissions of these pollutants have a fixed upper design limit.

The effects the plant may have on ambient air quality are regulated in each of two ways. First, there are absolute levels of pollutant concentrations (i.e., ambient air quality standards) that are not to be exceeded. A second tier of air quality regulation has recently been added in the form of Prevention of Significant Air Quality Deterioration (PSD) Standards. The PSD regulations provide increased pollution concentration increments for each of three classes of air quality sensitivity according to land use.

Table 4.4-7 lists the applicable ambient air quality standards. The higher, primary standards are based upon levels thought to be required to protect human health. The lower, secondary standards are designed to prevent damage to vegetation, materials and aesthetics. The Minnesota regulations are the same as the federal for TSP and NO_2. The Minnesota SO_2 regulations, however, are more stringent. The 3-hour standard is approximately one-half of the federal. Table 4.4-8 lists the existing regulations for PSD. These levels, designated for the Class I, II and III areas, are set to regulate incremental increases of TSP and SO_2 from new sources within regions meeting secondary ambient air quality standards. The class description indicates the amount of energy or industrial growth desired. These "classes" were established by the EPA based upon the following criteria.

- Class I - Applies to areas in which practically any air quality deterioration would be considered significant, thus allowing little or no energy or industrial development.
- Class II - Applies to areas in which deterioration that would normally accompany moderate, well-controlled growth would not be considered significant.
- Class III - Applies to areas in which deterioration would be permitted to allow concentrated or very large scale energy or industrial development, as long as the national secondary ambient air quality standards are not exceeded.

TABLE 4.4-7

AMBIENT AIR QUALITY STANDARDS ($\mu g/m^3$)

Protection of Public Health and Welfare

Pollutant	Averaging Time	Federal		Minnesota	
		Primary	Secondary	Primary	Secondary
Sulfur Dioxide	Annual	80	-	60	60
	24-hour	365*	-	260*	260*
	3-hour	-	1300*	655*	655*
Total Suspended Particulates	Annual	75**	60**	75**	60**
	24-hour	260*	150*	260*	150*
Nitrogen Oxides (measured as NO_2)	Annual	100	-	100	100

*Not to be exceeded more than once per year.

**Annual Geometric mean.

TABLE 4.4-8

EPA REGULATIONS FOR ALLOWABLE AIR QUALITY INCREMENTS
FOR PREVENTION OF SIGNIFICANT DETERIORATION ($\mu g/m^3$)

Pollutant	Standard	Class I	Class II	Class III
Total Suspended Particulates	Annual	5	10	75
	24-hour	10	30	150
Sulfur Dioxide	Annual	2	15	80
	24-hour	5	100	365
	3-hour	25	700	1300

The entire country currently is designated Class II, while some urban areas are de facto Class III areas.

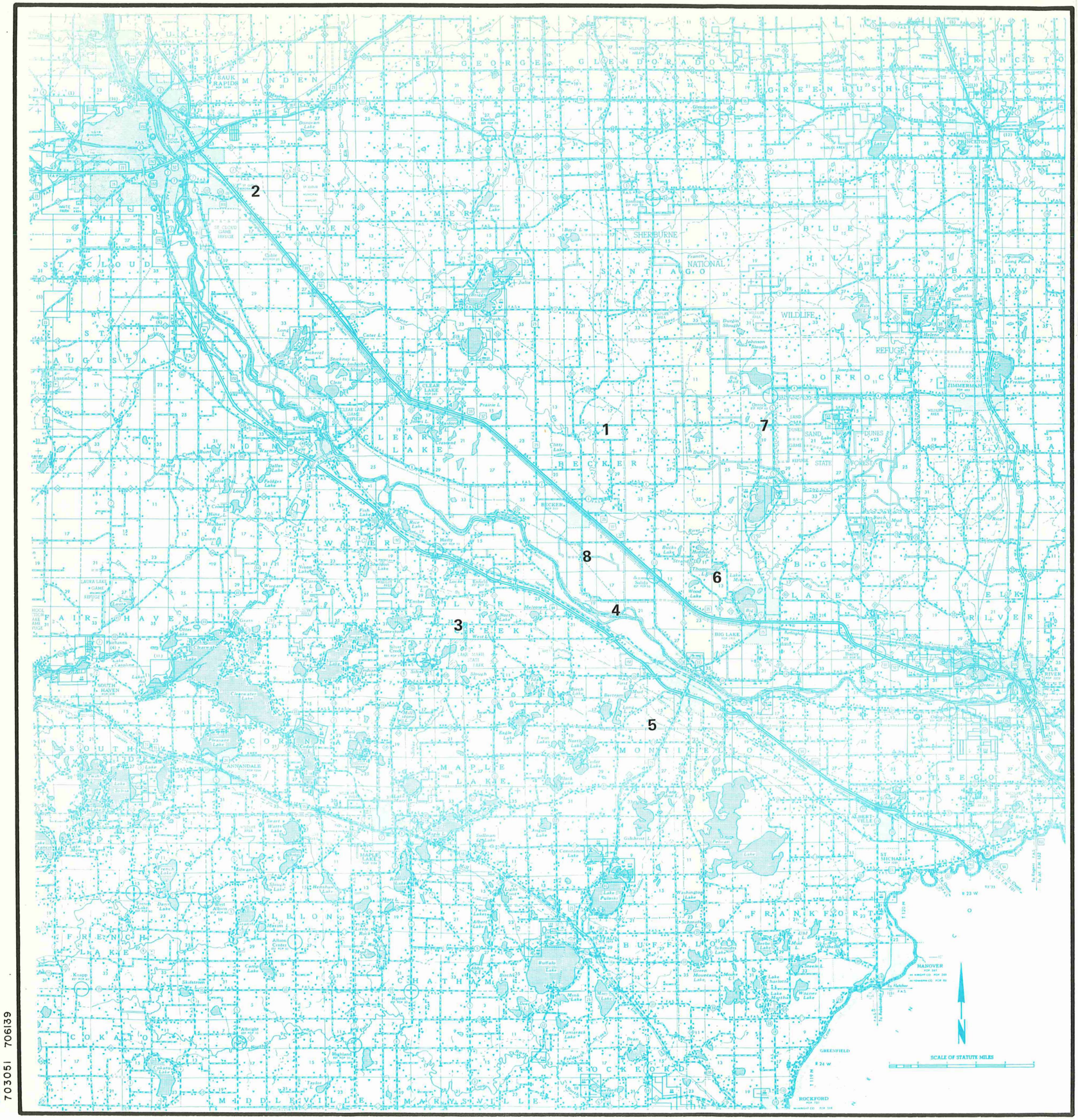
4.4.3 Baseline Air Quality Conditions

NSP currently maintains an eight-station air quality monitoring network in the vicinity of the SHERCO facility. These monitor locations were selected for the purpose of establishing baseline or "background" pollutant concentrations in areas eventually expected to experience highest SHERCO-related impact of SO_2, TSP and NO_x. ERT conducted a technical evaluation of NSP's ongoing air quality monitoring program, reviewed the air quality data gathered during the plant's pre-operative period to determine its adequacy and evaluated the utility of the data base for defining the air quality in the vicinity of the SHERCO facility. The results of this program indicated that portions of the data base were suspect or invalid. While this determination precludes using this monitoring data to derive quantitative "background" concentrations and because this was the only available data, the data were used to estimate the potential for violating standards.

The following discussion of existing air quality and the subsequent use of maximum monitored concentrations is presented in order to assess the impact of the SHERCO emissions on ambient pollutant levels. Clearly, these monitored values may over or underestimate background concentrations. However, previous air quality studies of rural environments conducted by ERT have evidenced similar pollutant magnitudes and trends.

Portions of the data base presented in the discussion of existing air quality include individual suspect values and disregard individual highly anomalous values. This analysis is differentiated from the data audit results and was performed in order to provide the best available estimates of background concentrations utilizing available monitoring data.

The locations of the monitoring stations are shown in Figure 4.4-8. Seven sampling sites are situated outside the facility boundaries and one site is within the facility boundaries. SO_2, TSP and NO_2 samples are collected at each station. SO_2 is measured continuously, while TSP and NO_2 are monitored on a one-in-six-day frequency at each location.



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MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.4-8
Locations of Existing Monitor Stations

TABLE 4.4-9

1975 MONITORED AMBIENT SO_2 CONCENTRATIONS ($\mu g/m^3$)
MEASURED BY SHERCO MONITORS[†] °

	3-Hour Average*		24-Hour Average*		Annual Average
Standard**	655		260		60
Monitoring Station	Highest	Second Highest	Highest	Second Highest	
1	79	71	42	26	13
2	58	39	26	21	13
3	71	58	24	21	13
4	97	97	45	34	17°
5	123	97	39	37	13
6	79	71	37	24	13
7	105	86	55	47	16°
8	71	71	26	21	13

[†]Questionable data were not included in the analysis of 3-hour and 24-hour averages.

*Nonoverlapping averaging periods

**Most stringent of the federal and state standards

°Portions of data are suspect.

TABLE 4.4-10

MONITORED AMBIENT TSP CONCENTRATIONS ($\mu g/m^3$)
MEASURED BY SHERCO MONITORS BETWEEN
JUNE 23, 1976 AND MARCH 14, 1977[Δ]

	24-Hour		9-Month Average
	Highest	Second Highest	
Standard*	150		60**
Monitor Site			
1	216	102	41
2	154	142	37
3	234[Δ], 221	179[Δ], 173	67[Δ]
4	166	158	46
5	129	126	43
6	164	94.5	42
7	165	150	49
8	165	149	51

*Most stringent of federal and state standards.

**Annual geometric mean.

[Δ]Suspect data.

TABLE 4.4-11

MONITORED AMBIENT NO_2 CONCENTRATIONS ($\mu g/m^3$)
MEASURED BY SHERCO MONITORS BETWEEN
MARCH 11 1975 AND JANUARY 24, 1976 Δ

Monitor Site	Number of Samples	Arithmetic Average
1	52	13
2	52	14
3	52	10
4	51	17
5	53	15
6	50	15
7	53	11
8	51	14

(NO_2 annual average standard - 100 $\mu g/m^3$)

Δ Suspect data

The existing level of air quality in the vicinity of the SHERCO facility was analyzed using the best available data obtained from the SHERCO monitors. These data were analyzed to determine the maximum monitored SO_2, TSP and NO_2 levels during each of the appropriate averaging times. A review of the data indicated that there were several maximum short-term averages of questionable validity (e.g., a 3-hour SO_2 value of 7,867.86 $\mu g/m^3$). The questionable data were not included in the assessment of 3- and 24-hour average concentrations since they would inappropriately bias the baseline assessment. Values reported by NSP as being invalid were also not used. The air quality data used as a result of this analysis are presented in Tables 4.4-9, 4.4-10 and 4.4-11.

The SO_2 data monitored in 1975 are representative of ambient levels experienced at the monitoring sites prior to the operation of SHERCO Unit 1. Except for two suspect 3- and 24-hour averages, these data indicate the ambient levels of SO_2 did not exceed any of the appropriate standards. Since neither the 3- nor 24-hour SO_2 standards are to be exceeded more than once per year, it is necessary to examine the second highest non-overlapping average for each of these periods. These values are compared to the Minnesota SO_2 standards since they are more stringent than the federal standards. The maximum second highest 3-hour average was 97* $\mu g/m^3$ or 15% of the state 3-hour standards. The maximum second highest 24-hour average was 47 $\mu g/m^3$, or 18% of the state 24-hour standards. The maximum annual average was 17 $\mu g/m^3$, or 28% of the state annual standards.

The available TSP data were monitored during the period June 23, 1976 and March 14, 1977. During this period SHERCO Unit 1 was operational. These data indicate that some of the monitors experienced TSP levels which exceed the appropriate standards. Some of the monitors are located near construction activities, agricultural fields or gravel roads, and therefore, these monitors may be recording the local-scale impact of these sources. Since the 24-hour TSP standard cannot be exceeded more than once per year, it is necessary to examine the second highest 24-hour average TSP level monitored at each station. The

*Suspect data as determined by an air quality audit.

maximum second-highest 24-hour average TSP concentration was 173* $\mu g/m^3$ or 67% and 115% of the federal and state primary and secondary 24-hour standards, respectively. The maximum nine-month average was 67 $\mu g/m^3$ or 112% of the federal and state primary and secondary annual standards, respectively.

An examination of the NO_2 data for the period March 11, 1975 to annual January 24, 1976 indicates that ambient NO_2 did not approach the NO_2 standard (100 $\mu g/m^3$). The highest 10-month average experienced during this monitoring period was 17* $\mu g/m^3$.

*Suspect data as determined by an air quality audit.

4.5 Water Quality

Historical Water quality data obtained from a variety of sources are used to estimate existing ground-water conditions at the SHERCO facility and surface water conditons on the Mississippi River upstream and downstream of SHERCO. Water quality analyses were conducted by the U. S. Geological Survey, NSP and the City of Minneapolis over the period 1957-1976. The following sections summarize baseline water quality conditions at the SHERCO site.

4.5.1 Surface Water

The Mississippi River borders the site to the south. There are no other streams, rivers, or other waterways flowing into the Mississippi River on or near the SHERCO site. Likewise, there are no natural lakes or ponds on or near the site.

Values for typical concentrations of Mississippi River water at SHERCO were estimated on the basis of available water quality data upstream and downstream of the site. Surface water on the SHERCO facility is considered hard, but is generally good quality. With the exception of slightly elevated dissolved iron and manganese concentrations, most major water quality components are present at levels below those specified as limits by Minnesota Water Quality Standards.

The most important baseline surface water quality components in terms of potential percentage increase due to project activity are sulfates, nitrates, hardness, and total dissolved solids (ERT 1977b). Concentrations of these constituents and corresponding Minnesota Water Quality Standards are listed in Table 4.5-1. Concentrations of water quality components were compared to permissable limits for various possible uses, including drinking water, industry, recreation, irrigation and livestock. In each case, the permissible limit presented in Table 4.5-1 represents the most restrictive limit associated with these various uses.

The existing river water quality is acceptable for its current downstream uses including irrigation and livestock, recreation, and industrial use. The Minneapolis Water Treatment Plant downstream from SHERCO

supplies water for domestic consumption and currently treats Mississippi River water for removal of calcium and magnesium hardness.

The concentration of chemical constituents in Mississippi River water varies with changes in river flow. Parameters such as total residue, total alkalinity, and total hardness increase in concentration with decreases in river flow. These relationships reflect fundamental hydrologic processes and characteristics of the upstream watershed. The patterns suggest the dominance of groundwater contribution to total river flow during low-flow periods and dilution by runoff during periods of high-flow. These relationships are used as partial bases for assumptions concerning baseline water quality during low flow periods.

4.5.2 Groundwater

Samples from eight existing wells at the SHERCO facility were analyzed by NSP over the period November 75 - December 76. These wells are widely distributed over the facility and in all cases draw water from the glacial deposits which mantle the granite bedrock.

Median values were computed from this available data and represent typical concentrations of water quality components in the groundwater at the SHERCO site. Typical concentrations of selected groundwater constituents and corresponding water quality standards are presented in Table 4.5-1. Groundwater on the SHERCO facility is of generally good quality, is hard, and as is typically the case, contains generally higher concentrations of dissolved solids than surrounding surface water (ERT 1977b).

TABLE 4.5-1

TYPICAL CONCENTRATIONS OF SELECTED WATER QUALITY COMPONENTS IN SURFACE WATER AND GROUNDWATER AT THE SHERCO FACILITY

Component	Concentration in mg/liter Surfacewater	Groundwater	Permissible* Limit	WPC 15* Use Category
Total Dissolved Solids	187	250	500	1B
Total Hardness	158	208	250	3B
Calcium Hardness	100	143	-	-
Magnesium Hardness	58	65	-	-
Nitrate Nitrogen	.22	5.9	10**	**
Sulfate	12.	15	250	1B

*Permissible limits are based on the classifications assigned to the Mississippi River at SHERCO in Minn. Reg. WPC25 and defined in Minn. Reg. WPC 15. For each constituent, the most restrictive use category is shown along with the permissible limit for this use. Category 1A refers to domestic consumption and 3B to Industrial consumption. Other use categories with less restrictive limitations for these constituents are Fisheries and Recreation Use, and Agricultural and Wildlife use.

**Minnesota Water Quality Standards do not specify a permissible limit for Nitrate Nitrogen. 10 Mg/l is the drinking water standard recommended by the EPA (1976).

4.6 Baseline Noise Levels

4.6.1 General Characteristics of Community Noise

The noise environment of a typical community has a base of steady background noise that is the sum of many distant noise sources. Superimposed on the background noise is the noise of the individual local sources, which can vary from an occasional aircraft flying over, to the virtually continuous noise from the traffic on a major freeway.

To describe noise environments and to assess impact on noise-sensitive areas, a frequency weighting measure that simulates the human perceptions is customarily selected. A-weighted ratings of noise sources, which reflect the human ear's reduced sensitivity to low frequencies, have been found to correlate well with human perceptions of the annoying aspects of noise. Consequently, A-weighted noise levels, described in decibels-A or dBA, are the values cited by federal and state agencies such as the Federal Highway Administration (FHWA) and MPCA in their noise criteria. Noise levels can often be predicted knowing the general characteristics of the source and its surroundings. Table 4.6-1 identifies noise levels, in dBA, associated with common sources of noise.

Both the fluctuation of the noise level and the maximum noise levels are important in assessing potential noise impact. Noise fluctuation may be described by determining those levels exceeded a certain percentage of the time. For a specified time period, the L_{90} (or the noise level exceeded 90% of the time) is generally considered as background. The L_{50} level represents the median noise levels. The L_{10} (or the level exceeded 10% of the time) is generally indicative of the higher noise levels occurring over the given time period. The L_{10} levels are those used as reference by FHWA. The L_{10} and L_{50} levels are those employed in the MPCA's noise regulations.

Noise impact may be judged by two criteria. First, noise levels projected for a proposed development must not exceed the relevant federal, state or local standards or regulations. The second

TABLE 4.6-1

COMMON NOISE LEVELS*

Sound Levels (dBA)	Associated Activity
130	Threshold of Pain
120	Chipping on Metal
110	Rock Band
100	Jack Hammer
	Jet Take-off (1/2 mile)
90	Threshold of Hearing Damage
80	Shop in Shipyards
	Busy Freeway
70	Downtown Traffic
	Electric Typewritter
60	Normal Conversation
	Dog Barking
	Urban Residential Area (Nearby Traffic)
50	Drafting Office
	Crickets in Evening and Night
40	Suburban Neighborhood (Distant Traffic)
	Private Office
30	
20	Quiet Rural Area (No Traffic)
10	
0	Threshold of Audibility

*Adapted for Acoustical Seminar, Robin M. Towne & Associates, 1971. (These values are approximate, involve typical observer to source distances, and do not reflect specific situations described in this report.)

measure of impact recognized by the noise analysts is the change in noise level above the existing ambient. Both types of impact have been investigated for the proposed SHERCO plant expansion.

4.6.2 Noise Regulations

Various federal agencies have regulations affecting noise emissions from specific sources (highways or aircraft) or permitted noise levels at specific receptors (FHA-financed housing projects). However, there are no federal community noise regulations or standards that apply directly to either the construction or operation of the NSP SHERCO plant expansion. The only community noise standards pertaining to the proposed project are MPCA regulations NPC-1 and NPC-2. NPC-1 contains definitions, thresholds and variance provisions for the MPCA noise pollution control regulations. (Under certain circumstances, including problems involving practicality and feasibility of compliance with these standards, the MPCA may grant a variance.) The MPCA regulation NPC-2 limits L_{10} and L_{50} (hourly) noise levels with a day-night distinction, according to a three-tier noise area classification (NAC) scheme. The most restrictive noise area classification is NAC-1, which represents various forms of human habitations ranging from single family dwelling units to camping areas and hotels. NAC-2 generally represents nonresidential, public area type of activity spaces, such as transportation terminals and commercial establishments. NAC-3 pertains to manufacturing, industrial and agricultural land uses. (A fourth category, NAC-4, generally represents undeveloped land; there is no standard applicable to this category.)

These noise standards are shown in Table 4.6-2.

TABLE 4.6-2

MPCA NOISE STANDARDS (dBA)

	Day (0700-2200)		Night (2200-0700)	
NAC	L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

The land activities nearest the SHERCO site are agriculture (which falls under NAC-3) and household units and farmhouses (which fall under NAC-1).

If a development causes an increase to the existing ambient noise level, even if the projected overall noise levels are within statutory maximum levels, an intrusion or impact in residential communities, schools, parks and other sensitive receptors will be perceived. However, the degree of impact is difficult to assess due to the highly subjective character of human perceptions of changes in noise. Empirical studies have shown that people in outdoor noise environments can distinguish changes in noise level of 5 dBA. Thus, changes in noise levels less than this amount may generally be considered minor unless applicable noise standards are exceeded. For changes above 5 dBA, it is difficult to quantify the extent of impact except to state that the greater the change in noise level and the greater the number of people exposed, the greater will be the impact. Judgment currently being used in noise impact analysis associates noise increases of 5 to 15 dBA with "some impact". Noise-level increases of more than 15 dBA are generally considered severe even when total ambient noise levels remain within applicable standards.

4.6.3 Noise Sensitive Receptors and Sources

Noise sensitive receptors are considered here to be those areas or land uses in which people could potentially be adversely affected by the environmental noise from the proposed project. Noise sensitive receptors were identified by a thorough review of recent aerial photographs and maps and direct field inspections.

The closest noise sensitive receptors are houses to the south and west of the site. Figure 4.1-2 illustrates the locations of the nine houses found through field surveys within a one-mile radius of the proposed stack location for Units 3 and 4. Based upon average occupancy factors, this corresponds to an estimated population of 25 residing within one mile of the proposed stack location. Beyond the one-mile radius are scattered farm residences at a relatively low density. The closest appreciable population grouping is the City of Becker (estimated present population of 517) located to the northeast of the plant site.

However, beyond the one-mile radius, other sources of noise begin to compete with the SHERCO facility in terms of dominating the ambient noise environment.

Sources of noise in the vicinity of the proposed project (other than the pre-existing power plant) are principally related to transportation. Heavy duty diesel trucks and automobile traffic on U.S. Highway 10 to the north and east of the project site represent major sources of intruding noise for residences in these directions from the project site. Parallel to U.S. Highway 10 are rail tracks of the Burlington Northern Railroad. To the south and west of the project site is U.S. Interstate Highway 94. Other local sources of anthropogenic noise in the vicinity of the project are related to agriculture and residential activity. The major land use near the plant is agriculture. Thus, during the growing and harvesting of crops, use of farm machinery will result in noise generation of a short-term nature.

4.6.4 Noise Measurements

Several sets of noise measurements have been conducted in the vicinity of the SHERCO facility. The general features of these measurement programs are summarized in Table 4.6-3. Five of these programs were sponsored by NSP. Another program was undertaken by ERT on behalf of MPCA. Of interest in this section are the community noise measurement data obtained in surveys 1, 2, 5 and 6. The noise measurement locations employed in these community noise surveys are shown in Figure 4.6-1 and correspond, generally, to noise sensitive receptor locations previously discussed.

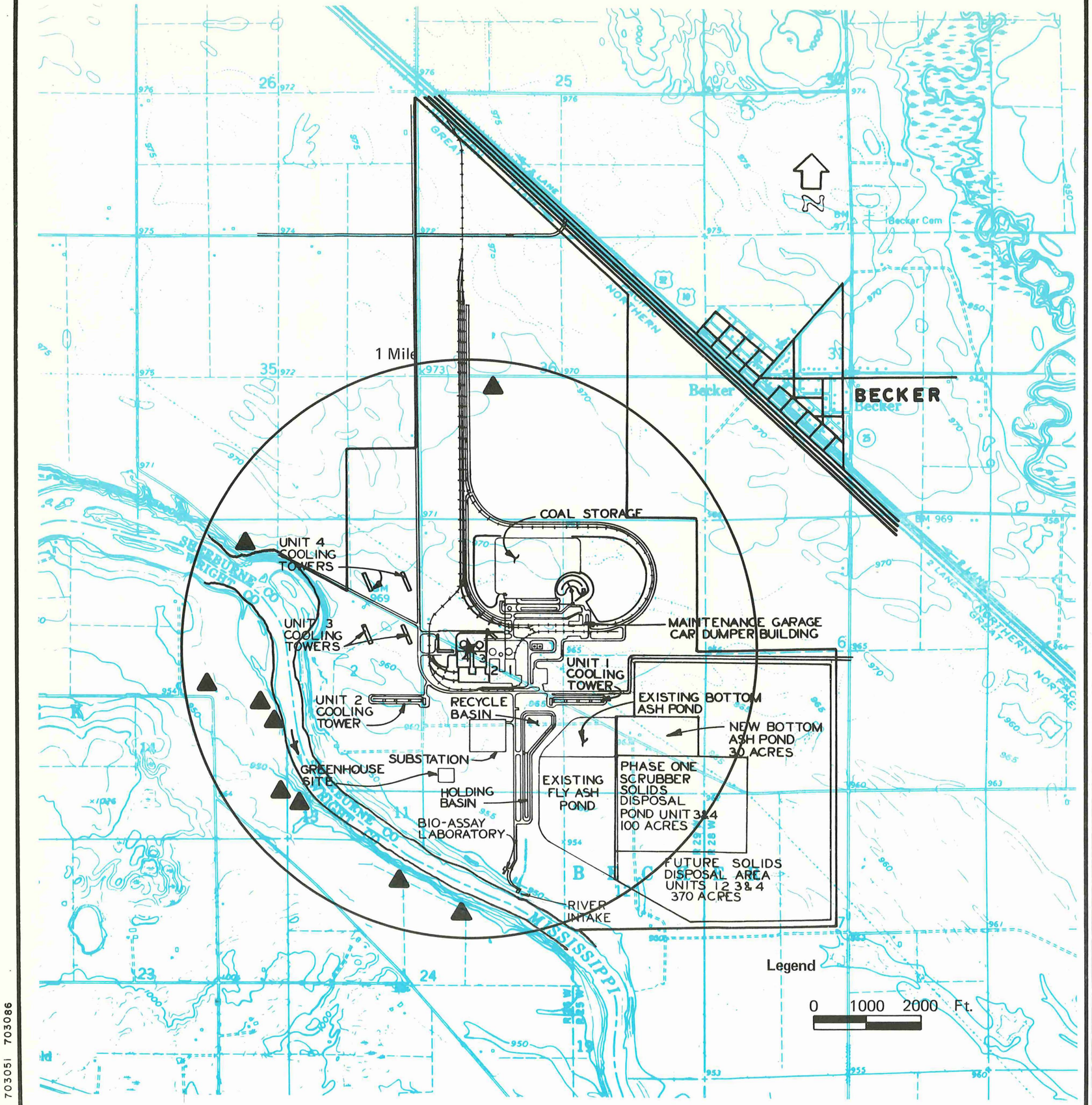
On March 13 and 14, 1977, ERT conducted its series of one-hour noise measurements at seven locations in the vicinity of the SHERCO facility. The objectives of this survey were to obtain noise level measurement data at those noise sensitive receptor points closest to the plant site, with an emphasis on the area to the southwest of the site, on the opposite side of the Mississippi River. This survey was to have the following three features (in accordance with MPCA guidelines and recommendations): (1) employ one-hour measurement periods, (2) include some of the same measurement locations as used in previous surveys, and (3) provide for monitoring of plant noise "emission" during the performance of community noise measurement.

TABLE 4.6-3

SUMMARY OF SOUND LEVEL MEASUREMENT PROGRAMS;
NSP SHERCO SITE, BECKER, MINNESOTA

Survey Number	Type Program	Survey Conditions	Conducted By*	Survey Period
1	Community	Pre (Unit 1) operational ambient noise levels.	NSP	Aug. 5-Sept. 26, 1975
2	Community	Post (Unit 1) operational ambient noise levels.	NSP	June 14-22, 1976
3	Equipment	Plant shut down; noise source measurements.	BBN	October 1976
4	Equipment	Steam flush; noise source measurements.	NSP	December 1976
5	Community	Supplemental, post (Unit 1) operational ambient noise levels (over 1-hour intervals).	ERT	March 13-14, 1977
6	Community	Post (Units 1 and 2) followup noise measurement at Location 1.	NSP	March 23-24, 1977

*NSP = Northern States Power Company
BBN = Bolt, Beranek & Newman, Inc.
ERT = Environmental Research & Technology, Inc.



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Dwelling Unit
SHERCO Site Center

MINNESOTA POLLUTION CONTROL AGENCY

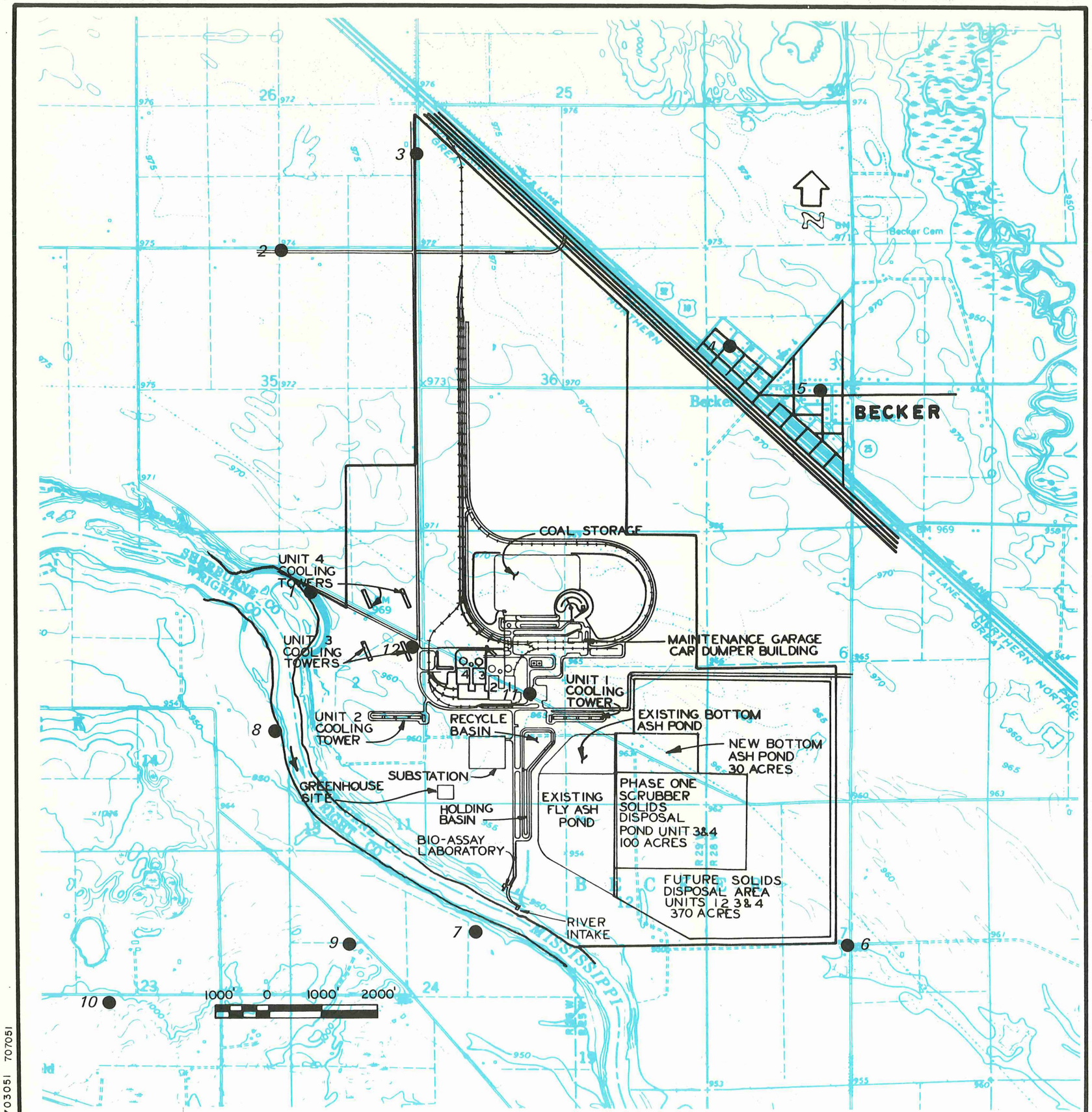
ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.6-1
Locations of Dwelling Units
in the Vicinity of SHERCO Site

During the course of this survey, only SHERCO Unit 1 was operating. Figure 4.6-2 illustrates the plant's power output history during the measurement period. Measurements were conducted using instrumentation consisting of a B&K 2209 sound level meter coupled to a B&K 166 (modified) classifier. Table 4.6-4 presents the noise level information obtained in this survey. These measurements represent observed total ambient noise levels due to all sources existing at the time of the measurement program.

By comparing Tables 4.6-2 and 4.6-4, several conclusions may be reached with respect to specific noise levels observed at the selected receptor locations during the period of the measurements program. Each of the observed on-site noise levels were within the ranges specified for NAC-3 land uses. All observed off-site values were within limits for NAC-2 land uses. Location 9 values exceeded levels specified for NAC-1 (residential). At location 9 observed evening levels were recorded at L_{50} = 51 dBA versus the standard of 50 and L_{10} = 56 dBA versus the standard of 55 for evening hours.



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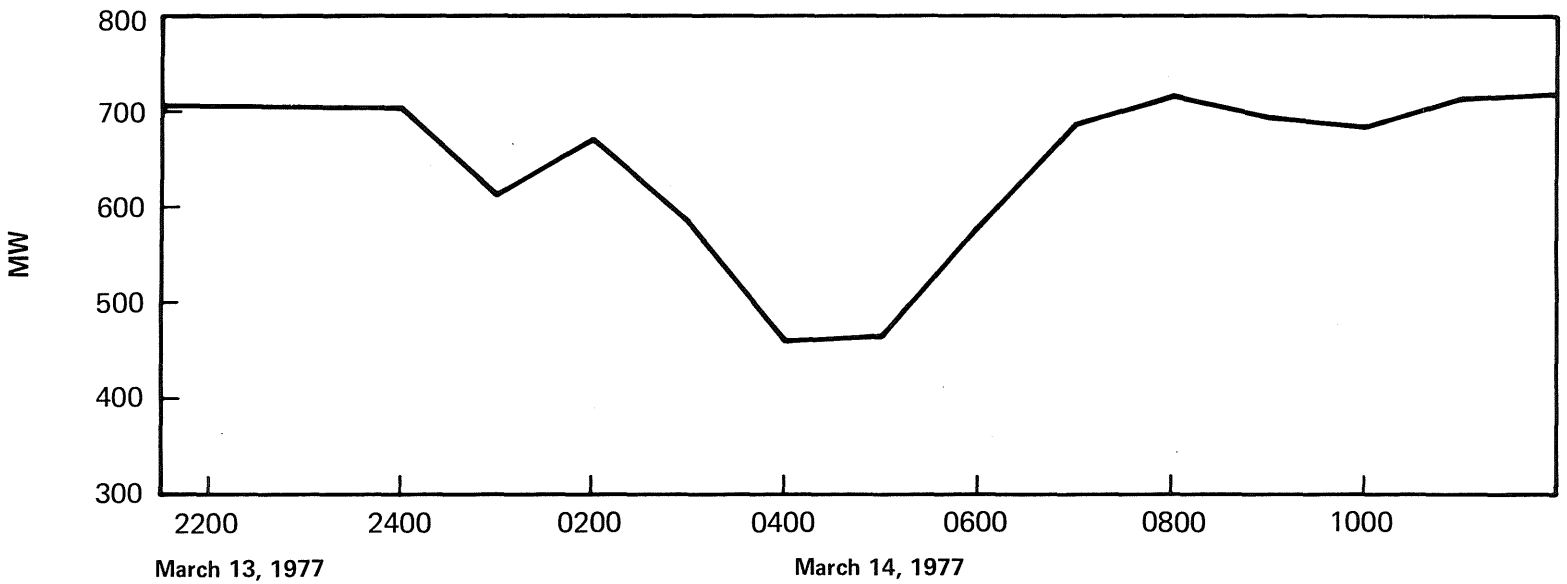
MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.6-2
Noise Measurement Locations



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.6-3 Unit 1 Generator Airport (Mw) During Mar 13 - 14, 1977

Noise Measurement Period

TABLE 4.6-4

RESULTS OF ERT NOISE SURVEY CONDUCTED IN THE VICINITY OF SHERCO PLANT

Number	Description, Comments	Date	Day	Time	Sound Pressure Level Statistics (dBA)* L_{90}	L_{50}	L_{10}	L_{eq}
1	Nelson's Landing (near dwelling unit at NW boundary of site)	3/13/77	Sunday	2227-2400	48	50	53	51
2	Seeley Farm (near dwelling unit at N boundary of site)	3/14/77	Monday	0050-0105	41	44	49	47
6	Old Hammacher Farm (near dwelling unit at SE boundary of site)	3/14/77	Monday	0239-0339	43	48	52	49
7	Southern Boundary (near dwelling unit at S boundary of site)	3/14/77	Monday	0847-0947	51	55	59	56
8	Western Boundary	3/14/77	Monday	0718-0818	48	55	60	59
9	Beyond Southern Boundary	3/14/77	Monday	0601-0701	48	51	56	53
10	Beyond Southern Boundary	3/14/77	Monday	0436-0536	45	50	55	52
12	On plant site, reference point	3/13/77	Sunday	2122-2132	58	59	62	61
11	On plant site, reference point	3/13/77	Sunday	2040-2140	63	64	66	64
11	On plant site, reference point	3/13/77	Sunday	2140-2240	63	64	67	65
11	On plant site, reference point	3/13/77	Sunday	2240-2340	63	64	67	65
11	On plant site, reference point	3/13/77	Sunday	2340-0040	63	64	66	64
11	On plant site, reference point	3/14/77	Monday	0040-0140	63	64	65	64
11	On plant site, reference point	3/14/77	Monday	0140-0240	63	64	65	64
11	On plant site, reference point	3/14/77	Monday	0240-0340	63	64	66	64
11	On plant site, reference point	3/14/77	Monday	0340-0440	63	64	67	65
11	On plant site, reference point	3/14/77	Monday	0440-0540	63	64	66	64
11	On plant site, reference point	3/14/77	Monday	0540-0640	63	64	65	64
11	On plant site, reference point	3/14/77	Monday	0640-0740	63	64	66	64
11	On plant site, reference point	3/14/77	Monday	0740-0840	63	64	71	74
11	On plant site, reference point	3/14/77	Monday	0840-0940	63	64	69	68
11	On plant site, reference point	3/14/77	Monday	0940-1040	63	64	65	65
11	On plant site, reference point	Total Inverval		2040-1040	63	64	66	67

*Represents data uncorrected for nonrepresentative effects such as steam relief noise.

4.7 Geology and Hydrology

4.7.1 Geology

The site occupies a bluff that forms the northeast bank of the Mississippi River. The bluff is a flat, alluvial terrace and is the main topographical feature at the site. The terrace slopes from El 970 to 950 across the site and drains to the southwest toward the river.

The SHERCO facility is situated in a geologic region known as the stable North American craton. In this portion of the upper Midwest essentially flat-lying sedimentary rocks overlie highly deformed igneous and metamorphic rocks, which are in turn overlaid by unconsolidated glacial and stream deposits.

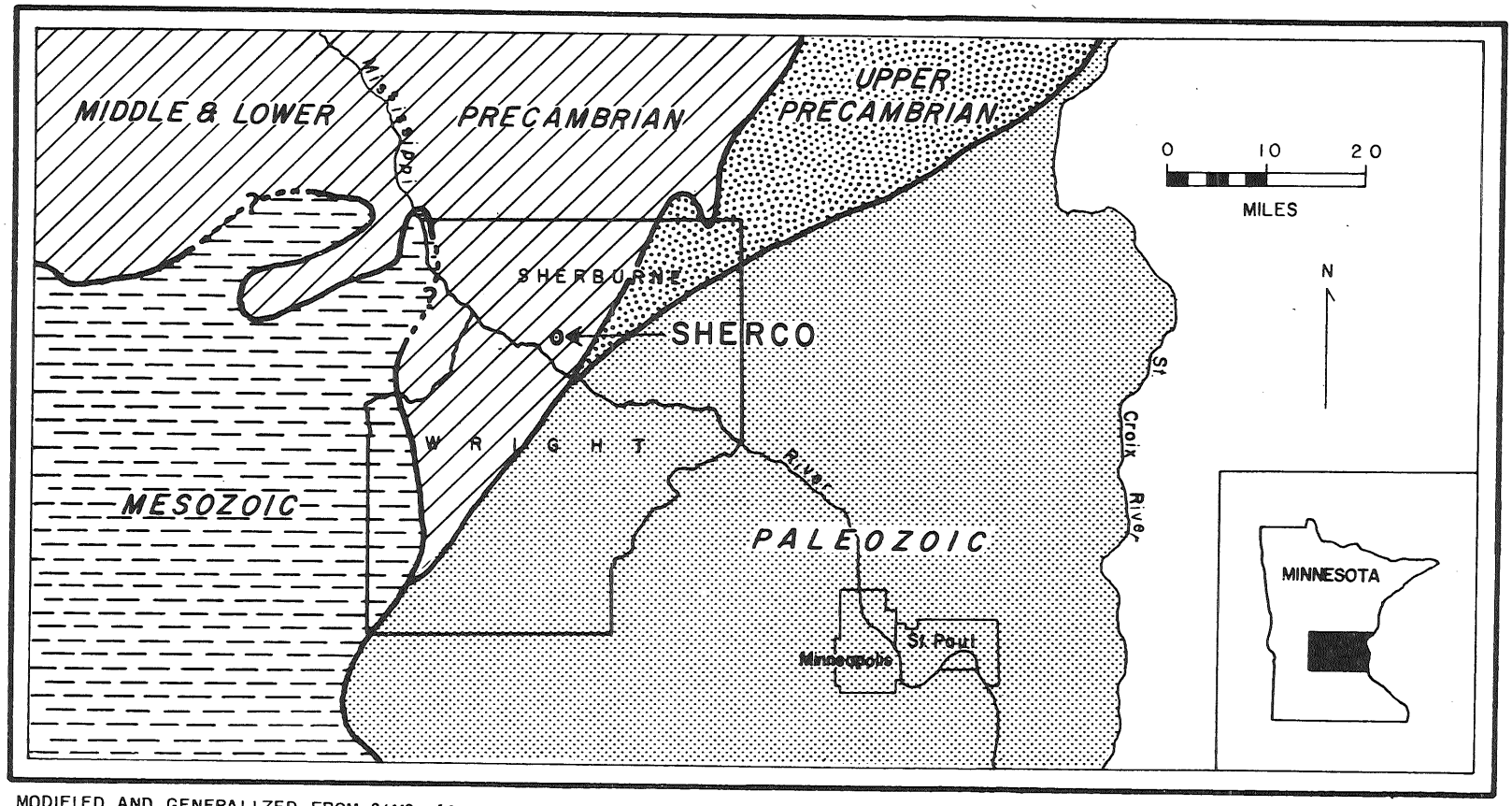
The principal structural feature in this part of Minnesota is a deep trough formed during Precambrian time (greater than 600 million years ago) in the granite and associated crystalline rocks. A late Precambrian rift zone is also found in Precambrian rocks in this area; however, significant crustal instability has not characterized the region for more than 600 million years.

Major Geologic Units

The principal geologic units in this region may be conveniently divided into three groups by the geologic eras during which they were formed; they are listed and described (in order of increasing age) in the following sections. The most recent (cenozoic) deposits consist of a veneer of unconsolidated sediments. Figure 4.7-1 shows the underlying bedrock geologic units as they would appear with the overburden of these cenozoic deposits removed.

Cenozoic Deposits

These sediments are generally younger than one million years and are glacial and alluvial in origin. This sequence represents successive depositions of glacial outwash and glacial till and, more recently, sediments laid down by the Mississippi River. On the SHERCO site these



MODIFIED AND GENERALIZED FROM SIMS, 1970

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.7-1 Bedrock Geology Project Vicinity

sediments range in thickness from 70 to 160 feet and consist predominately of clean sands with gravel, as well as a few layers of clay and glacial till.

Mesozoic and Paleozoic Deposits

Bedrock of this age consists of sedimentary (shale and sandstone) rocks in the Minnesota area. The thickness of sedimentary rock decreases in the vicinity of the plant and is apparently completely absent at the site proper.

Precambrian Deposits

Precambrian igneous and metamorphic rocks comprise the "basement" rocks in this region. These rocks are a portion of what is called the Canadian Shield, some of the oldest exposed rocks in the world. Precambrian rocks in the Minnesota area consist of granites, volcanics and some sedimentary. At the plant site these rocks are entirely granite and are weathered to depths of generally less than 10 feet.

Faults and Seismicity

A major fault system of Precambrian age has been inferred from regional geophysical surveys. This fault system is associated with the Precambrian structural trough. The major movements along this fault system, which amount to thousands of feet, appear to have been restricted to Precambrian time. Minor fault displacements occurred during the Paleozoic era, but faulting within the last few million years is not in evidence.

Earthquake history within the State of Minnesota includes one event on September 3, 1918 and another in 1860. The earthquake on September 3, 1918 was centered at Staples, which is 80 miles northwest of the site and had a magnitude of VI on the Modified Mercalli Scale. The Mercalli Scale is a measure of earthquake intensity on the basis of its effect on people and structures. A VI earthquake is felt by all, but damage to structures is slight. There is very little recorded information on the 1860 earthquake. Its exact date, intensity and area are unknown; its

locality is broadly listed as central Minesota. Several other earthquakes are recorded within the state, but all are less than a magnitude of VI on the modified Mercali Scale.

The State of Minnesota has been classified by the National Ocean and Atmospheric Administration as a Zone 1, minor damage, seismic risk area (U.S. Department of Commerce 1973).

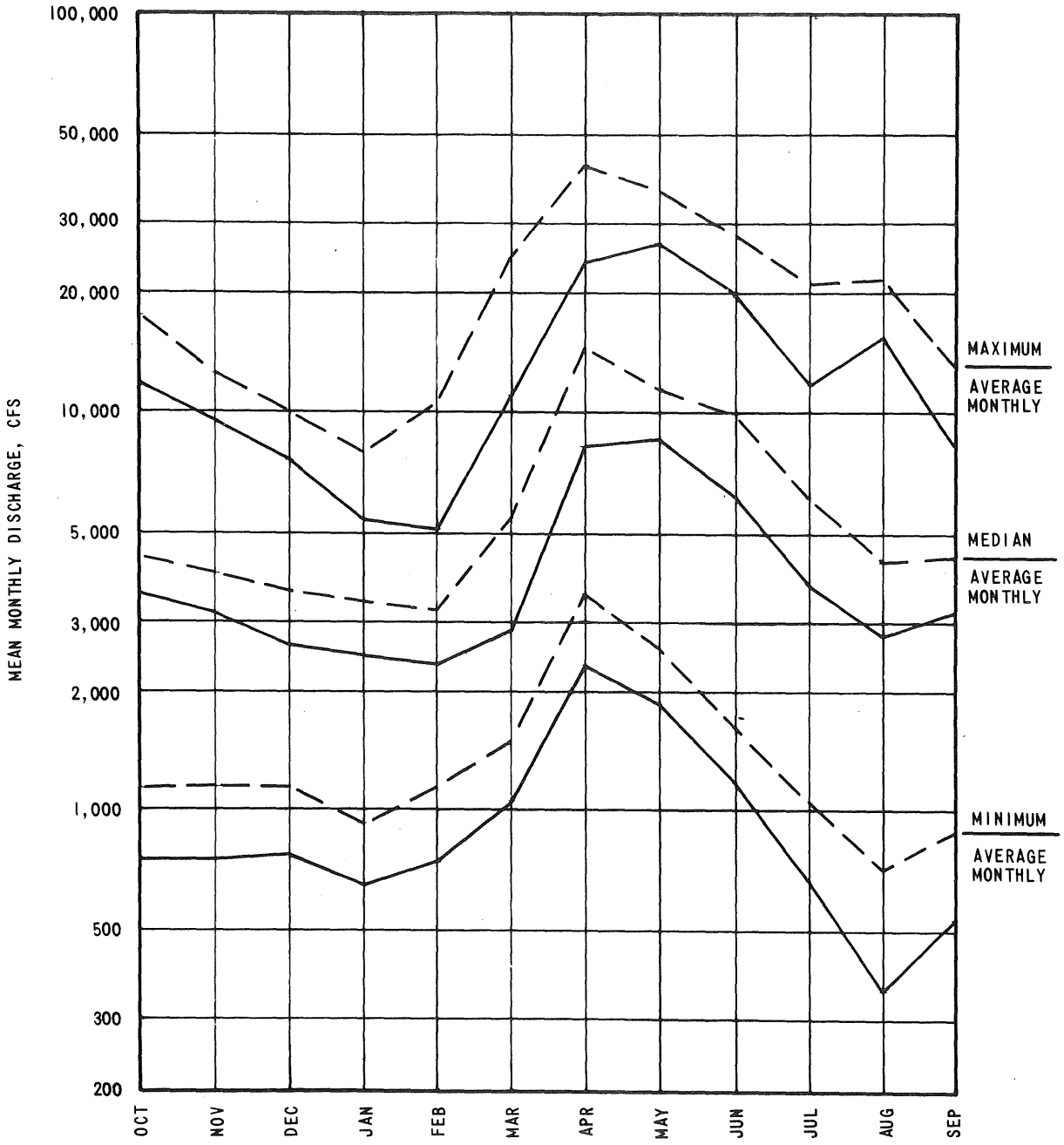
4.7.2 Hydrology

The Mississippi River borders the SHERCO facility to the south. No other streams, rivers or other waterways flow into the Mississippi River on or near the site. Annual precipitation in this area averages approximately 26 inches. Due to the low slopes and permeable soils, drainage on-site is predominately through infiltration through the sandy soils to the underlying groundwater table. The following sections summarize the hydrologic conditions in the vicinity of the SHERCO facility. Water quality is discussed in Section 4.5.

Surface Water

Records of Mississippi River flow are available from two gaging stations near SHERCO. The gaging station nearest SHERCO is located at the St. Cloud dam approximately 20 miles upstream of the site. The station was formerly operated by NSP. Daily average river flow records are available from 1925-1970. The drainage area of the Mississippi River above St. Cloud is approximately 13,400 mi^2. Since the St. Cloud flow data is that of flow over the dam and there was some leakage of water through and under the dam, the recorded flows are somewhat less than the actual river flow. No estimates of the leakage are available.

The U.S. Geological Survey (USGS) river gaging station closest to the site is located approximately 30 miles (48 Km) downriver at Anoka. Average daily flow records are available from 1931 through 1975. The drainage area of the Mississippi River above Anoka is 19,100 mi^2 Elk River, Rum River and Crow River flow into the Mississippi between SHERCO and Anoka. Average monthly discharges in terms of maximum, minimum and median flows are shown in Figure 4.7-2.



SOURCE:
ST. CLOUD - NSP ENGINEERING, USGS RECORDS
ANOKA - WATER RESOURCES OUTLOOK, 1973

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.7-2 Average Monthly Discharge of Mississippi River

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These values represent the minimum, maximum and median daily flows for each month, averaged over the period of record.

Mississippi River flows near SHERCO are affected by runoff of the drainage basin, by storage and release of water from upstream reservoirs and by withdrawal from the Mississippi River by power plants. Higher river flows during the spring are due to runoff from the spring thaw. Releases from upstream reservoirs are normally made in the fall in anticipation of high spring runoff. Major headwater lakes and reservoirs used to regulate river flow are Winnibigoshish, Leech, Pokegama, Sandy and Gull Lakes and the Pine River Reservoir (Federal Power Commission 1970). During the summer, nearly constant lake levels are maintained, resulting in minor fluctuations in downstream river flow.

High Water Flows

The Mississippi River has experienced high water due to back water created by ice blockages, however, the higher river stages are generally caused by spring thaws. The 100-year flood is that river flow with a probability of being equaled or exceeded once in 100 years. The 100-year flood, as calculated from St. Cloud and Anoka flow records is 49,000 cfs This flow corresponds to a river elevation at the SHERCO river intake of 932 feet above mean sea level.

The SHERCO plant site grade is between 960 and 965 or about 28 to 33 feet above the 100-year flood level.

Low Water Flows

The seven-day average low flow with a 10-year recurrence interval (the lowest average flow for seven consecutive days that is likely to be recorded in 10 years) at St. Cloud is approximately 582 cfs based upon NSP gage records from 1925 through 1970. The equivalent flow at the Anoka gage is estimated to be 1,000 cfs based on 44 years of records. Approximately 97% of all daily flows will equal or exceed this seven-day low flow.

The completion of construction of upstream dams and subsequent filling of reservoirs has contributed to a noticeable modification of

runoff in the Mississippi River. The average seven consecutive day low flow with a 10-year recurrence interval for the period 1940 through 1975 is approximately 1,520 cfs. The regulation provided by the upstream reservoirs is dramatic and a considerable improvement over the period prior to 1940.

Groundwater

Numerous wells withdraw groundwater from the glacial and alluvial deposits on and near the SHERCO site. Seven wells exist on the SHERCO site and numerous near-site wells withdraw water for irrigation and domestic use. The nearest municipal water supply wells are at Monticello, approximately seven miles south of the site and at Big Lake, about eight miles southeast of the site. Becker, whose corporate limits include the site, does not have a municipal water system, but relies on private wells for its water supply.

The water table is 35 to 40 feet below the surface at SHERCO. Seasonal and annual variations in the level of the water table can be expected due to continual recharge of the groundwater during rainfall periods and discharge through the ground to the Mississippi River during dry periods. Over the majority of the site, there is little or no surface runoff following rainfall. Water falling on the site quickly percolates through the granular soil to the water table. The water table slopes toward the Mississippi River at SHERCO (Soil Exploration Company 1970), indicating that groundwater flow is towards the Mississippi River.

Water Rights

SHERCO Units 1 and 2 have been granted water rights in the amount of 19,360 acre-feet annually and a maximum pumping rate of 17,000 gpm from the Mississippi River. The DNR has requested, in a public hearing of the MEQC May 19, 1975 at St. Paul, Minnesota, that SHERCO not be allowed to make any withdrawals from the Mississippi River when river flow is equal to or less than 2,000 cfs measured at the USGS gaging station on the Mississippi River near Anoka, Minnesota. River flow data summarized in Figure 4.7.2 indicate that historically the median flow

(that flow equalled or exceeded 50% of the time) is generally greater than 2,000 cfs but that the lowest daily flow during most months of the year is below this threshold. Flow duration curves for the Mississippi River near Anoka for the period 1931 through 1975 indicate that about 12% of the time flow is equal to or less than 2,000 cfs. Since 1940, river flow has been equal to or less than 2,000 cfs considerably less than 12% of the time due to regulation provided by upstream reservoirs (Beck 1977d).

4.8 Solid Waste

4.8.1 Solid Waste Sources

The major solid waste streams in the existing SHERCO Units 1 and 2 originate as by-products from the combustion of coal. The major constituents are bottom ash, fly ash and SO_2. (Fly ash and retrieved SO_2 are collectively referred to as scrubber sludge). Each of these combustion by-products is eventually a solid waste that must be collected and disposed of in an environmentally sound manner. In addition to the above-mentioned bottom ash and SO_2 scrubber sludge, much smaller quantities of other types of solid wastes are generated. These could be considered typical of the solid wastes generated by any major industrial facility, and include normal amounts of trash disposed of in a local sanitary landfill. Sludge is also generated at the waste water treatment plant. No detailed discussion of these minor solid waste streams will be provided.

As coal is ignited in the boiler, heavy ash and slag fall to the water-filled bottom ash hopper. The bottom ash is then sluiced from the bottom ash hoppers to the bottom ash ponds by water from the recycle basin. The fly ash and SO_2 in existing Units 1 and 2 are removed by a two-stage limestone flue gas scrubber. Wastewater from the scrubber is conveyed to one of two thickeners where the calcium sulfate and the resulting sludge is then sluiced to a scrubber sludge storage basin crystals and fly ash are thickened. A sludge thickener will not be used with Units 3 and 4.

4.8.2 Solid Waste Quantities

Approximately 108,000 tons per year (tpy) of bottom ash are generated by Units 1 and 2 based on a capacity factor of 65%. It is calculated that 565,000 tons of scrubber sludge consisting of retrieved SO_2 and fly ash, are generated annually. (Beck 1977c)

4.8.3 Solid Waste Disposal System

Solid waste is disposed of in two separate ponds, one for bottom ash and one for scrubber sludge. These ponds occupy a combined area of 100 acres.

The bottom ash pond is a diked earthen reservoir approximately 20 acres in size. The embankments are 54 ft. high with 2.5:1 side slopes and a central clay core approximately 20 ft. wide at the bottom, tapering to 10 ft. at the top. The overall embankment width at the top is approximately 20 ft.

The scrubber solids pond is approximately 80 acres in size. It's embankment dimensions are the same as that of the bottom ash pond.

The bottom ash and scrubber solids ponds are sealed with an 18-in. thick clay blanket having a 12-in. thickness of protective soil cover. The clay used was obtained from an area north of Becker. Laboratory tests conducted by Black and Veatch (1972) determined that this clay has a very low permeability. (The permeability coefficient, "k", ranged from 8.0×10^{-8} cm per second to 13×10^{-8} cm per second).

4.8.4 Seepage

There is some seepage from the existing bottom ash and scrubber solids ponds even though they are lined with 18 inches of clay. The seepage rate is a function of the permeability of the clay, pressure exerted by the weight of the water above the clay liner and the quality of construction.

Based on two calculation methods printed in Black and Veatch (1972), R.W. Beck and Associates (1977c) has estimated expected seepage rates from the existing ponds utilizing a conservative value of 1×10^{-7} cm/sec for the permeability (K) of the clay liner. These calculations are shown in Table 4.8-1.

The storage and supernatant contains high concentrations of suspended and dissolved solids, in addition to various trace elements. The clay liner will reduce the amount of dissolved solids and trace elements reaching the groundwater table through seepage.

TABLE 4.8-1

ESTIMATED SEEPAGE RATES FROM EXISTING
BOTTOM ASH AND SCRUBBER SOLIDS PONDS

Calculation Method 1	Disposal Depth (Head) ft (in)	Seepage Rates in gpm (Lpm) Bottom Ash Pond	Scrubber Solids Pond
	6	2	5
	(2)	(8)	(19)
	24	22	53
	(7)	(83)	(201)
	50		123
	(15)	-	(465)
Calculation Method 2	6	3	6
	(2)	(11)	(23)
	24	27	63
	(7)	(102)	(240)
	50	-	146
	(15)	-	(552)

Source: R.W. Beck and Associates (1977c)

4.9 Terrestrial Ecology

4.9.1 Regional Description

The region surrounding the SHERCO plant site is largely agricultural. Cropland within a five-mile radius from the facility boundaries covers 59.6% of the land area. Open fields represent an additional 4.3%. The presence of the Mississippi River creates varied natural habitats through the agricultural area.

In Sherburne County much of the land consists of a glacial river outwash plain, called the Anoka Sand Plain, which is characterized by light sandy soils. On the Anoka Sand Plain xeric oak species (those that require little moisture) dominate the upland forests. North and east of the plain, the rolling terrain is punctuated with numerous marshlands, swamp woods, bogs, ponds and lakes. Lower terraces and islands associated with the Mississippi River support other species such as green ash, American elm, slippery elm, basswood, hackberry and silver maple. Mixed deciduous forest and prairie extends downstream to Anoka and upstream to Brainerd (USDI 1976). Within the Anoka Sand Plain region, to retard wind erosion, an extensive program of "shelter belt" tree planting was initiated in the 1940s and now such plantings provide an effective deterrent against further erosion by reducing surface wind velocities (NSP 1976).

Three publicly owned areas in the project region support various habitats. Lake Maria State Park is three to four miles southwest of the SHERCO site at the eastern edge of the "Big Woods" (Daubenmire 1936). A climax maple-basswood forest is found on the better soil a sub-element of white and red oak dominate most of the drier sites, such as exposed slopes. These rather mesic "rich woods" forests contain a number of herbaceous plants not found elsewhere in the area except on some of the islands in the Mississippi River near Monticello (NSP 1976). Sand Dunes State Forest and the Sherburne National Wildlife Refuge are northeast of the plant site. The federal refuge contains some 30,500 acres, about equally divided among woodland (chiefly pin oak and aspen forests), marshy lowland meadow and abandoned fields. This area also contains small tracts of native prairie and two small stands of native white pine. Portions of the abandoned fields are being restored to native

prairie. The Sand Dunes State Forest consists of pin oak forest and oak - savanna plus large stands of conifers that were planted on abandoned fields in the 1940s and 1950s. This area also contains former sand dunes, largely stabilized by prairie grasses and forbs. Some of these areas harbor distinctive native plant species. These natural prairie areas have a rather high ecological priority for preservation (NSP 1976).

4.9.2 Soils

Soil types on the SHERCO project site have been mapped and described by the USDA Soil Conservation Service in the Soil Survey for Sherburne County (1968). In addition, NSP has collected and analyzed core samples at 20 locations representing each of the major soil types in the SHERCO area.

NSP reports that: nearly all of the soils in the SHERCO area are in the Hubbard-Estherville-Salida soil associations, described as nearly level to gently rolling, sandy soils, over deeply leached sand or calcareous gravel. The largest portion of the SHERCO site is Hubbard Series soil, which consists of deep, excessively drained or somewhat excessively drained soils, underlaid by deep sand. These soils warm quickly in spring and are easy to work. The moisture-holding capacity is very low and movement of air and water is rapid. Both the organic matter content and natural fertility are low (NSP 1976).

The existing soil conditions will influence plant community development, particularly on abandoned agricultural land. On-site soils have low moisture holding capacity, organic matter content and fertility. Field descriptions indicate past erosion on cultivated acreage. The limited natural areas are uneroded but are naturally droughty and low in fertility. Although xeric species are common to the Anoka Sand Plain (see Section 4.9.1), the vigor and composition of the vegetative cover will be influenced by the soil deterioration. Under natural succession, the deteriorated soils will slowly improve.

4.9.3 Project Site Vegetation

Vegetation studies conducted by Dr. Nicholas Zaczkowski of St. John's University (during the summer of 1974 and 1975) and by NSP biologists (in 1975) resulted in the identification of 233 species on the SHERCO site (ERT 1977d). The three vegetational types of land use

found on the SHERCO site are summarized below in outline form. Their locations are shown in Figure 4.9-1.

I Agricultural Land

1) Land presently farmed

2) Abandoned fields

3) Hay land

II Woodlands

1) Native deciduous forests

a) Upland oak forests

1) Bur oak-pin type

2) Cedar-oak-aspen type

b) Lowland silver maple-green ash forest

2) Shelter belts (chiefly coniferous)

III Grasslands

1) Native prairie

a) River bank and fence row remnants

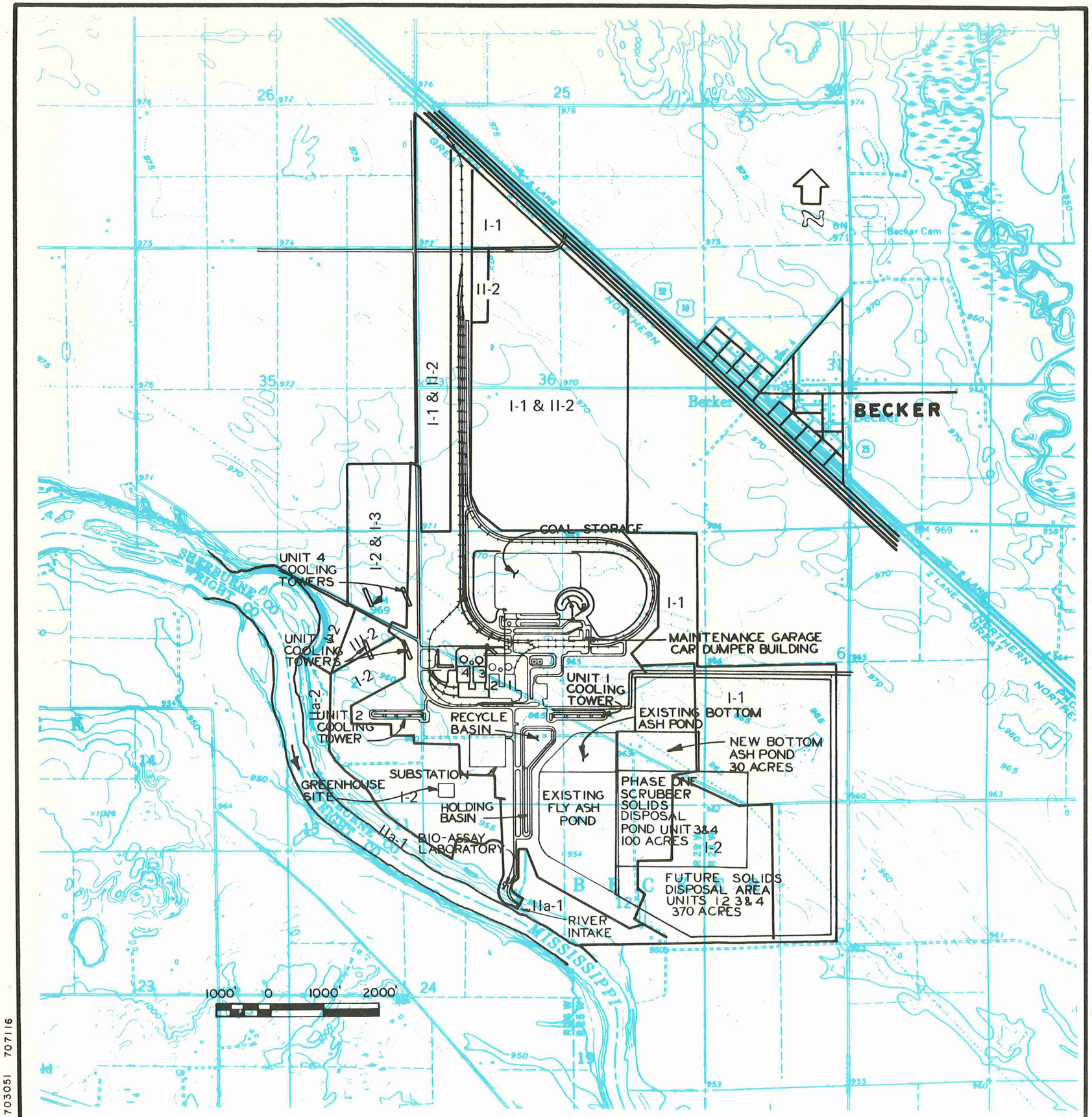
b) Savanna or "oak openings" in upland oak forests

2) Brome grass "soilbank" (NSP unpublished)

4.9.4 Birds (Avifauna)

NSP ecological studies have identified over 160 species of breeding and wintering birds on or adjacent to (within a five to six mile radius of the stack for Units 1 and 2) the SHERCO site.

NSP reports: Since several species of raptors (birds of prey) are on both state and federal endangered species lists, an attempt to locate all nesting raptors on the SHERCO site was begun in the spring of 1974. A more intensive effort was made in 1975. The area searched was expanded to include the riparian woodlands (beated along the river) one or two miles upstream from the SHERCO site down to the Monticello



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LEGEND

I-1 = Agric. Land - Farmed
I-2 = Agric. Land - Abandoned
I-3 = Agric. Land - Hay Land
II-a-1 = Upland Oak Forest
II-a-2 = Upland Cedar-Oak-Aspen
II-b = Lowland Silver Maple Ash
II-2 = Shelter Belts
III-1 = Native Prairie
III-2 = Brome Grass

MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 4.9-1
Vegetation and Land Use
on the SHERCO Site

(power station) site and included adjacent upland woodlots. The results for 1975 are summarized as follows.

Raptor Species	Comments
Red-tailed hawk	Pair nested in Big Oak Park.
Red-tailed hawk	Pair nested on Oxbow Island, across from the Monticello plant.
Red-tailed hawk	Pair nested in riparian woodland near transmission towers SSE of the SE corner of the plant boundary (west edge of Sec. 18)
Red-tailed hawk	Pair nested just across from the plant in Wright County (approximately 1-1/2 miles NE of Enfield)
Green horned owl	Nested in woods on plant site 200 yards upstream from intake.
Red-shouldered hawk	A last year's nest was found across the river from the plant site in upland oak woods. This year a pair was observed several times in the area but no nest was found.
Cooper's hawk	Observed several times in above woods. No nest found. (NSP 1976)

4.9.5 Mammals

Fifty-nine species of mammals are known to have occurred in Sherburne County (Bailey 1929, NSP unpublished). Thirty-three (56%) of these species were recorded from within the plant site boundaries between 1971 and 1975, while 14 additional species have been taken or observed within a 10- to 15-mile radius of the site since approximately 1960 (Hibbard, unpublished notes). A total of 47 (80%) species have been found in the general locality of the site within recent years. A few species recorded by the Baileys (1929) or checked in as "within 10 to 15-miles or less of the site might occur on the plant site but have not as yet been observed (NSP unpublished).

Small mammal trapping programs were conducted in 1971, 1974 and 1975. Tables 4.9-1 and 4.9-2 describe the results of these efforts.

Winter surveys for mammals were conduced on the SHERCO site in 1974 to 1976. Evidence was found (track sitings, etc.) indicating the

TABLE 4.9-1

COMPARISON OF 1971 AND 1975 SMALL MAMMAL CATCHES

Species	1971 Actual Catch	1971 Per 100 Trap Nights	1975* Actual Catch	1975* Per 100 Trap Nights
		Rye Field (Study Area A)		
Meadow vole	1/188	0.5		
Prairie deer mouse	28/188	14.9	12/468	2.6
Pocket mouse	-	-	12/468	2.6
Short-tailed shrew	-	-	1/468	0.2
Total Animals	29/188	15.4	25/468	5.3
		Conifer Plantation (Study Area B)		
Meadow vole	1/200	0.5	8/320	2.5
Prairie deer mouse	53/200	26.5	2/320	0.6
Pocket mouse	-	-	3/320	0.9
Masked shrew	-	-	2/320	0.6
Jumping mouse	-	-	1/320	0.3
13-lined ground squirrel	-	-	3/320	0.9
Total Animals	54/200	27	19/320	6.0
		Abandoned Anderson Farm Site (Study Area C)		
			1975**	
Prairie deer mouse	13/90	14.4	-	-
White-footed mouse	1/90	1.1	6/500	1.2
Red-backed mouse	8/90	8.9	1/500	0.2
Meadow vole	1/90	1.1	3/500	0.6
Jumping mouse	-	-	21/500	4.2
Eastern chipmunk	-	-	1/500	0.2
Short-tailed shrew	-	-	8/500	1.6
Masked shrew	-	-	2/500	0.4
Total Animals	23/90	25.6	42/500	8.4

Note: See Figure 4.9-1 for location of study areas.

*Live trapped for 13 nights, using 36 live traps in the rye field; trapped for 7 nights, July 22-25, 30-31, August 1 with 108 live trap nights and 212 snap trap nights in the conifer plantation.

**Snap trapped for five nights; August 8, 11-14 for Study Area C; data from three live-trapped nights; August 12-14 for Study Area D.

TABLE 4.9-1 (Continued)

Species	1971 Actual Catch	1971 Per 100 Trap Nights	1975* Actual Catch	1975* Per 100 Trap Nights	1975+ Actual Catch	1975+ Per 100 Trap Nights
			Pin Oak Woods (Study Area D)			
Prairie deer mouse	28/100	28	-	-	8/595	-
White-footed mouse	-	-	8/105	7.6	8/595	1.3
Red-backed mouse	10/100	10	1/105	0.9	5/595	0.8
Short-tailed shrew	-	-	1/105	0.9	9/595	1.5
Jumping mouse	-	-	-	-	1/595	0.2
Eastern chipmunk	-	-	-	-	1/595	0.2
Total Animals	38/100	38	10/105	9.5	24/595	4.0

**Snap trapped for five nights; August 8, 11-14 for Study Area C; data from three live-trapped nights; August 12-14 for Study Area D.

+Data from 17 live-trapped nights; August 12-28.

Source: NSP, Unpublished

TABLE 4.9-2

TRAPPING RESULTS FOR 1974 AND 1975

Species	Actual Catch	Per 100 Trap Nights
Angell Farm Site, Upper Terrace Woods (Study Area E)*		
Prairie deer mouse	11/120	9.2
Meadow mouse	2/120	1.7
Total Animals	13/120	10.9
Silver Maple-Ash-Elm Floodplain Woods (Study Area F)**		
White-footed mouse	9/108	8.3
Short-tailed shrew	9/108	8.3
Jumping mouse	6/108	5.6
Eastern chipmunk	2/108	1.9
Total Animals	26/108	24.1
Abandoned Field East of Anderson Farm Site (Study Area G)+		
Meadow vole	4/204	2.0
Prairie deer mouse	2/204	1.0
Pocket mouse	1/204	0.5
Jumping mouse	1/204	0.5
13-line ground squirrel	2/204	1.0
Total Animals	10/204	5.0

Note: See Figure 4.9-1 for locations.

*Snap-trapped for six nights with 20 snap traps in late October and early November 1974.

**Live-trapped for three nights with 36 live traps, August 6-8, 1975.

+Snap-trapped for two nights with 102 snap traps, July 25 and 28, 1975.
Source: NSP, Unpublished

presence of a number of larger mammals including: red and gray squirrels, beaver, deer, cottontail rabbit, jack rabbit, fox, short-tailed weasel and the domestic cats.

4.9.6 Reptiles and Amphibians (Herpetofauna)

Forty-five naturally occurring reptilian and amphibian species are in Minnesota (Breckenridge 1944; Ernst 1973; Conant 1975). Based on present knowledge of the distribution and habitat preference, 28 species could be expected to occur in the vicinity of the SHERCO plant site. To determine which of these reptiles and amphibians actually occur on the SHERCO site and which occur in the surrounding area. NSP's 1970 study reported: Seven reptile species were observed on the site. No amphibians were verified during the spring breeding season collections, although NSP biologists collected two species (leopard and wood frog) along the Mississippi River in September.

Two additional turtle species and two amphibian species were observed within one mile of the SHERCO site boundaries. One more turtle species has been reported from the Mississippi River within three miles of the plant site (brown soft shell turtle - Hopwood, 1974).

Specimens deposited at the University of Minnesota and collections made along the Elk River by Hibbard verify the presence of an additional turtle species, four species of snakes and two species of amphibians from within six to ten miles of the Sherburne site. At least two of these species (western hognose snake and the tiger salamander) are quite common in sandy areas of the Anoka Sand Plain and probably occur on or adjacent to the site. In all, 14 species were verified as living within a mile of the plant site, while an additional eight species are known to occur within three to ten miles of the plant site boundaries. This is a total of 22 species verified for the area.

Amphibian presence is limited on the plant site due to the virtual absence of temporary pools for breeding. During the 1975 season there appeared to be no amphibian reproduction on the plant site. However, several active amphibian breeding sites existed within one to two miles of the SHERCO boundary. Active amphibian breeding sites were found across the Mississippi River south of the plant, along the Elk River east of Becker, and near the transmission lines southeast of the plant.

Most of the reptilian activity in the vicinity appeared to be associated with the Elk and Mississippi Rivers and their associated bottomlands.

Of the 15 reptiles and amphibian species observed in the present study, none appear to be abundant on the SHERCO site. With the possible exception of the snapping turtle, none of the 28 species likely to occur in the area are of economic importance and none are endangered.

4.9.7 Invertebrates

The invertebrates that inhabit the SHERCO plant site, with emphasis on the insects, were surveyed by NSP staff at four areas between May 28 and August 5, 1975. They collected approximately 6,500 insect specimens and about 800 other arthropods (mites, ticks, spiders, sowbugs, etc.). At specific stations on the SHERCO site an additional 2,000 specimens of Diptera (true flies) were also collected .

Some of the unusual or rare invertebrates that were collected during the field studies are listed below:

I Class Insecta

Order Diplura - diplurans
Family Japygidae

Order Orthoptera
Family Tridactylidae - pygmy mole cricket

Order Hemiptera
Family Cydnidae - burrowing bugs
Family Dipsocoridae - jumping ground bugs

Order Coleoptera
Family Scaphidiidae - shining fungus beetles
Family Ptiliidae - feather-winged beetles

II Class Symphyla - garden "centipedes"

4.9.8 Rare, Endangered or "Threatened" Species

Vegetation

According to NSP (1976), no species of plant cited by Morley (1972) as endangered or threatened are known to occur in the SHERCO area at present nor did they exist before construction of SHERCO began.

Although Morley (1972) has cited several prairie plants as rare or endangered for Anoka County, he lists only one species for Sherburne County, shining bug-seed (Corispermum nitidum). This plant does not appear on the vegetation list (for the site) and it is doubtful if this species appears on the plant site.

Birds (Avifauna)

Two endangered species of birds potentially could occur during mitgration in the SHERCO area. These are the American peregrine falcon and the whooping crane (Moyle 1975). Both birds are also classified as endangered on the Federal List (Federal Register 1976). No confirmed sitings have been reported to date.

Four species of avifauna are listed as threatened in Minnesota (Moyle 1975). This group includes the greater sandhill crane, which may migrate through the area but does not nest any closer than approximately 50 miles to the north in Morrison County, where there have been several nesting reports in recent years (A. Grewe personal communication); the greater prairie chicken, which has not been a resident species in the area since the late 1940s; the bobwhite quail, which was not uncommon in central Minnesota in the early 1900s but has not been a resident species since the mid-1940s, although there have been recent attempts at reintroduction and the burrowing owl. The burrowing owl was not reported by Green and Janssen (1975) as present in the SHERCO area. However, it is a prairie dweller and could occur in the vicinity as a straggler or migrant.

Also listed by Moyle (1975) are nine birds that are "Species of Changing or Uncertain Status". Two of these species are birds listed as "in trouble" on most endangered species lists (e.g., Hine 1973) for Wisconsin. These are the bald eagle and the osprey. Both of these birds are known to follow the Mississippi in spring and fall migration (Carlson 1971 and personal observation, latest sighting of osprey was on September 5, 1975), but are not known to nest in this region at present.

Arib (1973) lists several avian species on his blue-list that occur in the SHERCO area. This list contains birds that are "suffering population declines or range diminution in all or parts of their range,

but are not now of sufficient rarity to be considered endangered". Included are several bird species also listed by Moyle (1975) as "Species of Changing or Uncertain Status".

Species included on both lists are the following: Cooper's hawk, marsh hawk, white pelican, double-crested cormorant and western grebe. The species of aquatic birds listed may fly over the area, but are lake-dwelling or marsh birds and only rarely or incidentally utilize the Mississippi River or its flood plain as habitat. The Cooper's and marsh hawks have both been observed in the SHERCO area and probably nest in the area.

Additional local information on threatened birds of prey is available from Carlson (1971). Carlson observed the bald eagle and the marsh hawk during March of 1969 (NSP 1976). The bald eagle is currently being considered for threatened status by th USDI (Federal Register 1976a).

Mammals

No endangered or threatened species of mammals occur on or near the SHERCO site. Furthermore, no endangered mammals occur in Minnesota (Moyle 1975). The pine marten (Martes americana) is listed as threatened by Moyle (1975), but suitable habitat for this species does not exist on the SHERCO site. However, there are important species which do occur, and they are discussed below.

Huntable populations of several game and fur-bearing species exist on the site. Of the small game species present, gray squirrels and cottontails are most common. They are rather restricted in their distribution, however, and are confined to suitable habitat in forests and shrubland bordering the Mississippi River.

Deer populations are rather low on the area. However, considering the available habitat, they are present in normal numbers.

Local trappers have harvested several species of fur-bearing mammals along the Mississippi River in past years. Gray and red fox, raccoon, and mink were reported taken southeast of the plant site in the winter of 1974-75 and 1975-76. Weasels of several species, spotted skunks, and one opossum have also been reported as trapped in this general area. Coyotes are rare in the area but one was taken within a mile of the site in the last two years. Otter have also been recently observed along the Mississippi River downstream from SHERCO near the Monticello Nuclear Generating Plant.

Several species of mammals especially characteristic of grassland habitats are common on-site. Included are the pocket gopher, 13-lined ground squirrel, pocket mouse, and jack rabbit. The latter two species are rather unique to the area.

The jack rabbit is a western prairie species that was restricted to the region west of the Mississippi River until about 1900 (Bailey 1929). It is now again relatively rare or uncommon over much of its former range in the central and southern parts of the state, hence its relative abundance on the prairie-like abandoned fields of the SHERCO site is a rather fortunate and unique occurrence (NSP unpublished).

4.10 Aquatic Ecology

The following is a description of the major groups of organisms found in the Mississippi River near SHERCO, presented in order of increasing level in the food chain.

4.10.1 Primary Producers

Macrophytes, periphyton and phytoplankton are the primary producers of aquatic systems. Their productivity and distribution are largely determined by physiochemical factors and the current of the river (Russel-Hunter 1970). Consumption of planktonic or periphytic algae is necessary for many organisms to complete part or all of their life cycle.

Macrophytes and Periphyton

Aquatic macrophytes and periphyton are general terms applied to communities of organisms which exist on the river bottom or at the interface between the river and land. Such communities are complex and composed of primary producers belonging to several major algal divisions and higher vascular plants. These communities provide a rich food source for invertebrate animals. The general term periphyton is often applied to the coarser, more obvious forms.

Although macrophytes are important in other reaches of the upper Mississippi (Moyle 1940), they are mainly restricted to isolated backwaters in the SHERCO area, and are considered unimportant compared with phytoplankton and periphyton to this segment of the Mississippi River.

There is little periphyton data available on the upper Mississippi River other than the ecological monitoring information collected at the Monticello site from artifical substrates. These studies show certain diatoms predominate most of the year, with blue-green algae frequently dominant during part of the summer and green algae present in lesser numbers throughout the year. Nuisance mats of Cladophora have been reported in the Monticello area, but information on Cladophora distribution in the SHERCO area is lacking. Kuhl (1975) sampled and examined diatoms in the SHERCO area but this study disregarded the nondiatoms segment of the periphyton at this time. Available data are not sufficient to adequately define baseline conditions of periphyton communities at SHERCO.

Phytoplankton

Phytoplankton are microscopic plants suspended in water. As in the case of macrophytes and periphyton, the principal role of phytoplankton in the aquatic ecosystem is primary production. These organisms use sunlight to fix essential chemical elements into substances metabolically useful to higher levels in the food chain.

The phytoplankton of the upper Mississippi River are derived from upstream impoundments, river backwaters and displaced periphyton. Mischuk (1976) studied phytoplankton at the Monticello site in 1973-1974 and concluded that 18 to 40% of the primary production of the river was due to a mixture of displaced bottom-dwelling species and true phytoplankton. Mischuk indicated that diatoms predominate throughout the year except for a brief period in July when green algae are dominate.

4.10.2 Zooplankton

Zooplankton are animals characteristically found suspended in water. The food of major zooplankton species is primarily suspended particulate organic matter. Zooplankton are, in turn, food for a wide variety of higher order consumers, including fish, insects and other invertebrates. Thus, the primary role of the zooplankton community is as the link between the higher consumers and the primary producers.

Historical data on the diversity and density of zooplankton associated with the upper Mississippi River are scarce and no data are available specific to the SHERCO facility. Studies conducted in the upper Mississippi, most notiably Williams (1966), demonstrate that the river system has been capable of producing large populations of plankton species. Although the absence of recent and site-specific data precludes a definitive statement, it is not expected that the Mississippi River at SHERCO presently maintains a large population of zooplankton organisms. Any individuals found would probably result from impoundments, backwashes or boundary layers. If the river is physically altered and the velocity of the river is reduced, the system would be capable of producing and supporting a significant population of planktonic organisms.

4.10.3 Macroinvertebrates

Macroinvertebrates are those animals of a certain minimize size (those detained by a U.S. Standard No. 30 sieve) that live on, in or near the substrate of a body of water. They are important in the food web of aquatic systems because they are the major link between the primary producers and secondary consumers and serve as the food base for higher forms such as fish.

Although extensive qualitative and quantitative macroinvertebrate investigations have been conducted near Monticello, little or no work on this group has been undertaken in the Mississippi River in the vicinity of Becker. The SHERCO site is located four miles (6.4 km) upriver from the Monticello site. Hopwood (1972) conducted the only known macroinvertebrate survey at the SHERCO site in which all definition of the SHERCO site was based on two samples. Although data from the two sites are not directly comparable, i.e., location, replication, sampling time, Hopwood (1972) stated that the environment for macroinvertebrates at SHERCO was similar to the Monticello site and that any quantitative differences in fauna were caused by small sample size. There exists, however, numerous inconsistencies in sampling and data collected at the two sites. It is believed that available data are insufficient at this time to equate definitely the types and density of macroinvertebrates between the Monticello and SHERCO sites.

While macroinvertebrates are normally bottom-dwellers, drift of these organisms is a common occurrence. Drift plays an important role in recolonization of denuded areas. Invertebrate drift near SHERCO has been investigated by Wefring (1976) and by Zimmerman and Hopwood (1975). Sixteen orders of macroinvertebrates were collected by Wefring (1976) during a consecutive five-day study.

4.10.4 Fish

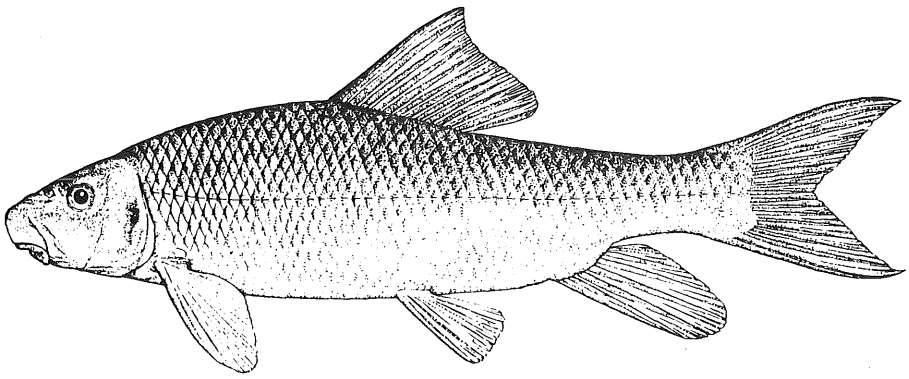
Fish are excellent indicators of environmental conditions as both species composition and abundance can accurately reflect environmental change. The following description of the fish community at the SHERCO site is based largely upon electrofishing data for 1975 (Barels 1976) and (NSP 1976 unpublished). Due to the lack of data on smaller species

this description concentrates on the composition of the larger individuals in the site vicinity. It should be noted, however, that minnows may actually be the numerically dominant members of the fish fauna.

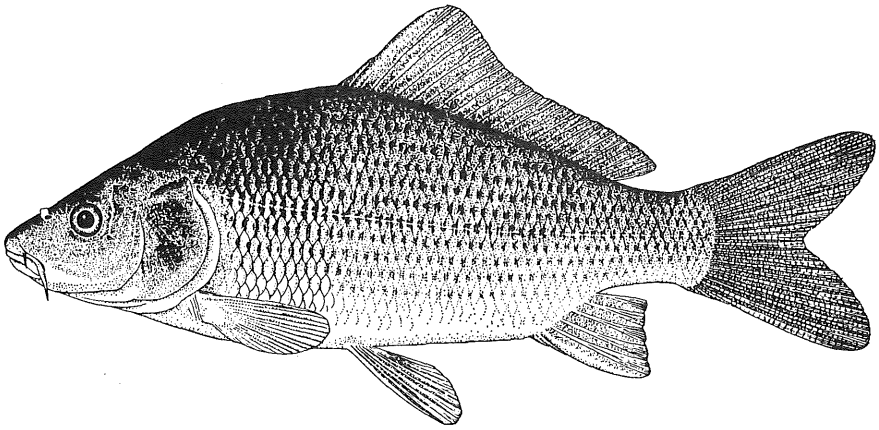
The community of larger fish at the SHERCO site is dominated by shorthead redhorse and carp with additional species such as silver redhorse, white sucker, smallmouth bass and, occasionally, black crappie composing most of the remaining density and biomass. This community structure has been present in the region of the upper Mississippi River where SHERCO is located for a number of years, and is probably representative of the future community structure at the site as well. Illustrations, common names and brief descriptions of the dominant larger fish species at SHERCO are presented in Figure 4.10-1.

Density data for 1975 (NUS 1976) indicate that the area immediately upstream of the intake, had relatively low mean densitites of the above six species along the side of the river on which the intake is located when compared to mean density data for those species for west-side transects and to mean density data for sectors upstream and downstream. The area immediately downstream of the intake had relatively low east-(intake) side mean densities of shorthead redhorse, silver redhorse and white sucker; low-to-moderate mean densities of black crappie; moderate mean densities of smallmouth bass and high densities of carp when compared to transects elsewhere in the sampling area. Mean density data for northern pike, rock bass, black bullhead and burbot indicated relatively low densities of these species immediately upstream of the intake. Pike and bullhead were also observed in relatively low mean densities immediately downstream of the intake while burbot and rock bass were collected in relatively high mean densities in this area.

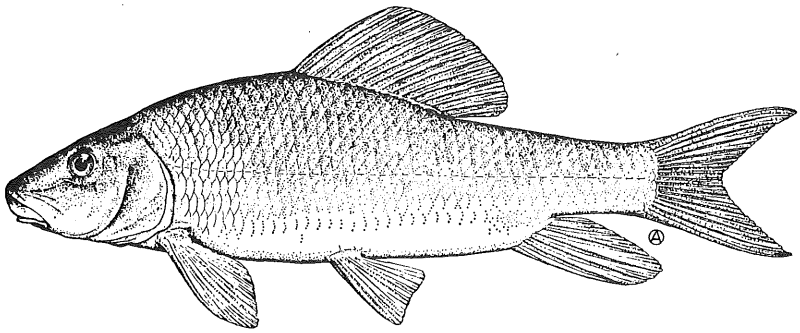
Studies of the fish eggs and larvae (ichthyoplankton) at the SHERCO site are presently being conducted.



SHORTHEAD REDHORSE: Usually 14-18 inches (356-457 mm) in length; upper sides brown to olive, lower sides lighter in color.



CARP: Usually 15-18 inches (381-457 mm) in length, coloration variable; adults usually olive green on the back, yellowish on the belly.



SILVER REDHORSE: Usually 12-16 inches (305-406 mm) in length; Body bronze to olive green, sides silvery.

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.10-1 Dominantly Larger Fish Species in the Mississippi River of SHERCO

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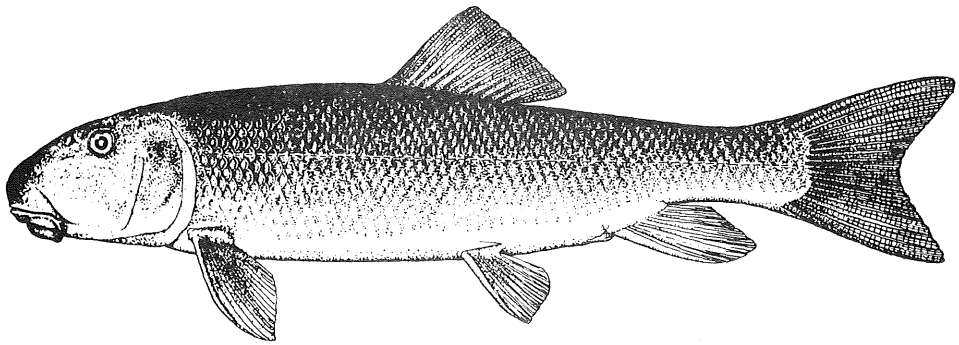
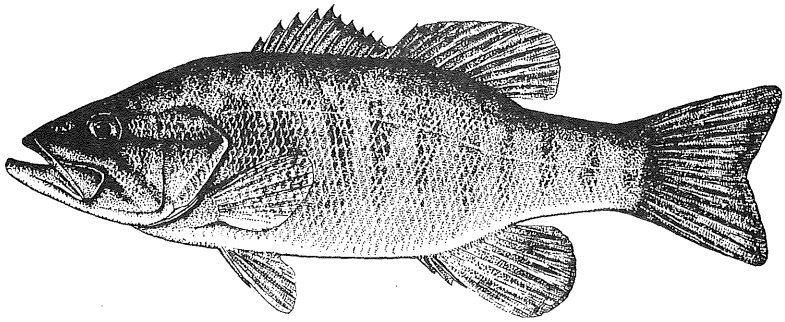
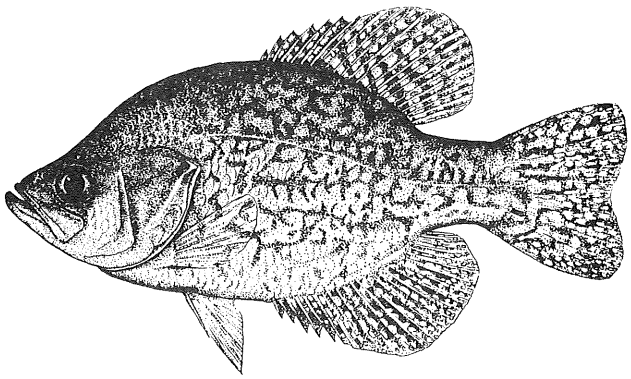


WHITE SUCKER: Usually 12-20 inches (305-508 mm) in length; back and upper sides gray, brown, or black, lower sides cream to white.



SMALLMOUTH BASS: Usually 8-15 inches (203-381 mm) in length; coloration variable, head brown through olive to green, sides lighter.



BLACK CRAPPIE: Usually 7-10 inches (174-254 mm) in length, back and head olive, metallic green to brown, sides lighter.

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 4.10-1 (Continued) Dominantly Larger Fish Species in the Mississippi River of SHERCO

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4.11 Energy

NSP is an investor-owned utility which supplies electric power to approximately 900,000 service customers in Minnesota, North Dakota, South Dakota and Wisconsin. NSP's service area covers approximately 40,000 square miles (103,600 km^2) and includes 630 communities and approximately three million people (NSP 1975).

NSP presently has a total installed capacity of 6,300 megawatts and a system of 200 miles (320 kilometers) of transmission lines (NSP 1976).

4.11.1 Interconnections and Pooling Arrangements

NSP is a member of the Mid-Continent Area Power Pool (MAPP), a consortium of the major utilities in the upper midwest region of the United States. The MAPP service area includes portions of Michigan and Illinois, the western half of Wisconsin and extends through the states of Iowa, Minnesota, Nebraska, North and South Dakota and into eastern Montana, encompassing the entire NSP service area. Benefits of membership of MAPP include coordinated planning and participation in the development and operation of power supply resources; availability of power supply services from other members, including reserve sharing, emergency and scheduled outage service; surplus capacity purchases and sales; participation in power purchases and sales; peaking power purchases and sales and transmission service.

NSP is also a member of the Mid-Continent Area Reliability Coordination Agreement (MARCA), whose region is the same as that for the MAPP service. MARCA reports on reliability of planning and operating activities of its members. This overview is provided to MARCA by each system, reporting on load forecasts, planned new facilities and the resultant generating capacity and reserves. To minimize interruptions in service, the overall projected system is tested periodically according to criteria established by MARCA.

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5. ENVIRONMENTAL IMPACT OF THE PROJECT

5.1 Land Use

5.1.1 Land Use Impacts During Construction

Preemption of Current Land Uses

The construction activities will directly disturb approximately 320 acres of land east of the existing fly and bottom ash disposal ponds. All other construction work will be conducted within the general perimeter of the existing plant facilities. As a result, most construction work will take place in areas already dedicated to an industrial purpose.

These 320 additional acres, which are required for solid waste disposal, are agricultural land, though only the northern half is actively cultivated at the present time (O'Connor 1977). The preemption of this land and its eventual dedication to heavy industrial activity is not considered significant in view of the relative abundance of similar land both locally and regionally. The expansion of the SHERCO site will eliminate only about 1.1% of all agricultural land found within five miles of the site and less than 0.04% of similar land found in the four county, Central Minnesota region.

Compatibility with Land Use Plans and Ordinances

Minnesota Regulations NR 2400

As noted in Section 4.1, Minnesota Regulation NR 2400 designates portions of the southern boundary of the SHERCO site as being within a Recreational River Land Use District. The plan for the proposed facilities indicates that within the boundaries of the Recreational River Land Use District, there will be no additional physical structures or ancillary facilities with the exception of part of the construction waste landfill area. Furthermore, Units 3 and 4 will use the existing river intake and outflow system, and no alterations will be made to the physical appearance of the existing structures along the riverbank (NSP 1976). Although power plants are not normally a permitted use within a Recreational Land Use

District, the existing SHERCO generating facilities, as well as the proposed additions, are all considered permitted uses by virtue of the following special provision of NR 2400:

> The Northern States Power Company SHERCO and Monticello power plant sites shall be listed in the Sherburne and Wright County Ordinances as permitted uses. Northern States Power Company shall work with the Department of Natural Resources to determine the most appropriate location for the development of any structures or related facilities that may be located within the Scenic and Recreational Land Use District boundary. Such development shall be consistent with all other provisions of NR 79.

Since the development of the construction waste disposal area will occur on nearly flat terrain and will not require vegetative cutting, the only relevant provision of Minnesota Regulations NR 79 is the setback requirement. A review of the plan clearly indicates that the proposed construction waste area will be located substantially beyond the 100-foot minimum setback requirement, measured from the normal high water mark. Since the SHERCO facilities are a permitted use within the Recreational Land Use District and since the siting of the proposed construction waste disposal area is in conformance with the requirements of NR 79, the proposed project is considered consistent with the State's Recreational Land Use District designation as defined in NR 2400.

City of Becker Comprehensive Plan and Zoning Ordinance

The recently completed comprehensive land use plan for the City of Becker indicates that the existing SHERCO site and the expansion area for Units 3 and 4 should be devoted to heavy industrial use. The city's revised zoning ordinance changed the classification of the expansion area fix from an agricultural district to an industrial power generation district. This new designation includes power plants as a permitted use. Thus, the proposed development of Units 3 and 4 would be consistent with both the comprehensive land use plan and the zoning ordinance for the City of Becker.

Unique Farmland

The U. S. Department of Agriculture has designated currently irrigated agricultural land in Minnesota as unique farmland. The 320 acre

expansion area for Units 3 and 4 contains approximately 160 acres of agricultural land which is currently irrigated (O'Connor 1977). The proposed conversion of this farmland to an industrial activity is inconsistent with the unique farmland designation, for federal policy encourages the preservation of such land unless "other national interests override the importance of preservation or otherwise outweigh the environmental benefits derived from their protection." (Executive Office of the President, Council on Environmental Quality 1976.)

Impact on Adjacent Land Uses

The construction phase of any major project typically involves the generation of various negative impacts such as increased traffic, noise and dust. However, beyond three to four miles, there should be no perceptible indication of the construction activities, for as established earlier in Section 4.1, the stack is the only plant component which is visible beyond this distance.

The negative impacts associated with the proposed construction program may temporarily depress directly adjacent residential property values. However, as noted in Section 4.1, there are only nine dwelling units within a mile of the proposed stack location for Units 3 and 4. Such impacts are likely to rapidly diminish with increased distance from the construction site. The proposed construction program should have little effect on adjacent agricultural activities though there may be isolated instances where construction related dust will temporarily interefere with crop productivity. Such occurrences are likely to be limited to farm lands immediately adjacent to the construction site and similar areas situated alongside heavily traveled, unpaved roads used to haul construction materials. The extensive use of sprinkler irrigation in the Becker area may serve to diminish this effect for the water would act as a cleansing agent, preventing long-term accumulation of dust on the crop leaves.

Commercial and recreational land uses in the vicinity of the site are unlikely to be adversely impacted during the construction period. The commercial strip along U.S. Highways 10 and 52 caters primarily to convenience type activities (gas stations, package stores, restaurants, etc.) that will be in demand during the construction period. As a

result, the construction activities may slightly improve commercial land values along this roadway. The major recreational area within the immediate vicinity of the construction site is the Mississippi River/ Although the construction activities will not physically interfere with the use of this river for fishing and boating, the river's attractiveness may temporarily decline due to construction related noise and dust. The same may also be true of certain segments of the Elk River, located approximately two miles away, though the negative impacts during construction will be substantially less noticeable at this distance.

5.1.2 Land Use Impacts During Plant Operations

Preemption of Other Uses

Once the construction phase begins, the site will be committed to an industrial land use. Thus, operation of the facility will not involve further preemption of existing land uses.

Adjacent Land Uses

One method for evaluating the degree to which Becker and nearby towns can expect long-term changes in land uses in direct response to the operation and maintenance of the proposed generating facilities is to draw upon the past experience of other localities where power plants have been constructed. Although the case histories (Riordan 1970 and Howard Needles, Tammer and Bergendorf 1975) do not provide a rationale for why power plants do not attract complementary activities, the answer may be found in the literature of economic location theory (Alonso 1964; Isard 1960; Hoover 1948 and Harris 1954). According to this literature, industrial location decisions are primarily determined by such factors as the distance to markets, labor raw materials or transportation facilities. Given these considerations, the presence or absence of a power plant seemingly does little to change the inherent attractiveness of an area as an industrial location. Even for energy dependent industries such as aluminum manufacturing, there is no particular incentive to locate near a power plant, for intrastate electricity rates within a given service area do not vary with distance to the generating facility.

There has been some speculation that industrial growth could occur in Becker as a result of the potential availability of waste heat. NSP, U.S. EPA and the University of Minnesota have been conducting experiments regarding the use of this potential energy source for agricultural purposes. There are no plans at this time to export the waste heat for other industrial uses (Gregerson 1977).

While a power generating station is unlikely to induce additional industrial growth the operation of such a facility may have a negative impact upon adjacent residential development, particularly that which may in the future occur in and around the City of Becker. The degree or magnitude of impact is unclear, however, due to the multiplicity of factors which determine the demand for and price of residential land.

On one hand, a large-scale industrial facility such as an electrical generating station may negatively affect residential land use decisions by lowering neighborhood amenity levels. On the other hand, this same facility could create a favorable property tax situation for homeowners. In short, it is impossible to evaluate accurately how different households will react to the situation, for consumer tastes, preferences and budgets vary substantially. The evaluation of impacts on adjacent residential land uses is further complicated by the fact that SHERCO Units 1 and 2 are already in operation. As a result, it could be reasonably assumed that any negative land use effects would occur regardless of whether Units 3 and 4 are built.

Although plant operations are unlikely to induce industrial or commercial development nor act as a catalyst for residential expansion, adjacent agricultural land uses may be negatively affected as a result of projected air quality. Section 5.9 (Terrestrial Ecology) includes a more detailed examination of the relationship between vegetation and air quality. In summary, it is noted that the projected air emissions from the SHERCO facilities may adversely affect certain sensitive crops. A reduction in crop productivity (for selected species) may occur as a result of sulfur dioxide (SO_2) emissions and from the interaction of SO_2 and ozone. More localized and less extensive effects may occur due to deposition (settling) of particulates, trace elements and salt drift (from the cooling towers).

5.1.3 Visual Impact During Construction

The construction program will last approximately seven years. During this period, there will be visual and physical disruption of the site and its immediate environs. This is an unavoidable by-product of any major construction program. Clearing operations, earthwork, construction, installation and paving procedures will all modify the visual quality of the site area. There will also be some unavoidable visual intrusion resulting from truck traffic and attendant creation of dust and/or mud and debris on surrounding roads.

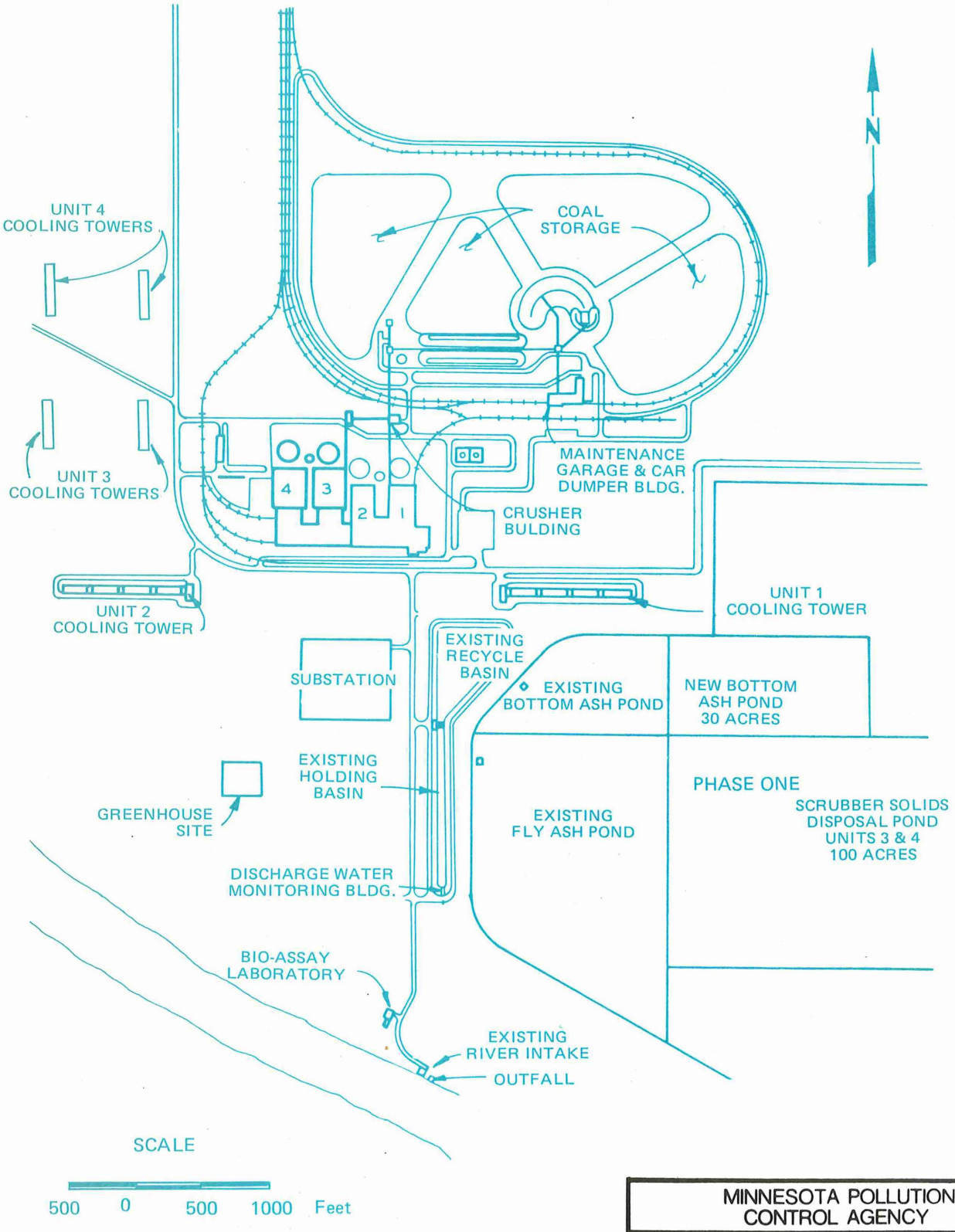
The residents who currently live within close proximity to the construction areas, particularly those who are located south of U.S. Highway 10 will be among those most affected by the construction activity. The construction program will serve to slightly alter existing views of the SHERCO site for these nearby residents. To a lesser degree, persons traveling along the major roadways in the area as well as persons living, working and participating in recreational activities in more distant locations from the construction site may also be affected. In many respects, however, the visual changes in the area may be considered minor since the site area has already been disrupted by the earlier development of SHERCO Units 1 and 2.

5.1.4 Visual Impact During Plant Operations

Description of Site Layout and Plant Design

As shown in Figure 5.1-1, the central building complex for Units 3 and 4 will be located west of and adjacent to the central complex for Units 1 and 2. The cooling towers for Units 3 and 4 will be located northwest of Unit 4. The existing coal handling facilities will be expanded to accommodate the requirements for Units 3 and 4 with the coal storage area remaining entirely within the existing track loop. The solid waste products (bottom ash, fly ash and scrubber solids) for all four units will be stored in areas located south and east of the main plant complex (NSP 1976).

The general external appearance of the plant has been developed in an attempt to achieve maximum compatibility with existing facilities and



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.1-1 Central Building Complex, Units 3 and 4

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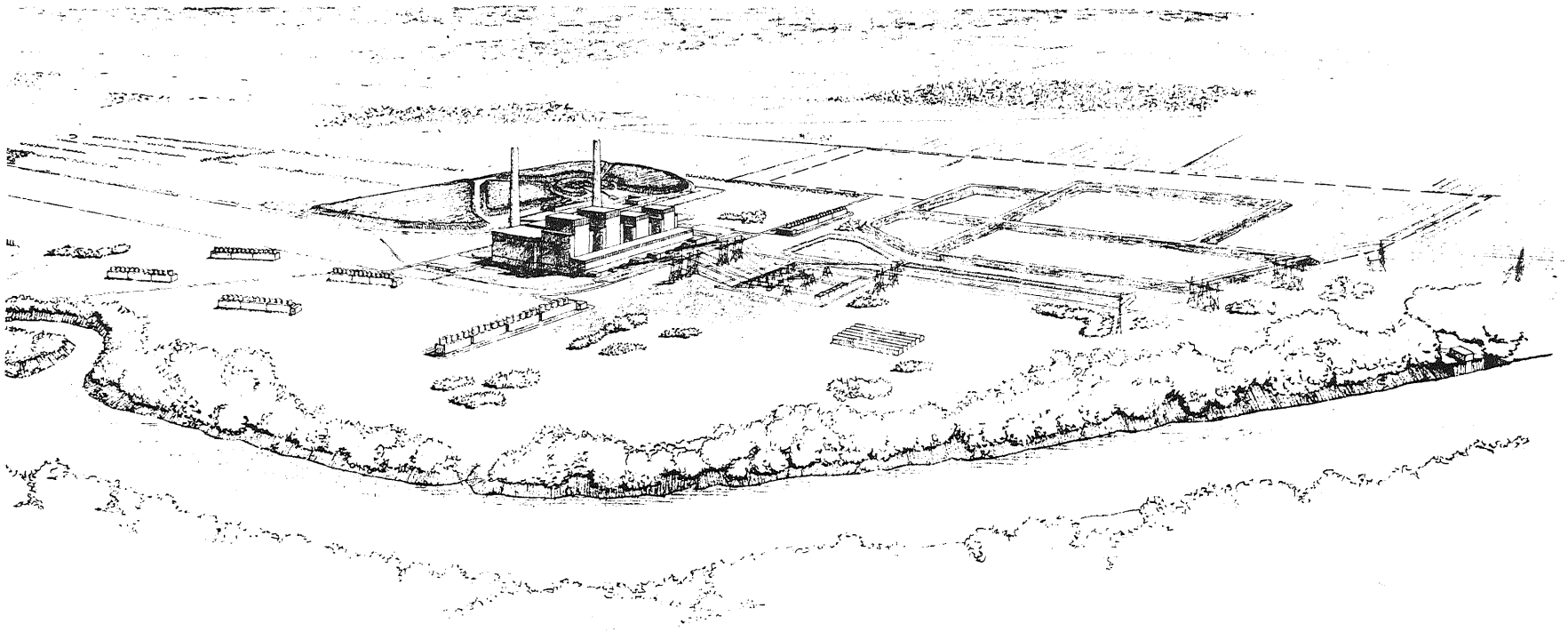
the surrounding community. New structures will be architecturally similar in design, color and materials to those of Units 1 and 2.

Figure 5.1-2 is an artist's conception of the four-unit plant. This illustration shows that there will be two chimneys on site, the existing one for Units 1 and 2 and another for Units 3 and 4. Each chimney is 650 feet tall. The steam generator housing for Units 1 and 2 is 235 feet high, and the housing for Units 3 and 4 will be approximately 300 feet high. Directly south of the steam generator housing is the long, lower building which contains the turbine generators. Other facilities such as cooling towers, crusher building, coal piles and dikes for solid waste storage areas will generally be less than 100 feet high.

The existing river intake structure is approximately 30 by 50 feet in plan view and about 40 feet above the average river surface elevation. It is constructed of precast concrete panels. With the exception of the intake structure, plant facilities are set back from the river. In addition, the wooded area along the shoreline will be preserved and will continue to serve as a buffer. Land not required for plant operation will be used for agricultural purposes or vegetated to minimize erosion.

Impact Assessment

It was noted earlier in the baseline analysis (Section 4.1) that the visual quality of the area has already been intruded upon and altered by the earlier development of SHERCO Units 1 and 2. As a result, the addition of two more units to the existing generating complex will produce only a small incremental change in the quality of the local landscape. The change in visual quality will be most perceptible to those who are located within approximately 2 miles of the plant facilities, for it is within this area that there is a maximum discernment of detail and scale. Fugitive dust from the coal stockpiles and handling operations may also be perceptible within this two mile area. As a result, there may be a decrease in local visibility. (For further discussion of fugitive dust emissions see Section 5.4.) Beyond this distance, the lower plant structures begin to recede from view, and after 3 to 5 miles, the only visible plant component will be the stacks



MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.1-2
Artists Conception
of 4-Unit Plant

and their respective vapor plumes. There will be little to no perceptible change in visual quality for those who view the SHERCO facilities from locations beyond approximately 7 miles; at this distance the plant stacks and vapor plumes will generally blend into the background pattern of the landscape, making it difficult to identify one stack from the other.

Within the primary zone of potential visual impact, or the area within 2 miles of the proposed stack location, there are five sensitive land uses: The Mississippi River (3/4 mi. southwest); U. S. Highway 10 (1-1/4 mi. northeast); the City of Becker (1-1/4 mi. northeast); the Elk River (2 mi. east-northeast) and; a 660-foot scenic corridor along U. S. Highway 10 between county roads 25 and 65 (2 mi. north). What will actually be seen from each of these five sensitive land uses will vary substantially in spite of their relative proximity to the plant complex. Full and complete views of Units 3 and 4 will be available to persons traveling along U.S. Route 10 and to some persons living and working on the edge of the City of Becker. Views of Units 3 and 4 will be substantially more limited from interior locations in the City of Becker and from positions on the Mississippi and Elk Rivers. These latter locations will continue to have partially to fully screened views of the plant due to either the interjacent topography or to the dense vegetation which exists between the plant and the viewing location.

5.1.5 Historical and Archaeological Impacts During Construction

The construction of Units 3 and 4 will have no immediate effect on archaeological resources since none exist on the site area to be disturbed. This conclusion is based upon the results of a field survey conducted by the state archaeologist, Elden Johnson, during the summer of 1975. Mr. Johnson (1975) concluded that,

> The entire area lies on the level Anoka sand plain and is now cultivated agricultural land, planted in row crops. This is a very unlikely place to find archaeological evidence, and the survey confirmed this. (ERT 1977f)

Similarly, there will be no immediate effect on historical resources since there are no structures located on the areas to be disturbed by construction activities. Off-site impacts during construction are

primarily a function of changes in visual quality. The baseline inventory (see Section 4.1) identified 14 historic sites within a 15-mile radius of the proposed stack location for SHERCO Units 3 and 4. These sites are predominantly situated in areas 6-1/2 to 9 miles away. The nearest historic site is the Edwin H. Sherwin House (C. 1860s), located approximately 6-1/2 miles southeast of the proposed stack location. Based upon information previously presented in the visual impact assessment, only those locations within close proximity to the construction site (within approximately 2 miles) will be affected. Since the Sherwin House is located beyond this general visual impact range, no effect on local and regional historic resources is anticipated during the construction phase of the proposed project.

5.1.6 Historical Impacts During Plant Operations

Long-term impacts on nearby historic resources are also related to potential visual effects. The visual impact evaluation presented in Section 5.1.4 indicated that the visual quality of the area has already been intruded upon and altered by the earlier development of SHERCO Units 1 and 2. As a result, the operation of two additional generating units will produce only a small incremental change in the visual quality of the local landscape. Since there are no historic sites within close proximity to the plant location, it is expected that the long-term visual impacts of SHERCO Units 3 and 4 will not be significant.

In support of the evaluation of impacts on historic sites, comments were solicited from Mr. Charles W. Skrief, Environmental Assessment Officer, Minnesota Historical Society on February 4, 1977. Mr. Skrief (1977) states:

> We have come to the conclusion after considering the fact that the only effect that the additions may have on historic sites is a visual effect. The proposed additions will change the visual perspective of the plant only by adding another stack to the existing stacks. Quite simply, therefore, this addition will not have any effect greater than the effect of the existing stacks.

5.2 Transportation

5.2.1 Impact During Construction

During construction of SHERCO Units 3 and 4, there will be increased transportation activity, due to movement of construction equipment, truck deliveries and worker commutation. Because of the relatively low levels of traffic on adjacent roadways, trucking activity, by virtue of its low volume and tendency to be predominant outside the peak hour, should have little impact. At times, as with SHERCO 1 and 2, there may be a need for redirection of traffic along U.S. 10, but that disruption should be minimal.

It is anticipated that construction worker commutation will present a major addition to traffic on the local network. In 1979, at the peak of construction, slightly less than 1,100 people will be commuting to the site, virtually all of them in automobiles. This will represent approximately 2,000 one-way vehicle trips per day, one-half of which will occur in the peak travel hours. Asuming a two-hour peak period, approximately 1,000 trips per hour will be added in each of the morning and evening peak hours. This is a substantial increase. It is estimated that in 1976 peak hour travel on U.S. 10 and 52 was about 705 vehicles.* This figure will probably remain about the same over the next few years since I-94, recently opened, has been drawing off traffic from U.S. 10. Construction worker commuting will therefore increase peak hour travel on U.S. 10 by 142%, to 1,700 vehicles. It is significant to note, however, that the two-way capacity of this four-lane arterial, with no obstructions, major grades or width restrictions, is over 2,000 vehicles in each direction. Though this capacity will be reduced somewhat by left turning vehicles gaining access to the site (mostly from metro-area construction workers), it will be able to handle even this large, temporary influx of construction workers at the time when maximum employment will occur. It may be necessary, though, to facilitiate flow with temporary traffic control, as was done with Units 1 and 2.

U.S. 10 currently provides a level of service "A", based on current traffic volumes and operating characteristics in the peak hour. This level of service, as more fully described in the Highway Capacity Manual

*Representing a peak hour factor of about 8%, typical for this type of area (Highway Capacity Manual 1965).

of 1965, is the highest operating level for a roadway and is characterized by high speed and free flow with little interference among drivers. Based upon the travel forecasts previously mentioned, this facility will be reduced to a level of service "C" at the time of maximum construction employment. This level is characterized by stable flow, higher volume and more restrictions on lane changing and speed. It is still, however, not near capacity, defined as occurring at level "E". For most of the rest of the construction period, except at the very beginning and again at the end, level of service "B" will be obtainable (stable flow, few restrictions on operating speed). At the beginning and end of the construction period, level "A" will prevail.

5.2.2 Impact During Operation

Transportation impacts during the operation phase of SHERCO 3 and 4 will occur due to permanent employee commutation and due to coal trains interfering with local traffic.

SHERCO 3 and 4 will employ about 170 people, a figure which should not very significantly over the life of the plant. This in effect will double the present number of employee-related trips to about 620 per day. Using 1985 as a typical operating year and assuming a growth rate of 3% per year,* U.S. 10 and 52 will at that time be carrying about 11,520 vehicles per day, or 920 in the peak hour. This will be far short of capacity. Therefore, while plant-related commuter traffic will increase from a current estimated 3.5% of the ADT (average daily traffic), to a projected 5.4%, it will not represent a significant impact on the level of service performance of the roadway. (This is the only roadway on which it is expected any measurable impacts will occur.)

The delivery of coal to the site will continue in the same manner as is presently used for Units 1 and 2, by 100-car unit trains, each about 1.25 miles long, traveling at a maximum speed of 50 mph. The combined four units at SHERCO will require an average of 5.5 unit coal trains per day,** an increase of about three per day. (These figures are for both

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*This type of growth rate on a facility paralleling a major interstate route should be considered conservative (that is, estimates future travel on the high side).

**Figure supplied by Mr. G. Bird of R.W. Beck, engineering consultant to MPCA.

full inbound and empty outbound trains.) However, as was explained in Section 5.1, Burlington Northern does not expect the rail line which services the plant to reach capacity in the next 25 years. The increase in coal-train traffic will therefore not adversely affect rail line haul capacity but will cause increased impacts at grade crossings of local roadways. These trains will represent nearly 20% of the traffic on this line.

Outside the primary impact area, there are numerous crossings (about 65 urban ones, and 114 rural ones) (NSP 1976). However, in these areas, the train will likely be traveling close to its 50 mph maximum speed. At 1.25 miles per train, the crossing delay is only about two minutes. The impact, therefore, should be minor (an increase in delays of six minutes per day per crossing), if crossings occur during off-peak traffic hours.

Within urban areas, there is a greater potential for delay due to reduced speeds, heavier cross vehicular traffic and switching operations. Within 20 miles of the site, the largest urban area is St. Cloud. There are numerous at-grade crossings in the city and surrounding areas, which prompted the St. Cloud Area Council of Governments to conduct a Railroad Impact Study, which addressed rail crossing issues. Five selected intersections were studied, of which the busiest, Trunk Highway 152, crosses the main Burlington Northern line (Barton-Aschman Associates 1976).

T.H. 152 had an observed ADT in 1975 of 13,140 (Barton-Aschman Associates 1976) of which about 860 were recorded in the peak hour. The average number of vehicles queued per train at that intersection during the peak hour was 19.2. Assuming two trains per peak hour (this is conservative since there were only 14 trains recorded in a 16 hour period) about 4% of the peak hour flow was delayed. Average delay was 1.9 minutes per train, plus 56 seconds for queue dispersal.

Contrary to first impressions, there was no appreciable slow-down in coal train speeds observed in St. Cloud, with speeds averaging almost 48 mph, (Barton-Aschman Associates 1976). Thus, the assumption of a two minute delay per train crossing is still valid. It was also noted that traffic slowdowns at T.H. 152 were due to reasons other than railroad operations.

High vehicle delay time was also observed at T.H. 152 in the vicinity of the railroad tracks and old U.S. 10. Observations at this intersection revealed that much of the delay is not the result of railroad operations, but rather results from the nearby traffic signal at old U.S. 10. Unfortunately, it was impossible for field observers to properly separately record the vehicle delay caused by the traffic signal and any delay that might have been caused by a train which crossed the roadway during the time when vehicles were queued due to the traffic signal. As a result, the total vehicle delay recorded for T.H. 152 should not be attributed entirely to the railroad (Barton-Aschman Associates 1976).

The increase of three trains per day will cause a total of about nine minutes more delay, including queue dispersal. At present traffic rates, about 60 vehicles will be affected if all trains are added in the peak hours. This is unlikely. By 1990, the number of coal trains is expected to be 15 per day. Thus, about 25% of the projected increase will be due to BN SHERCO operations.

Within the primary impact area, however, and especially at Routes 53, 52 and 8, the trains will be traveling at slower speeds as they approach the switching area for the plant and as they leave the site. Delays here could be considerably longer, almost 7.5 mintes per crossing, assuming an average train speed of 10 mph. This impact will be negligible, however, since the roadways at which these crossings will occur carry relatively little traffic. Route 53, for example, had a 1974 ADT of only 50 vehicles. State Aid Highway 8, which carries 500 vehicles per day, will encounter the longest delays, due to the fact that the spur line to the site crosses this road.

Because the rail crossings are at grade with the roadways, increased numbers of trains will mean an increase in the probability of traffic accidents. As reported in the Barton-Aschman report for St. Cloud on Railroad Impacts, the range of accidents per year in the period 1970-1975 was from 0.2 to 0.4. It may be expected that rural areas outside of St. Cloud with lower traffic volumes, have even lower accident rates. The addition of three trains per day is not expected to alter significantly the accident rate at these intersections.

There will also be increases in truck deliveries of limestone, fuel oil, gasoline and some other materials necessary for plant operation. However, as previously noted, the number of such trips is too small to have an appreciable impact on local traffic.

5.3 Socio-Economic Impact Assessment

5.3.1 Introduction

The evaluation of potential social and economic effects resulting from construction and operation of SHERCO Units 3 and 4 is summarized in this section. For the purpose of this analysis only peak construction and operational years are analyzed, 1980 and 1985 respectively.

The projected settlement patterns of nonlocal workers during the construction and operational phase of SHERCO Units 3 and 4 are shown in Tables 5.3-1 and 5.3-2. These estimates are based upon studies of worker relocation patterns elsewhere in the U.S. and on an NSP survey of its permanent employees at Units 1 and 2.

5.3.2 Impacts During Construction

Effects on Population

The peak of construction (1980) is expected to require 435 nonlocal workers, who are likely to be accompanied by 609 dependents. Of the total construction-related population, 418 persons are projected to settle in the PSA and 626 in the SSA.

Becker City and Becker Township are the only localities that should experience an increase of more than 2.5% over their current populations as a result of this in-migration. Together these two communities are projected to account for over 20% of the construction-related population growth.

The construction of Units 3 and 4 will generate additional population growth of 226 temporary residents in Becker City and Becker Township. Of this total, 161 are likely to live in Becker City, while the remaining 65 should settle in the larger township. These figures represent increases of 31.1% and 5.2%, respectively, over the current population of the city and township. Thus, construction-related population impacts in Becker City will be significant.

The city previously experienced the consequences of temporary residency by construction workers associated with Units 1 and 2. Thus, while the construction employees at Units 3 and 4 may cause further concern about service inadequacies and the problems of growth, current

TABLE 5.3-1

PROJECTED SETTLEMENT PATTERN OF NONLOCAL CONSTRUCTION WORKERS

Location	Current Population	Number of Nonlocal Workers	Total New Residents (Includes Workers and Dependents)	% Increase New Residents Would Represent
Primary Study Area				
Sherburne County				
Becker (c)	517	67	161	31.14
Becker (t)	1,263	27	65	5.15
Big Lake (c)	2,043	20	48	2.35
Big Lake (t)	2,092	14	34	1.63
Clear Lake (c)	316	3	7	2.22
Clear Lake (t)	912	6	14	1.54
Wright County				
Clearwater (c)	298	2	5	1.68
Clearwater (t)	625	2	5	0.80
Monticello (c)	1,786	13	31	1.74
Monticello (t)	3,442	20	48	1.39
Secondary Study Area				
Benton County				
Foley (c)	1,179	2	5	0.42
Gilman - part (c)	39	-	-	-
Gilmanton (t)	819	1	2	0.24
Glendorado (t)	749	2	5	0.67
Minden (t)	1,461	3	7	0.48
St. Cloud - part (c)	4,682	13	31	0.66
St. George (t)	919	3	7	0.76
Sauk Rapids (c)	5,093	12	29	0.57
Sauk Rapids (t)	1,582	3	7	0.44
Sherburne County				
Blue Hill (t)	715	2	5	0.70
Elk River (c)	3,132	11	26	0.83
Elk River (t)	3,146	10	24	0.76
Haven (t)	1,593	7	17	1.07
Livonia (t)	1,209	4	10	0.83
Orrock (t)	998	4	10	1.00
Palmer (t)	1,111	6	14	1.26
St. Cloud - part (c)	4,390	14	34	0.77
Santiago (t)	693	4	10	1.44
Zimmerman (c)	675	2	5	0.74
Stearns County				
Fairhaven (t)	857	2	5	0.58
Lynden (t)	542	3	7	1.29
St. Augusta (t)	1,815	5	12	0.66
St. Cloud - part (c)	35,384	68	163	0.46
St. Cloud (t)	4,885	10	24	0.49
Waite Park (c)	3,030	7	17	0.56
Wright County				
Albertville (c)	531	2	5	0.94
Annandale (c)	1,476	7	17	1.15
Buffalo (c)	4,092	11	26	0.64
Buffalo (t)	1,555	4	10	0.64
Corinna (t)	1,609	13	31	1.93
Dayton (c)	48	-	-	-
Frankfort (t)	1,711	4	10	0.58
Hanover - part (c)	389	1	2	0.51
Maple Lake (c)	1,258	2	5	0.40
Maple Lake (t)	1,542	2	5	0.32
Otsego (t)	3,343	9	22	0.66
St. Michael (c)	1,416	4	10	0.71
Silver Creek (t)	1,415	4	10	0.71

Note: (c) = city
(t) = township

TABLE 5.3-2

PROJECTED SETTLEMENT PATTERN OF NONLOCAL PERMANENT EMPLOYEES

Communities	No. of Workers	Total New Resident (Includes Workers and Dependents)	% of Total New Residents
Becker (c)	10	29	7.5
Becker (t)	24	71	18.4
Clear Lake (c)	5	15	3.9
Clear Lake (t)	15	44	11.4
St. Cloud (c)	16	48	12.4
St. Cloud (t)	2	5	1.3
Big Lake (c)	7	20	5.2
Big Lake (t)	7	21	5.4
Monticello (c)	5	14	3.6
Monticello (t)	9	27	7.0
Elk River (c)	7	20	5.2
Elk River (t)	7	21	5.4
Clearwater (c)	3	9	2.3
Clearwater (t)	6	18	4.7
Other Communities	8	24	6.2
Total	131	386	100.0

Note: (c) = city
(t) = township

residents will probably realize the transitory nature of the impact during the construction period. Furthermore, since Becker includes many permanent employees at the existing SHERCO facilities and benefits from the tax revenues generated by the plant, resident attitudes towards the construction employee households will likely be tolerant if not positive.

Effects on Employment and Wages

The proposed construction program will have a positive impact on the local and regional economy by providing new jobs. There was an average of nearly 3,850 jobs in Sherburne County in 1975 (Minnesota Department of Employment Services 1976). The construction program will directly generate an average of 700 additional jobs each year over the next seven years, or almost 20% of current employment.

The construction program will also indirectly result in the creation of other jobs, primarily in the service and trade sectors. It is estimated that the secondary or multiplier effect will be on the order of 2.29; that is, each construction job will generate 1.29 additional employment opportunities. Thus, the construction phase of SHERCO Units 3 and 4 would be expected to generate an annual average of over 900 additional secondary jobs. During the peak period, the number of induced jobs could be more than 1,700. Average annual employment estimates (direct and indirect) are provided in Table 5.3-3.

The total construction payroll for Units 3 and 4 is estimated to be $90 million (in 1975 dollars) (Gregerson 1977). Since the construction activities will require approximately 4,880 manyears of effort, the average wage per manyear will be a little more than $18,400. In contrast, according to the Minnesota Department of Employment Services' statistics for 1975, the average wage in Sherburne County was only about $8,100 (Minnesota Department of Employment Services 1977).

The income multiplier effect has also been estimated. Based on studies conducted by Isard and by a Federal Task Force on energy development in the Southwest, a construction income multiplier of 1.52 represents a reasonable approximation (Southwest Energy Study 1974). The direct payroll and induced income effect of constructing the proposed generating units are summarized in Table 5.3-4.

TABLE 5.3-3

ANNUAL AVERAGE CONSTRUCTION EMPLOYMENT IMPACTS

	Construction Jobs	Induced Jobs	Total Jobs
1977	175	226	401
1978	550	710	1,260
1979	1,025	1,322	2,347
1980	1,350	1,742	3,092
1981	1,025	1,322	2,347
1982	605	780	1,385
1982	150	194	344

TABLE 5.3-4

ESTIMATED ANNUAL AVERAGE CONSTRUCTION

WAGE IMPACTS

(in 1975 dollars)

	Estimated Direct Payroll	Estimated Indirect Payroll	Estimated Total Payroll
1977	$ 3.2 million	$ 1.7 million	$ 4.9 million
1978	10.1	5.3	15.4
1979	18.9	9.8	28.7
1980	24.9	12.9	37.8
1981	18.9	9.8	28.7
1982	11.2	5.8	17.0
1983	2.8	1.5	4.3
Total	$90.0 million	$46.8 million	$136.8 million

Effects on Community Facilities and Services

The proposed construction program itself will not have any measurable effect on local community facilities and services. The construction site is located within the incorporated boundaries of Becker and as such is entitled to police and fire protection. However, NSP will employ its own security force and train its employees to handle fire-fighting equipment (Gregerson 1977).

Sewer and water will be provided by NSP on a continuous basis (Gregerson 1977). Sewage will be handled through the installation of three temporary sewage disposal facilities on site. The effluent will be treated through the use of an on-site septic system (Gregerson 1977). Potable water will be supplied by the existing on-site wells (Gregerson 1977).

The following sections summarize the expected infrastructure effects associated with the nonlocal construction workers and their families, who are expected to relocate within the PSA and SSA. The analysis of likely construction worker relocation patterns indicates that for the most part nonlocal construction workers are expected to be faily dispersed throughout the area. As a result, the influx of new residents into any one community is expected to be small. For this reason, the infrastructure analysis is limited to a few, selected communities where greater numbers of nonlocal construction workers are likely to reside.

Housing

On the basis of estimated construction worker relocation patterns, the largest demand for housing is expected to occur in the Stearns County portion of the City of St. Cloud (68 dwelling units) and in the City of Becker (67 dwelling units). Substantial demand is also expected in the City of Big Lake (20 dwelling units) and in the Township of Monticello (20 dwelling units). The demand for housing in each of the remaining communities in the study area will range between 1 and 14 dwelling units. Jobs induced by construction employment (Table 5.3-3) may aggravate the demand for housing beyond that calculated for the construction force itself.

Under the assumption that 2% of all seasonal homes could be made available and that mobile home parks have a 2% vacancy rate, substantial

housing problems could occur in the following five communities due to the apparent housing scarcity: Becker City, Becker Township, Big Lake City, Monticello Township and Elk River Township. All other communities appear able to absorb the increased housing demand, though housing prices could rise in some areas as vacancy rates decline.

Domestic Water

The increased demands for domestic water generated by the in-migration of nonlocal construction workers and their families should not have a significant impact on available supplies. The projected scattering of these newcomers in the large number of communities in the study area suggest that their incremental effects on any one municipality would be minor. A demand-capacity analysis of the Becker and St. Cloud municipal systems indicates that both have sufficient reservoir capacity to adequately meet the needs of the new populations expected to reside in these two municipalities as a result of the construction program.

Sewage Treatment

Sewage flows generated by the construction-related population may have a very minor incremental adverse impact in several communities with municipal wastewater treatment systems which currently do not comply with MPCA's effluent limits. Four cities in the study area: St. Cloud, Monticello, Elk River and Albertville, discharge treated effluents that do not meet applicable standards. While the number of additional residents who are expected to reside in these communities at the peak of construction is relatively small (228 in St. Cloud, 48 in Monticello, 26 in Elk River and only 5 in Albertville), the sewage flows produced by these newcomers may aggravate current effluent limit violations though flow rates will be within the capacity of the existing systems.

The City of Becker, which is expected to experience the most significant population impact (in-migration of 161 newcomers, or about 31% of the current population), has sufficient capacity to absorb additional flows. Its municipal treatment plant currently operates at about 44% of capacity and can accommodate incremental loadings of 25,000 GPD (Mader 1977). The 161 nonlocal construction workers and dependents will generate an additional flow of about 16,100 GPD, a

figure somewhat less than the available capacity. These estimates are based upon a sewage generation rate of 100 GPD, equivalent to the estimated rate of water use.

Solid Waste Disposal

The approximately 1,044 nonlocal construction workers and dependents who are expected to settle in the study area may contribute to a projected inadequacy of landfill space. As noted in Section 4.3.6, five of the seven landfill sites which serve the area have useful lives of only 2-5 years. Based upon solid waste generation standards of 3.5 pounds per capita per day and one acre of landfill per year for each 5,000 residents (Pulford 1977; Egner & Niederkorn Associates 1970), the newcomers associated with project construction will generate 3,654 pounds of solid wastes per day and a requirement for about 0.2 acres of additional landfill space per year. While it is expected that there may be an insufficient amount of landfill area available in 1980 independent of the population increase associated with project construction, these additional residents will slightly aggravate this problem.

Fire Protection

An evaluation of fire flow (ERT 1977h) and personnel requirements for the Becker Volunteer Fire Company (which Becker City, Becker Township and Santiago Township) and for the St. Cloud Fire Department indicates that in both cases the construction workers and their families will not have an appreciable impact on staff and equipment needs. Although the Becker's Volunteer Fire Company is currently somewhat below standards in terms of manpower, this does not constitute a significant problem since nearby communities traditionally extend mutual aid. The St. Cloud fire department currently has more than double the manpower required and thus should readily be able to absorb the additional demands from the projected increase in population.

Police Protection

The number of police necessary to provide effective protection varies with the size of the population of the areas to be served.

According to standards based on national averages (Intermountain Planners and Wirth-Berger Associates 1974), two policemen are required per thousand population to provide a medium level of protection to towns of 10,000 people or less. Anything below 1.4 per thousand is considered below standard. In typical communities of over 10,000 population, 1.7 policemen per thousand population provides a medium level of service.

The City of St. Cloud's population is estimated to be about 44,456. The 51 officers serving the city result in a ratio of only 1.15 officers per thousand population. The influx of 228 construction workers and dependents would have a very minor adverse effect to the extent that these newcomers would add to police protection requirements in an understaffed community.

The City of Becker had an estimated population of 517 in 1976. With one city police officer, the city had the equivalent of 1.93 men per thousand population. If no policemen are added, the influx of an additional 67 people would lessen this ratio to 1.71, still above the minimum standard. Thus, the proposed expansion should have no effect on the Becker City police department and only a very minor effect on the St. Cloud police department.

Health Care

An evaluation of the adequacy of acute health care facilities was undertaken using the Hill-Burton standards, federal guidelines used by hospitals requesting federal aid. Two hospitals were analyzed: the Big Lake Memorial Hospital, which serves Becker City and Becker Township and St. Cloud Hospital, which seves the City of St. Cloud. The evaluation showed that the SHERCO-related populations expected to reside within the respective service areas of these two hospitals would have no effect on these facilities. Regardless of whether the proposed project is developed, projected bed needs for both hospitals are well below the current capacity.

Schools

The impact analysis concentrates on two specific schools districts, No. 726 in Becker and No. 742 in St. Cloud, since the largest concentrations of

nonlocal construction workers are likely to reside within these two districts. The Becker School District (No. 726) serves all or part of the following six communities: Becker City, Becker Township, Clear Lake Township, Palmer Township, Blue Hill Township and Santiago Township. A "worst-case" assumption was made for the purposes of impact assessment that all school-aged children moving to these six communities, regardless of whether their place of residence is within the districts' boundary, will attend schools in District No. 726. Thus, on the basis of the worker relocation patterns previously presented in Table 5.3-1, there will be an estimated population influx of 269 persons, of whom 61 are expected to be school-aged children. Since the elementary school serving District No. 726 is projected to be 250 students below capacity in 1980 and the secondary school will be about 305 below capacity, the children of SHERCO construction workers can be easily absorbed into the District No. 726 schools.

The same worst-case assumption was made in evaluating potential impacts in District No. 742 in St. Cloud. This district serves all or part of St. Cloud City and Township, Clear Lake City and Township, Waite Park City, Haven Township, Lynden Township, Minden Township and Palmer Township. If all 78 school children who are expected to move to these communties enroll in District No. 726, there would not be an appreciable impact since the elementary schools will be 910 students below capacity in 1980 and secondary schools are projected to have 769 spaces available in that year.

Effect on Taxes

The 320-acre expansion area for Units 3 and 4 has an assessed valuation of approximately $137,600. This estimate is based upon the fact that in 1976, unimproved land in the City of Becker had an assessed valuation of about $430 per acre (NSP 1977). Based on the current tax rate of $53.21 per $1000 assessed valuation, the expansion site yields a little more than $7,300 in total property taxes.

The construction of Units 3 and 4 on this 320-acre site will provide substantial property tax benefits to those local government units

to be affected, namely, the City of Becker, School District No. 726, Sherburne County and the Big Lake-Monticello Hospital District.

The potential implications of the seven year construction program are presented in Table 5.3-5. This table shows how the taxable value of the various government units change each year as a direct result of the proposed construction activities. Changes in assessed valuations are presented for three of the four applicable taxing jurisdictions. An analysis was not conducted for the Big Lake-Monticello Hospital District since over the past five years the taxes levied by this special district have represented only 1% of a typical homeowner's total tax burden.

The construction of the SHERCO site would result in substantial expansion of the tax bases of local taxing jurisdictions. The net effect of increasing the taxable capacity of a community is to provide that jurisdiction with a great deal of latitude in adjusting its tax-service mix. The analysis showed that during the peak construction year (1980), each dollar of non-NSP tax receipts would receive $125 in revenues from the four SHERCO units. Likewise, School District No. 746 would gain $9 in SHERCO-generated receipts for each dollar of non-NSP revenues and Sherburne County would receive $3 from the four generating units for each non-NSP tax dollar.

5.3.3 Impacts During Plant Operations

Effects on Population

The operation of SHERCO Units 3 and 4 will require 131 nonlocal workers, who are expected to bring 255 dependents. The projected place of residence of these 386 newcomers was previously displayed in Table 5.3-2. Because these newcomers are not expected to be concentrated in any one municipality, the population impacts generated by operation of the proposed facilities should be negligible. The newcomers represent less than 5% of the current estimated population of all of the 14 cities and townships with the exception of Becker City and Becker Township (where the newcomers would generate increases of slightly more than 5% over present populations). The projected newcomers represent only 0.1% and

TABLE 5.3-5

COMPARISON OF ASSESSED VALUATIONS WITH AND WITHOUT SHERCO UNITS 3 AND 4

City of Becker

	Without Units 3&4			With Units 3&4				
	Non-NSP	Units 1&2	Total	Non-NSP	Units 1&2	Units 3&4	Total	Units 3&4 As % of Total
1977	$0.8	$86.8	$87.6	$0.8	$86.8	$0.1	$87.7	0.1
1978	1.0	108.3	109.3	1.0	108.3	0.1	109.4	0.1
1979	1.1	108.3	109.4	1.1	108.3	9.2	118.6	7.7
1980	1.3	108.3	109.6	1.3	108.3	47.2	156.8	30.1
1981	1.5	108.3	109.8	1.5	108.3	107.5	217.3	49.5
1982	1.8	108.3	110.1	1.8	108.3	175.2	285.3	61.4
1983	2.1	108.3	110.4	2.1	108.3	225.0	335.4	67.1

School District No. 726

1977	7.9	$86.8	$94.7	$7.9	$86.8	$0.1	$94.8	0.1
1978	10.7	108.3	119.0	10.7	108.3	0.1	119.1	0.1
1979	14.4	108.3	122.7	14.4	108.3	9.2	131.9	6.9
1980	19.3	108.3	127.6	19.3	108.3	47.2	174.8	27.0
1981	26.0	108.3	134.3	26.0	108.3	107.5	241.8	44.4
1982	34.9	108.3	143.2	34.9	108.3	175.2	318.4	55.0
1983	47.0	108.3	155.3	47.0	108.3	225.0	380.3	59.2

Sherburne County

1977	56.0	$86.8	$142.8	56.0	$86.8	$0.1	$142.9	0
1978	62.5	108.3	170.8	62.5	108.3	0.1	170.9	0
1979	69.8	108.3	178.1	69.8	108.3	9.2	187.3	4.9
1980	78.0	108.3	186.3	78.0	108.3	47.2	233.5	20.2
1981	87.1	108.3	195.4	87.1	108.3	107.5	302.9	35.5
1982	97.3	108.3	205.6	97.3	108.3	175.2	380.8	46.0
1983	108.7	108.3	217.0	108.7	108.3	225.0	442.0	50.9

4.8%, respectively, of the current populations in St. Cloud City and Clear Lake Township, the two other communities which are expected to accommodate more than 10% of the nonlocal operational population.

The nonlocal operational workers and their families should not cause any significant social impacts in these communities. The numbers of newcomers who would settle in individual communities are very small (see Table 5.3-2) and in most cases even smaller than the in-migration generated during the construction phase.

Effects on Employment and Income

The operation of SHERCO Units 3 and 4 will commence sometime in 1984 or 1985. The full permanent work force associated with the operations of Units 3 and 4 will consist of approximately 138 persons (Leno 1976). The multiplier or indirect employment effect of plant operations is expected to be in the vicinity of 1.90 (Drake 1977). Thus, the 138 direct jobs will induce approximately 124 additional support jobs.

The annual payroll for Units 3 and 4 has been estimated to be approximately $2.4 million or nearly $17,400 per employee (Leno 1976). Using an income multiplier of 1.65, (Southwest Energy Study 1974), the induced annual payroll associated with the wages paid to the Units 3 and 4 employees is estimated to be nearly $1.6 million annually.

Effects on Community Services and Facilities

Normal plant operation of Units 3 and 4 is not expected to have any direct and measurable effect on local community facilities and services. NSP will use the services of the Becker Police, Sherburne County Sheriff's Department and the Becker Volunteer Fire Department on an "on call" basis (Gregerson 1977). In addition, NSP currently has its own internal security system. If the experience associated with the current operation of Units 1 and 2 is indicative of what may occur in the future with respect to the operation of Units 3 and 4, it would appear that current arrangements are sufficient and will not produce any long-term adverse effect on the ability of the local police and fire departments to maintain an adequate level of service. According to NSP officials, there has been no need for the services of the fire department since the plant became operational. Furthermore, the Becker police

have assisted on only a couple of occasions to control traffic, such as during the plant Open House (Gregerson 1977). The operation of Units 3 and 4 will place no demands on local sewers, potable water supplies and solid waste disposal facilities since these services will be provided on-site on a continuous basis (Gregerson 1977).

Operational worker relocation patterns were previously shown on Table 5.2-3. The data indicate that nearly 50% of the 386 new residents who are projected to relocate in the Becker area will likely seek homes in four specific communities: Becker Township (18.4%); the City of St. Cloud (12.4%); Clear Lake Township (11.4%) and the City of Becker (7.5%). The number of new residents moving into any one of these other communities will be rather small, with no one community expected to have a population influx equalling 5% or more of its current population. For this reason the infrastructure analysis is limited to an examination of potential impacts in four communities: Becker City and Township, the City of St. Cloud and Clear Lake Township.

Housing

There may be significant housing impacts in three of the four communities where project-related housing demand is expected to be greatest. A large disparity exists between employee demand and the potentially available housing supply in Becker Township, Clear Lake Township and Becker City. In the case of St. Cloud, the estimated available supply far exceeds estimated NSP employee demand by a factor of over 12 (ERT 1977h).

Unless additional housing becomes available between now and 1985, particularly in Becker Township, many of the nonlocal permanent employees may have to seek housing elsewhere. In addition, the demand pressures could force rents and values to increase at a faster than normal rate in these communities where vacancies are limited.

These adverse effects may not occur if developers respond to the NSP employees' demand for housing. There are several subdivisions in the Becker area that have been plotted and approved, though few homes have been actually constructed (ERT 1977h). These subdivisions could provide more than 300 additional dwelling units, more than enough to satisfy the NSP demand estimated for the three communities involved.

Domestic Water

The incremental demand for domestic water which would be caused by the in-migration of nonlocal operational workers and their families should not have a significant impact on available supplies. An analysis of demand and capacity relationships indicates that the projected peak demand for potable water in the cities of Becker and St. Cloud are well within the current capacities of these two systems. The 71 persons expected to settle in Becker Township and the 44 persons who are likely to move to Clear Lake Township will have to rely upon water drawn from private wells.

Sewage Treatment

St. Cloud City is the only community with a sanitary sewage system of the cities and townships which are each expected to accommodate more than 10% of operational workers and dependents. The incremental loading on the wastewater treatment plant in St. Cloud City should be about 4,800 GPD based upon an estimated rate of water consumption of 100 gallon per capita per day (gcd). This additional flow will account for less than 0.1% of the design capacity of this system. However, since the discharge from this system currently exceeds applicable state effluent limits, the sewage generated by the operational population may contribute slightly to this problem.

Becker and Clear Lake Townships rely upon septic systems and cesspools for disposal of wastewater. It is assumed that any new units which may be needed to service the newcomers will have to comply with applicable sanitary and building codes.

The City of Becker has a municipal treatment facility which presently operates at only 44% of design capacity. The incremental loading of about 2,900 GPD generated by the 29 nonlocal operational workers and dependents expected to settle in this city is well within the available capacity at this facility.

Solid Waste Disposal

As in the case of the construction-related population growth, nonlocal operational employees who move to study area communities may have

a very minor effect on the projected insufficiency of landfill space. St. Cloud City and Clear Lake Township are both served by the St. Augusta landfill which has a remaining useful life of only 3-4 years. Thus, this facility will no longer be functioning when the nonlocal operational employees settle in the area. The 92 persons who are expected to move to St. Cloud City and Clear Lake Township will generate a need for less than 0.1 acres of additional landfill space per year. However, if a replacement for the St. Augusta landfill has not been established, the solid wastes generated by these newcomers will contribute to disposal problems.

Becker City and Becker Township are both served by the Elk River landfill. This facility presently has a minimum useful life of 15 years and should have sufficient space for disposal of the negligible amount of additional solid wastes generated by the operational population.

Fire Protection

It was established in the construction phase analysis of potential impacts on fire protection requirements that the influx of 228 people to St.Cloud would have no discernible effect on the city's fire protection services. Thus, the potential impact imposed by the 48 nonlocal operational employees and dependents will be negligible. For the same reason there should also be no impact on fire protection requirements in Becker City and Becker Township. The remainder of the discussion is therefore confined to Clear Lake Township, the other potentially affected community.

The Clear Lake City Fire Department provides fire protection to Clear Lake Township, Clear Lake City and Palmer Township. These communities have a combined current estimated population of 2,339 with an expected SHERCO operational population influx of 59 people. Based on insurance industry's standards for fire protection, Clear Lake would already be considered below standard. However, as mentioned before, surrounding communities extend mutual aid to one another when fires are too large for local companies to handle. In any event, the direct population increase caused by the operation of SHERCO Units 3 and 4 will not increase Clear Lake's fire protection needs.

Police Protection

As noted in Section 5.3.2, the construction related population growth in the cities of Becker and St. Cloud would have a negligible impact on the adequacy of police protection in these communities. Thus, the smaller number of newcomers associated with operation of Units 3 and 4 will have no significant impact.

Becker and Clear Lake Townships receive their police protection from the Sherburne County Sheriff's office. As mentioned earlier, this law enforcement agency currently has a level of staffing below accepted standards. The influx of 71 people to Becker Township and 44 to Clear Lake in addition to about 130 people in other parts of the county may have a minor effect onpolice protection services.

Health Care

The effect that the SHERCO Units 3 and 4 operational employees and their families will have on health care in the area will be minimal. As discussed in Section 4.3.6, the hospitals providing care to the service area are currently operating well below capacity. The small numbers of people brought into communities at the operational stage will clearly be insufficient to create any deficiencies.

Schools

The operational phase school impact analysis considered potential impacts in three school districts: Nos. 882, 726 and 742. The demand-capacity evaluation showed that even under worst-case assumption (described in Section 5.3.2), all schools in the above mentioned districts would continue to remain substantially below capacity. Thus, the operational phase is expected to have no adverse effect on local educational facilities.

Effect on Taxes

The major effect of operation of Units 3 and 4 on local taxing jurisdictions will be similar to that described in the impact analysis for the construction period. When Units 3 and 4 become operational

and taxable, they will continue to significantly enhance the capacity of certain local taxing jurisdictions to raise revenue through the property tax.

The net effect of Units 3 and 4 on the local tax base is presented on Table 5.3-6 for the year 1985. This table shows how the taxable value of the City of Becker, School District 726, and Sherburne County each change as a result of adding Units 3 and 4 to the respective tax rolls. The data indicate that by 1985, Units 3 and 4 will add nearly $268 million in assessed valuation to each of the three taxing jurisdictions. As a result, Units 3 and 4 will represent nearly 71% of the City of Becker's total tax base, 58% of School District 726 and 52% of Sherburne County.

The leverage of subsidy effects of Units 3 and 4 on the taxing capacities of the local jurisdictions was estimated for the year 1985. According to the data, the assessed valuation of Units 3 and 4 will create a fiscal condition whereby for each dollar of non-SHERCO related tax revenue the City of Becker will receive $134 of SHERCO generated revenues. The net tax effect will be substantially less for School District 726 and Sherburne County. In these latter two jurisdictions, the total revenue yield per non-NSP tax dollar will amount to $3 and $2, respectively.

The power plant will have a substantial and positive effect on the public finances of local governments. The plant facility provides a large increase in the tax base. At the same time, it places little strain on public services.

TABLE 5.3-6

COMPARISON OF ASSESSED VALUATIONS WITH AND WITHOUT
SHERCO UNITS 3 AND 4 ($ million)

	Without Units 3&4			With Units 3&4				
	Non-NSP	Units 1&2	Total	Non-NSP	Units 1&2	Units 3&4	Total	Units 3&4 as % of Total
City of Becker								
1985	$2.8	$108.3	$111.1	$2.8	$108.3	$267.7	$378.8	70.7
School District 726								
1985	85.0	108.3	193.3	85.0	108.3	267.7	461.0	58.0
Sherburne County								
1985	135.6	108.3	243.9	135.6	108.3	267.7	511.6	52.3

5.4 Air Quality

5.4.1 Stack Emissions Impact on Ambient Air Quality

Technical Approach

The air quality impact of the SHERCO facility was assessed using the ERT PSDM model, a Gaussian plume diffusion model that employs stability-dependent Briggs' plume rise formulas (Turner 1970d, Briggs, 1969), and meteorological data recorded at the St. Cloud and Minneapolis-St. Paul airports. This section presents the results of ERT's analysis and compares the results to applicable air quality regulations.

PSDM considered 128 receptors at critical and sensitive locations. Receptors were placed in a polar pattern around the plant at distances of 1.0 km, 3.0 km, 5.0 km, 7.5 km, 10 km, 15.0 km, 20 km and 80 km. Receptors out to 15.0 km represent those locations where maximum facility impacts are expected. Receptors at 20 and 80 km were examined due to the potential for sensitive receptors, such as Class I Prevention of Significant Deterioration Areas, to be located at such downwind distances. It should be noted that the modeling performed was not calibrated with monitored data.

Emissions and stack parameters used in the predictive model are indicated in Table 5.4-1. The full load numbers are based on maximum summertime emissions. The emission rates for Units 3 and 4 are the maximum allowable for new stationary combustion sources, 0.1, 1.2 and 0.7 lb/MM Btu for particulates, SO_2 and NO_x, respectively. The emission rates for Units 1 and 2 were confirmed by stack test. The 50% load emission and flue gas rates were determined by assuming a constant exit temperature and reducing the flow and emissions values linearly. If the emission rates of Units 3 and 4 vary from the NSPS maximum allowable standard, the stack emissions and predicted stack related impact will vary correspondingly.

The meteorological data were obtained from National Weather Service surface observations at the Minneapolis-St. Paul International Airport and from radiosonde observations at the St. Cloud Airport. The meteorological data are considered representative of the SHERCO plant site. For PSDM simulations, the interpolated hour-by-hour mixing height is categorized into one of five categories, 200, 350, 700, 1,300 and 2,000 meters.

TABLE 5.4-1

INPUTS TO THE MODELING ANALYSIS

Stack and Emission Parameters	Units 1 & 2	Units 3 & 4
Stack Height (ft)	650	650
Stack Diameter (ft)	30.8	35.4
Exit Temperature (°F)	163	170
Full Load Flue Gas Rate (ACFM)	4.534×10^6	5.250×10^6
Full Load SO_2 Emission Rate (lb/hr)	1.394×10^4	1.997×10^4
Full Load NO_x Emission Rate (lb/hr)	1.553×10^4	1.165×10^4
Full Load TSP Emission Rate (lb/hr)	1.264×10^3	1.664×10^3
Half Load Flue Gas Rate (ACFM)	2.267×10^6	2.625×10^6
Half Load SO_2 Emission Rate (lb/hr)	6.97×10^3	9.98×10^3
Half Load NO_x Emission Rate (lb/hr)	7.765×10^3	9.985×10^3
Half Load TSP Emission Rate (lb/hr)	6.320×10^2	8.320×10^2

Additional Model Inputs Parameters	Value
Vertical Potential (°K/m) Temperature Gradient	0.035
Ambient Pressure (mb)	960
Ambient Temperature (°K)	293
Wind Reference Height (m)	6.1
Stability Dependent Wind Power Law Exponent	0.10, 0.15, 0.20, 0.25, 0.30

Three-hour Average Concentrations

Modeling analysis was performed to determine pollutant (SO_2, TSP and NO_2) concentrations associated with the operation of Units 1, 2, 3 and 4 for both the 100% and 50% load conditions. These calculations were performed for the five mixing depth height categories. The results of this analysis are presented in Table 5.4-2. As indicated by these data the maximum facility-related 3-hour average is expected to occur with Units 1, 2, 3 and 4 operating during 100% load conditions.

The highest predicted plant related 3-hour SO_2 impact was 500 $\mu g/m^3$. When added to the second highest monitored 3-hour average SO_2 concentration of 97* $\mu g/m^3$ the projected ambient concentration is 597 $\mu g/m^3$ (see Table 5.4-3) or 91% of the Minnesota standards and 46% of the federal primary 3-hour standard. It must be noted that the background concentration of 97 $\mu g/m^3$ was the maximum second highest 3-hour SO_2 concentration recorded at any of the monitors during the 1975 monitoring period. This estimated background level is conservative since it is not necessarily the background concentration which would occur during the same meteorological conditions or at the same location as the maximum predicted plant impact.

Twenty-Four Hour Average Concentrations

ERT's analysis of maximum 24-hour concentrations was performed using a sequential version of PSDM inputting a series of hour-by-hour (sequential) meteorological observations. PSDM used this series to create a corresponding time series of hour-by-hour concentrations at each receptor considered. The hour-by-hour simulations were then processed into 24-hour averages.

The results of this analysis indicated that there would be 39 times when a 24-hour facility related SO_2 concentration would exceed 85 $\mu g/m^3$. These concentrations were predicted to occur at distances between 5 and 15 kms from the facility along various radials. The maximum predicted 24-hour SO_2 level associated with Units 1, 2, 3 and 4 operating was calculated to be 150 $\mu g/m^3$ (see Table 5.4-3). This concentration is predicted to occur 5 km from the plant. When the second highest monitored 24-hour average concentration of 47* $\mu g/m^3$ is added to this

*Suspect data as determined by Air Quality audit.

TABLE 5.4-2

PREDICTED PEAK 3-HOUR SO_2 CONCENTRATION ($\mu g/m^3$)

UNITS 1-4 FOR 100%/50% LOAD CONDITIONS

Load	Mixing Depth (m)	Downwind Distance (km)	Wind Speed (m/s)	Stability	Concentration ($\mu g/m^3$)
100%	200*	-	-	-	0
	350	7.0	8.94	4	453
	700	5.0	3.58	2	500
	1300	5.0	1.79	1	368
	2000	6.0	8.94	4	368
50%	200*	-	-	-	0
	350	8.0	5.36	3	424
	700	3.0	2.68	1	410
	1300	6.0	5.36	4	300
	2000	6.0	5.36	4	300

*At 200 m plume is found to penetrate the top of the mixing layer or the lid for all combinations of wind speed, stability and mixing height categories. Under such circumstances the model assumes no ground level plume impacts.

TABLE 5.4-3

MAXIMUM CONCENTRATIONS ($\mu g/m^3$) ASSOCIATED WITH THE OPERATION OF THE SHERCO STACKS

Pollutant	Averaging Period	Background*	PSDM Maximum Predicted SHERCO Stack Impact	Estimated Total Ambient Level	Most Stringent Standard
SO_2	3-hour (100% load)	97[Δ]	500	597	655
	(50% load)	97[Δ]	424	521	655
	24-hour	47[Δ]	150	197	260
	Annual	17	5.8	22.8	60
TSP	24-hour	173[Δ]	13	186	150
	Annual	67[∇]	0.5	67.5	60
NO_2	Annual	17[†]	4.7	21.7	100

*Suspect data as determined by Air Quality data

[Δ]Maximum second highest monitored level

[∇]Based on 9-months of data

[†]Based on 10-months of data

concentration the resultant ambient level would be 197 $\mu g/m^3$. This concentration is 76% of the Minnesota primary and secondary standards and 54% of the federal primary standard. Again, since the second highest measured background level did not necessarily occur with the same meteorological conditions associated with the modeled impact, the use of this background estimate is felt to be conservative.

To determine the maximum 24-hour TSP concentration associated with the SHERCO stack emissions, the predicted SO_2 concentrations were multiplied by the ratio of TSP emissions to SO_2 emissions. This procedure was based on the assumption that the dispersion for each of these pollutants is identical. The calculated maximum 24-hour average TSP concentration associated with Units 1, 2, 3 and 4 operating was determined to be 13 $\mu g/m^3$ (see Table 5.4-2). The maximum second highest monitored 24-hour average TSP level, 173* $\mu g/m^3$, is already above the appropriate federal and state primary and secondary standard. (This concentration was monitored during operation of Unit 1; therefore, it could include the influence of Unit 1). When this concentration is added to the simulated plant-related maximum 24-hour average TSP concentration, the ambient level is estimated to be 186 $\mu g/m^3$ or 88% of the federal and state primary standards and 153% of the federal and state secondary standards.

Annual Average** Concentrations

The PSDM calculations of annual average concentrations due to SHERCO emissions were calculated with four-dimensional wind rose. Annual simulations were made for SO_2, TSP and NO_2. NO_2 simulation assumes that all the NO_x emissions are NO_2. Figures 5.4-1, 5.4-2 and 5.4-3 illustrate the distribution of annual average pollutant concentrations due to the SHERCO emissions for the full load operating conditions for each of the three pollutants analyzed. Concentrations in micrograms per cubic meter ($\mu g/m^3$) are plotted on a polar grid which extends 80 km from the SHERCO facility.

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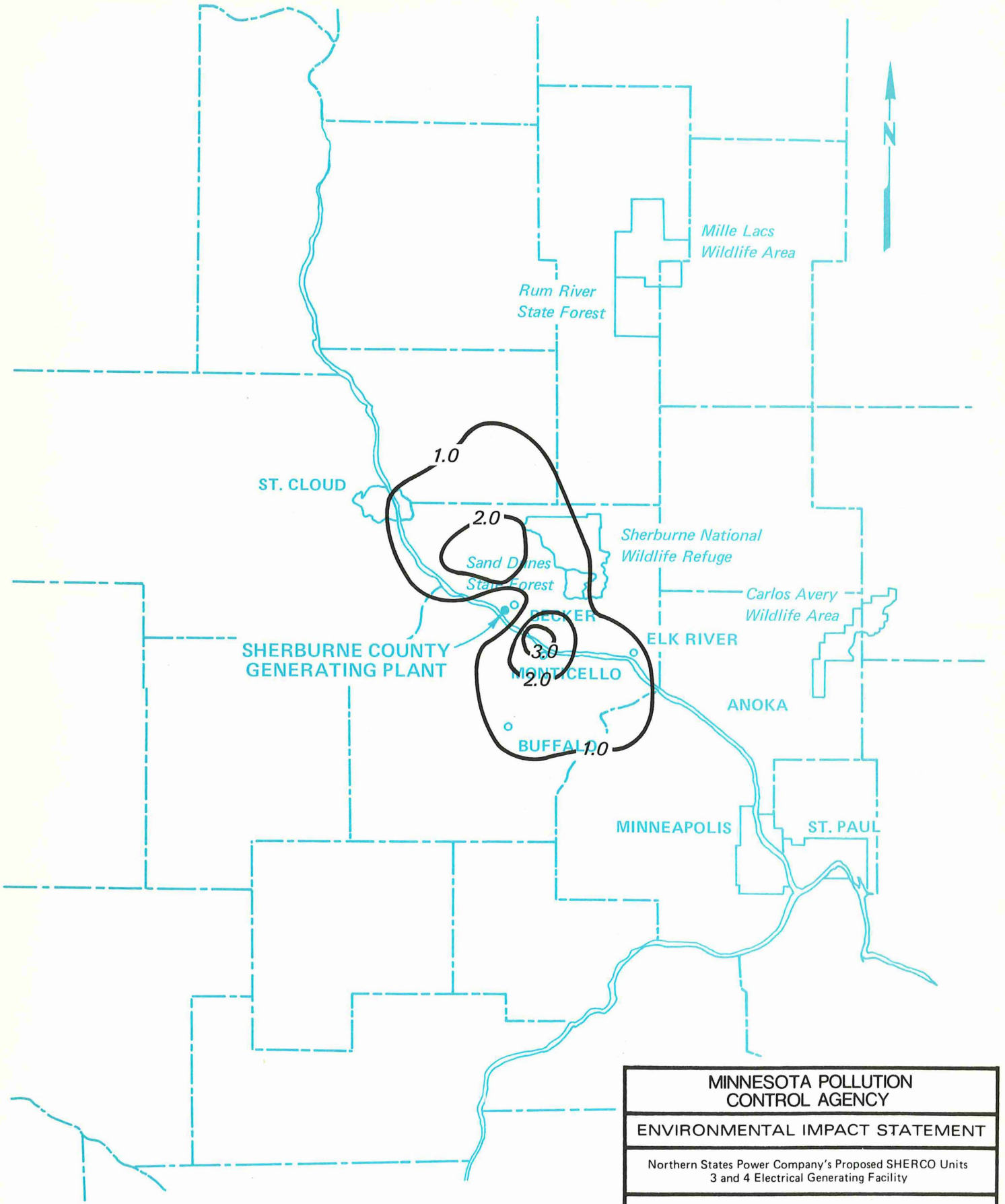
*Suspect data as determined by an air quality audit

**Within the context of this report annual average is defined as annual arithmetic mean.



MINNESOTA POLLUTION CONTROL AGENCY
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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.4-1 Isopleths of Annual Average SO_2 Concentrations ($\mu g/m^3$) Due to SHERCO Units 1,2,3 and 4 Stack Emissions

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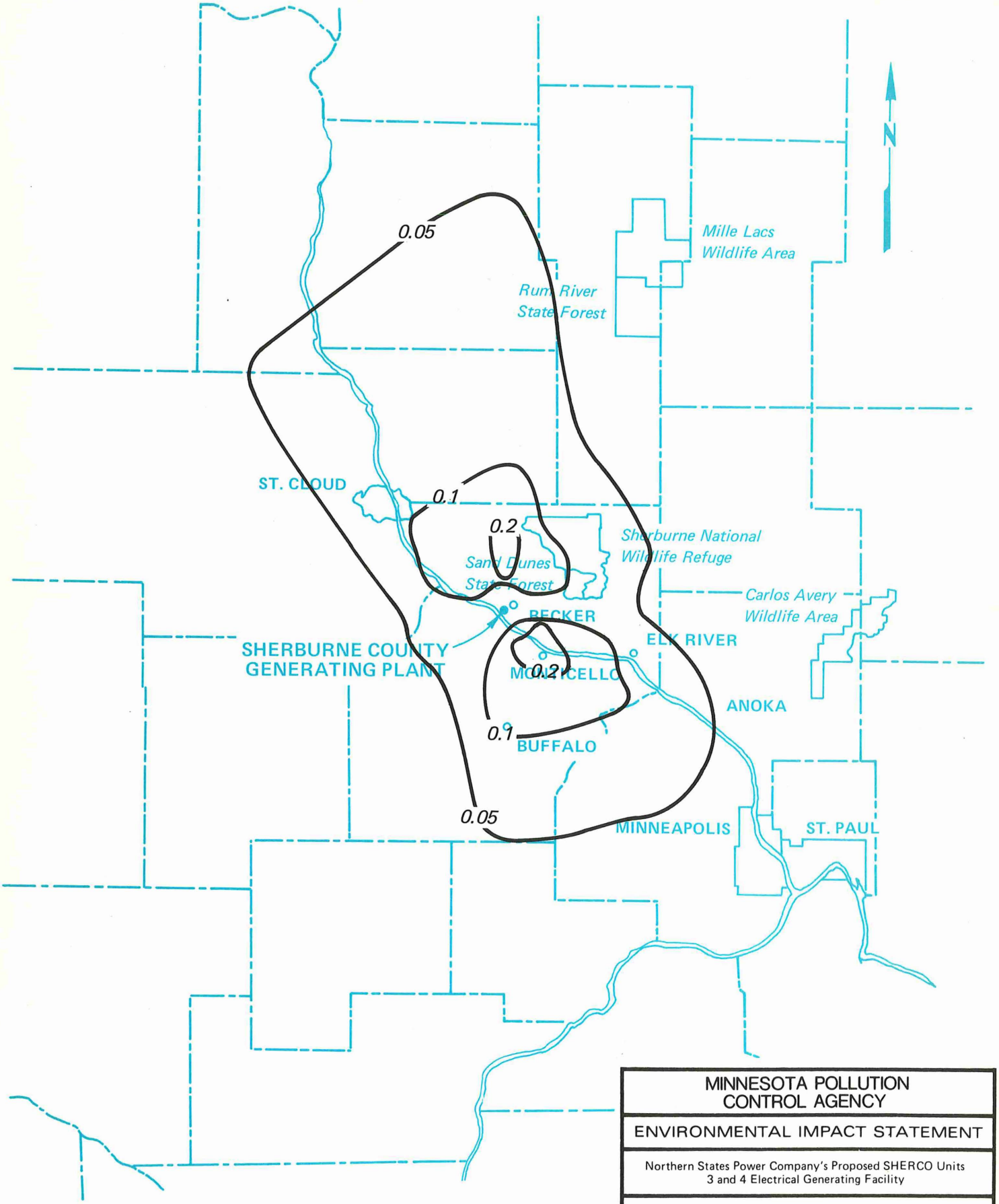

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.4-2 Isopleths of Annual Average TSP Concentrations ($\mu g/m^3$) Due to SHERCO Units 1,2,3 and 4 Stack Emissions

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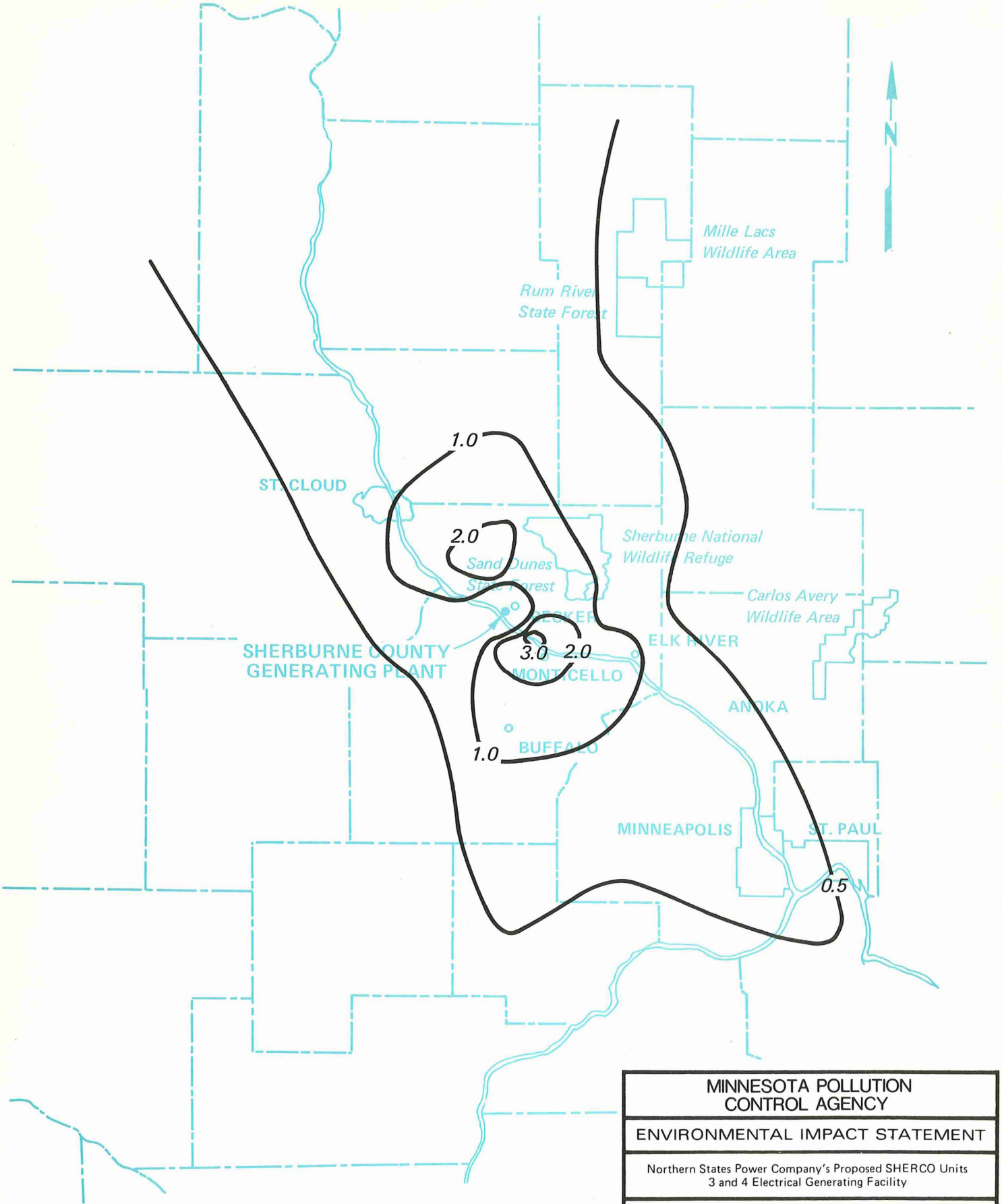

MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.4-3 Isopleths of Annual Average NO_2 Concentrations ($\mu g/m^3$) Due to SHERCO Units 1,2,3 and 4 Stack Emissions

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The maximum concentrations simulated are listed in Table 5.4-3. As indicated by these data, the maximum annual average SO_2, TSP and NO_2 plant-related concentrations were 5.8, 0.5 and 4.7 $\mu g/m^3$, respectively. Adding the maximum measured long-term background concentration to the maximum plant-related concentrations, the total estimated ambient annual average concentrations are 22.8, 67.5 and 21.7 $\mu g/m^3$ for SO_2, TSP and NO_2, respectively. The ambient levels of SO_2 and NO_2 do not exceed the applicable standards. However, the background TSP concentration alone exceeds the federal and state secondary annual standards. Adding the appropriate maximum plant-related impact to the background concentrations indicates a concentration of 67 $\mu g/m^3$ or 89% of the applicable federal and state primary annual standards and 112% of the federal and state secondary standards.

5.4.2 Prevention of Significant Deterioration Impact

The purpose of this analysis was to determine if the emissions impact of SHERCO Units 3 and 4 would comply with current prevention of significant deterioration regulations. This assessment of the impact of Units 3 and 4 at the SHERCO facility was performed in three steps. The first step was to determine maximum 3-hour, 24-hour and annual impacts associated with the emissions from the stack serving these two boiler units. Secondly, the results of step one were compared to current prevention of significant deterioration regulations to determine the percent of the Class II increments used. Finally, available land use maps were obtained to determine if there are any potential Class I areas in the vicinity of SHERCO. The impact of SHERCO Units 3 and 4 emissions at these locations were examined to determine the percent of the Class I increments used.

PSDM was used to simulate the ambient air quality impacts expected from SHERCO Units 3 and 4. Model calculations were made for SO_2 and TSP for a dense network of ground-level receptors at critical and sensitive locations. Again, receptors were placed in a polar pattern around the plant at distances of 1.0 km, 3.0 km, 5.0 km, 7.5 km, 10.0 km, 15.0 km, 20 km and 80 km. Receptors out to 15.0 km represent those locations where maximum impacts of Units 3 and 4 are expected. Receptors at 20 km and 80 km were examined due to the potential for Class I

areas to be designated within this range of downwind distances. Three-hour, 24-hour and annual averages were determined as previously discussed for Units 1, 2, 3 and 4, collectively. Both full load and half load plant operation and emission parameters were considered.

The maximum 3-hour SO_2 level was predicted to occur with the plant operating at half load. This predicted maximum of 358 $\mu g/m^3$ occurred approximately 3 km from the stack under unstable atmospheric stability and 5.4 meters per second wind speed. A review of the meteorological data set indicated that the meteorological conditions associated with the 358 $\mu g/m^3$ had a 0.0 frequency of occurrence during the years 1960-1964. Therefore, the 358 $\mu g/m^3$ is a conservative estimate of maximum 3-hour average plant impact. This is approximately 36% of the Class II allowable 3-hour increment (see Table 5.4-4).

The maximum predicted 24-hour SO_2 level was 87 $\mu g/m^3$ and was predicted to occur approximately 7.5 km southeast of the plant during full load plant operating conditions. Predominant meteorological conditions during this 24-hour period were a persistent wind direction from the northwest, neutral atmospheric stability and 8.9 meter per second wind speed. This level represents 88% of the allowable Class II increment (see Table 5.4.4). The maximum 24-hour TSP level of 7 $\mu g/m^3$ also occurred on the same day and the same receptor under identical meteorological conditions as the SO_2 maximum. This value represents approximately 23% of the allowable Class II 24-hour TSP increment. The NSP ER indicates maximum 24-hour TSP levels of 4 $\mu g/m^3$.

The maximum annual average SO_2 concentration was predicted to be 3.2 $\mu g/m^3$ approximately 6 km southeast of the plant. This is 21% of the allowable annual Class II increment for SO_2 (see Table 5.4-4). The maximum TSP level of 0.3 $\mu g/m^3$ occurred at the same receptor. Isopleth drawings of annual average SO_2 and TSP concentrations surrounding the plant are presented in Figures 5.4-1 and 5.4-2. In each case annual increments will be maintained by adequate margins.

Potential Class I Areas

The air quality impact region within 80 km of SHERCO, like the rest of the country, is presently considered a Class II impact area (Federal Register, December 5, 1974). Class II areas are those areas where

TABLE 5.4-4

COMPARISON OF MAXIMUM PREDICTION PLANT IMPACT
TO PSD CLASS II INCREMENTS

Pollutant	Averaging Period	Maximum Predicted Impact Unit 3 & 4 $\mu g/m^3$	Class II Allowable Increment $\mu g/m^3$
SO_2	3	358	700
	24	87	100
	Annual	3.2	15
TSP	24	7	30
	Annual	0.3	10

moderate, well controlled energy or industrial growth would be allowed to take place without air quality deterioration up to the national standards. If the proposed Senate version of the 1976 Clean Air Act Amendments passes, certain areas may be redesignated as Class I impact areas at the discretion of the State of Minnesota. Class I areas are described as those areas where almost any deterioration of current air quality is undesirable and little or no major industrial development would be allowed.

Land use maps indicate potential Class I areas within the impact area of SHERCO. These are listed in Table 5.4-5. Of these areas, the Sherburne National Wildlife Refuge, which meets the Congressional Conference Committee's criteria of a Class I area of 5,000 acres or greater, is closest. The SHERCO Units 3 and 4 emissions impact in this selected area is presented below:

	Maximum Impact ($\mu g/m^3$)	Class I Increment ($\mu g/m^3$)
3-Hour		
SO_2	264.7	25
24-Hour		
SO_2	37	5
TSP	3	10
Annual		
SO_2	1.4	2
TSP	0.1	5

As indicated by these data, Class I increments for 3-hour and 24-hour SO_2 levels are predicted to be exceeded in Sherburne National Wildlife Refuge.

5.4.3 Cooling Tower Impact

ERT conducted an evaluation of the predicted environmental impacts, as described in the NSP's ER due to air emissions from the cooling towers of the proposed SHERCO Units 3 and 4. ERT's evaluation was performed using ERT cooling tower models. The modeling analysis included a simulation of the impact of a system of four rectangular mechanical

TABLE 5.4-5

POTENTIAL CLASS I DESIGNATED AREAS

Areas	Distance from Plant (km)	Direction from Plant
Sand Dunes State Park	12.5 to 21	ENE
Sherburne National Wildlife Refuge	15-21	NNE
	21-23	ENE
	8-27	NE
Run River State Forest	60-73	NNE
Mille Lacs Wildlife Area	73-89	NNE
Carlos Avery Wildlife Area	62-77	E
Sand Dunes State Forest	15-21	E

draft towers with a total of 52 fans. Evaluations were made of the: (1) atmospheric effects under selected worst-case meteorological conditions, i.e., fogging, icing, and obscuration due to extended saturated (visible) plumes; and (2) average monthly surface deposition pattern of cooling tower drift.

Fogging and Icing

The occurrence of fogging and/or icing due to cooling tower plumes is a by-product of downwash. The meteorological condition associated with downwash is high wind speed. Associated with this condition, the presence of the tower structure in the ambient flow field results in the formation of a low-pressure wake in the lee of the towers. Plume rise is inhibited in such circumstances, and part or all of the tower effluent may be temporarily deflected into this wake region. At sufficient downwind distances, the buoyancy of the plume allows it to escape the lee cavity; therefore, ground-level impact is restricted to the region adjacent to the cooling towers.

The cooling tower model incorporates a scheme to simulate the aerodynamic effect associated with high wind speeds. Downwash of the plume is assumed to occur when the ratio of tower exit velocity to the wind speed at tower height falls below a critical value which is a function of the plume exit radius, building height and the angle between the wind vector and the long axis of the tower. For the mechanical draft towers studied here, the critical wind speed for downwash varied from 5 meters/sec for winds perpendicular to the tower's long axis, and 10 meters/sec for winds parallel to the tower's long axis.

The worst case meteorological conditions were chosen using the average annual joint distribution of wind speed, temperature and relative humidity reported for Minneapolis during the period 1951 to 1960. The cases selected consist of situations with coincident high relative humidity (96%), high wind speed, neutral stability and the extreme temperatures (maximum and minimum). The meteorological cases selected are listed in Table 5.4-6 as are the associated downwind distances of fogging and/or icing due to SHERCO Units 3 and 4 cooling towers. These results assume that the wind is perpendicular to the tower's long axis.

TABLE 5.4-6

WORST CASE OCCURRENCE OF TOWER INDUCED FOGGING AND/OR ICING*

Wind Speed (m/s)	Temperature (°C)	Predicted Length of Fog and/or Icing (m) Downwind of Towers
17.88	6.67	359
17.88	20.00	427
13.41	-6.67	308
13.41	20.00	364
10.73	-9.94	311
10.73	26.10	323
6.26	12.20	283
6.26	26.10	280**

*Wind perpendicular to long axis of towers. Relative humidity of 96%. Neutral stability assumed.

**Plume dissipated before lifting off the ground.

The results presented indicate that the length of fogging and/or icing will only rarely, if ever, extend farther than 500 meters downwind of the towers. In addition, it can be seen that the fogging and/or icing lengths are a function of wind speed and ambient temperature. The higher the wind speed, the more bent-over the plume is as it leaves the influence of the tower's wake. This causes the plume to drag along the ground for a greater distance. Also, a high ambient temperature reduces the relative buoyance of the plume causing it to rise at a slower rate as it leaves the wake region. Thus, both effects result in longer patches of fog and/or icing. In any event the impacts of fogging and icing will be confined to the SHERCO site itself.

Visible Plume Length

Model sensitivity tests indicate that over a wide range of temperatures, the cases of light winds accompanied by high relative humidity result in the longest calculated plumes. In a worst case study, visible plume lengths were determined for a range of meteorological conditions which are observed in Minnesota. As in the worst case fogging study, the meteorological conditions were derived from the average annual joint distribution of wind speed, temperature and relative humidity for Minneapolis (1951-1960). The specific worst cases simulated are summarized in Table 5.4-7.

The results of the worst case simulations indicate that only rarely will the visible plume lengths from the four rectangular mechanical draft cooling towers exceed 15 kilometers. As expected, the longest plumes were predicted for moist and stable conditions with light winds. The longest visible plume length obtained was 20 kilometers.

Cooling Tower Drift

The expected salt drift deposition pattern is presented in Figure 5.4-4. It is elongated along the north-northwest/south-southeast axis with a predicted maximum of 16 lb/acre/month occurring just north of the towers. These results reflect the dominant local wind directions. The most frequent wind direction evidenced at Minneapolis is southerly. This high frequency of southerly winds results in a maximum deposition

TABLE 5.4-7

WORST CASE OCCURRENCE OF VISIBLE PLUME LENGTH*

Wind Speed (m/s)	Temperature (°C)	Stability	Predicted Visible Plume Length (m)
0.89	26.10	neutral	2,353
0.89	26.10	stable	4,459
0.89	4.44	neutral	7,383
0.89	4.44	stable	20,349
0.89	-17.80	neutral	4,506
0.89	-17.80	stable	14,730
1.79	26.10	neutral	2,182
1.79	26.10	stable	3,695
1.79	4.44	neutral	6,006
1.79	4.44	stable	16,094
1.79	-17.80	neutral	3,762
1.79	-17.80	stable	7,012
4.47	26.10	neutral	2,383
4.47	4.44	neutral	4,113
4.47	-12.20	neutral	1,899

*Assuming a realtive humidity of 96%.

located north of the towers. ERT's simulation indicates that no deposition rates in excess of 10 lb/acre/month are predicted to occur outside of the plant site boundaries (Figure 5.4-4). While Minnesota currently has no applicable regulations for deposition, the significance of these levels can be inferred by comparison to the New York State standard which is 27 lb/acre/month. In short, little, if any, impact may be attributed to SHERCO Units 3 and 4 salt deposition.

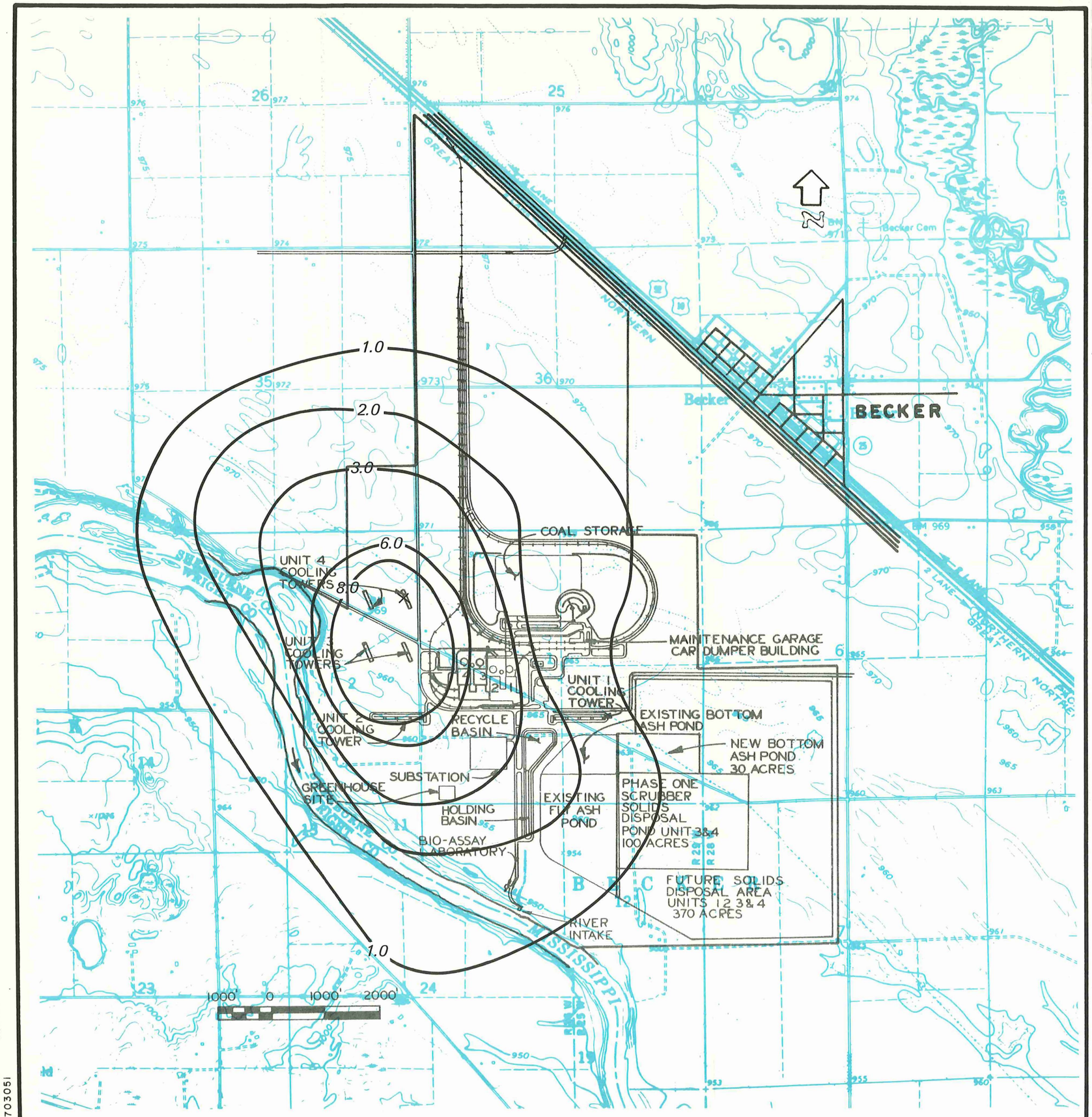
5.4.4 Trace Elements Impact

This analysis was conducted to evaluate the airborne concentration and surface deposition impacts of the trace element emissions from the SHERCO Generating Facility.

ERT's model PSDM was employed to predict trace element concentrations for 1-hour and annual averaging times. PSDM was modified to consider not only airborne concentrations but also surface deposition rates.

The emissions of trace elements from the four SHERCO units were approximated by comparison with data provided in an EPA study (EPA, Region VIII, 1975), because of the similarities between coal operations of the Station I unit in the EPA study and the SHERCO operations (Northern States Power, 1976). The percent distribution of trace elements among the various ash streams for Station I were used for the SHERCO plant and adjusted for differences in particulate loading. Because the trace element emission rates based on this analysis represent an average rate expected during the year, they were used in this study to estimate annual average airborne and surface deposition concentrations. These emission rates are presented in Table 5.4-8.

The 1-hour concentrations were based on a worst-case set of trace element emissions data. Conservative assumptions based on two studies of trace elements from coal-fired power plants (Klein et al. 1975; Kaakimen et al. 1975) were made concerning the coal trace element concentrations, trace element control efficiencies, and the application of trace element concentration factors. This information was used to estimate maximum atmospheric emissions of trace elements. Table 5.4-9 presents, for each trace element, emissions data applicable to the calculation of the maximum 1-hour concentrations.



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MINNESOTA POLLUTION CONTROL AGENCY

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Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.4-4 Average Monthly Drift Deposition Rate (lb/acre/mo) Due to SHERCO Cooling Towers [x=Peak Deposition Rate=16 lb/acre/mo]

TABLE 5.4-8

ESTIMATED AVERAGE EMISSIONS TO ATMOSPHERE (g/s) OF

TRACE ELEMENTS FROM SHERCO UNITS 1 - 4

Trace Element	Emissions	
	Units 1 and 2	Units 3 and 4
Antimony	7.8×10^{-4}	1.0×10^{-3}
Arsenic	2.4×10^{-2}	3.2×10^{-2}
Barium	3.9×10^{-1}	5.0×10^{-1}
Beryllium	8.7×10^{-4}	1.1×10^{-3}
Boron	2.7×10^{-1}	3.5×10^{-1}
Cadmium	1.1×10^{-3}	1.4×10^{-3}
Chlorine[a]	9.4×10^{1}	1.2×10^{2}
Chromium	7.5×10^{-2}	9.7×10^{-2}
Copper	8.7×10^{-3}	1.1×10^{-2}
Fluorine[a]	1.7×10^{-1}	2.3×10^{-1}
Germanium	4.9×10^{-3}	6.3×10^{-3}
Lead	1.5×10^{-2}	1.9×10^{-2}
Manganese	5.7×10^{-2}	7.4×10^{-2}
Mercury[a]	1.7×10^{-2}	2.1×10^{-2}
Molybdenum	1.5×10^{-1}	1.9×10^{-1}
Nickel	6.1×10^{-2}	7.9×10^{-2}
Selenium[a]	3.9×10^{-3}	5.0×10^{-3}
Silver	3.9×10^{-4}	5.1×10^{-4}
Uranium	5.8×10^{-3}	7.6×10^{-3}
Vanadium	2.9×10^{-2}	3.8×10^{-2}
Zinc	5.2×10^{-2}	6.8×10^{-2}

[a]Gaseous trace elements

TABLE 5.4-9

ESTIMATED MAXIMUM 1-HOUR EMISSIONS TO ATMOSPHERE (g/s) OF TRACE ELEMENTS FROM SHERCO UNITS 1 - 4

	Emissions	
Trace Element	Units 1 and 2	Units 3 and 4
Antimony	6.7×10^{-2}	7.8×10^{-2}
Arsenic	2.2×10^{-1}	2.6×10^{-1}
Barium	4.7×10^{0}	5.5×10^{0}
Beryllium	2.7×10^{-2}	3.3×10^{-2}
Boron	3.8×10^{-1}	4.5×10^{-1}
Cadmium	1.7×10^{-2}	2.2×10^{-2}
Chlorine[a]	3.8×10^{2}	4.5×10^{2}
Chromium	4.1×10^{-1}	4.8×10^{-1}
Copper	3.4×10^{-1}	4.0×10^{-1}
Fluorine[a]	1.1×10^{1}	1.2×10^{1}
Germanium	5.2×10^{-1}	6.1×10^{-1}
Lead	7.7×10^{-1}	9.1×10^{-1}
Manganese	3.6×10^{0}	4.3×10^{0}
Mercury[a]	2.7×10^{-2}	3.3×10^{-2}
Molybdenum	1.5×10^{-1}	1.8×10^{-1}
Nickel	2.8×10^{-1}	3.3×10^{-1}
Selenium[a]	1.6×10^{-1}	1.9×10^{-1}
Silver	2.2×10^{-3}	2.8×10^{-3}
Uranium	2.7×10^{-2}	3.3×10^{-2}
Vanadium	4.6×10^{-1}	5.5×10^{-1}
Zinc	2.5×10^{0}	2.9×10^{0}

[a]Gaseous trace elements

TABLE 5.4-10

MAXIMUM ANNUAL AVERAGE AMBIENT CONCENTRATIONS ($\mu g/m^3$) OF

TRACE ELEMENTS FROM SHERCO UNITS 1 - 4

Trace Element	Concentration
Antimony	2.7×10^{-6}
Arsenic	8.5×10^{-5}
Barium	1.4×10^{-3}
Beryllium	3.1×10^{-6}
Boron	9.5×10^{-4}
Cadmium	3.8×10^{-6}
Chlorine	2.9×10^{-1}
Chromium	2.6×10^{-4}
Copper	3.1×10^{-5}
Fluorine	5.5×10^{-4}
Germanium	1.7×10^{-5}
Lead	5.1×10^{-5}
Manganese	2.0×10^{-4}
Mercury	5.2×10^{-5}
Molybdenum	5.1×10^{-4}
Nickel	2.1×10^{-4}
Selenium	1.2×10^{-5}
Silver	1.4×10^{-6}
Uranium	2.0×10^{-5}
Vanadium	1.0×10^{-4}
Zinc	1.8×10^{-4}

Maximum annual average ambient concentrations and maximum hourly concentrations are both predicted to occur 7.5 km southeast of the plant. Predicted annual concentrations are listed in Table 5.4-10. These concentrations are the result of emissions transported by frequently occurring northwesterly winds. Similarly, the maximum predicted annual average surface deposition fluxes for gaseous and particulate trace elements, which also occur 7.5 km southeast of the plant, are listed in Table 5.4-11. Summaries of the predicted maximum hourly effects are listed in Tables 5.4-12 and 5.4-13. These values may be expected to occur with neutral stability, a mixing depth of about 350 m and wind speeds about 8.9 m/s.

Trace Element Standards

Although there are no federal or State of Minnesota trace element standards, calculated concentrations may be compared to existing standards in other states. Presently, three states (Montana, Oregon, and Pennsylvania) have passed laws for airborne lead concentrations, ranging from 3 to 5 $\mu g/m^3$ for a 30-day average. Since the maximum 1-hour concentration does not exceed these values, the maximum 30-day average concentration should fall far short of these concentrations. Five states (Montana, Idaho, Pennsylvania, New York, and Texas) have passed beryllium airborne concentration laws, ranging from 0.01 $\mu g/m^3$ for a 24-hour average to 0.01 $\mu g/m^3$ for a 30-day average. Once again, since even the 1-hour average concentrations do not exceed these values, it is expected that these standards would not be exceeded.

Several state laws presently exist for gaseous fluoride airborne and/or deposition concentrations. The most stringent of these standards list airborne concentration values range from 3.68 $\mu g/m^3$ for a 12-hour average, to 0.8 $\mu g/m^3$ for a 24-hour average, and 0.5 $\mu g/m^3$ for the eight-month growing season (March through October). While the 1-hour maximum concentrations may be occasionally higher than the 24-hour and eight-month standard values, it is very unlikely that any of the appropriately averaged values will approach these standards. The standard for surface deposition flux for fluorides, 0.3 $\mu g/cm^2$ for a one-month averaging period, will not be exceeded from emissions from SHERCO Units 1 through 4.

TABLE 5.4-11

MAXIMUM ANNUAL AVERAGE SURFACE DEPOSITION FLUXES ($\mu g/m^2$) OF TRACE ELEMENTS FROM SHERCO UNITS 1 - 4

Trace Element	Concentration
Antimony	7.7×10^{-9}
Arsenic	2.4×10^{-7}
Barium	3.8×10^{-6}
Beryllium	8.7×10^{-9}
Boron	2.7×10^{-6}
Cadmium	1.1×10^{-8}
Chlorine	8.3×10^{-3}
Chromium	7.4×10^{-7}
Copper	8.7×10^{-8}
Fluorine	1.5×10^{-5}
Germanium	4.8×10^{-8}
Lead	1.4×10^{-7}
Manganese	5.7×10^{-7}
Mercury	1.5×10^{-6}
Molybdenum	1.5×10^{-6}
Nickel	6.1×10^{-7}
Selenium	3.4×10^{-7}
Silver	3.9×10^{-9}
Uranium	5.8×10^{-8}
Vanadium	2.9×10^{-7}
Zinc	5.2×10^{-7}

TABLE 5.4-12

MAXIMUM 1-HOUR AVERAGE AMBIENT CONCENTRATIONS ($\mu g/m^3$) OF TRACE ELEMENTS FROM SHERCO UNITS 1 - 4

Trace Element	Concentration
Antimony	1.9×10^{-2}
Arsenic	6.2×10^{-2}
Barium	1.3×10^{0}
Beryllium	7.9×10^{-3}
Boron	1.1×10^{-1}
Cadmium	5.0×10^{-3}
Chlorine	9.5×10^{1}
Chromium	1.2×10^{-1}
Copper	9.5×10^{-2}
Fluorine	2.6×10^{0}
Germanium	1.5×10^{-1}
Lead	2.2×10^{-1}
Manganese	1.0×10^{0}
Mercury	7.0×10^{-3}
Molybdenum	4.2×10^{-2}
Nickel	7.8×10^{-2}
Selenium	4.0×10^{-2}
Silver	5.7×10^{-4}
Uranium	7.9×10^{-3}
Vanadium	1.3×10^{-1}
Zinc	6.9×10^{-1}

TABLE 5.4-13

MAXIMUM 1-HOUR AVERAGE SURFACE DEPOSITION FLUXES ($\mu g/m^2$) OF TRACE ELEMENTS FROM SHERCO UNITS 1 - 4

Trace Element	Concentration
Antimony	6.7×10^{-5}
Arsenic	2.2×10^{-4}
Barium	4.7×10^{-3}
Beryllium	2.8×10^{-5}
Boron	3.8×10^{-4}
Cadmium	1.8×10^{-5}
Chlorine	3.4×10^{0}
Chromium	4.1×10^{-4}
Copper	3.4×10^{-4}
Fluorine	9.4×10^{-2}
Germanium	5.2×10^{-4}
Lead	7.7×10^{-4}
Manganese	3.6×10^{-3}
Mercury	2.5×10^{-4}
Molybdenum	1.5×10^{-4}
Nickel	2.8×10^{-4}
Selenium	1.4×10^{-3}
Silver	2.0×10^{-6}
Uranium	2.8×10^{-5}
Vanadium	4.7×10^{-4}
Zinc	2.5×10^{-3}

Predicted concentrations from SHERCO Units 1 through 4 are expected to be far below any of these related state standards. Similarly element fluxes predicted to be deposited upon the ground surface from SHERCO Units 1 through 4 are below 99.98% compared to 99.996% used in ERT's simulation.

5.4.5 TSP Impact Due to Fugitive Dust Emissions from the SHERCO Coal Handling Facilities

Significant emissions of fugitive dust can occur during the coal handling process at transfer points and storage piles. A portion of these emissions can impact the surrounding ambient air as suspended particulates. To assess the worst-case impact of these emissions, a multi-source diffusion model was employed along with worst-case emissions and meteorology to calculate the maximum incremental impact of the coal handling operations on 24-hour and annual average TSP concentrations. The results are evaluated with respect to the concurrent impact of stack emissions of TSP, and the total resulting TSP concentrations are compared to the applicable standards.

Model Input and Assumptions

In order to calculate the emissions of total suspended particulates (TSP) due to transfer and storage of coal, emission factors reported in a recent EPA sponsored study of fugitive dust sources (PEDCo, 1976) were employed. These factors relate the emissions of TSP to the amount of coal transferred or the acreage covered by storage. An uncontrolled emission factor of 0.2 pound per ton of coal transferred was employed to calculate the emissions from transfer points. This emission factor represents the highest value presented in the PEDCo study for a range of 0.0 to 0.2 lb/ton. The Uncertainty (two standard deviations) of this fugitive dust emission estimate is on the order of a factor of 5. The 0.20 lb/ton emission factor used, therefore, is extremely conservative and probably overestimates the actual emissions. An uncontrolled emission factor of 3.5 pounds per acre per day was employed to calculate the emissions from storage piles. This emission factor was developed from studies of crushed rock storage piles and represents emissions due only to wind erosion.

Table 5.4-14 lists the transfer points of the coal handling facility, the type of control employed and the efficiency of these controls. The locations of these points are depicted in Figure 5.4-5. Table 5.4-15 lists the amount of coal being transferred at each point based on the assumed daily scenario. Table 5.4-16 lists the weighted 24-hour average emission rate and height of release for each point and area source, along with the assumed control efficiencies and periods of operation.

Meteorological Conditions Used in Modeling

For annual average computations, a stability wind rose derived from observations at the Minneapolis-St. Paul Airport from 1960-1964 was employed. For worst-case 24-hour averages, an assumption of a 3-meter per second wind persisting for 12 of the 24 hours in one wind direction under stable atmospheric conditions was used. This represents the duration of a typical nocturnal inversion and associated low wind speeds from the hours of sunset to sunrise. It should be noted that worst-case ground-level impact from ground-level sources is associated with stable conditions due to inhibited vertical motions in the atmosphere. However, under stable conditions, the ground-level impact from elevated sources is usually negligible. Therefore, maximum impact from both types of sources would not occur simultaneously.

Results

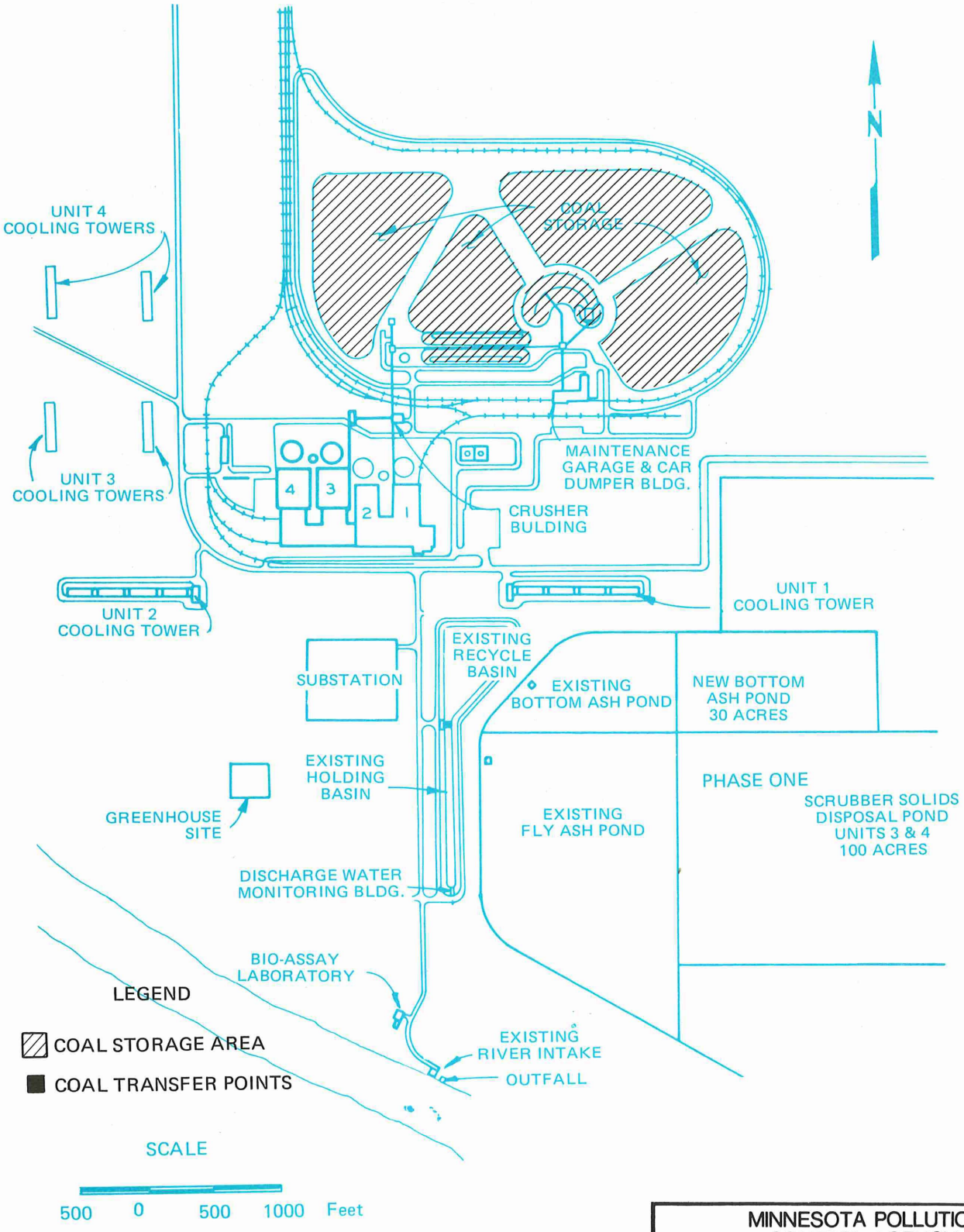
Annual average TSP concentrations were calculated for 100 ground-level receptors distributed in all downwind directions out to a distance of approximately four miles. Receptors northeast of the plant experience the highest predicted annual average TSP concentrations. Figure 5.4-6 represents the downwind profile of annual average TSP concentrations for those receptors northeast of the plant. Receptors at other downwind directions would experience lower annual averages than those depicted in the figure.

The analysis of worst-case annual average ambient TSP levels indicates that the federal and state primary standard of 75 $\mu g/m^3$ could be exceeded within approximately 1.4 miles of the plant boundary. The federal and Minnesota secondary annual standard of 60 $\mu g/m^3$ could be

TABLE 5.4-14

COAL TRANSFER POINTS AND CONTROLS

No.	Type	Control	Efficiency
1	Rotary Car Dumper	Bag	99.9%
2	No. 1 Transfer House	Rotary-Mechanical	90%
3	Units 3 and 4 Radial Stacker	Water	50%
4	Units 1 and 2 Stacker/Reclaimer	Water	50%
5	No. 2 Transfer House	Rotary-Mechanical	90%
6	Crusher Building	Bag	99.9%
7	No. 3 Transfer House	Rotary-Mechanical	90%
8	Units 1 and 2 Coal Silos	Bag	99.9%
9	Units 3 and 4 Coal Silos	Bag	99.9%
10	Radial Reclaim Hopper	Rotary-Mechanical	90%
11	Units 3 and 4 Ready Storage	None	0
12	Units 1 and 2 Ready Storage	None	0
13	Reserve Storage	Water	50%



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.4-5 SHERCO Plant Facility Layout and Coal Transfer Points

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TABLE 5.4-15

COAL TRANSFER (TONS/HOUR) AT TRANSFER POINTS BASED ON ASSUMED DAILY SCENARIO

Time Period	Transfer Point*	Ton/Hour
1st 8-hours	1, 2	2625
	3	458
	4	367
	5, 6	1800
	7, 9	1000
	8	800
Remaining 16-Hours	2, 7, 9, 10	1000
	4, 8	800
	5, 6	1800
All 24-hours	11, 12, 13	At Capacity

*See Table 5.4-14 and Figure 5.4-5.

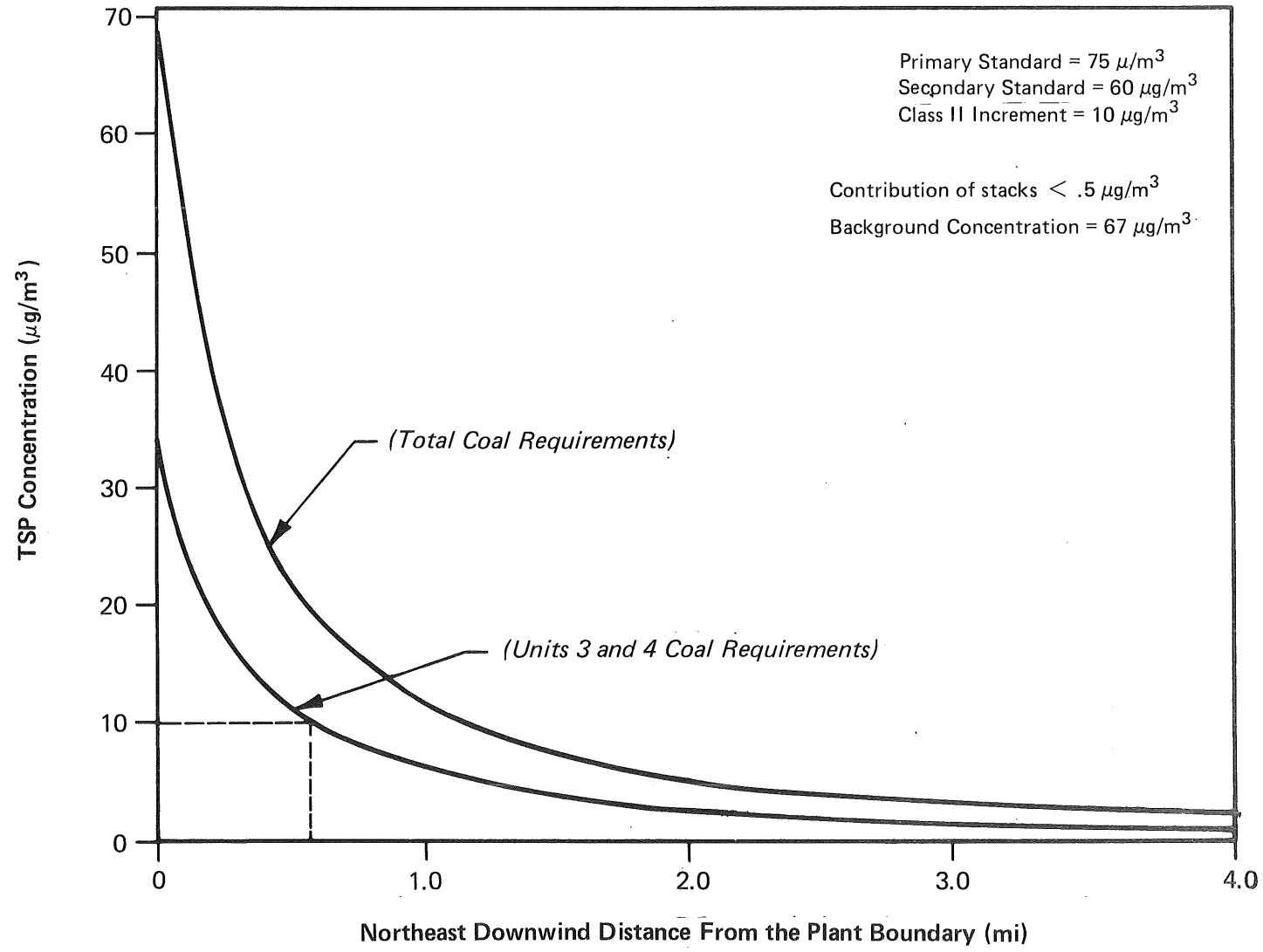
TABLE 5.4-16

24-HOUR TSP EMISSION RATES

	Emission Point/Area	Height (m)	Control Efficiency (%)	Assumed Hours of Operation			Particulate Matter Emission Rates	
				First 8	Next 16	All 24	pounds/day	grams/sec
1	Rotary Car Dumper	8.53	99.9	X			4.21	0.0221
2	No. 1 Transfer House	15.85	90	X	X		740.01	3.885
3	Units 3 and 4 Radial Stacker	10.0	50	X			549.53	2.885
4	Units 1 and 2 Stacker/Reclaimer	10.0	50	X	X		1573.94	8.263
5	No. 2 Transfer House	11.89	90	X	X		863.83	4.535
6	Crusher Building	28.65	99.9	X	X		8.65	0.0454
7	No. 3 Transfer House		90	X	X		480.01	2.520
8	Units 1 and 2 Coal Silos	55.78	99.9	X	X		3.85	0.0202
9	Units 3 and 4 Coal Silos	55.78	99.9	X	X		4.80	0.0252
10	Radial Reclaim Hopper	10.0	90		X		320.01	1.680
11	Units 3 and 4 Ready Storage*	20.0**	0			X	9.64	0.0506 (4.54 g/m^2-sec)
12	Units 1 and 2 Ready Storage*	10.0**	0			X	12.86	0.0675 (4.54 g/m^2-sec)
13	Reserve Storage*	14.0**	50			X	131.36	0.6896 (4.54 g/m^2-sec)
							4702.70	

* Acreages are those depicted in Figure 5.4-6

** Mixing volume



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.4-6 Highest Predicted Annual TSP Concentrations

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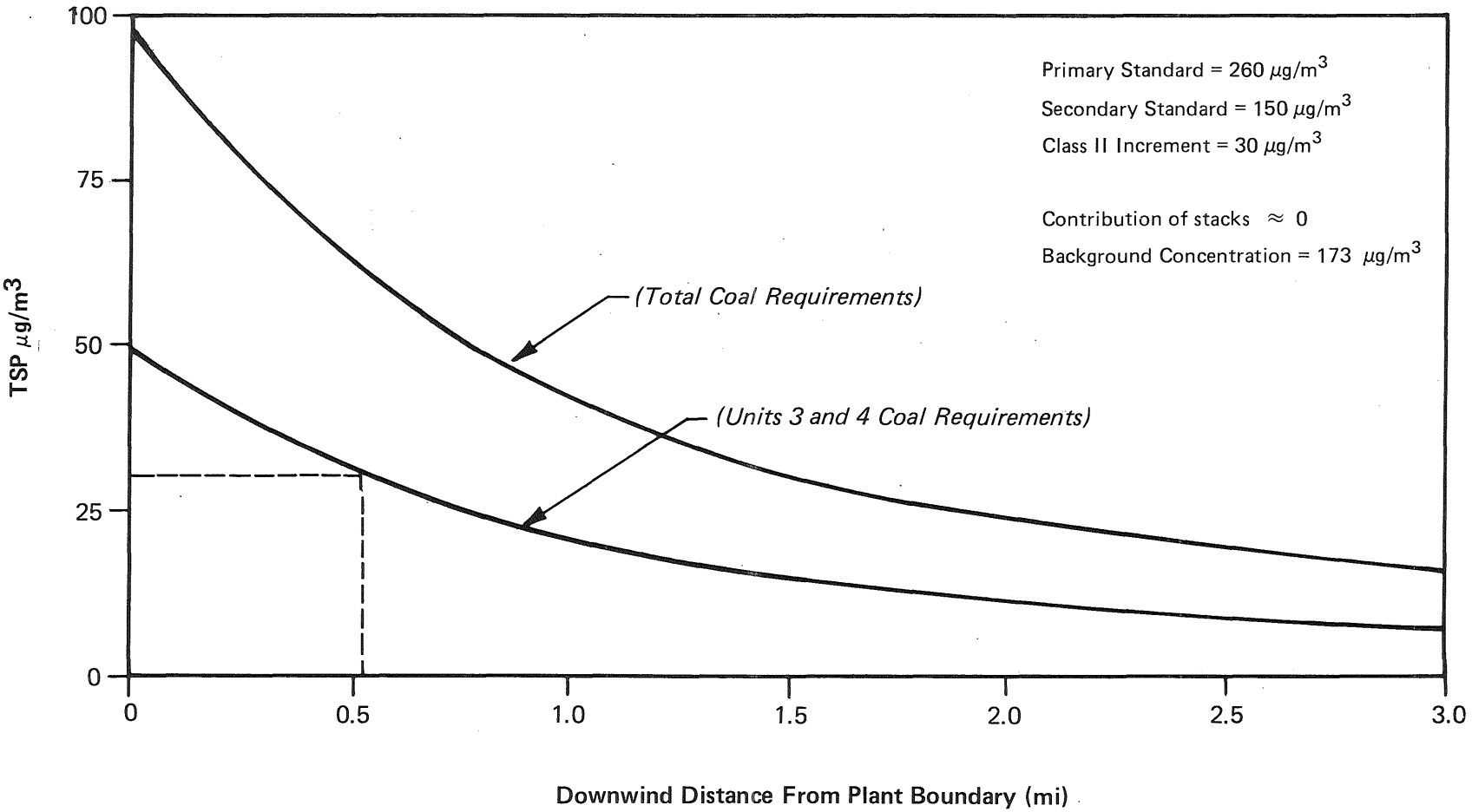
exceeded by background alone. Comparison with the Class II 10 $\mu g/m^3$ prevention of significant deterioration (PSD) standard is made with the results which assumed only Units 3 and 4 coal requirements. The 10 $\mu g/m^3$ standard is predicted to be exceeded within approximately 0.5 miles downwind of the plant boundary. The maximum contribution of annual TSP concentrations due to emissions from the unit boiler stacks alone is less than 0.5 $\mu g/m^3$ everywhere, which is small compared to the results for the coal handling operations.

The model results for the assumed worst-case 24-hour meteorology of persistent stable, low wind speed conditions are shown in Figure 5.4-7. The calculated contribution from the SHERCO stacks would be negligible during these assumed meteorological conditions. To determine total ambient TSP levels the maximum second-highest 24-hour monitored background (173 $\mu g/m^3$) was added to the modeling results. (It must be noted that this monitored background concentration exceeds the federal and Minnesota secondary standards.) The analysis indicates that total ambient TSP levels will exceed the federal and state primary standard of 260 $\mu g/m^3$ within approximately 0.15 miles from the plant boundary. The 30 $\mu g/m^3$ Class II PSD standard is predicted to be exceeded within approximately 0.5 miles downwind of the plant boundary.

In both the annual and 24-hour cases, the transfer points account for more than 96% of the maximum predicted concentrations. The sources which would benefit the most from further control measures are those transfer points where watering, having an assumed efficiency of 50%, is the only control measure. These are the radial stacker, and the stacker/reclaimer. Together, these sources account for approximately 30% of the total calculated daily fugitive emissions of TSP.

5.4.6 Analysis of Sulfates and Acid Rain

In the last few years there has been a considerable increase in the level of scientific attention and concern given to analysis to sulfate compounds and their mechanisms of production transport and removal in the atmosphere. Both sulfates and SO_2 are being evaluated in current research studies as to their roles in the formation of acid rain. It may be concluded that considerable additional research is necessary before a rational basis for standards and control strategies for sulfates



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.4-7 Downwind Distance from Plant Bounding

will exist. However, due to the uncertainties in any assessments of the risks associated with sulfate concentrations in the ambient air or fluxes deposited upon the surface, it is only possible to make preliminary quantitative estimates which are accurate to an order-of-magnitude for the cases modeled.

The PSDM model was utilized to calculate both the ambient air concentrations and the deposition fluxes which would be expected to occur downwind of the SHERCO generating station. It was assumed for these calculations that the plant was operating at full load with four units. Thus, the resulting annual average concentration estimates are expected to be conservatively high.

The maximum calculated ambient hourly concentration of SO_4 occurs at the maximum distance considered, 90 km, due to the slow rate of conversion from SO_2 to $SO_4^=$. The Gaussian dispersion models become much less reliable at distances of this magnitude. Thus, the concentrations predicted at 90 km or more should be considered as a rough estimate. The highest hourly concentration of $SO_4^=$ in the air could be 74 $\mu g/m^3$. Although sulfate transformation products in sufficient concentrations are likely to produce adverse health effects, no Minnesota or federal standards have yet been developed to serve as a basis for assessment of impact. This concentration includes 1.5 $\mu g/m^3$ due to primary SO_4 emissions, and occurs with a wind speed of 2.7 m/sec and a mixing depth of 350m. Under this same set of conditions, the deposition flux for $SO_4^=$ aerosols would be 0.080 $\mu g/m^2$-sec or 288 $\mu g/m^2$-hr.

The annual average concentrations and rates of deposition for $SO_4^=$ are greatly reduced from the hourly average values by meteorological variability. The annual average ambient air concentrations due to primary $SO_4^=$ emission are listed separately in Table 5.4-17 from those due to species transformation from SO_2 emissions. It is clear from the tabulated values that the transformed $SO_4^=$ concentrations dominate the totals for all downwind distances listed. The primary $SO_4^=$ emissions are predominant only for distances less than 1 km.

Table 5.4-18 shows a similar listing of annual average values for the deposition fluxes for $SO_4^=$. If the maximum calculated value of 0.198×10^{-3} $\mu g/m^2$-sec is multiplied by the number of seconds in a year (31.5×10^6), the total annual deposition of $SO_4^=$ per square meter is

TABLE 5.4-17

MAXIMUM ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS ($\mu g/m^3$) OF $SO_4^=$ AEROSOL

Wind Direction	Downwind Distance (km)	Primary $SO_4^=$ from Stack Emissions ($\mu g/m^3$)	Secondary $SO_4^=$ from SO_2 Conversion ($\mu g/m^3$)	Total Ambient $SO_4^=$ ($\mu g/m^3$)
SE	2.5	1.65×10^{-3}	2.7×10^{-3}	4.35×10^{-3}
SE	5.0	6.79×10^{-3}	2.27×10^{-2}	29.5×10^{-3}
SE	7.5	7.80×10^{-3}	4.35×10^{-2}	51.3×10^{-3}
SE	10.0	7.13×10^{-3}	5.67×10^{-2}	63.8×10^{-3}
N	20.0	4.01×10^{-3}	8.33×10^{-2}	87.3×10^{-3}
N	50.0	1.53×10^{-3}	9.65×10^{-2}	98.0×10^{-3}
N	70.0	1.29×10^{-3}	1.43×10^{-1}	144.2×10^{-3}
N	90.0	1.17×10^{-3}	1.95×10^{-1}	196.2×10^{-3}

TABLE 5.4-18

MAXIMUM ANNUAL AVERAGE DEPOSITION FLUX ($\mu g/m^3$)
OF $SO_4^=$ AEROSOL

Wind Direction	Downwind Distance (km)	Primary $SO_4^=$ from Stack Emissions ($\mu g/m^3$)	Secondary $SO_4^=$ from SO_2 Conversion ($\mu g/m^3$)	Total Ambient $SO_4^=$ ($\mu g/m^3$)
SE	2.5	5.32×10^{-6}	7.57×10^{-6}	0.013×10^{-3}
SE	5.0	2.09×10^{-5}	5.67×10^{-5}	0.078×10^{-3}
SE	7.5	2.21×10^{-5}	1.13×10^{-4}	0.135×10^{-3}
SE	10.0	1.92×10^{-5}	1.32×10^{-4}	0.151×10^{-3}
N	20.0	8.55×10^{-6}	1.49×10^{-4}	0.158×10^{-3}
N	50.0	2.92×10^{-6}	1.42×10^{-4}	0.145×10^{-3}
N	70.0	2.18×10^{-6}	1.68×10^{-4}	0.170×10^{-3}
N	90.0	1.80×10^{-6}	1.96×10^{-4}	0.198×10^{-3}

approximately 6.2 mg. This estimate includes the effects of precipitation. The magnitude corresponds to a buildup rate of approximately 1 ppm in the top 1/10 of an inch of soil (by weight) each year. The impact of this buildup would be determined by the specific soil chemistry at each downwind location. At present there are no Minnesota or federal standards for assessing this impact.

Although no quantitative analysis has been performed, it appears possible that the cooling tower plume and stack plume may interact. Under this situation, the rates of transformation of SO_2 to $SO_4^=$ and of formation of acid mist may increase.

5.4.7 Regional Impact of SHERCO Emissions

In order to assess the regional air quality significance of the operation of SHERCO Units 3 and 4, a comparison of the emissions resulting from these new sources to the Sherburne County emission is presented in Table 5.4-19. It must be noted that the data for Sherburne County are representative of the point-source emissions generated in 1975. These data do not include the contribution of industrial non-point sources, residential and commercial fuel consumption, or fugitive dust sources. Therefore, the emissions from SHERCO are not directly comparable to the 1975 emission data presented in Table 5.4-19. As indicated by the data listed in Table 5.4-19, Units 3 and 4 would generate a significant amount of emissions. However, as indicated by the results of the SHERCO facility impact analysis the only potential for violation of SO_2 standards would result during a three-hour period of full-load operation of Units 1, 2, 3 and 4 and worst-case background concentrations. The exceeding of the TSP 24-hour standard was achieved by background alone and the TSP and NO_2 annual standards were not predicted to be exceeded.

TABLE 5.4-19

EMISSION BURDEN COMPARISON

(tons/year)

Pollutant	Sherburne County*	Units 1 + 2**	Estimated Existing Emissions	Units 3 + 4**	Estimated Future Emissions
SO_2	1,541	3,969	5,510	5,685	11,195
TSP	168	3,859***	4,027	4,997***	9,024
NO_x	295	4,421	4,716	3,317	8,033

*These data only include point sources in operation in 1975.

**These data were calculated assuming an annual average operating capacity factor of 65% (see R. W. Beck).

***These data include both stack TSP emissions and fugitive emissions from the transfer and storage of coal.

5.5 Water Quality

5.5.1 Projected Waste Discharges

Potential discharges to the hydrologic environment from the proposed facility include:

- Holding pond discharge to river
- Seepage to groundwater
  - bottom ash pond
  - scrubber sludge pond
- Septic tank effluent to groundwater
- Drift from cooling towers
- Excess (uncollected) runoff

Of the above discharges, the first is considered to be of primary importance and detailed in Section 5.5.2. Ash pond seepage is discussed in Section 5.5.6. The septic tank for the facility has been designed in accordance with Minnesota standards. Cooling tower drift would be dispersed and of negligible water quality impact. Accordingly, impacts of septic tank effluent and cooling tower drift are not considered further.

Rainfall runoff from plant roofs, the yard area and the coal storage pile will be collected and routed to the recycle basin. After cycling within the plant, collected runoff will eventually be discharged to the river in the holding pond effluent. During extreme rainfall events, total runoff may exceed available storage capacity. Thus, some runoff might be diverted to surrounding land areas and/or to the river. Because of the "first-flush" effect characteristic of pollutant loadings in stormwater runoff and in coal pile seepage most of the contaminants would be expected to be flushed relatively early in a given storm event and thus be successfully collected in the recycle basin. Water quality impacts of any excess (uncollected) runoff during extreme storm events are considered relatively unimportant. Of greater importance is the potential damage the holding basin dike caused by erosion from overflow of excess runoff. Means of diverting excess runoff and thus preventing overflows from the recycle basin are available.

Calculated holding pond discharge quantities and qualities under maximum and typical operating conditions are summarized in Table 5.5-1. Corresponding rates of water withdrawal from the Mississippi River are also specified for each operating condition. These data pertain to the operation of all four SHERCO power units at peak production capacity. Units 3 and 4 alone are estimated to account for about 55% of the water consumption and discharge.

The impact of chemicals to be employed in preoperational and maintenance cleaning of Units 3 and 4 is discussed in Section 5.5.3. Spent cleaning solutions are planned to be discharged to the scrubber system and eventually to the river in the holding pond effluent. Impacts related to trace metal concentrations are discussed in Section 5.5.4.

5.5.2 Impacts of Defined Waste Discharges on Surface Water Quality

Based upon available plant discharge estimates and baseline water quality data from the Mississippi River, normal operation of SHERCO Units 3 and 4 is projected to result in violation of existing water quality standards for the proposed uses of the Mississippi River beyond the allowable discharge mixing zone defined in WPC 15(c)(5) under critical conditions (low river flow and maximum waste discharge rate). As a result of bioassays conducted by ERT (1977i), effluent standards specified in WPC 15(c)(b) are projected to be violated for unspecified toxic or corrosive substances. The bioassay results will be discussed in Section 5.10. After waste discharges are totally mixed with the Mississippi River, it is projected that water quality standards will not be exceeded.

A simple, mass-balance model has been employed by ERT (1977b) to estimate the impact on surface water quality of the SHERCO holding basin discharge downstream of the plant. The calculation scheme accounts for both withdrawal from and discharge to the river. Concentrations are predicted downstream of the discharge after the effluent is completely mixed with ambient river water. The extent of the discharge mixing zone is considered separately in Section 5.5.5.

Computations have been performed for each water quality component with available discharge estimates (Table 5.5.1), under each of two discharge conditions ("typical" and "maximum") and under each of two

TABLE 5.5-1

ASSUMED WATER USE AND DISCHARGE CONCENTRATIONS UNDER TYPICAL AND MAXIMUM OPERATING CONDITIONS FOR ALL FOUR SHERCO UNITS

		Operating Conditions	
	Units	Typical	Maximum
Water Use			
Withdrawal Rate	cfs	58.3	78.4
Discharge Rate	cfs	2.45	9.58
Net Consumption	cfs	55.9	68.8
Effluent Quality			
Total Dissolved Solids	mg/liter	12,010	4,623
Calcium (Ca^{++})	mg/liter	500	396
Magnesium (Mg^{++})	mg/liter	1,960	607
Sodium (Na^{+})	mg/liter	160	75
Bicarbonate (HCO_3^{-})	mg/liter	30	156
Sulfate ($SO_4^{=}$)	mg/liter	9,040	3,221
Chloride (Cl^{-})	mg/liter	100	52
Nitrate (NO_3^{-})	mg/liter	60	38
Silica (SiO_2)	mg/liter	160	78

river flows (average and low). River flows have been taken from the USGS gaging station at St. Cloud, where the flow averages 4,730 cfs. A low flow value of 582 cfs has been assumed, corresponding to the seven consecutive day average low flow with a 10-year frequency.

For each water quality component, flow condition and operating condition, the estimated concentration in the river downstream of the SHERCO discharge has been computed. In addition, changes and percent changes in ambient concentrations resulting from the discharge have been calculated. Downstream concentrations have been compared with their respective standards, and the percents of available river flow required to dilute the effluent and to achieve the respective standards have been estimated.

The primary surface water impacts of discharges from the proposed facility are projected to be increases in sulfate, magnesium, hardness, total dissolved solids and nitrate levels. Table 5.5-2 lists the water quality components most severely influenced in decreasing order of impact. The percent increases over baseline concentrations expected under average and critical conditions are listed for locations immediately downstream of the SHERCO facility and further downstream at the intake to the Minneapolis Water Treatment Plant.

Calculations have been made on the basis of all four SHERCO units operating at 100% capacity. The impacts of SHERCO Units 3 and 4, in terms of changes and percent changes in river concentration, would be approximately 55% of the respective values as seen in Table 5.5-2. In addition, R. W. Beck (1977c) has estimated that waste discharges for operation at a realistic capacity factor of 0.57 would be approximately 75% of the "typical" discharge rates assumed here.

It should be noted that impacts under critical conditions (low river flow and high plant discharge) are particularly important to consider. Hot, dry periods tend to induce: increased water consumption and discharge at the SHERCO facility; lower river flows (permitting less dilution of the SHERCO effluent); and increased demands for river water by other users. Because of these factors, it is important to consider impacts both under average conditions and under critical conditions.

The most severaly impacted component downstream of the SHERCO facility is sulfate, with estimated increases of 39.4% (4.7 mg/liter)

TABLE 5.5-2

SUMMARY OF WATER QUALITY COMPONENTS MOST SEVERLY IMPACTED BY SHERCO DISCHARGES

Percent Increase in Baseline Concentration Due to Discharge from SHERCO Units 1-4[a]

Condition:	Average		Critical	
River Flow:	Mean		Low[b]	
Plant Discharge:	Typical		Maximum	
Location:	SHERCO	Minneapolis[c]	SHERCO	Minneapolis[c]
COMPONENT[d]				
Sulfate	39.4	25.1	332.2	176.1
Magnesium hardness	7.2	5.0	73.3	42.3
Total dissolved solids	3.3	2.0	41.1	20.3
Total hardness	3.0	1.9	36.7	19.4
Nitrate nitrogen	3.1	1.4	176.5	93.6

[a]Increases due to Units 3 and 4 alone are approximately 55% of those listed for all four units.

[b]Low flow = seven-day average low flow with a 10-year frequency at St. Cloud = 582 cfs.

[c]Assuming conservative behavior of each component in river reach between SHERCO facility and Minneapolis.

[d]All other components impacted less than 20% under critical conditions at SHERCO facility.

and 332.2% (59.8 mg/liter) under average and critical conditions, respectively. Units 3 and 4 alone are estimated to induce increases of 21.7% and 182.7%, respectively. Under critical conditions, a sulfate concentration of 59.8 mg.liter is expected downstream of the SHERCO facility. This is still less than one-fourth of the corresponding water quality standard, 250 mg/liter. Under these conditions, approximately 24% of the available river flow will be required to dilute SHERCO effluent enough to satisfy the standard.

Baseline data indicate average influent and effluent hardness levels of 158 and 76 mg/liter as $CaCO_3$, respectively, at the Minneapolis Water Treatment Plant (average of monthly composite samples 1972-75) Minneapolis Department of Public Works (DPW 1975). Under average river flow and typical SHERCO discharge conditions, this analysis indicates that influent hardness at Minneapolis will increase to 161.1 mg/liter. To achieve the same effluent quality (76 mg/liter), hardness removal will have to increase from 82 mg/liter to 85.1 mg/liter. Assuming that hardness removal is proportional to softening chemical doses, a 3.8% increase in average chemical doses would be required to achieve the same effluent (drinking water) quality. This assumption applies to the carbonate hardness presently receiving treatment in the Minneapolis Water Treatment Plant. Since sulfate is expected to be a major effluent constituent, treatment at the treatment plant may require different chemical additives such as soda ash. Under critical flow and discharge conditions, average influent hardness is estimated to increase from 169 to 201.8 mg/liter or requiring an increase in hardness removal from 93 to 125.8 mg/liter, or a 35.3% increase in chemical dose. The increases due to SHERCO Units 3 and 4 alone are estimated to be 1.9% and 19.4% under average and critical conditions, respectively.

Minnesota Water Quality Standards (WPC 15, C.5) specify that no more than 25% of river flow be needed for dilution of effluent. Under worst conditions, 76% and 26%, respectively, of available river flow will be required to dilute the total hardness and total dissolved solids concentrations of the effluent.

Despite substantial percentage increase in sulfates, hardness, total dissolved solids and nitrates expected to occur as a result of the SHERCO facility expansion, the concentrations of these components in

river water after complete mixing will not violate water quality standards for the proposed water uses (drinking water, irrigation, livestock and cooling) under low river flow and high plant discharge conditions.

WPC 15 specifies effluent and water quality standards. It also requires that waters which are of better quality than established standards, such as the quality of the Mississippi River at the Sherburne County Generating Plant, shall be maintained at that high quality unless a determination is made that a change is justifiable as a result of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters.

Specific ecological impacts possible resulting from changes in water chemistry in the discharge zone and downstream are discussed in Section 5.10.

5.5.3 Impacts of Chemicals Used in Cleaning and Water Conditioning

Chemicals to be used in cleaning and water conditiong include: materials used in preparation and maintenance cleaning; ammonia and phosphate compounds to be used in conditioning the steam cycle waters; and chlorine to be used to control biological growths in the cooling towers.

Spent cleaning solutions will be discharged to the scrubbing system. Calculations indicate that the river water component most significantly affected by the discharge of spent cleaning solutions would be ammonia nitrogen. Recirculation within the scrubbing system and discharge to the holding pond would promote gradual release of these cleaning chemicals to the river. In addition, volatilization or precipitation of some of these components within the scrubber system would tend to reduce the quantities actually discharged to the river. Existing water quality standards are not likely to be violated by release of these quantities of cleaning materials in the prescribed manner.

Ammonia and phosphate compounds are planned to be used in conditioning the steam cycle waters. Calculations indicate that average concentrations of these compounds in the river may increase by 1.0% and 3.2%, respectively (ERT 1977b). These values represent upper limits due to the possibility of a portion of the ammonia nitrogen becoming volatilized in the scrubber system, and some of the phosphorous precipitating or absorbing to particulates in the ash ponds.

Chlorine will be used to control biological growths in the cooling towers. The chlorine concentration of 50 mg/liter in the plant effluent indicates a considerable potential for the existence of chlorinated organic compounds or chloramines in the discharge. A substantial portion of the chlorine, however, would not appear in the discharge due to volatilization of chlorine reaction products within the plant. The toxicity of chloramines and chlorinated organics which have also been shown to be carcinogenic raises a potential water quality concern. Due to lack of specific water quality criteria and the analytical difficulties included in reliably measuring such compounds, integrative measurements, such as the on-going bioassay program, will be useful to the detection of any potential problems resulting from chloramines and chlorinated organics. Existing standards and data do not indicate any problems resulting from chlorine use, provided that the NPDES discharge permit residual chlorine levels are below the detectable level of 0.03 mg/1.

5.5.4 Trace Metals

Primary sources of trace metals include: (1) coal, (2) cooling water withdrawn from the river and (3) leaching from the power plant equipment itself. The relatively closed-cycle design of the plant is such that two primary pathways exist for direct discharge of trace metals to the hydrologic environment: (1) holding pond discharge to the river, and (2) bottom and fly ash pond leachates to groundwater. Comparisons of surface and groundwater trace metal concentrations with their respective standards do not indicate any existing problems (ERT 1977b).

The potential contributions of trace metals as a result of deposition from cooling tower and stack emissions cannot be quantified. The soil conditions do, however, exist for the transport of trace metals into groundwater aquaifiers which feed surface waters in the area.

Although increases are anticipated, baseline river concentrations and the chemistry of the plant process waters indicate that trace metal discharge from the proposed facility is not likely to result in violation of existing water quality standards. The importance of maintaining

high pH levels in the process waters in order to maintain a low potential for solubilization and release of trace metals is stressed. Monitoring of trace metals in process, surface and groundwaters should continue to provide a means of identifying problems, and indicating needs for corrective measures.

5.5.5 Mixing Zones

The extent of the mixing zone, the area immediately downstream of the plant discharge in which compliance with existing water quality standards is measured and violations are projected, will be governed first by total hardness, second by total dissolved solids (TDS) and third by sulfate. Approximate estimates of the size of the mixing zone necessary to achieve the respective water quality standards have been obtained from the results of a mathematical modeling study commissioned by NSP (Chen and Warner 1976).

Under critical conditions, it is projected that the hardness standard of 250 mg/liter will be violated in an area which extends further than 1,000 feet downstream and a maximum of 300 feet across the river. (The total river width is approximately 400 feet.) The zone in which TDS and sulfate standards will be violated under critical conditions extends a maximum of 600 feet downstream and a maximum of about 260 feet across the river. The size of the mixing zone for these three constituents under critical conditions is in violation WPC 15 which specifies that the total mixing zone at any transect of the river shall not extend more than 50% of the river width.

The modelling study referred to above simulated dispersion of the plant effluent under average river flow and maximum plant discharge conditions. Under such conditions, the hardness standard will require 7% of available river flow for dilution, and 3% of available river flow will be required to satisfy the TDS and sulfate standards.

5.5.6 Groundwater

The major potential impacts on groundwater quality would result from the bottom ash pond and fly ash pond leachates. Any impacts would be expected to be most pronounced in the area between the ponds and the

river (in the direction of bulk groundwater flow). There are no domestic wells in this area. The continuing groundwater monitoring program in this area and in other areas surrounding the plant should serve to identify any developing problems.

R. W. Beck (1977c) has estimated maximum seepage water from these ponds for representative years over the life of the plant.

Year	Total seepage in gpm from existing and future scrubber solids and bottom ash ponds
1977	8
1980	84
1985	217
1990	382
1995	500
2000	492
2005	618
2010	622
2015	452

Seepage is expected to increase over the life of the plant due to the addition of new storage areas and due to increasing pressure exerted as solids accumulate in the basins. After the year 2005, actual seepage quantities will be limited by operation of ponds and the schedule of filling (Beck 1977c). The figures shown above are considered to be rather conservative. Under worst conditions, the total seepage rate would be approximately 622 gpm.

Under steady-state operating conditions, the quality of scrubber solid pond supernatant is expected to be similar to that of the holding pond effluent (Beck 1977c). Leachate would probably be of similar quality, due to the insolubility of the calcium sulfate, calcium sulfide, calcium carbonate and ashes in the pond sludges. Leachate dissolved solids content might be attenuated somewhat by the clay liners (Beck 1977c) and by precipitation in the soil column.

Indirect discharges to the river as a result of pond leachates would effectively increase the total discharge rates considered in impact assessments in Section 5.5.2. Discharge of total solids would

still be subject to overall mass balance constraints on the plant. Based on the results of Section 5.5.2, the considerations outlined above and the conservative nature of the seepage estimates, the impacts of such indirect discharge on river water quality are estimated to be relatively insignificant.

5.5.7 Construction Impacts

The short-term impact on water quality will occur predominantly during the construction phase of the proposed facility. Significant effects are possible from the following sources:

1) soil erosion: increase of turbidity and color in the river near construction site;

2) spill or discharge of fuel and oil from construction equipment; and

3) generation of sanitary wastes at the construction site.

The increase in turbidity and color in the river near the construction site will primarily depend on the extent of soil erosion and sedimentation influenced by the slope, existing degree of soil erodibility and soil wetness. Because of the flat nature of the site topography and the sandy soil, erosion will likely be low. Erosion will be further minimized by mulching of exposed slopes and surfaces during construction.

Any inadvertent spill or discharge of fuel and oil could conceivably contribute to the contamination of ground and surface water by hydrocarbons. Similarly, if sanitary wastes generated at the construction sites are not properly disposed of, contamination of ground and surface water could result. However these potential threats to water quality can be greatly reduced by introducing proper precautions into the construction contract and by careful enforcement of the contract during construction.

5.6 Predicted Noise Levels and Impact Assessments

To determine the noise impacts associated with the construction and operation of SHERCO Units 3 and 4 the following steps were followed:

a) the baseline SHERCO facility (Units 1 and 2) was modeled and noise levels were predicted;

b) the proposed SHERCO additional Units 3 and 4 were added to the baseline model; predicted noise levels due to the completed plant facility were then compared with the baseline noise levels (obtained under item a);

c) traffic noise levels were also evaluated to determine the relative noise contributions from traffic and the SHERCO plant at each receptor location;

d) noise impacts resulting from the operation of the expanded facility were assessed in terms of noise regulations and the effects on people;

e) construction noise effects were included with the baseline (two-unit) SHERCO facility to predict construction phase noise levels; and

f) construction phase noise impacts were assessed.

5.6.1 Noise Modeling Considerations

Based upon the measurements and source-receptor distances involved in this study, it is appropriate to consider the SHERCO facility as comprised of four major categories of noise emission:

1) induced draft fans noise emitted from the stack;

2) ventilation (intake and exhaust fans) at roof top levels;

3) cooling tower noise; and

4) coal handling equipment noise.

Results of individual subsystem noise measurements, conducted previously in October of 1976, by Bolt, Beranek and Newman, Inc. formed the basis for characterizing the noise emission elements of the SHERCO facility. The noise emission characteristics of the individual noise sources were used in the ERT/NOI program to predict noise levels at various receptor points.

There are a number of factors that influence the propagation of sound power out-of-doors. The basic mechanism determining sound pressure level at a distance from a source is the spreading of the sound wave front or "wave divergence". For a point source, hemispherical spreading of the source emission results in the attenuation rate of 6 dBA per distance doubling from the source. Other factors affecting sound power propagation are:

- atmospheric absorption
- barriers
- source directivity
- vegetation, such as trees or grass
- precipitation
- wind and temperature gradients, air turbulence

In the case of the SHERCO facility, major points of noise emission (the stack and the roof ventilation fans) are elevated, with generally unobstructed views to the receptor points of interest. Other sources such as the cooling towers are lower, and under some geometric conditions the power plant buildings would act as barriers. However, the location of the cooling towers with respect to the plant buildings and the closest noise receptor points are such that barrier effects are not important. Because of these factors, barrier effects were not employed in the modeling of the SHERCO facility. The major sources have a omnidirectional noise emission characteristic, so that source directional characteristics were not used. Cooling tower noise emission does exhibit a directional characteristic with the emission at the closed ends generally being 10 to 13 dBA below that at the louvered sides. However, because the region of lowered emission has a relatively narrow angular coverage (approximately ±10 degrees off of each end) the cooling towers were treated as omnidirectional sources.

As observed previously, traffic noise represents a significant contribution to the ambient noise level at a number of noise sensitive receptor locations. The traffic noise computer model of the U.S. Department of Transportation, Transportation Systems Center (DOT-TSC) was employed to evaluate the traffic noise component.

5.6.2 Baseline Noise Levels

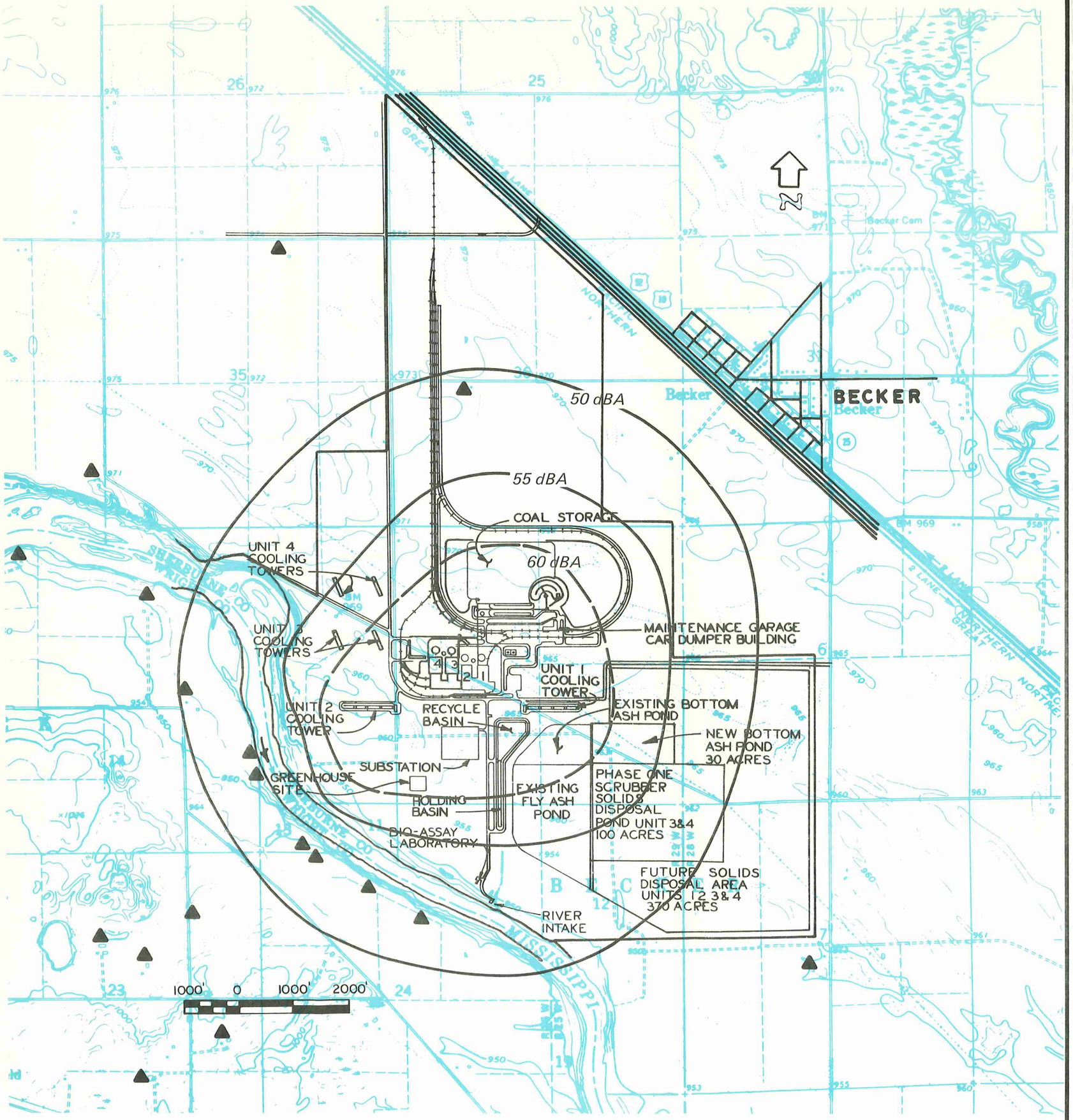
The baseline condition for the EIS is the SHERCO facility with Units 1 and 2 in full, normal operation. Since Unit 2 was not fully operational during the time that noise surveys could be performed, baseline noise levels were obtained from the prediction model. The only major difference between the representation for Unit 2 and Unit 1 is the location of the Unit 2 cooling towers, which are separated by 3,000 ft directly to the west of the Unit 1 cooling towers.

Figures 5.6-1 and 5.6-2 show isopleths of modeled baseline noise levels due exclusively to the operation of SHERCO Units 1 and 2. Figure 5.6-1 shows calculated L_{50} baseline levels and Figure 5.6-2 shows L_{10} isopleths. From these isopleths it can be seen that there are no daytime violations of NPC-2 for NAC-1 land uses as a result of plant operations. On the other hand, it appears that marginal violations of both the NAC-1 L_{10} and L_{50} standards of 55 dBA and 50 dBA, respectively, take place during the evening hours when lower noise levels, are allowed. It is probable that from one to four residences across the river experience noise levels on a regular basis slightly above the nighttime L_{50} standard of 50 dBA. It is possible that five more residences may be exposed to L_{50} levels when noise propogation is maximized by plant activity and atmospheric conditions.

5.6.3 Expanded Plant (Four Units) Noise Levels

The proposed expansion of the SHERCO facility to four units will involve additional noise sources similar to those employed to represent the SHERCO Units 1 and 2 baseline condition. Units 3 and 4 will have induced draft fans feeding a new stack, roof ventilation fans and cooling towers. The cooling towers are laid out in a slightly different physical arrangement as shown in Figure 5.6-3.

Table 5.6-1 presents a comparison of noise levels at noise sensitive receptors of baseline and expanded plant noise levels, along with high



▲ *Indicates Dwelling Units*

MINNESOTA POLLUTION CONTROL AGENCY

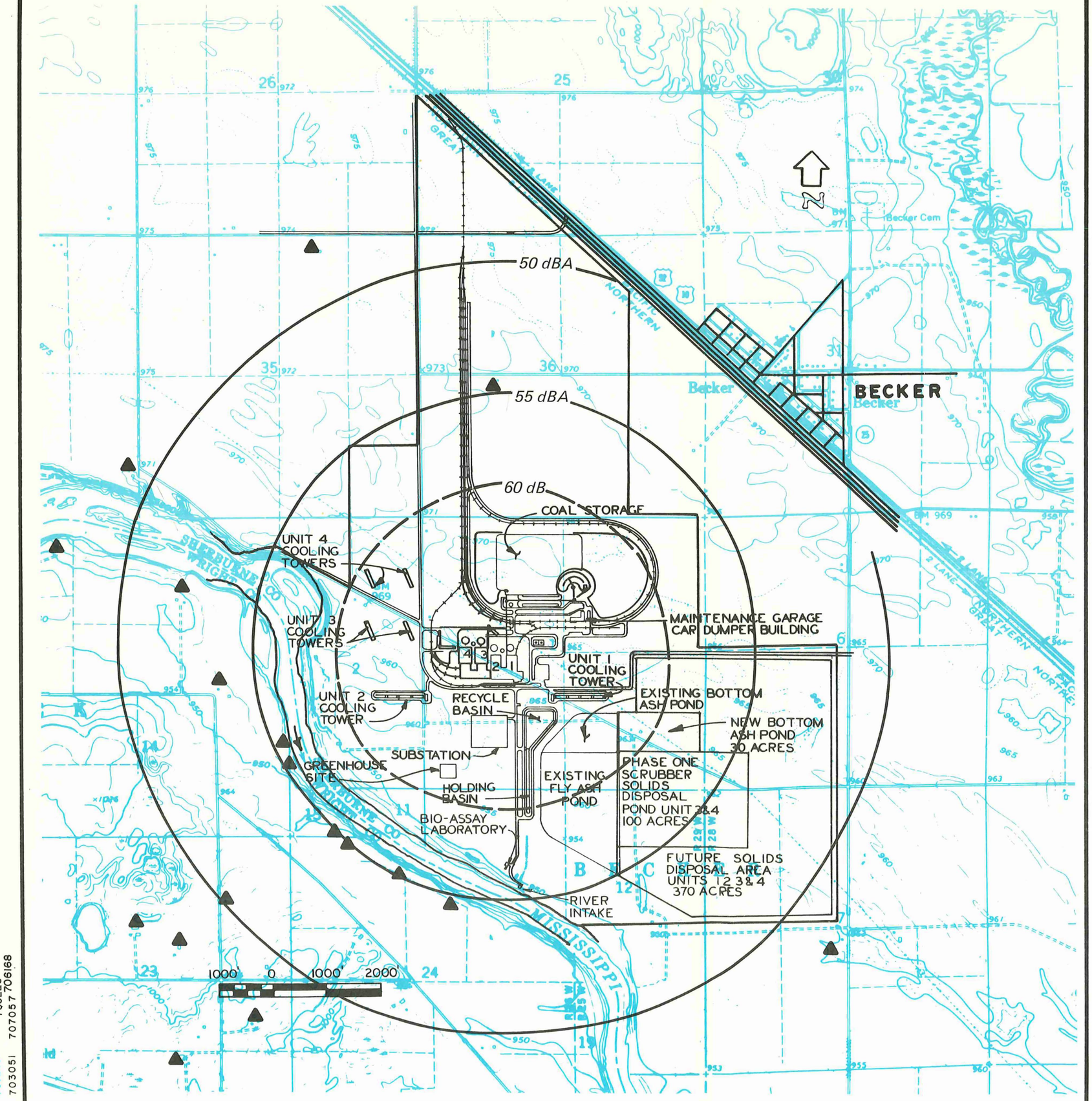
ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.6-1

Baseline L_{50}

703051 707056 707057



703228 707057 706168
703230 703051

▲ *Indicates Dwelling Units*

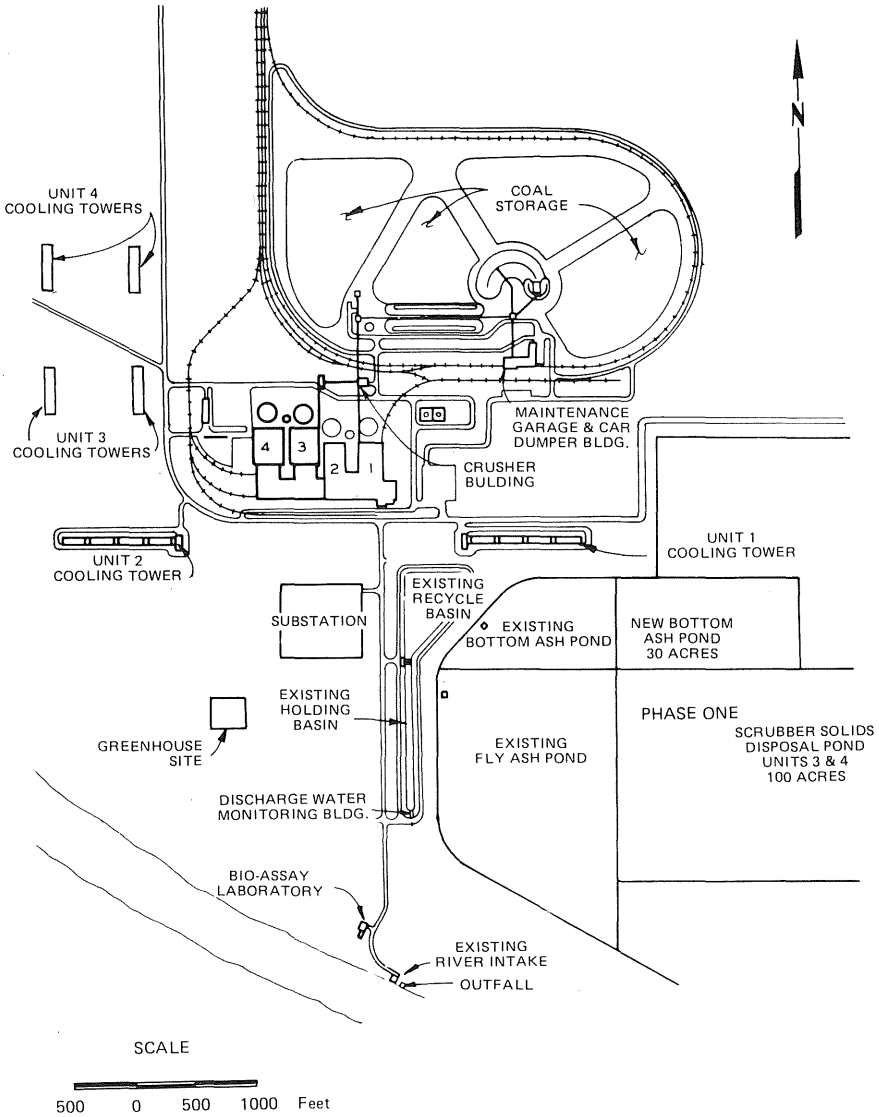
MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.6-2

Baseline L_{10}



MINNESOTA POLLUTION CONTROL AGENCY
ENVIRONMENTAL IMPACT STATEMENT
Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility
Figure 5.6-3 Plan View of the 4-Unit SHERCO Facility

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TABLE 5.6-1

COMPARISON OF BASELINE AND EXPANDED PLANT TOTAL NOISE LEVELS

Receptor Location Number	Noise Level Statistic	Predicted Noise Levels (dBA) Low Traffic Volume Baseline	Low Traffic Volume Expanded	High Traffic Volume Baseline	High Traffic Volume Expanded
1	L_{90}	50	55	50	55
	L_{50}	53	58	53	58
	L_{10}	56	61	56	61
2	L_{90}	44	46	48	49
	L_{50}	48	50	52	53
	L_{10}	53	55	56	56
6	L_{90}	43	45	46	47
	L_{50}	47	48	49	50
	L_{10}	51	52	52	53
7	L_{90}	48	50	49	50
	L_{50}	51	53	52	53
	L_{10}	54	56	55	56
8	L_{90}	50	53	50	53
	L_{50}	53	56	53	56
	L_{10}	56	59	56	59
9	L_{90}	47	48	49	50
	L_{50}	50	52	52	53
	L_{10}	54	55	55	56
10	L_{90}	45	46	49	49
	L_{50}	49	51	53	53
	L_{10}	54	55	56	57

and low traffic volume noise predictions. The addition of Units 3 and 4 will produce maximum increases of 3 to 5 dBA at receptor points closest to the plant. Operation of Units 3 and 4 is expected to result in exceedance of the L_{50} nighttime noise limit for NAC-1 land uses by 8 dBA at receptor 1 (due to proximity of the Units 3 and 4 cooling towers). At location 8, the exceedance is approximately 4 dBA. At more distant points such as locations 9 and 10, the amount of change will be less, in the order of 0 to 2 dBA, depending on I-94 traffic conditions. Actual exceedances may be somewhat less than these peak predicted values since no allowance was made for the following three potential areas of noise abatement: (1) under conditions of reduced power demand the Unit 3 and 4 cooling tower fan speed can be reduced , resulting in a reduction of cooling tower noise by about 5 to 7 dBA; (2) NSP indicates that the roof ventilation fans for Units 3 and 4 "... are expected to have noise emissions significantly lower than those presently operating in Units 1 and 2;" and (3) the induced draft fan system for Units 3 and 4 is being designed to have a lower noise emission than the ID fan system currently in use for Units 1 and 2.

Normal operation of the proposed four-unit SHERCO facility will result in small (2 to 3 dBA) noise level increases at most noise sensitive receptors in the vicinity of the plant. The largest increases are 5 and 4 dBA, occuring at receptor locations 1 and 2, respectively. (These receptors are closest to the Unit 3 and 4 cooling tower.) Facility noise level increases of 2 to 5 dBA would be just perceptible if presented as an instantaneous comparative test. When accomplished over time, this would not be readily noticable to residents in the vicinity of the plant. Thus, in terms of changes in people's perceptions of power plant noise, the addition of two units will not produce a significant impact.

The baseline (two units) conditions, however, indicated that there are some certain violations of NAC-1, and several other cases in which observed noise levels would be borderline in terms of compliance. As a result thes, 2 to 5 dBA increases become more significant. Figures 5.6-4 and 5.6-5 represent isopleths of modeled noise levels of plant operation with four units. From these figures it can be seen that approximately 10 to 12 violations of the nighttime NAC-1 standard occur due to the four-unit plant.

50 dBA

55 dBA

60 dBA

UNIT 4 COOLING TOWERS

UNIT 3 COOLING TOWERS

UNIT 2 COOLING TOWER

UNIT 1 COOLING TOWER

COAL STORAGE

MAINTENANCE GARAGE CAR DUMPER BUILDING

RECYCLE BASIN

SUBSTATION

GREENHOUSE SITE

HOLDING BASIN

BIO-ASSAY LABORATORY

EXISTING FLY ASH POND

EXISTING BOTTOM ASH POND

NEW BOTTOM ASH POND 30 ACRES

PHASE ONE SCRUBBER SOLIDS DISPOSAL POND UNIT 3&4 100 ACRES

FUTURE SOLIDS DISPOSAL AREA UNITS 1,2,3 & 4 370 ACRES

RIVER INTAKE

BECKER

Becker

Becker Cam

SHERBURNE CO

WRIGHT CO

MISSISSIPPI

NORTHERN GREAT

CHIC NORTHERN

2 LANE

1000' 0 1000' 2000'

▲ *Indicates Dwelling Units*

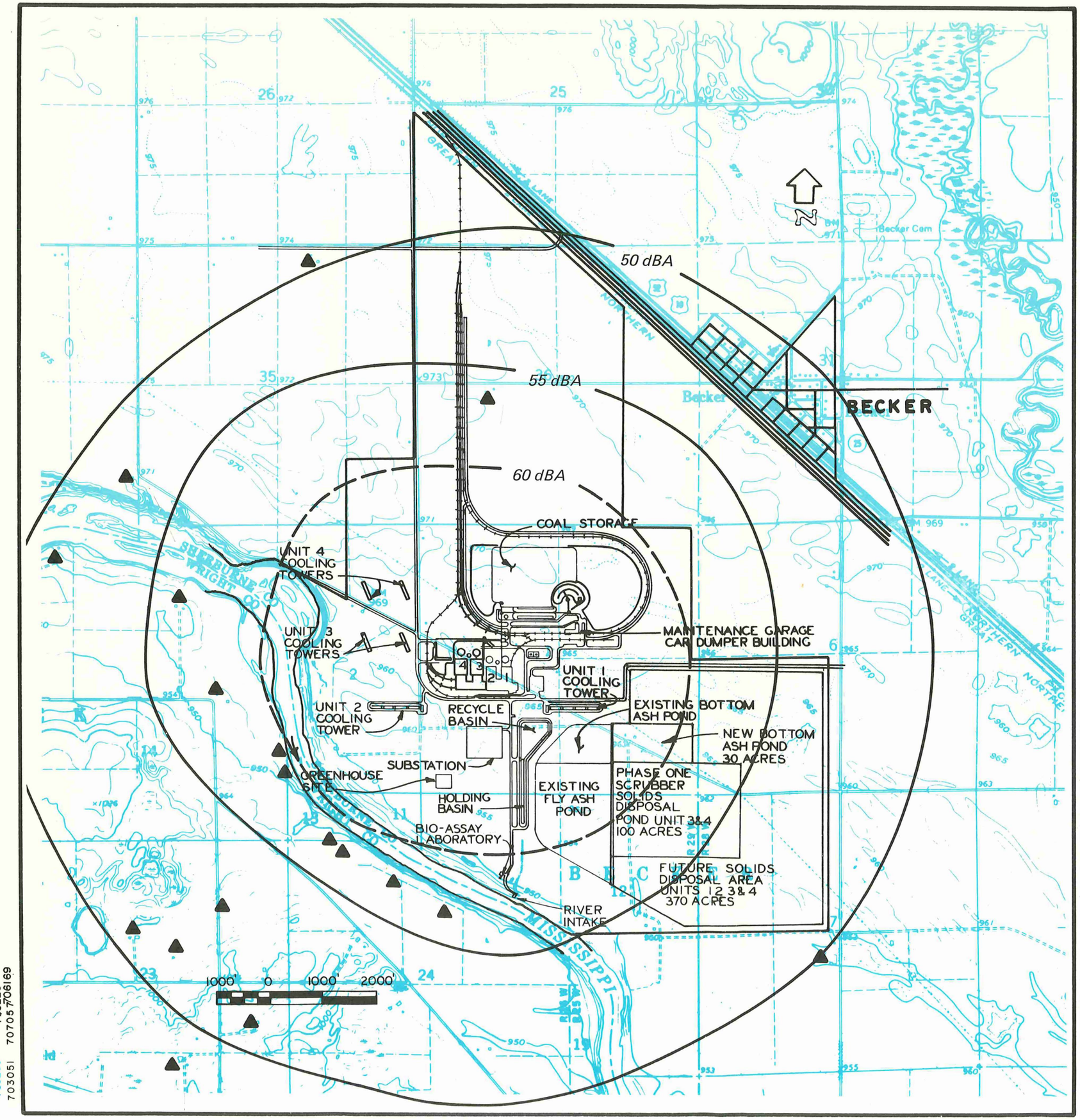
MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.6-4
Expansion L_{50}

703051 707057 707112



▲ *Indicates Dwelling Units*

MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.6-5

Expansion L_{50}

This is compared to the baseline situation where up to 9 exceedance points may occur. Furthermore the addition of Units 3 and 4 will mean that an additional 1,600 acres of land adjacent to the expanded SHERCO site will fall within the land area in which NAC-1 (L_{50} nighttime) violations will occur. To some extent the violation of NAC-1 in vacant lands may be considered a disincentive for use to existing or future owners. In this sense the expanded land area in which NAC-1 is violated is a significant impact.

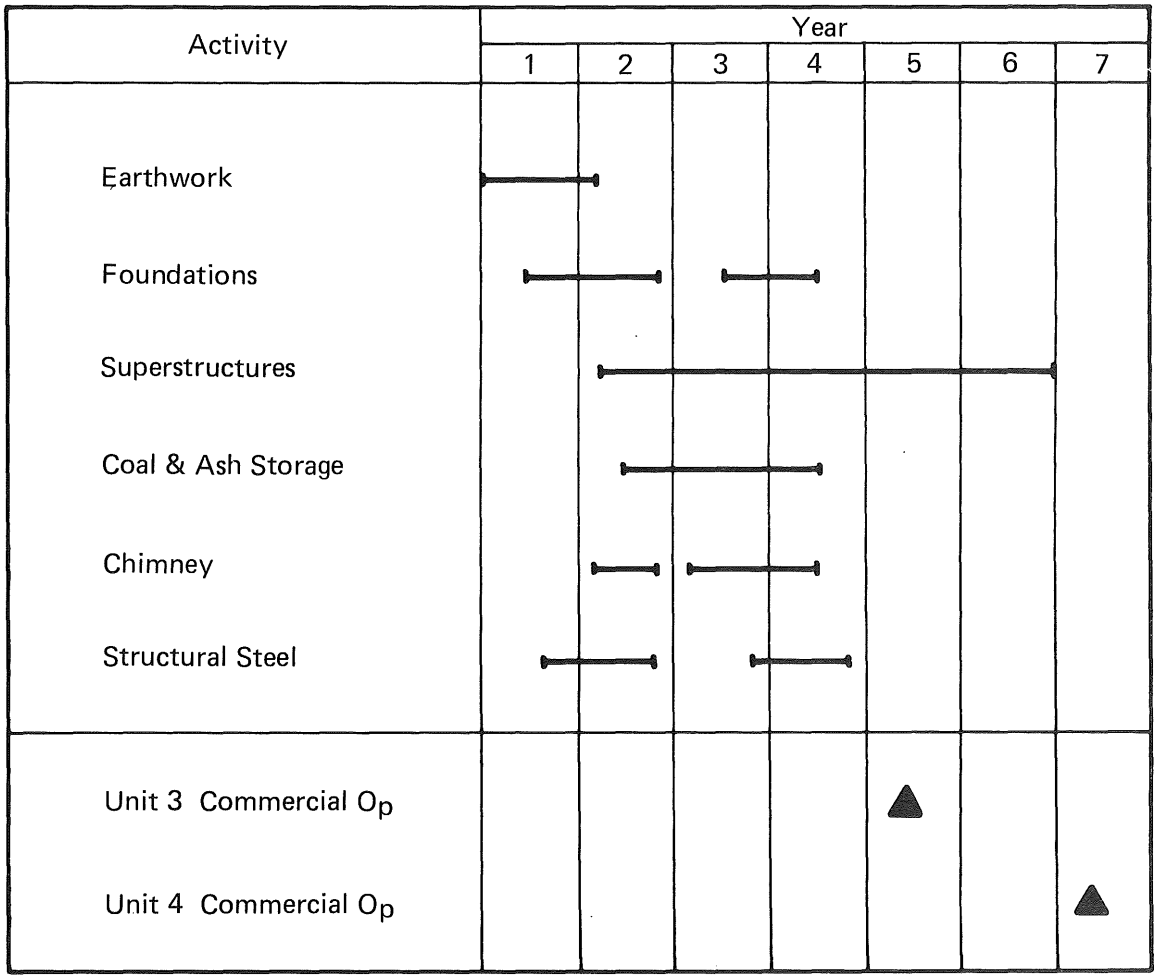
To the extent that the two additional units will increase the frequency of boiler safety and power control valve operation, an existing source of annoyance will be made worse. In this latter case, an important noise impact would result from the proposed action.

The most significant (in terms of relative contribution to community noise levels) source of plant noise emission are the ID fans. Studies have indicated that many people find the tonal quality of ID fan noise particularly annoying. Experience to date with SHERCO Unit 1 appears to further support this observation.

5.6.4 Construction Noise Levels

Noise levels during the construction of Units 3 and 4 will vary with the stage of construction and the quantity and types of construction equipment in operation at any one time. Figure 5.6-6 represents a schedule of the major construction activities which would produce appreciable noise emissions. The major noise producing operations will be those using diesel powered earth-moving equipment such as trucks, bulldozers and graders. Air compressors and cranes represent other typical sources of construction noise. (This project will not require blasting or pile driving operations.) Table 5.6-2 indicates average noise level values which can be expected from construction equipment and operations required in building Units 3 and 4.

Typically, the noisest portion of the construction period is during the initial year to 18 months, when relatively large numbers of heavy machinery are used in excavation and foundation work. The approach used here is to predict construction noise levels based upon this peak activity period. Thus, during other periods, construction noise levels will be



MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.6-6
Schedule of Major Construction Activities; SHERCO Units 3 and 4

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TABLE 5.6-2

MAJOR NOISE SOURCES DURING CONSTRUCTION
OF SHERCO UNITS 3 AND 4

Equipment	Average Sound Level (dBA) 250 Feet	Peak Activity Period Scenario (Equipment Quantities)
Earthmoving		
Front Loader	79	2
Backhoes	85	3
Dozers	80	4
Tractors	80	1
Scrapers	88	4
Graders	85	1
Truck	88	6
Paver	89	-
Materials Handling		
Concrete Mixer	85	-
Concrete Pump	82	-
Crane	83	2
Derrick	88	-
Stationary		
Pumps	76	2
Generators	78	1
Compressors	81	2
Other		
Saws	78	-
Vibrator	76	-

somewhat lower; typically construction period noise levels vary from 3 to 5 dBA over the whole construction period. A representative construction equipment scenario, in terms of mix and quantities of equipment typically used at this stage is included in Table 5.6-2.

Community noise levels based on this peak period representation of plant construction and normal operation of the Units 1 and 2 presented along with the baseline median noise levels in Table 5.6-3. Resulting noise level increases due to construction range from 3 to 10 dBA. The maximum increase of 10 dBA occurs at the receptor location (location 1), which is closest to the center of construction activity. Location 1 is also the single measurement location at which the NAC-2 L_{50} limit of 60 dBA is exceeded.

Construction noise will likely be limited to daytime hours, when people are less likely to be disturbed by noise. The L_{50} levels of 63 dBA at location 1, and 58 dBA at location 8 suggest that some degree of outdoor speech interference may be experienced by people at these locations. This impact probably will be limited to the extent of the major exterior portion of the construction period (about two to three years) and to the households relatively close to the SHERCO site.

Near the completion of the construction period, it is necessary to purge the steam lines of construction debris. The steam blowout of lines produces high noise levels even when silencers are used. NSP plans to employ a silencer which is guaranteed to limit the noise level to 84 dBA at 1,000 feet. In terms of noise levels at noise receptor points previously discussed, this is equivalent to an approximate increase of 11 dBA over the construction noise values cited in Table 5.6-3. This results in short-term L_{50} exceedances of the 60 dBA standard at five of the seven receptor locations enumerated in Table 5.6-3. In addition an L_{10} violation of NPC-2 requires only six minutes of exposure at 65 dBA for any one hour period.

The steam line purging operation, even with a silencing device, will be perceived as a loud noise by residents in the general area of the plant. The operation will be perceived as a definite intrusion and presents a definite noise impact. It is a brief operation, consisting of a series of 10-minute purges over an approximately two week period of time for each unit; it is temporary in that, as planned, it will not be repeated once the systems are purged.

TABLE 5.6-3

COMPARISON OF BASELINE PLANT NOISE AND UNITS 3 AND 4 CONSTRUCTION NOISE LEVELS*

Receptor Location Number	Predicted Median Noise Levels (dBA) Units 1 & 2 Baseline*	Construction*	NPC-2 NAC-1 Daytime L_{50} Limit
1	53	63	
2	44	51	
6	45	48	
7	51	55	60
=			
8	53	58	
9	49	53	
10	44	48	

*Indicated noise levels do not include traffic noise component.

5.7 Geology and Hydrology

Potential geology-related impacts associated with a project of this nature involve the regional earthquake potential, the stability of soils and earth retaining structures and the effect of construction activity on runoff and erosion rates.

5.7.1 Geology

Seismic Activity

Historical records in the area indicate little or no damage due to seismic activity. The most recent data show a maximum intensity on the Modified Mercalli Scale to be VI. The maximum intensity earthquake expected to occur in Central Minnesota is VIII on the Modified Mercalli Scale. Considering the historical records, which are admittedly of short duration, severe damage to SHERCO due to seismic activity is improbable.

Liquefaction of soils on the SHERCO site due to seismic activity is considered a very remote possibility. It is recognized that the upper soil layer has a large percentage of fine sands; however, the liquefaction of these soils would require a higher intensity earthquake than that expected in this area.

Stability of Earth-Retaining Structures

The breaching of embankment structures due to seismic activity or other natural occurrence could release effluent and potentially contaminate groundwater and surface water. A detailed analysis of design criteria and safety factors related to retaining structures at SHERCO was conducted by Black and Veatch (1972) and reviewed by R. W. Beck (1977d). The design analysis by Black and Veatch (1972) was performed for the earth retaining structures required for coal storage areas, fuel oil storage areas and water and ash storage ponds. The safety factors for stability of all earth embankments are within the normal range of design values as calculated for normal and earthquake conditions (R. W. Beck 1977d).

Construction Impacts

On-site surface runoff is expected to be negligible during plant operation due to the low relief and sandy soils found on the site. However, erosion of dikes and other slopes may occur during construction activities. Erosion will be minimized by using the topsoil generated during site preparation as cover for the dikes and other new slopes. In this manner, an adequate seeding operation can be conducted to provide abundant vegetation to prevent long-term soil erosion. Where slope vegetation is ineffective, drop culverts will be installed.

5.7.2 Hydrology

Flooding Hazard

Flooding could release effluent from the bottom ash and fly ash ponds, recycle basin and holding basin; however, flooding of the SHERCO site is improbable. A 100-year flood would produce an estimated water surface elevation of about 932 ft. A 1,000-year flood would only raise the water surface another 3.5 ft. The 100-year flood would produce a discharge at the SHERCO site of 49,000 cfs, and the 1,000-year flood would produce 68,000 cfs. The elevation of the plant site ranges from 960 to 965 ft.

Seepage from Ponds

Areas to be sealed to protect the groundwater from possible pollution are: coal storage area, fuel oil storage area, recycle basin, holding basin, bottom ash pond and fly ash pond. The sealing material selected was compacted clay. Laboratory tests on clay samples obtained from the borrow pit area located in the southeast quarter of Section 20, Range 28 West, Township 34 North, indicated that the permeability of the clay is within desirable limits as specified by relevant design criteria (R. W. Beck 1977d).

The permeability of the compacted clay blankets is low; however, seepage is expected. Seepage will generally be continuous at the bottom ash and fly ash storage areas, holding basin and recycle basin. Seepage will occur at the coal and fuel oil storage areas only when runoff from precipitation is present.

The quantity and quality of seepage from storage areas is discussed further in Sections 4.8, 5.8 and 5.5. As discussed in Section 5.5, monitoring of water quality in wells in the immediate vicinity of the storage areas will be necessary to define the effects of seepage; such monitoring has been in effect since SHERCO Unit 1 went online.

Construction Impacts

There are no streams or other surface water on the SHERCO site. On most of the site, no special drainage precautions during construction activity are required since most precipitation percolates through the sandy soil. Drainage will have to be controlled, however, in areas where oil, greases and gasoline are to be stored.

Water Supply

It is apparent that SHERCO Units 3 and 4 should have an additional source of water for cooling purposes. The flow duration curve for the Mississippi River near Anoka for the period 1931 through 1975 indicates that about 12% of the time flow is equal to or less than 2,000 cfs (57 m^3/sec), which may be the limitation placed on SHERCO Units 3 and 4. Generally, only one unit at a time is down for scheduled maintenance. The possibility exists for scheduling both units (SHERCO Units 3 and 4) to be down during the period of low flows. However, the low flows occur over a relatively broad time period (eight months); therefore, an additional supply of water is necessary during periods of low flow.

A serious water supply problem would be aggravated if existing water allocations (for SHERCO Units 1 and 2) were withdrawn and limitations imposed such as those referred to in Section 4.7.2.

The quantity of water necessary would depend on NSP operation of the SHERCO plant, seasonal loads, scheduled and unscheduled down time and final status of water rights. If the proposed water limitation is liberalized, the total amount of additional water could be reduced dramatically. However, if water allocations are limited severely, the SHERCO plant would have to overcome serious water supply problems.

At this time, there has been no request from NSP for additional groundwater withdrawals to satisfy water supply requirements for the expanded facility. Studies by R. W. Beck (1977d) and Layne Minnesota Co. (1971) indicate that current groundwater withdrawal for Units 1 and 2 has had a minimal effect on the water levels in surrounding agricultural and residential wells. Existing SHERCO wells currently withdraw a maximum of 950 gpm of groundwater. It is unlikely that additional withdrawals of a similar magnitude would have any significant adverse impact on wells surrounding SHERCO (Beck 1977d). It is recommended, however, that if additional groundwater withdrawals are requested, pumping tests be conducted and analyzed to document the effect on nearby groundwater levels.

5.8 Solid Waste

5.8.1 Solid Waste Sources

Solid waste will be generated in Units 3 and 4 through the combustion of coal. The major constituents are the same as those generated by Units 1 and 2; bottom ash, fly ash and retrieved SO_2.

The bottom ash, about 20% of the total ash, is composed of heavy ash and slag which fall from the boiler furnace to a water-filled bottom ash hopper. This ash will be sluiced to the bottom ash pond by water from the recycle basin. The fly ash (about 80% of the total ash) and the SO_2 formed during the combustion of sulfur in the coal will be entrained in the combustion stack gases and removed by a two-stage limestone scrubber. Scrubber sludge is pumped to the scrubber pond.

5.8.2 Solid Waste Quantities

Units 3 and 4 will burn approximately 1,002.4 tons (909 mt) of coal per hour. An estimated 123,000 tons per year of bottom ash will be generated by Units 3 and 4 at a capacity factor of 65%. Annual quantities of scrubber sludge from these units will be approximately 664,000 tons (Beck 1977c).

The major components of solid waste are bottom ash and flue gas desulfurization sludge (scrubber sludge) consisting of fly ash, calcium-sulfate compounds and unreacted calcium carbonate.

5.8.3 Solid Waste Disposal System

The bottom ash and scrubber sludge from Units 3 and 4 are to be disposed of in large clay-lined disposal ponds adjacent to the plant similar to Units 1 and 2 solid waste disposal.

The bottom ash pond is presently 20 acres. It will provide bottom ash storage for all four units until 1983. Approximately 40 additional acres of storage will be required over the life of the four-unit plant.

The scrubber solids from Units 3 and 4 will be sluiced to a new scrubber solids pond separate from the Units 1 and 2 scrubber solids pond. The pond size will initially be 145 acres and provide storage

capacity for the two units with an additional 245 acres being required for the remaining life of Units 3 and 4. Embankment dimensions will be similar to those of existing storage areas described in Section 4.8.3.

A total of approximately 430 additional acres of storage area will be required to accommodate solid waste for the life of the expanded plant. A portion of this required area will be located on property added to the original Units 1 and 2 site. The effects of the conversion of this area from its present land use is discussed in Section 5.1.

5.8.4 Seepage

The Units 3 and 4 bottom ash and scrubber solids ponds will be sealed with a clay liner similar to the one installed for the first two units. Seepage rates from existing and future storage areas for representative years over the life of the plant are presented in Table 5.8-1. As shown in this table, the expected seepage rates increase over the life of the plant due to increased pressure exerted by the settled solids. The potential effect of seepage on groundwater and surface water quality is discussed in Section 5.5.6.

5.8.5 Reclamation Potential

Reclamation of bottom ash and scrubber solids storage areas will require preventing precicipation from rewatering to ash and sludge. To allow for reclamation, the top surfaces should be sloped to induce runoff of precipitation. When the scrubber solids are at the design height, the surface should have an impermeable or semipermeable layer installed over it. It should be noted that the use of this technique may generate large quantities of storm runoff. Either detention ponds or storm drainage conduits may be required to prevent localized storm drainage damage. This would be especially true during an interim period when impervious covers have been provided, but revegetation has not been started.

TABLE 5.8-1

PREDICTED SEEPAGE RATES* FROM STORAGE PONDS
FOR REPRESENTATIVE YEARS OVER THE LIFE
OF THE SHERCO PLANT

Seepage Rates in gpm

Year	Existing Bottom Ash Pond	Existing Scrubber Solids Pond	New Bottom Ash Pond	New Scrubber Solids and Bottom Ash Pond	Future Scrubber Solids and Bottom Ash Pond	Total
1977	2	6	-	-	-	8
1980	21	63	-	-	-	84
1985	51	120	-	46	-	217
1990	19	106	46	211	-	382
1995	-	93	95	224	88	500
2000	-	80	15	190	207	492
2005	-	68	65	158	327	618
2010**	-	55	116	124	327	622
2015**	-	42	34	89	287	452

*Based on a coefficient of permeability of 1×10^{-7} cm/sec for the clay liner.

**Seepage dependent on operation of ponds and schedule of filling.

5.9 Terrestrial Ecology

The methodology utilized in the collection of both air quality and terrestrial ecology information as well as subsequent analysis of these data provided by NSP has not followed standard acceptable scientific techniques. Although problems exist in collection and analysis of the baseline data, an evaulation was performed based on these data.

5.9.1 Soils

Construction Impacts

The major activities that could have an impact on soils include construction of the central plant facilities, coal storage and solid waste disposal areas, temporary facilities and laydown areas, as well as disposal of construction wastes and excavation for underground utilities such as water supply lines for the cooling towers. Several impacts are involved in land disturbance during construction activities. Vegetation will be removed that will expose surface soils to wind and water erosion. Soil compaction will occur on heavily used areas. The bulk density, infiltration rate and moisture holding capacity of the soils will be altered. A decrease in soil infiltration rates will increase surface runoff, but this may be only a minor problem on the nearly level site.

Soil impacts may be reduced by taking precautions to maintain surface soils. The revegetation program for the laydown areas should involve soil restoration by loosening surface soil and adding organic matter. Slight compaction could increase the moisture holding capacity of the droughty soils and still maintain adequate soil aeration. Though soils affected by the construction are primarily sandy loam soils with only moderate to low natural fertility, land committed to the project will mean loss of agricultural productivity on these soils.

Operational Impacts

The primary soil impact will be cooling tower drift within the immediate SHERCO site. Maximum deposition from Units 3 and 4 of

16 lb/acre/month will occur just north of the cooling towers. Deposition will range between 1 to 8 lb/acre/month within the immediate SHERCO plant site. According to the NSP 1976 ER:

> "The composition of total dissolved solids in the drift droplets is less than the suggested limit for irrigation waters."

It is anticipated that drift deposition will eventually leach into the soils. The actual movement will constantly depend upon the soil moisture regime and uptake by plants. Precipitation generated by the drift is not adequate to induce percolation into the soil. Thus, drift salts will accumulate on the surface soil between rains. Deposition amounts are equivalent to low-level fertilizer applications.

Stack emissions, from coal combustion, of which sulfur oxides and nitrogen oxides are major components, will contribute to background levels of atmospheric pollutants. A possible long-term impact on soils from these emissions may be caused by "acid rain." The sulfur and nitrogen oxides can combine with moisture in the atmosphere to form sulfuric and nitric acids.

Stack emissions will also contribute to surface deposition of trace elements. Trace elements that may be least recovered by the scrubber system include fluoride, mercury, germanium, arsenic, boron, cadmium, lead and selenium (Radian Corp. 1975). Upon deposition, many of these elements will be incorporated into the soil.

5.9.2 Vegetation

Construction Impacts

Within the construction activity areas, plant communities will be affected by permanent removal, temporary disturbance and modification of surface soils. Initial losses are restricted to abandoned agricultural land. Construction traffic will physically damage production in the laydown areas. More long-term effects on plant development may result from soil compaction. In addition, exposed soil surfaces may encourage weed species to increase on the site.

The proposed project will preclude potential agricultural production on 240 acres for the life of the project. The abandonment of agricultural and grazing practices will allow natural revegetation to continue in the area. Natural revegetation should enhance vegetative diversity on the site.

Operational Impacts

Emissions from SHERCO Units 1 through 4 may have adverse impacts on vegetation. Sources of air pollutants include stack emissions, cooling tower drift and drift from coal piles. Stack emissions will be dispersed over a large area. Cooling tower drift and fugitive coal pile dust are more localized.

Air quality modeling for the combined stack emissions from Units 1 through 4 indicates that 3-hour ambient concentrations of sulfur dioxide (SO_2) in excess of the Minnesota state standard (655 $\mu g/m^3$ or 0.25 ppm) may occur (see Section 5.4). Sensitive species have shown threshold injury at 2-hour SO_2 exposures of 0.25 to 3.0 ppm (Heggestad and Heck 1971). Thus, the predicted short-term ambient concentrations of SO_2 may be within the range at which vegetation damage has been observed.

Preoperational studies of the impact of air pollutants on vegetation indicate possible ozone damage (Krupa and Kohut 1976). Soybean leaves at a site 1.0 mile north of the SHERCO plant have shown upper surface stipple, likely induced by ozone. This effect is considered to be a result of pollution from the Minneapolis-St. Paul area. Hourly average ozone levels monitored at two air quality sampling stations in Sherburne County in the summer of 1975 recorded maximum hourly averages ranging from 0.073 ppm to 0.157 ppm. The National Ambient Air Quality Standard for photochemical oxidants is 0.08 ppm hourly average not to be exceeded more than once per year. Exposures of 0.1 ppm SO_2 and 1.0 ppm ozone for 6 hours per day over five days have been observed to cause a significant decrease in top and seed weights of soybean plants (Heagle et al. 1975). This finding is significant since the SO_2 emissions expected to be produced by SHERCO Units 1 through 4, combined with the

high background levels of ozone, may have a significant synegistic impact on vegetation. Of further concern may be impacts resulting from trace elements including fluorine and chlorine identified in Tables 5.4-11 through 5.4-13.

The deposition of total suspended particulates (TSP) on leaf surfaces could also have a potential adverse impact on vegetation. Although the injury mechanism is not well understood, there is limited evidence to support theories that particulate deposition causes injury due to screening of light, plugging of leaf openings and direct chemical injury of the particulates on the leaf surface (Leaman and Darley 1975). Particulate emissions from the power plant stacks and coal piles, combined with the high background levels of particulates that have been recorded in the vicinity (see Section 5.4), could have a negative effect on vegetation.

Finally, deposition of cooling tower drift (salts) from the SHERCO facility may have an effect on certain sensitive species on the plant site. One recent study showed trace injury to bush beans at salt concentrations below that which are expected from SHERCO Units 3 and 4 (Hindawi et al. 1976).

5.9.3 Birds (Avifauna)

The impact of the SHERCO facility on avifauna cannot be effectively separated into construction and operational effects. Several potential areas of impact on birds are described below:

1) Inadvertent creation of nesting habitat, i.e., sand banks used by breeding swallows that will be created during construction are a beneficial impact only if the existence of the created habitat is not compromised. If there is no intention to create bank habitat for swallows, construction or elimination of potential habitat should be scheduled either before the arrival of breeding swallows in spring or after their departure from the burrows in late summer.

2) The construction of another 650-ft effluent gas stack may cause increased incidences of birds striking the stacks especially during migration.

3) Deposition of salts from the cooling towers could alter site habitat for birds.

4) The cumulative effect of fugitive coal dust, salt drift and stack effluents may cause an effect upon the respiratory and reproductive functions of organisms within the impact area.

5) There could be increased consumption of potentially toxic heavy metals by birds using the settling ponds.

5.9.4 Mammals

Construction Impacts

The major impact on mammals will occur during the construction phase. The clearing of 373 additional acres for SHERCO Units 3 and 4 will affect the resident mammal population. Most of these mammals are fossorial in habit or are expected to be in ground nests during clearing activities. These mammals are not expected to survive the clearing operation. Those that do survive and are forced into adjacent habitats will be competing with established resident populations on those areas and the immigrant may be forced to continue to move until it finds an unoccupied habitat or it succumbs to any of a number of mortality factors.

More mobile species, such as the white-tailed deer and cottontail rabbit, will move into adjacent habitats as clearing activities approach. These species will have to survive similar competition from the established resident populations, but since their home ranges are, in general, larger than those of the rodent group, these mobile species are expected to survive the clearing operations and displacement more readily. Wide ranging predators, such as the gray fox and red fox, may be benefitted temporarily by greater prey availability in habitats adjacent to the cleared areas. Ultimately, the loss of the productivity from the cleared land will mean a reduction in mammals on the NSP property.

Noise from construction activities may also affect mammals adjacent to the disturbed areas. Loud variable noise sources are expected during the land clearing and facility construction stages will initially

frighten mammals and some are expected to move further away from the site. In addition, the increase in vehicular traffic expected to occur during facility construction will result in greater numbers of road kills.

Operational Impacts

Impacts during operation include the beneficial effects of revegetation, which will lead to establishment of a mammal population on those areas restored to vegetative cover. The species composition may be altered depending upon the methods and vegetational species used during revegetation. Revegetation with native plants commonly found in the SHERCO area and natural succession on these revegetated areas will allow faunal succession to occur and the reestablishment of a natural population of mammals.

A detrimental impact of operation will be the increase in air pollutant levels in the vicinity of the site. These pollutants will be inhaled as well as consumed by the resident mammals. Effects on mammals may include increased respiratory ailments and decreased life expectancy. However, available literature on air pollutant effects on mammals indicates that effects will appear in the vegetative community at levels much lower than the levels which result in visible effects on mammals (Ball et al. 1960). NSP has initiated a blood physiology program during the preoperational studies for SHERCO Units 1 and 2. As these studies continue into the operation phase, the results will be of value in determining mammalian impact.

5.9.5 Reptiles and Amphibians (Herpetofauna)

Several potential areas of impact on herpetofauna during construction and operation of the SHERCO site are as follows.

1) Inadvertent creation of breeding habitat, i.e., temporary pools of standing water, during construction or operation is a beneficial impact only if the existence of the created habitat is not compromised. If there is no intention to create breeding habitat for herpetofauna, construction or elimination of potential habitat should be scheduled before or after critical periods of breeding activity.

2) Deposition of salts from the cooling towers could alter the site habitat for herpetofauna.

3) The cumulative effect of fugitive coal dust, salt drift and stack effluents may cause an effect upon the respiratory and reproductive functions of terrestrial and aquatic herpetofauna.

4) An increase in road surface and traffic is expected to adversely affect mobile species attempting to traverse home territories. Limited migrations by herpetofauna will also be impacted by increases in traffic and transportation lanes.

5.9.6 Impacts on Rare and Endangered Flora and Fauna

Field surveys and local literature indicate that no endangered or threatened species of flora or fauna inhabit the SHERCO site or the immediate area. The literature does suggest that several endangered or threatened bird species may migrate along the Mississippi River in the vicinity of the SHERCO site. The peregrin falcon, bald eagle, whooping crane and greater sandhill crane have the potential for using any of the habitats at or near the SHERCO site. The impacts of operation upon these species is not known at this time.

Several birds of changing or uncertain status which have the potential for utilizing the habitats on-site are Cooper's Hawk, Marsh Hawk and Osprey. Each has been observed within a five to six mile radius of the SHERCO site.

The literature indicates that no endangered or threatened reptiles or amphibians exist within the area of the SHERCO site. Two species of turtle, Wood turtle and Blanding's turtle, which are species of changing or uncertain status (Moyle 1975), do have the potential and are expected to be in the SHERCO area. Neither species, however, has been accorded legal protection.

No rare or endangered plant species or mammal species are expected to occur on the SHERCO site. Therefore, no impact on such species should occur.

5.10 Aquatic Ecology

This section addresses the potential problems regarding the effects on the biological communities found in the Mississippi River from withdrawal of make-up water used by the NSP facility and as a recipient of effluent materials through the wastewater discharge.

Biological studies involving power plant impacts on aquatic systems must provide the following.

- a description of the influence of natural variables operating on physical characteristics of the aquatic system, over both long and short time scales (e.g., both seasonal and episodic conditions during storms or low flows, and on the life history, growth and mortality of organisms that live or migrate within the influence of cooling water);
- a description of the intensity extent and direction of the mechanical and thermal perturbations imposed on living organisms by the intake water in its passage through the intake, pumps and cooling towers and continuing during its dispersion from the outfall; and
- the best information that can be provided on the life histories, distribution, movement and thermal and mechanical tolerances of those groups of organisms that either represent a direct resource (e.g., fish and fish food) or contribute in a more subtle way to a healthy ecological situation in the aquatic system such as the Upper Mississippi River.

Surface water use at SHERCO may produce water quality changes by altering the solubility of dissolved gases, by varying the rate of biological processes that affect water quality and by the addition of substances used in plant operations. Drainage or leachate from ash storage areas at SHERCO may reach the Mississippi River. In addition, water used for cooling will be discharged with increased concentrations of water quality components due to evaporation in the cooling towers. Chemicals used for slime and corrosion control and air pollutants scrubbed from the atmosphere may also be discharged.

The possible ecological effects of impingment and entrainment of organisms in water intake systems are of significant concern. Impingement includes the trapping or confinement of organisms within an intake system or holding of organisms on screening devices such that the organisms are unable to return to their natural habitat. Fish are of primary concern although large invertebrates may also become entrapped or impinged.

Entrainment is the process whereby small organisms in the river water are passively carried with the cooling water into an intake structure, through a cooling system and then back to the river. Planktonic forms entrained in the effluent plume by mixing processes are also included within the category of entrained organisms. These two types of entrainment are referred to as plant and plume entrainment, respectively. Entrainable organisms include members of the phytoplankton and zooplankton communities, small fish, fish eggs and larvae and small benthic forms periodically in the water column.

Pacific Northwest Laboratories (PNL) recently reviewed the aquatic biological monitoring programs of the Monticello Nuclear Power Plant (Battelle 1976). NSP submitted these aquatic biological data for the SHERCO proposal because of the close proximity of the two sites. In view of the PNL comments on the data presented through the ecological monitoring program and the fact that only two stations from that program can be considered representative of ambient stream conditions above Monticello, impacts on the SHERCO site cannot be adequately assessed. Two significant concerns remain: (1) the validity of using Monticello data as being representative of conditions at the SHERCO site and (2) the reliability of using Monticello aquatic biological data for predicting quantitative aquatic biological impacts which will result from the proposed SHERCO Units 1 through 4.

5.10.1 Primary Producers

Macrophytes and Periphyton

Macrophytes are probably not an important factor in the study of aquatic organisms in the vicinity of SHERCO. However, increases in stream fertility could cause them to be more prominent and consequently

impacted. Water quality information indicates that the two macronutrients, nitrate and phosphate, will be discharged at higher levels with operation of Units 3 and 4. Macrophytes should also be considered a potential substrate for growth of periphytic species.

As noted in Section 4.10.1, very few periphyton studies have been completed except for the Monticello ecological monitoring studies and the study by Kuhl (1975) at SHERCO. Considering the amount of data derived from the monitoring studies carried out at Monticello and the limited scope of the study by Kuhl (1975), no adequate baseline can be drawn for assessing impact at SHERCO.

Although the means of quantifying the impacts do not exist, they can be hypothesized qualitatively. Under low flow conditions the constituents of the effluent discharge at SHERCO could exert a considerable influence on the algal community structure. Algae can concentrate certain compounds such as organophosphates metals where chlorides have been shown to adversely affect algal communities. The discharge of magnesium and calcium in small amounts may favorably influence community structure. Heavy metals, organometallic complexes and other various salts have been shown to affect attached communities by nature of their constant exposure. Although the exact quantities or composition of the SHERCO discharges is unknown, it is likely that within the mixing region of the river individual species composition as well as total numbers are likely to be affected. The lack of quantifiable information prevents a more detailed definition of the potential impacts. In view of the habitat preferences and the lack of this habitat in the SHERCO area, entrainment of periphyton should have a minimal impact.

Phytoplankton

Although phytoplankton contributions as primary producers are much less in river systems compared with periphyton, they may be crucial to fish production. Data are presented by Mischuk (1976) for the Mississippi River, but these studies were conducted near Monticello and may not be representative of the SHERCO area. Phytoplankton impact assessment based on data presented from old studies and work dealing with other river systems or other portions of the Mississippi may not necessarily

be indicative of conditions at SHERCO. However, given the information at hand and the rapid generation of new cells in the phytoplankton community little impact is anticipated on the phytoplankton community as a whole. The lack of species data and their potential link to the food chain, interrelationships in the lotic system cannot be specifically addressed.

5.10.2 Zooplankton

The determination of the plant operation impact on the zooplankton population is a difficult task when working with a nondefinitive baseline assessment. Without specific data, it is assumed that the present zooplankton population is a secondary food source for game fish and macroinvertebrates, and a minor contributor to the total biomass for this aquatic ecosystem.

Potential impacts from the operation of combined Units 1, 2, 3 and 4 upon the zooplankton population would be from entrainment within the plant's make-up water and toxic impact from the constituents in the plant's discharge. As currently assessed, it does not appear that the quantity of water required by the plant would critically reduce the zooplankton transported past the intake facilities. Likewise the introduction of a chronically toxic constituent would have minimum impact upon the zooplankton population because of the small numbers transported through the discharge plume. With the zooplankton as a secondary food source within this lotic system, it does not appear that a disruption would be seen in the aquatic food chain.

5.10.3 Macroinvertebrates

Macroinvertebrates, because of limited mobility and long life cycles, spend much of their existence in one area. For this reason they may be exposed to the SHERCO discharge for extended periods. Drifting macroinvertebrates, while only receiving limited exposure to the discharge, are also subject to impingement/entrainment by the intake structure. The various salts and heavy metals contained in the SHERCO effluent will probably have the greatest impact on resident macroinvertebrates, providing concentrations reach toxic proportions. There appears to be little published literature dealing with the effects of

the various salts found in the SHERCO discharge on benthic animals. At least for two salts in the discharge, sodium sulfate and magnesium sulfate, it appears that high concentrations are needed to produce toxic effects (Sorber and Thatcher 1963; Dowden and Bennett 1965). The effects of sodium chloride have been studied and again high concentrations are necessary to produce toxic effects (Shaw 1955; Hamilton et al. 1975).

Although there is limited evidence of toxicity for the above mentioned salts, other effluent components (which have not been isolated or studied), heavy metals and high total dissolved solids (TDS) have the potential to impact macroinvertebrate communities within the discharge plume. Since the macroinvertebrate community is a primary fish food source impacts to this trophic level may have a secondary impact on fish populations.

Site specific quantitative data on macroinvertebrate density/diversity are needed to definitively assess any potential impact to bottom dwelling macroinvertebrates in the SHERCO area. Any effects of the SHERCO discharge on drifting macroinvertebrates will probably be minimal.

5.10.4 Fish

Operation of the plant cooling water system can affect fish populations through entrainment of early life stages and smaller individuals, impingement of larger individuals on the intake plates and through increased chemical concentrations in the plant discharge. Dredging for maintenance of a channel to the cooling water intake is another operational factor that could affect fish through increased turbidity and siltration downstream.

Intake operation at SHERCO will result in entrainment and impingement of fish. ERT is currently conducting an Ichthyoplankton survey to identify and enumerate fish eggs and larvae in the Mississippi River at the SHERCO site. The only data available are the results of an entrainment study at Monticello, which was conducted in 1973-1974. Quantitative estimates of entrainment impact are impossible to develop at this time because of the lack of applicability of Monticello data to SHERCO and due to sources of inaccuracy in that data which result in underestimating

the numbers of larvae entrained. There is a further lack of predictive information to assess the impact on the future fish populations. A qualitative analysis of available data indicates that impact of two additional units on fish populations would be anticipated to be relatively low during most years. During years of low river flow, however, operation of all four units might prove detrimental to that year's spawning.

Impingement effects at SHERCO are also not quantifiable at this time. Indications are that if adequate duration and frequency of backwashing on the intake plates is implemented, mortality of impinged fish would be very low. It is recommended that a schedule for intake plate backwashing be established, which would enhance the likelihood of survival of impinged fish.

Dredging to maintain intake channel depth could affect spawning success of fish downstream; however, proper timing of maintenance dredging operations, if implemented, would obviate this. It is further recommended that any maintenance dredging be conducted in early spring when water temperatures are below 8°C. This should avoid the peak spawning period of many species at the site while ensuring a high flow volume to provide for maximum dispersal of dredging-associated siltation.

The effects of discharge toxicity have been examined by means of a bioassay which is discussed in Section 5.10-5. The acute toxicity will affect the populations at the point of discharge and will diminish downstream; however, a chronic situation may likely exist throughout the effluent plume. In addition, the ichthyoplankton study currently being conducted will serve to aid in quantifying some of the potential impacts on fish communities at SHERCO.

5.10.5 Bioassay Testing

The discharge of any substance or mixture of substances into Minnesota interstate waters determined to be acutely toxic to fish, fish food organisms or other biota has been restricted by Water Pollution Control (WPC) Regulation 15(c)(5)(d) and WPC 15(c)(14). Specifically, WPC 15(c)(15)(d) restricts the discharge of contaminants, other than heat, which exceed the 96-hour median tolerance limit for indigenous fish and food organisms at any point within an acceptable mixing zone.

WPC 15(c)(14) states that toxic substances shall not exceed one-tenth of the 96-hour median tolerance limit as a water quality standard. Bioassay tests are performed to determine the acute toxicity of an effluent of similar composition as that expected to be discharged into the Mississippi River by the operation of SHERCO Units 1, 2, 3 and 4. The median tolerance limit was determined by the percent concentration of effluent which caused 50% of the test organization to die within four days (96-hour < C_{50}).

A literary analysis of the effluent to determine its potential toxic impact could have been unsatisfactory because of the additive synergistic or antagonistic reactions which occur with the combination of chemical components and the formation of unknown by-products. For these reasons, on-site toxicological testing of the SHERCO effluent was performed to determine the potential impact upon aquatic biota in Mississippi River water.

Methods

The methodology for acute testing of the effluent toxicity followed the bioassay recommended procedures. The effluent test water was comprised of unfiltered supernatant collected from the Units 1 and 2 clarifer. Dilution water was collected from the Upper Mississippi River approximately 30 meters upstream of the SHERCO intake facilities, 12 meters offshore and 1 meter below the surface. Throughout the testing period, temperature, conductivity, pH and dissolved oxygen content of the test solutions were routinely monitored for validation and interpretation of the toxicological results. Simultaneously, records of dead fish versus test duration for each concentration were maintained. A total of three 96-hour tests were performed on two species of fish, the bluegill sunfish (Laponus maerochirus) and the fathead minnow (Pimephales promelas).

Results and Significance

The calculated 96-hour LC_{50} for bluegills in unaerated effluent was 58% effluent concentration. In test solutions of 100% effluent, death began to occur within the first 8 hours and 100% of the test fish were dead within 48 hours. In 85% effluent, death occurred as quickly;

however, 100% death was delayed until the 64th hour. Fifty percent effluent was the lowest concentration to cause effluent-related death (19.4%). However, initial deaths were delayed until the 64th hour.

Within the 96-hour test period with bluegills, the maximum percent killed occurred in 100% effluent (44%). Death within this concentration did not occur until 72 hours. Similarly, delay deaths occurred in the 85 and 50% effluents. Fatheads within the aerated effluent demonstrated the same delay; however, deaths occurred within 40 hours. At the end of the 96-hour test period, 95.4% and 54.4% of the fatheads had died in 100% and 85% effluent concentrations, respectively. The results of these tests indicate that with sufficient dissolved oxygen (>5.5 mg/1) significant deaths do not occur at effluent concentrations $\leq$50%. Although the effluent would not violate the water quality standard established by WPC 15(c)(14), the 96-hour median tolerance limit would be exceeded in the mixing zone established by WPC 15(c)(15)(d). With the existence of an acute toxic impact from the effluent, it would appear that the likelihood exists for additional impacts to occur from chronic exposures. Another area of concern is the acute and chronic impacts upon aquatic biota other than fish. A third and more complex area of concern is the determination of the secondary impacts upon the higher trophic levels by the accumulation of toxics within the food chain or disruption of a trophic component.

In an attempt to determine the potential impacts previously discussed, a preliminary review has been made of the literature (EPA 1973; National Academy of Sciences 1973; EPA 1976) concerning some of the constituents indicated in Tables 5.10-1 and 5.10-2 and their toxic by-products upon representative species of the phytoplankton, zooplankton, benthic macroinvertebrate and fish communities including icthyoplankton. The result supports the concerns for the potential acute and chronic impacts. Due to the complexity, specificity and magnitude, a listing of the toxicities of each potential constituent to the various aquatic organisms is not presented. Impacts from the introduction of chronically toxic effluent could vary the baseline condition of the following indicators of individual ecosystem quality.

TABLE 5.10-1

CHEMICALS USED IN PLANT OPERATION

Aluni
Chlorine
Chromates
Organic biocides
- sodium polychlorophenol
- quaternary amines
- methylene bis-thiocyanate

Oxygen inhibitors
- sodium mercaplobenzothio

Silt control polymers
- acrylamide
- polyaerylate
- polyethylamine

Sodium hydroxide
Sodium lignosulfonate
Sodium sulfite
Sulfuric acid
Zinc

TABLE 5.10-2

ELEMENTS FOUND IN COAL

Aluminium
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chlorine
Chromium
Cobalt
Copper
Fluorine
Gallium
Germanium
Iron
Lead
Magnesium
Manganese
Mercury
Molybdenum
Nickel
Phosphorus
Potassium
Samarium
Selenium
Silicon
Silver
Sodium
Sulfur
Titanium
Uranium
Vanadium
Yttrium
Zirconium
Zinc

1) primary productivity;

2) value of the land source;

3) population density;

4) species diversity;

5) reproductive rates;

6) survival of sensitive life stages;

7) fecundity rates;

8) flesh tainting;

9) respiratory stress;

10) osmotic regulation;

11) enzyme activity;

12) bioaccumulation;

13) genetic abnormality;

14) organism sensitivity to environmental changes; and

15) organism susceptibility to diseases and parasite infections.

Recommendations

It has been demonstrated that the potential effluent discharged by the operation of SHERCO Units 1, 2, 3 and 4 is acutely toxic. Bioassay tests performed indicate that the effluent simulated would violate WPC 15(c)(6).

Additional treatment of the effluent would be required to reduce the toxicity below that which is acutely harmful to animal and plant life in the receiving waters. Due to the limitations of the study design and duration, only qualitative results of the acute toxic impact of the potential effluent upon aquatic biota other than fish can be concluded. Although the acute toxicity of the effluent would only affect a small population within the immediate vicinity of the discharge, a potentially chronic situation may exist throughout the effluent plume. Additional testing seems warranted to address not only the direct chronic impacts upon each trophic level, but the secondary impacts from food chain

transport and/or disruption. A chemical analysis of the effluent is not required since the expense cannot be justified by the value of the results of such an effort.

5.10.6 Construction

During construction, modification of the shoreline and increased turbidity associated with dredging can result in removal or creation of spawning and nursery habitat. The existing intake structure was designed to provide the additional cooling water capacity required by Units 3 and 4. No new construction is anticipated for Units 3 and 4 that would affect the river at the site. Therefore, no effects of construction on fish populations are anticipated.

5.11 Energy

5.11.1 Effects of Proposed Units

SHERCO Units 3 and 4 constitute a substantial addition of generating resources to the NSP system for meeting both power and energy requirements in addition to maintaining an adequate margin of reliability.

Table 5.11-1 shows NSP's historic and projected energy sales for residential, small commercial and industrial, large commercial and industrial, mining, street and highway lighting and other uses. As determined in the Decision of the Director (MEA 1976), the addition of SHERCO Units 3 and 4 is necessary to meet the projected forecasts of demand.

The NSP forecasts of demand include an assumed increase in use with major shifts from fuel oil and natural gas to electricity. The Decision of the Director (MEA 1976) concludes that "...the forecasts appear to be a reasonable representation of future electricity demand in the Applicant's service area." The additional units will also help to maintain system reliability. Without the addition of these two units, the probability of power outages in the MAPP region would increase (NSP 1975). Figure 5.11-1 summarizes the data on demand as developed by NSP (1975).

TABLE 5.11-1

HISTORIC AND PROJECTED ENERGY SALES*

NSP (Minnesota and Subs.)
GWH Sales

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Residential	3,442	3,727	3,928	4,315	4,718	5,131	5,297	5,729	5,770	5,823	6,114	6,670	7,148
Small Commercial and Industrial	1,319	1,479	1,583	1,724	1,931	2,111	2,245	2,457	2,568	2,595	2,764	2,858	3,064
Large Commercial and Industrial	3,814	4,261	4,672	5,309	5,853	6,304	6,645	7,241	7,766	7,761	8,125	8,764	9,393
Mining	16	18	17	17	30	112	109	118	125	119	110	131	141
Street and Highway Lighting	145	147	145	145	145	148	156	165	171	173	177	191	204
Other**	238	264	283	308	353	364	376	399	430	401	346	442	474
Total Retail	8,974	9,896	10,628	11,818	13,030	14,170	14,828	16,109	16,830	16,872	17,636	19,056	20,424
Sales to Nongenerating Utilities	355	379	405	445	469	507	539	605	641	656	575	687	736
Company Use and Losses	811	879	961	1,150	1,138	1,239	1,330	1,325	1,198	1,257	1,584	1,717	1,840
Native Requirements	10,140	11,154	11,994	13,413	14,637	15,916	16,697	18,039	18,669	18,785	19,795	21,460	23,000

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Residential	7,583	7,988	8,414	8,827	9,262	9,697	10,160	10,598	11,065	11,562	12,093	12,587	13,116
Small Commercial and Industrial	3,250	3,423	3,606	3,783	3,969	4,156	4,354	4,542	4,742	4,955	5,183	5,395	5,621
Large Commercial and Industrial	9,965	10,496	11,055	11,598	12,170	12,742	13,350	13,926	14,539	15,193	15,891	16,539	17,234
Mining	149	157	166	174	183	191	200	209	218	288	238	248	259
Street and Highway Lighting	217	228	240	252	265	277	290	303	316	330	346	360	375
Other**	503	530	559	585	613	643	674	701	733	766	801	855	869
Total Retail	21,667	22,822	24,040	25,219	26,462	27,706	29,028	30,279	21,613	33,034	34,552	35,984	37,474
Sales to Nongenerating Utilities	781	822	866	909	954	998	1,047	1,091	1,139	1,190	1,245	1,296	1,350
Company Use and Losses	1,952	2,056	2,166	2,272	2,384	2,496	2,615	2,728	2,848	2,976	3,113	3,240	3,376
Native Requirements	24,400	25,700	27,072	28,400	29,800	31,200	32,690	34,098	35,600	37,200	38,910	40,520	42,200

*Data through 1974 are historical.

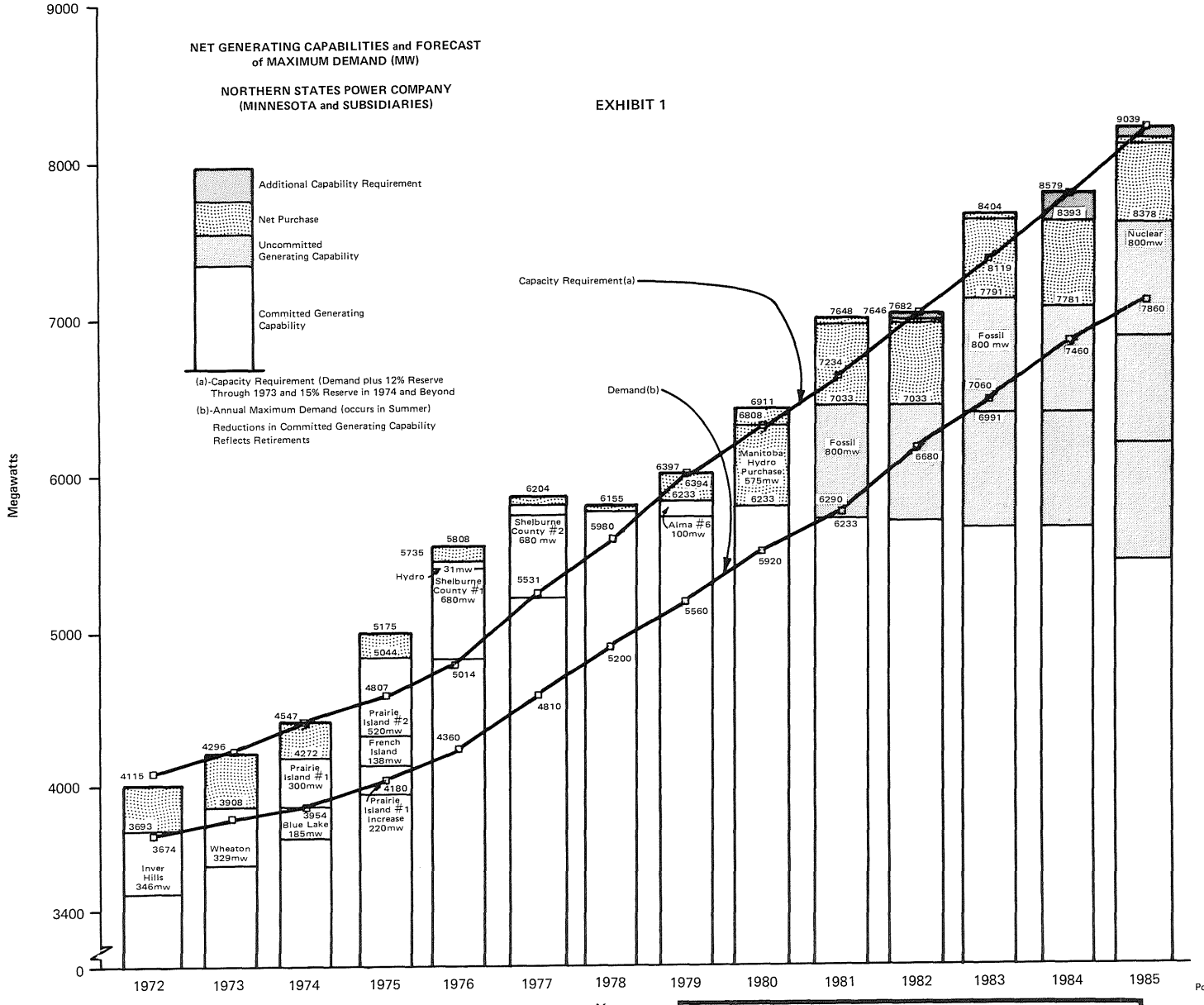
**Other sales to public authorities and interdepartmental sales.

Source: Northern States Power Company, Certificate of Need Application for a 1,600 Mw Electric Generating Facility, 1975, Table 2.

NET GENERATING CAPABILITIES and FORECAST
of MAXIMUM DEMAND (MW)

NORTHERN STATES POWER COMPANY
(MINNESOTA and SUBSIDIARIES)

EXHIBIT 1



Power Supply Planning
October - 1975

MINNESOTA POLLUTION CONTROL AGENCY

ENVIRONMENTAL IMPACT STATEMENT

Northern States Power Company's Proposed SHERCO Units 3 and 4 Electrical Generating Facility

Figure 5.11-1 NSP Data on Demand

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6. METHODS FOR MINIMIZING SIGNIFICANT IMPACTS

Many of the impacts associated with SHERCO Units 3 and 4 are unavoidable given the nature and scope of the project. On the other hand, several of the impacts discussed throughout the EIS may be mitigated by design changes, scheduling or management efforts. Within this section, potential means for mitigating some of the more "significant" impacts are suggested. For the purposes of this discussion "significant" impacts are violations of environmental standards or conflicts with other pertinent regulations, guidelines or policies. Likewise, impacts on a large population or particularly severe impacts in areas in which there are no regulations are considered to be significant.

6.1 Land Use and Aesthetics

Construction and operation of SHERCO Units 3 and 4 is not expected to generate any significant adverse impacts on land use or cultural resources (historic and archaeological sites). The project is consistent with applicable land use plans and zoning and no historic sites or evidence of archaeological artifacts have been identified on the property. For these reasons, consideration of mitigating measures was deemed unnecessary.

While no standards or regulations exist for evaluating the significance of potential visual impacts, the inherent physical characteristics of any large electrical generating station provide a strong visual image upon the surrounding landscape. Visual impacts related to the power plant stack and visible plume are not capable of mitigation. It is possible, however, to reduce views of the project from ground level. Landscaping and planting activities could soften the visual effect of the entire generating station complex. This would be particularly beneficial along the U. S. Route 10 corridor so that those traveling along the highway or living in the city of Becker would have a reduced view of the project.

6.2 Transportation

Construction and operation of SHERCO Units 3 and 4 is not expected to generate any significant adverse impacts. However, at times, as was the case with Units 1 and 2, there may be a need for reduction of traffic or the use of temporary traffic controls on U. S. 10 in the immediate vicinity of the plant. This would facilitate access to the site by workers during the peak commuting hours and by vehicles making construction deliveries, while mitigating potential disruption of flow along this thoroughfare.

6.3 Socio-Economics

The socio-economic impact analysis has shown that there are very few potential adverse impacts. For the most part, the construction period impacts will be minor and the same can be said about the long-term effects associated with the influx of permanent employees. It is important to note that most of the potential problems which are anticipated might occur independently of SHERCO.

The possible inadequacy of certain local community services and housing for non-local construction and permanent employees cannot be directly mitigated by NSP. The utility company can, however, work with officials of potentially effected communities in promoting proper planning for project-related population growth. NSP can advise such officials of the project schedule and provide information regarding the expected number of newcomers to assist the communities in accommodating these new residents.

6.4 Air Quality Mitigation Measures

The impact analyses performed for this study indicate that, with two potential exceptions, the addition of Units 3 and 4 to the SHERCO facility should not significantly affect the surrounding air quality. The potential for exceeding the short-term SO_2 and TSP standards are the two areas in which mitigating measures may be appropriate.

6.4.1 Facility SO_2 Impact

Mitigating the short-term effect of SO_2 stack emissions would be best accomplished after identifying the probability of this potential impact. The analysis performed of the expected impact involved adding the maximum 3-hour facility SO_2 contribution to the second highest 3-hour monitored SO_2 value. This type of approach is conservative in that the meteorology conditions that cause higher concentrations from relatively high single source releases do not necessarily cause coincidently high background concentrations. Notwithstanding this fact, the predicted maximum ambient concentration (597 $\mu g/m^3$) is very close to the state standard of 655 $\mu g/m^3$. The facility will reportedly be meeting the required new source performance standards. Since an exceedance of the standard was not predicted, it does not seem warranted to require limitations. Since the predicted is relatively close to the standard, however, the potential for this occurrence should be identified through actual monitoring. For this reason, it has been recommended that the monitoring sites be relocated to ensure a greater probability of monitoring facility related contribution.

Measures that could be taken to reduce short-term ambient impact include combustion of lower sulfur coal, increased SO_2 removal prior to emission and/or increased effective height of release. If monitoring indicates that the short-term SO_2 standard will be exceeded, these mitigation measures might be used to decrease the impact. Combustion of a lower sulfur-content coal may be an option if the proposed coal is beneficiated or if an alternate coal is obtained. These measures are discussed in Section 10. Increasing the SO_2 removed from the flue gas would require design and/or operational changes in the control system. Increasing the effective height of release could be accomplished by

additional heat flux for plume bouyancy or by using a taller stack (see Section 10).

6.4.2 Fugitive Dust Impact

The conservative emission factors used to identify the fugitive dust impact indicated that the annual and 24-hour average ambient TSP concentrations associated with coal handling could exceed federal and state standards. Since this analysis was based upon conservative emission factors that could result in an overprediction of the impact by a factor of 5, monitoring is recommended to identify more accurately the potential for relatively high fugitive dust impact. Two to three high-volume air samplers located 0.3 to 0.5 km from the plant boundary would help identify the potential for such impact.

The SHERCO facility reportedly will use a number of control measures for coal handling and storage operations. Additional control options for those phases of the handling and storage operation that have controls are not readily available. Enclosure of the 1A-2A conveyor transfer would effectively reduce a significant contributor to the fugitive dust emission burden. The addition of venting and particuate removal equipment to the stacker/reclaimer for Units 1 and 2 and the radial stacker for Units 3 and 4 would also effectively reduce fugitive dust emissions. Enclosure and/or water control practices for the ready storage areas would not effectively reduce fugitive dust emissions since their relative contribution to the total is rather small (approximately 3%).

Since this facility will be using many state-of-the-art control practices for fugitive dust and the predicted fugitive dust impact is expected to be conservative, it is recommended that the potential for exceedances be identified by monitoring before instituting mitigation measures.

6.5 Water Quality

Plant Effluent

Impact analyses indicate that the potential water quality effects resulting from the plant discharge is related to the toxicity of the effluent and the volume of river flow necessary to dilute the effluent to meet water quality standards within the allowable mixing zone. Mitigation of the potential adverse effects may be accomplished by the use of lower sulfur coal or effluent treatment. While reducting of the quantity of the effluent may mitigate the water quality violations, there is likely to be an increase in the effluent toxicity due to greater pollutant concentrations.

The results of the bioassay, which indicate acute toxicity, do not define the cause of the toxicity. Those specific pollutants in the effluent alone or in combination which result in toxic conditions cannot be defined without further study. The questions regarding potential chronic toxicity conditions raises even greater need for information to help determine specific mitigating measures. It is possible that measures can be implemented that will result in mitigation of effluent toxicity and also provide an effluent that will comply with water quality standards.

The use of lower sulfur fuel and the attendant decrease in limestone consumption would decrease the sulfate, TDS and total hardness concentrations of the effluent. A high-cost alternative would be to treat plant effluent or portions of the plant effluent through a distillation, ion-exchange, reverse osmosis or chemical softening process before reuse in the plant or discharge to the river. A final measure that would eliminate the water quality impacts would be to shut down or curtail plant operations during low flow periods.

Ion exchange is a physical treatment process which removes dissolved solids by passing waste through a column of resinous material where ion substitution removes the dissolved minerals. The treatment units are regenerated by passing a chemical solution through, resulting in a concentrated brine solution which must be disposed of. Ion exchange systems are proposed for boiler water treatment due to the high quality water needed for the steam cycle.

Reverse osmosis removes dissolved solids by applying a pressure to the waste that forces the water through a semi-permeable membrane. Dissolved materials are thereby separated from the waste in this process. Pretreatment of the effluent is required to avoid fouling of the membrane. In this process a concentrated brine solution is produced which must be disposed of.

Distillation or evaporation is accomplished by heating the effluent water vapor, which is then condensed to produce purified water. The dissolved materials are left behind as a scale which must be cleared from the unit and disposed of.

Chemical softening can be used to reduce the hardness and total dissolved solids content of wastewater. The treatment process is estimated by NSP to reduce the total dissolved solids content of scrubber sludge effluent by approximately 70% (NSP 1976). In the process large quantities of lime and acid are used. This will require a pond for disposal of lime softening sludge.

Ion exchange, reverse osmosis and distillation are all forms of demineralization, and are only used when a very pure effluent is necessary. These units could be used as a final treatment step on wastewater if the particular consitutents causing the toxic problems has been identified to be dissolved materials. These treatment processes would also reduce the total dissolved solids and hardness so that water quality standards could be met.

Sanitary Waste Treatment

The proposed action includes treatment of sanitary sewage by septic tank drain fields. There are potentially other types of systems which could be used such as a package biological type treatment plant, oxidation ponds, physical/chemical type treatment, activated sludge, and trickling filters. Through these processes it is possible that the sewage effluent could be discharged to the ash ponds instead of the drain fields. Properly designed and maintained septic tank drain field treatment systems are acceptable means of treatment for sanitary sewage. Mitigation of potential groundwater impacts would be traded for potential impacts to surface waters.

Cooling Water Treatment

Due to the toxicity of chlorine residuals to aquatic biota and the potential formation of chloro-organics and chloremenes, various options to the proposed action's use of chlorine as a biocide are the use of ozone ultraviolate light, non-oxidizing biocides and chlorine reducing agents.

There are several types of potential cooling water treatments other than the use of chlorine. Ozone and ultraviolet are possibilities that warrent consideration in the reduction of possible toxic impacts when they are specifically defined. There are significant increased costs for these processes over the use of chlorine.

Non-oxidizing biocides are frequently used to supplement chlorine or other oxidizing biocides, in order to reduce chlorine usage, to compensate for the deficiencies of chlorine performance and to improve blowdown quality by eliminating toxic chloro-hydrocarbons which may be formed in the circulating water. Non-oxidizing biocides are particularly used in controlling fungus attack of lumber in wood cooling towers, where chlorine is not effective. Non-oxidizing biocides may be any of a great variety of compounds, such as organo-sulfur compounds, chlorinated phenols, cationic biocides, and organo-metallic compounds. Often a combination of several of these non-oxidizing biocides will be used in a treatment program which, along with timely use of chlorine, offers a very high level of microbe control.

The use of non-oxidizing biocides also offers the possibility of complete replacement of chlorine use. Methylene-Bis-Thiocyanate, an organo-sulfur compound, has been successfully used to completely replace chlorine. However, as biological control problems are highly site-specific, no accurate prediction can be made before operation as to the extent to which chlorine might be replaced.

One method to reduce chlorine in cooling tower blowdown would be the use of chlorine reducing agents. Sulfur dioxide, sodium bisulfite and sodium sulfite are chemicals used in dechlorination which react with available chlorine in oxidation - reduction reactions to form inert chlorides.

Dechlorination is a method normally used in controlling chlorine in discharges that have been superchlorinated (chlorinated to very high levels). Dechlorination of the blowdown for continuous chlorination systems is more appropriate than for intermittant systems. Continuous systems maintain certain chlorine levels throughout the circulating water system, which may necessarily be reduced to acceptable levels in the blowdown before discharge.

6.6 Noise Mitigating Measures

6.6.1 Plant Operation

There are three distinct types of noise impact for which mitigating measures should be considered. The first is the startle and annoyance caused to the people living closest to the plant, due to the intense noise produced by the intermittent and unpredictable operation of steam relief valves. With more operating experience it is conceivable that plant control systems could be optimized to reduce the frequency of such occurrences. If this is not possible, another standard approach is to employ multiple relief valves with differing trip pressures. Discharge type silencers are designed and installed for the lower pressure trip valves to reduce community noise impacts without compromising plant safety requirements. Likewise, the unmuffled steam relief valves could be located in semi-open chambers in which noise was reduced without hampering the necessary steam relief at specified pressure.

The other noise impacts are due to the tonal quality of noise and predicted exceedance of the MPCA nighttime L_{10} and L_{50} noise standard. This exceedance is predicted essentially on the basis of an extrapolation of the Units 1 and 2 designs. The extent of the exceedance (if it actually occurs), in terms of noise level and numbers of residents affected, depends on the success of various design efforts currently in progress. These potentially mitigating measures for Units 3 and 4 are:

- improved ID fan system;
- improved ventilation fans; and
- two-speed enclosed fans for cooling towers.

It is possible that successful design and implementation of these measures will result in both prevention of high amplitude tonal components of noise and compliance with MPCA nighttime standards at all but one or two residences. In particular, it would be impossible to achieve compliance at the residence near measurement location 1 (Nelson's Landing). This is because of the proximity (about 1,000 feet) of this house to the Unit 4 cooling towers.

Should the improved design of Units 3 and 4 prove to comply with the NPC-2 noise regulations, it is possible that Units 1 and 2 could be retrofitted with similar control measures to bring the entire SHERCO operation within specified noise levels. Retrofitting would probably involve substantial costs and significant down time for Units 1 and 2 while modifications were undertaken.

NSP might also consider a noise abatement/equipment management plan which would have very little cost. In such a plan NSP could plan to use its quieter equipment, and equipment most removed from sensitive receptors during non-peak power generating times. While such scheduling would obviously not eliminate peak noise levels, it would reduce the frequency of exceeding NPC-2 noise levels adjacent to the plant.

6.6.2 Plant Construction

Because of the nature of construction activities, few mitigating measures are available. Use of properly sized and maintained mufflers on all vehicles and machinery will help to minimize noise impacts. Temporary noise barriers could also be used in construction zones near sensitive receptors. However, the steam line purging operation is considered a source of potential noise impact. Since this operation represents an essential step in construction of a major steam system, NSP has proposed the following noise impact mitigation steps:

- the community will be given appropriate notice of what day and times the operation will occur;
- the operation will be confined to daylight hours to the maximum feasible extent; and
- the operation will be conducted with an adequately sized silencer.

These steps should serve to reduce the "startle" aspect of impact and to some extent the annoyance aspect as well.

6.7 Geology and Hydrology

No significant geology-related adverse impacts are expected as a result of plant expansion. The only significant hydrology-related potential adverse effects involve the issue of water supply. It is apparent that operation of Units 3 and 4 will require a considerable amount of additional water. It is unlikely that this quantity could be obtained from groundwater wells without a significant adverse effect on near-site irrigation and domestic wells. The use of Mississippi River water for plant needs may be severely limited by a Minnesota Department of Natural Resources request that withdrawals be limited only to periods when Mississippi River flow equals or exceeds 2,000 cfs.

A possible mitigating measure to ensure adequate water supply without significant stress to surface water flow or aquifer conditions would be to allow for water storage on the plant site. In this manner additional river water can be withdrawn and stored during periods of high river flow and used to supplement water supply during low flow periods.

By treatment of wastewater and reuse additional reductions in the withdrawal of river water can be accomplished. The degree and quantities of water treated will determine the amount of withdrawal.

6.8 Solid Waste

The major adverse effect associated with solid waste disposal at the SHERCO facility involves the potential water quality impact of seepage from present and future bottom ash and scrubber sludge storage ponds. Although it is impossible at this time to precisely quantify the effects of seepage on groundwater and surface water quality, the continuing groundwater monitoring program at the SHERCO site will serve to identify any developing impacts. If monitoring reveals significant degradation of water quality, possible mitigating measures include decreasing the design height of present storage areas and substituting more effective, albeit more costly, design criteria for future storage areas.

Increasing depth of disposal increases the pressure exerted by disposed solids and therefore increases seepage rates. Hence, it is possible to control seepage from existing storage ponds by limiting the height to which they are filled if water quality problems are shown to exist. This, however, would require additional land for waste disposal.

Future storage areas are planned to accommodate the solid waste generated by all four SHERCO units. At the time of construction, if existing storage areas have been shown to cause significant water quality contamination, new more stringent design criteria may be applied to these new ponds.

An additional mitigating measure would be to alter the type of lining used for future storage areas from clay to a less permeable one such as plastic or rubber membranes. This would lead to probable higher waste disposal costs.

6.9 Terrestrial Ecology

The major adverse impacts of SHERCO Units 3 and 4 on terrestrial organisms will be (1) the elimination of habitat as a result of clearing, grading and other construction activities and (2) the effects of air pollutants on vegetation and, to a lesser extent, wildlife. Restoration of vegetative cover upon completion of construction can mitigate effects on wildlife due to loss of habitat. Revegetation with native plants commonly found in the vicinity and allowing natural succession to occur on these areas will facilitate faunal succession and the reestablishment of a natural population of mammals. The potential effects of air emissions on vegetation and wildlife will be mitigated to the extent possible by the use of pollution abatement equipment (particulate and SO_2 scrubbers). Dust control during construction, through the use of water or chemical sprays can also serve to reduce adverse effects on terrestrial flora and fauna. However, regardless of these mitigating measures, there will be substantial air emissions and, therefore, the impacts to terrestrial ecology, as presented in Section 5.9, will occur.

6.10 Aquatic Ecology

On the basis of available information, construction and operation of SHERCO Units 3 and 4 is expected to generate adverse impacts on the biological communities present in the Mississippi River at SHERCO. It should be noted, that an ichthyoplankton study may generate some evidence to this effect. In addition, mixing zones may significantly restrict the passageway for fish and other aquatic species. Possible mitigating measures to minimize the extent of mixing zones are discussed in Section 6.5, Water Quality.

If ongoing studies indicate significant potential impact to fish and other species, a number of scheduling and design efforts may be effective in mitigating impact. If adequate duration and frequency of backwashing the intake plates is implemented, mortality of impinged organisms would be very low. Dredging to maintain intake channel depth could affect spawning success of fish downstream; however, proper timing of maintenance dredging operations, if implemented, would obviate this.

6.11 Energy

The expansion of the SHERCO facility is not expected to have any adverse effect on regional power supply resources. The Director of the Minnesota Energy Agency issued a Certificate of Need for the additional two 800 MW (net generating capacity) generating units to be constructed at the SHERCO site. The socially beneficial uses of the output of the proposed facility have been deemed to justify construction of the facility. For these reasons, consideration of mitigating measures was deemed unnecessary.

7. UNAVOIDABLE ADVERSE IMPACTS

The analysis of potential environmental impacts presented in Section 5 of this report indicated that there are several areas in which adverse effects are anticipated as a result of construction and operation of SHERCO Units 3 and 4. Some of these impacts are expected to occur despite implementation of reasonable mitigating measures (described in Section 6). Likewise, these unavoidable impacts are anticipated regardless of what alternatives to the proposed action are taken.

This section identifies the significant adverse impacts that cannot be avoided if the project is implemented. The discussion explains the nature of such impacts and the reasons why they cannot be avoided.

- A significant increase in the demand for housing will occur during both the construction and operational phases of the project. This impact will result from the projected settlement of nonlocal construction and permanent employees in the vicinity of the SHERCO site. Unless additional housing becomes available, many of these nonlocal employees may have to seek housing in communities more distant from the project site. Realistically, there are no mitigating measures available to reduce the expected demand for housing since NSP will have to depend to some extent on nonlocal workers. However, as noted in Section 6, NSP can provide certain information to assist communities in accommodating these new residents and to promote the construction of needed housing.

- Because of the relatively high background levels of TSP in the area, SHERCO Units 3 and 4 will probably contribute to TSP violations beyond the site boundary. Available monitored data (which includes the influence of SHERCO Unit 1) indicate that ambient concentrations of TSP exceed federal and state 24-hour and annual secondary standards. Regardless of mitigating measures that may be taken to reduce TSP emissions from the power plant stack and coal handling activities, operation of Units 3 and 4 will likely result in more frequent violations of applicable standards.

- In areas more distance from the SHERCO site where ambient air quality standards are expected to be met, the SHERCO facility will add considerably to the regional pollutant burdens. The emissions burden associated with Units 3 and 4 will reduce the air quality increment available for other development.

- The additional effluents associated with the operation of Units 3 and 4 will add to the pollutant burdens of the Mississippi River. Even where reasonable mitigation are adopted to ensure attainment of all applicable water quality standards, more treatment will be required for downstream uses. The degradation of the river and the decrease in river flow, however limited, will foreclose some of its uses for other future users.

- Water effluents and air emissions, even with the adoption of mitigating measures, will result in impacts to aquatic and terrestrial acosystems as discussed in Section 5.9 and 5.10.

- Noise emissions from the operation of Units 3 and 4 will increase ambient noise levels in the vicinity of the plant. This may result in a curtailment of certain activities as well as some speech and sleep interference for nearby residents.

8. SHORT-TERM USES OF THE ENVIRONMENT VERSUS LONG-TERM PRODUCTIVITY

This section briefly describes the tradeoffs involved between the short-term and long-term benefits and costs associated with use of the environment for the proposed generating facilities. In this discussion, short-term refers to the period during which construction and operation of Units 3 and 4 will take place; that is, the 100-month construction period and the 35 years of expected plant operation. Long-term refers to the period subsequent to the 35-year useful life of the generating facilities.

The short-term benefits of the proposed power generating facilities are primarily those related to NSP providing power to its customers. While production of electric power does not directly benefit the natural environment, electricity may be used for many functions that protect or enhance environmental quality, such as powering and controlling anti-pollution devices used in industry and providing a clean end-use energy resource in densely populated urban areas. More importantly, the electricity will provide a broad range of services to residential, farm, commercial and industrial customers, including lighting, heating, cooling, driving household appliances and powering commercial and industrial devices and processes. The MEA, in granting a Certificate of Need for SHERCO Units 3 and 4 (see Section 1.3 of this report), found that these facilities were required to meet projected future energy demands.

Construction and operation of Units 3 and 4 will also provide substantial employment opportunities. Workers will be required to build and operate the plant and additional employment will be induced in secondary industries (supplies of raw materials, services to meet the needs of nonlocal workers, etc.). This employment also will directly and indirectly produce additional personal income through the wages paid to such workers. Finally, the plant will generate significant tax revenues, particularly as a result of property tax payments to units of local government. In turn, these revenues will help provide facilities and services for residents of these taxing jurisdictions.

Whether operation of Units 3 and 4 will result in long-term benefits is a function of the extent to which the generation of power during the

plant's useful life facilitates other activities that can provide future benefits. For example, the availability of power from the proposed facilities may indirectly influence decisions regarding future residential, industrial and commercial developments that will continue to provide shelter, goods and services after the plant is deactivated.

These potential short-term and long-term benefits must be contrasted with the environmental costs associated with the project. As indicated in Section 5, Environmental Impact of the Project, construction and operation of Units 3 and 4 will generate a number of short-term adverse environmental effects. These include:

- pre-emption of agricultural production on a portion of the site;
- generation of incremental adverse visual impacts and to the visibility of the plant facilities;
- increased traffic on local highways and possible congestion during peak hours due to worker commutation to the site as well as deliveries of raw materials;
- potential hazards and delays at rail crossings caused by more frequent deliveries of coal;
- increased demands for housing and community services as a result of the settlement of nonlocal construction and permanent employees;
- substantial emissions of air pollutants associated with the use of coal for power generation, particularly SO_2, TSP and NO_x;
- possible violation of 3-hour secondary ambient air quality standards for SO_2 in the vicinity of the site;
- contributions to existing local violations of ambient air quality standards for TSP;
- some localized fogging and icing due to cooling tower plumes;
- possible curtailment of water availability to downstream users during low-flow periods due to withdrawal of large amounts of water for power plant cooling and other processes;

- discharge of pollutants in wastewater effluent (primarily from the holding pond) and localized violations of some water quality standards for the Mississippi River is the mixing zones for these pollutants.
- some seepage from solid waste disposal ponds to groundwater and eventually the Mississippi River;
- incremental increases in noise levels and violation of MPCA noise standards in the immediate vicinity of the proposed facilities;
- elimination of vegetation and wildlife habitat on the site;
- potential adverse effects of air emissions and salt deposition from cooling tower drift on terrestrial flora and fauna;
- entrainment and impingement of aquatic organisms in the water intake structure;
- detrimental effects of pollutants in effluent discharge on aquatic life in the Mississippi River; and
- localized impact of dredging operations to maintain the water intake system on aquatic habitat and biological communities.

Note, however, that some of these potential adverse effects can be eliminated or minimized by implementation of reasonable mitigating measures (see Section 6, Methods for Minimizing Significant Impacts).

In addition to these potential short-term environmental costs, construction and operation of SHERCO Units 3 and 4 could cause long-term adverse effects. For example, on-site property devoted to solid waste disposal may be precluded from future agricultural or other use if reclamation is not possible. At this time it is not apparent that any other long-term impacts are likely.

9. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The construction and operation of SHERCO Units 3 and 4 will result in the commitment of various natural and man-made resources. Some of these resources are irretrievable by virtue of the duration of commitment or cost of reclamation. In other cases, the commitment of resources is irreversible since the resource is consumed during construction or operation of the electric generating facilities. The following discussion describes the various resources that will be irreversibly or irretrievably commited to the project.

- The current SHERCO site consists of approximately 1,700 acres. About 320 additional acres of land will be required for Units 3 and 4. The project will preclude agricultural use of 240 acres for the life of the plant (35 years). Furthermore, it may not be possible to reclaim portions of the site for crop production (e.g., solid waste disposal ponds). Thus, Units 3 and 4 will result in an irretrievable loss of agricultural productivity during plant operations and an irreversible loss of some agricultural land.

- A variety of natural resources will be used to construct the facility, including sand, gravel, clay and other materials used to make concrete. While these materials are virtually irretrievable, they are readily available in sufficient quantities. Steel, other metals, plastics and asphalt will be used in plant structures and equipment, as well as for ancillary facilities. At the end of the plant's useful life, some of these materials, particularly the metals, may be recovered and recycled to create new products.

- Operation of Units 3 and 4 will result in average annual consumption of 5,708,000 tons of coal. Based upon a useful life of 35 years and the capacity factors specified in Section 3.3.2, this represents total consumption of 175,622,000 tons of coal. Other fossil fuels (diesel fuel and gasoline) will be consumed by (1) unit coal trains, (2) workers commuting to the

site, (3) construction equipment, (4) trucks making deliveries of raw materials, (5) maintenance vehicles, (6) emergency generating units and (7) other plant equipment. The consumption of coal and other fossil fuels represents a major irreversible and irretrievable commitment of resources.

- The proposed air pollution abatement system will use approximaterly 120,000 tons of limestone annually. While this resource is readily available, its use represents an irretrievable commitment of resources.

- A variety of other chemicals will be required for cleaning, maintenance and other purposes. These chemicals include acid, compressed hydrogen and carbon dioxide gases, sodium hydroxide, chlorine, anhydrons ammonia, etc. These chemicals will be consumed during plant operations and some wastes will be gradually discharged through the holding pond into the river. The use of these chemicals thus constitutes an irretrievable commitment of resources.

- Operation of Units 3 and 4 will require an average water inflow for power plant cooling of 12,950 gpm. Total evaporation is cally 11,500 gpm, while drift from the cooling towers will average less than 100 gpm. Thus, evaporation and drift from the cooling towers will represent an average loss of 90% of all water used for cooling. The remaining water (approximately 1,400 gpm) will be returned to the recycle basin or the scrubber surge basin. This large amount of water consumed for cooling (as well as the use of much smaller amounts of water for other purposes) represents an irreversible and irretrievable commitment of the area's resources. However, because much of the water is lost due to evaporation into the atmoshpere, it will remain in the earth's water cycle.

- Air pollutants emitted due to operation of Units 3 and 4 may cause some irreversible damage to vegetation, soils and, to a lesser extent, wildlife in the vicinity of the site. These emissions could also reduce agricultural productivity of

nearby lands. While the likely extent of such effects is difficult to quantify because of the lack of scientific knowledge on these subjects, research conducted to date suggests a potential for some irreversible impacts.

- The estimated capital cost for construction of SHERCO Units 3 and 4 is approximately $900 million. In addition, NSP will also incur operating costs throughout the life of the project. While these costs will be ultimately recovered through payments received from its customers, NSP's commitment of these resources is irreversible and forecloses use of the funds for other purposes.

- Construction and operation of Units 3 and 4 will involve a significant irretrievable commitment of labor. Construction, which will take place over a 100-month period, will require an average field force of about 700 employees, with 1,450 workers needed at the peak construction period. The construction activities are expected to require a total of about 4,880 man-years of labor. The permanent work force at the facilities will consist of approximately 140 persons. Over the 35-year life of the plant, this represents a commitment of an additional 4,900 man-years of labor.

- Finally, an undetermined amount of labor has been and will continue to be expanded by public and private employees as well as citizens. This labor is in relation to the issuance of a certificate of site compatability, certificate of need, environmental impact statement, issuance of permits, and evaluation of limited work authorizations.

10. ALTERNATIVES

10.1 Introduction

This section develops reasonable alternatives to the major features of the project (Units 3 and 4 at SHERCO) and describes those alternatives so that some comparison can be made between their effects and those of the proposed action. A reasonable alternative to a proposed action is one that is technically feasible, reasonably available and has significantly different environmental impacts from the proposal. Developing a list of reasonable alternatives to the proposed action required consideration of many factors and their probable effects upon the project and the environment. Following is a list of these factors along with some comments as to what could be considered desirable effects.

1) Available technology - must be demonstrated to be reliable, adequate and available.

2) Compliance with regulations - must comply with federal, state and local regulations and standards, and adhere generally to federal and state policies.

3) Energy consumption - higher energy efficiency for the power plant and more efficient use of fuel.

4) Fuel source - consumption of fuel that is easily obtainable.

5) Air emissions - lower emissions of air pollutants.

6) Water consumption - decrease in total water requirements.

7) Water effluents - lower quantity of pollutants and/or water discharged.

8) Solid waste - decrease in solid waste quantities or a desirable change in the nature of the waste materials.

9) Land requirement - decrease in the amount of land needed for the plant site.

10) Raw materials - decrease in the amounts of raw materials consumed by the power plant.

11) Local benefits - increased benefits to local communities resulting from the presence of the plant.

12) Noise - reduction in the noise generated by plant operation.

13) Capital and operating costs - decrease in the overall cost of constructing and operating the power plant.

It is important to realize that almost any alternative may have adverse effects along with beneficial ones. For example, a decrease in air emissions may result in an increase in energy consumption, raw materials use and costs. Throughout this section both positive and negative consequences associated with alternatives are contrasted with those of the proposed approach in order to weigh relative benefits and costs of each option.

The following major categories of power plant systems are evaluated in this section with regard to reasonable alternatives.

- Power plant cooling
- Air pollution abatement systems, (SO_2 and particulate removal)
- Fuel sources and processing
- Fuel transportation (not including alternative routings)
- Supplemental fuels
- Solid waste disposal
- Water supply and management

As a result of factors specific to the project or as a result of special concern on the part of government or public interest groups, the following alternatives were also given special attention:

- Use of wood as an auxiliary fuel;
- Maintenance of a minimum flow of 2000 cfs (56.6 m^3/s) in the Mississippi River; and
- District heating using waste heat from the power plant.

The subsections that follow address each of these subject areas and describe both discounted (infeasible, inappropriate, unreliable, etc.) and reasonable alternatives to the proposed systems.

10.2 Power Plant Cooling

A number of methods could be used for power plant condenser cooling. The magnitude of the potential impacts of the cooling method emphasizes the need to evaluate carefully the available technology and the environmental effects of each alternative.

The description and analysis of the cooling system alternatives focuses on the primary component of environmental concern, the heat dissipation system. The alternative methods of heat dissipation that are usually considered can be grouped into three major categories: once-through cooling, cooling towers and cooling ponds. There are several reasonable alternatives to the proposed mechanical-draft wet cooling towers. The characteristics of these options are compared in Table 10.2-1.

10.2.1 Discounted Alternatives

Once-through Cooling

In the past, most steam electric power plants in this country used once-through condenser cooling systems. Though federal and state regulations severly limit its future applications, once-through cooling remains the simplest, most economic and most effective means of dissipating condenser thermal energy. Once-through cooling uses a river to provide cooling water. Water is withdrawn from the source, pumped through the condenser and then discharged at an increased temperature back into the location selected to avoid recirculation. The use of once-through cooling for two 800-Mw generating units at the proposed site would not be an available alternative. The annual momentary minimum daily discharge (Beck 1977d) at Anoka station on the Mississippi River is close to or less than the once-through cooling water flow requirement for 28 out of 44 years from 1931 through 1975. Therefore, this cooling system alternative is not considered as technically feasible.

TABLE 10.2-1

COMPARISON OF POWER PLANT COOLING ALTERNATIVES*

Criteria	Mechanical Draft Wet Cooling Towers (Proposed)	Natural Draft Wet Cooling Towers	Mechanical Draft Dry Cooling Towers	Cooling Pond	Mechanical Draft Wet-Dry Cooling Towers
Fuel Consumption (tons of coal per year)	5,700,000	5,700,000	6,000,000	5,609,700	5,750,000
Water Consumption (gallons per minute)	12,000	11,000	120	16,700	8,500
Water Discharge (Blowdown) (gallons per minute)	1,500	1,500	15	2,100	1,050
Land Requirements (acres)	1.5	6.0	12.0	1,600	3.0
Fogging (hours per year)	2,000	-0-	200	+	1,000
Capital Cost	$50,000,000	$70,000,000	$120,000,000	$50,000,000	$70,000,000
Operating Cost (compared to Mechanical Draft Wet Cooling Towers) (includes replacement cost)	NA	higher	higher	generally lower	higher

*Designed to provide generally comparable performance.

+Greater than proposed system.

NA - not applicable

Source: R.W. Beck and Associates 1977b. Technical Work Paper No. 2, Alternatives for Northern States Power Company Sherburne County Generating Plant.

District Heating

There are two basic ways in which a steam electric generating plant can also function as a source of thermal energy to nearby users. These are broadly classified as "waste heat utilization" and "steam extraction." The first method removes steam from the steam cycle after it has passed through the turbine and before it reaches the condenser. The heat that would be otherwise removed by the condenser is distributed for heating purposes. The second method removes (extracts) steam from some intermediate point in the turbine and therefore the steam has a greater heat content than if it were removed after completing its passage through the turbine. The method to be used depends upon the proposed use of the waste heat. The extraction method is preferred where high energy process steam is required for use such as in an industrial process, while the waste heat method is generally more applicable for heating of buildings or residences.

Use of waste heat from steam electric power plants has been identified as a possible means of providing thermal energy to urban areas using the energy center concept. The same concept has long been used for industrial facilities located close to steam electric power plants and/or adjacent urban areas (Miller et al. 1971). However, preliminary calculations show that only about 2 to 7% of the waste heat from SHERCO Units 3 and 4 could be utilized even assuming all the residences in the county were to be heated in that manner. This is not a large enough proportion of the waste heat available from Units 3 and 4 to make it a reasonable alternative for cooling the power plant. This does not preclude the possibility of using some of the waste heat in this manner. However, the applicability of using waste heat in this manner is generally limited to areas where the density of residential and commercial users is high and/or where there are or will be large industrial users. This is not the case for the SHERCO site.

10.2.2 Reasonable Alternatives

Natural-Draft Wet Cooling Tower

This type of cooling tower is designed so that a natural draft is created through the tower because of the difference between the density of the warmed air inside the tower and the cooler air outside. The towers are built as high as possible to achieve the greatest air flow. Natural draft towers could be as high as 500 feet (152 m), and base diameters almost equal the heights. A single plume is expelled from each tower and occurs well above ground level, thus reducing the potential for localized ground fogging under some circumstances. Although the massive structure is very expensive to construct, its operating costs are relatively low since natural density forces (rather than powered fans) are used to move the air. In addition noise impacts may be decreased by utilizing this alternative.

Natural draft wet cooling towers comparable in performance to the proposed towers would be substantially higher, resulting in more significant visual impacts and would cost about $20 million more to construct. The benefits would have to be significant to overcome the capital cost advantage of the proposed mechanical-draft wet cooling towers.

Mechanical-Draft Dry Cooling Towers

Dry cooling dissipates heat by conduction and convection without direct contact of the ambient air with the condenser cooling water. There is no evaporation of water into the air stream with consequent water consumption. Thus, in areas where the availability and consumption of water are critical environmental concerns, dry cooling may be a potentially advantageous alternative.

Water requirements associated with the use dry towers, (including the cooling water for auxiliary equipment) are minimal (on the order of 1% of the evaporation rate of the comparable wet tower) and fogging is a relatively negligible problem. However, there are several problems associated with their use as an alternative. First, U.S. experience

with dry cooling towers in utility applications is very limited. Second, an optimized dry cooling system could be at least twice as expensive to install as a mechanical draft wet tower (see Table 10.2-1). In addition, a dry system would suffer capability losses especially during the summer.

Cooling Pond

A cooling pond is an attractive alternative for heat dissipation in a closed-loop process, where ample land suitable for a water impoundment is available and water storage is a desirable contingency for periods of low source water availability. The pond cools by transferring heat from its surface to the atmosphere.

The layout and cooling effectiveness of cooling ponds are determined by topography, available land and ease of construction at a given site. In some locations, they may be constructed quite simply by building an earth dike or a small dam. However, the construction costs can be very high where much excavation and fill is required or where lining or surface preparation and compaction are needed to avoid excessive water losses to the ground. Such would be the case at the SHERCO site.

A major disadvantage of cooling ponds is the large amount of land required, about 1,600 acres for SHERCO Unit 3 and 4 cooling. If sufficient land is available at a reasonable price, the cooling pond offers advantages such as simplicity, low maintenance, potential recreational value, ecological value, aesthetic value, lower auxiliary power requirements, etc.

The Minnesota Department of Natural Resources' (DNR) proposed water withdrawal limitation for the Mississippi River raises the possibility of a joint use pond or lake which would provide for water storage as well as power plant cooling. This issue is discussed further in Section 10.8.

Mechanical-Draft Wet-Dry Cooling Towers

The features of both wet (evaporative) cooling and dry cooling are combined in the wet-dry cooling tower through the use of both wet and dry cooling sections. By varying the balance of each, a wide spectrum

of design and performance characteristics can be achieved. On one hand, the system can be basically a wet cooling tower with supplemental dry cooling to reduce or eliminate plume formation and ground-level fogging. On the other hand, water consumption can be reduced by operating it as a dry tower with supplemental wet cooling.

While wet-dry cooling is relatively new and operational experience is relatively limited, its technology is a rather simple adaptation of proven wet cooling tower systems and newer dry cooling tower technology. However, the incentive for the use of wet-dry cooling would be strongly tied to a serious plume formation or water consumption problem with a conventional wet cooling tower.

Characteristics of wet-dry cooling towers designed to achieve an overall decrease in water use and to reduce fogging potential during critical periods are shown in Table 10.2-1. This system reduces fogging in half, reduces water consumption by almost 30%, but costs 40% more to construct than the proposed mechanical draft wet towers. Operating costs should also be somewhat higher due to the inherently less efficient nature of dry cooling.

Conclusions

While a cooling pond used jointly for water storage would eliminate the potential impacts of the water use restrictions on plant operations, the extremely large land requirement would likely pose serious siting and acquisition problems. The natural-draft wet cooling towers would eliminate fogging, but would generate significant visual and aesthetic impacts due to their height, as well as requiring about 20 million more for construction. Dry cooling towers, while they would virtually eliminate water consumption, have a capital cost over two times greater than the proposed cooling method. Wet-dry towers would reduce water consumption and ground-level fogging, but would cost approximately $20 million more than the proposed cooling method.

10.3 Air Pollution Abatement Systems

The purpose of an air pollution abatement system is to control stack emission of air contaminants in order to reduce the impact on air quality, and to ensure that emissions and air quality standards are met. The two products of coal combustion having the greatest likelihood of adverse air quality impacts are SO_2 and TSP.

A number of possible air pollution abatement systems are available that would provide compliance with applicable regulations and standards. Evaluation of these alternatives considers the environmental (residual wastes and resource requirements), technical and economic consequences of using these control system alternatives. The discussion below describes why certain alternative methods for limiting SO_2 and particulate emissions were deemed inappropriate for SHERCO Units 3 and 4. The implications of using electrostatic precipitators as a reasonable alternative for particulate removal is also addressed.

10.3.1 Discounted Alternatives

Particulate Removal

Several possible methods exist for particulate removal. The most common technologies include:

1) Electrostatic precipitators

2) Mechanical cyclone collectors

3) Baghouses

4) Wet scrubbers

Of these, only electrostatic precipitators are considered reasonable alternatives to the proposed use of wet scrubbers. The mechanical cyclone collectors were not considered reasonable because their collection efficiencies generally do not approach those of electrostatic precipitators or wet scrubbers, especially for micron and/or sub-micron size particles. Baghouses were not considered reasonable because their

history of use at large power stations, such as the proposed units, is not substantial. In addition, they have large area requirements for installation on large power stations.

Flue Gas Desulfurization (SO_2 Removal)

Available processes for the removal of sulfur from flue gas streams of coal-fired power plant boilers generally are based on the absorption of the gas stream SO_2 into a solution. Since the processes are generally capable of achieving approximately 90% sulfur removal, the major environmental difference among them lie in the solids and sludge disposal requirements, which must be considered in balance with process reliability, marketability of regeneration by-products, energy requirements and economic costs.

The desulfurization systems discussed below are categorized into regenerative and nonregenerative, depending on the type of product resulting from the processes (saleable or throw-away). The regenerative processes have the advantage of producing a potentially scaleable by-product (sulfuric acid, elemental sulfur, etc.) Table 10.3-1 presents characteristics of the various flue gas desulfurization systems.

Regenerative Systems

The Wellman-Lord, Magnesium Oxide and Catalytic Oxidation processes have not been fully demonstrated in accordance with the National Academy of Engineering criteria. Other regenerable systems, including the Shell/UOP Copper Oxide System, Foster Wheeler RESOX process, Westvaco Activated Carbon process, and Citrate process are in the developmental stages. For the above reasons, these systems are not considered reasonable alternatives. Furthermore, the benefits of sulfur recovery are somewhat offset by higher capital and/or operating costs than those of the proposed lime/limestone slurry process.

Nonregenerative Systems

The double alkali process is a nonregenerative alternative to the proposed method of flue gas desulfurization. While the process has some advantages over the proposed system (less equipment corrosion and

TABLE 10.3-1

ENVIRONMENTAL COMPARISON OF FLUE GAS DESULFURIZATION METHODS

Parameter/Method	Land Requirements	End Product	SO_2 Removal Efficiency	Advantages (Relative to Other Systems)	Disadvantages (Relative to Other Systems)
Limestone/Lime (proposed)	Large for disposal of slurry	Waste Slurry	80-95%	1. Simple system 2. Minimum amount of equipment 3. High operating experience 4. Low cost	1. Slurry disposal 2. Pluggage and corrosion 3. High limestone usage 4. Low efficiency
Double-Alkali	Large for disposal of slurry	Waste Slurry	80-95%	1. Simple system 2. Low pluggage and corrosion 3. Lower liquid-to-gas ratios	1. Slurry disposal 2. Chemical handling system more complex 3. Low operating experience on units in excess of 100 Mw 4. Soluble salts in waste slurry
Wellman-Lord	Large for equipment	SO_2, H_2SO_4 Sulfur	85-95%	1. Sulfur recoverable 2. Relatively high SO_2 removal efficiency	1. System is complex 2. Operation not fully demonstrated on large coal-fired units 3. High cost 4. Availability of natural gas required
MgO	Large for equipment	$MgSO_3$ concentrated SO_2 gas sulfur	85-95%	1. Sulfur recoverable 2. Relatively high SO_2 removal efficiency	1. System is complex 2. Operation not fully demonstrated on large coal-fired units 3. High cost 4. High energy requirements
Catalytic Oxidation	Relatively compact	SO_2, H_2SO_4 Sulfur	80-90%	1. Sulfur recoverable	1. High cost 2. Catalyst replacement 3. High temperature operation 4. System is complex 5. Operation not fully demonstrated on large coal-fired units
Citrate	Large for equipment	Sulfur	80-90%	1. Sulfur recoverable	1. Hydrogen sulfide handling 2. Use of natural gas 3. Operation not fully demonstrated on large coal-fired units 4. Use of natural gas
Dry Adsorption	Relatively compact	Sulfur	80-90%	1. Does not require water 2. Sulfur recoverable	1. High energy use 2. High cost 3. Operation not fully demonstrated on large coal-fired units

possibly less water consumption), operating experience with large coal-fired units (> 100 Mw) is limited, and there are additional chemical handling requirements. On balance, the double alkali process is not considered a reasonable alternative.

The limestone injection process is a dry process in which limestone is injected into the boiler and the products are subsequently removed by an electrostatic precipitator or wet particulate scrubber. This process is not considered a reasonable alternative due to its limited operating experience.

Stack Height

The height of the stack, as well as exit gas temperature, gas volume and exit velocity, plays an important role in the dispersion of pollutants. However, stack height alone cannot enable the proposed plant to meet regulations and standards without the installation of particulate and sulfur removal equipment (Beck 1977b). Hence, the establishment of stack height becomes an optimization process taking into account (1) reduction of ground-level pollutant concentrations achieved by increasing the stack height and (2) economic costs of achieving this reduction.

NSP has indicated that an increase in stack height from the proposed 650 feet to 800 or 950 feet would cause a reduction in 3-hour, ground-level SO_2 concentrations of 5% and 9.5%, respectively under adverse meteorological conditions (NSP 1976). The 800-foot stack would cost approximately $2.4 million more and the 950-foot stack $5 million more than the 650-foot stack (NSP 1976). In addition, these taller stacks would cause greater visual impacts. Thus, there would be an environmental benefit from increasing stack heights with increased cost and the potential for more significant visual impacts.

Furthermore, EPA's policy on stack height, based upon the proposed 1976 Clean Air Act Amendments, only allows credit for purposes of dispersion modeling, for a stack height 2-1/2 times the tallest building on the facility site. Therefore, although increased stack height would slightly reduce 3-hour, ground-level SO_2 concentrations, EPA would not consider this alternative of taller stacks for the purposes of comparing ground-level impact to PSD increments.

10.3.2 Reasonable Alternatives

Electrostatic Precipators for Particulate Removal

Electrostatic precipitators are the most commonly used method of high-efficiency particulate removal. As such, they represent a reasonable alternative to the proposed use of wet scrubbers. When properly designed, both hot-side (located before the air pre-heater) and cold-side (located after the air pre-heater) precipitators can provide in excess of 99.5% removal efficiency. A hot-side precipitator would be preferred for SHERCO units 3 and 4 to maximize removal efficiency due to the low sulfur coal that will be used.

The technical advantages of the hot-side electrostatic precipitator when compared to the proposed wet scrubber system are: (1) less corrosion and fouling problems (less maintenance), (2) lower power requirements, and (3) more commonly used with low sulfur coal. The amount and quality of solid wastes produced by both systems are very similar; however, since the precipitator produces dry ash wastes, it provides for more flexibility in waste disposal.

The wet scrubber has one significant advantage with respect to resource use when used in combination with a lime/limestone slurry (for SO_2 removal) as proposed. The fly ash entrained in the wet particulate scrubber would reduce limestone requirements by 120,000 tons per year (NSP 1976). However, this saving is partially offset by the higher energy consumption of the wet scrubber (i.e., approximately 6,700 tons of coal per year are required).

The most important factor favoring the proposed wet scrubber system is its lower economic cost when compared with the electrostatic precipitator. The differential present worth of annual operating cost is about $34 million less for the wet particulate SO_2 scrubber system as compared to the electrostatic precipitator SO_2 scrubber system. In addition, the present worth of fixed charges on comparative capital investment is about $24 million less for the wet particulate scrubber-SO_2 scrubber system (NSP 1976).

10.4 Fuel Sources and Processing

NSP has proposed using western sub-bituminous, low-sulfur coal for SHERCO Units 3 and 4 from the Colstrip and Sarpy Creek fields in Montana, the same source of supply used for Units 1 and 2 (NSP 1976). There are a number of other possible sources of coal, but as explained below, only one reasonable alternative is available. It may be reasonable to use coal with a low enough sulfur content ("compliance coal") to preclude the need for an SO_2 scrubber and eliminate production of scrubber sludge with its accompanying water consumption and disposal requirements.

10.4.1 Discounted Alternatives

Illinois Bituminous Coal

Prior to the installation of SHERCO Units 1 and 2, NSP used Illinois bituminous coal (Department of the Army, Corps of Engineers). Typical coal from these areas has been analyzed as shown below:

	Western Field	West Central Field
Moisture (%)	15-19	12-24
Ash (%)	8-13	9-11
Sulfur (%)	2-4	3-5
HHV (Btu/lb)	9,700-10,300	10,500-11,000

Reasons why this coal is not considered a reasonable alternative are: it has a significantly higher sulfur content than the Montana coal; would probably involve a rail-barge-rail transport combination, which is unlikely to result in less significant impacts than the proposed use of rail transportation for delivery of Montana coal (proposed source; and would probably involve higher cost.

North Dakota Lignite Coal

North Dakota lignite coal was considered as another possible fuel source. The Fort Union Group, one of the coal reserves from this area, has typical characteristics as shown below (Department of the Army, Corps of Engineers):

	Average	Range
Moisture (%)	37.9	33.5 - 43.8
Ash (%)	6.2	4.4 - 8.0
Sulfur (%)	0.6	0.2 - 1.4
HHV (Btu/lb)	6783	5,960 - 7,487

While this coal would require a shorter rail transportation route than would be needed for the proposed source, lignite does not compare well with other available coal fuels due to its low heating value as well as lignite mining areas being relatively undeveloped. Therefore, it is not a reasonable alternative to the Montana coal.

10.4.2 Reasonable Alternatives

Wyoming Sub-Bituminous Coal

Another possible source of fuel is the Powder River Coal Basin in northeastern Wyoming. U.S. Bureau of Mines reports (Keystone Coal Industrial Manual 1974) show the following characteristics for Wyoming sub bituminous coal:

	Average	Range
Moisture (%)	14.2	1.7 - 32.8
Ash (%)	5.2	1.4 - 17.2
Sulfur (%)	0.7	1*
HHV (Btu/lb)	10,850	8,400 - 13,000

*99% estimated to be less than 1% sulfur.

Wyoming coals have good potential for meeting air emission requirements without the utilization of an SO_2 scrubbing system. However, even though approximately 50% of the coal reserves have a sulfur content of less than 0.7%, it would probably be necessary to utilize coal beneficiation to remove conventional pyritic sulfur, which averages about 30% of total sulfur in Wyoming coal.

Coal Beneficiation

Coal beneficiation refers to treatment of the coal to enhance its characteristics as a fuel and remove undesirable materials such as noncombustibles and pyritic sulfur. NSP has concluded that beneficiation

of the coal supply currently being used for the existing SHERCO units (Montana coal) cannot be expected to produce reliably a fuel that would not require flue gas SO_2 treatment for Units 3 and 4. However, this process may be a reasonable alternative if Wyoming sub-bituminous coal were used.

Conclusions

Use of compliance coal (in this case from Wyoming) to meet SO_2 air quality standards without using an SO_2 scrubber at the power plant is a realistic possibility. Coal supplies may be available which have a low enough sulfur content to allow plant emissions to meet standards, though this may require beneficiation of the coal. It will also be necessary to obtain long-term (life of the plant) coal contracts with the requirement that the sulfur content be at or below the necessary value.

The effect of burning "compliance coal" will be to eliminate the capital and operating costs and the energy penalty resulting from the scrubber, and to eliminate the environmental impacts associated with the production of scrubber sludge and the need for a disposal site. This must be balanced against the possibility of some excursions beyond emission standards or reductions in plant availability due to variations in coal quality. The flexibility of plant operation will be severely restricted by the need to use a relatively uncommon fuel supply. This may also adversely affect the cost of the fuel.

10.5 Fuel Transportation

Rail transport has been proposed by NSP for shipment of coal from Montana to the SHERCO Plant. Possible alternatives for transporting fuel include: barge, slurry pipeline, truck and conveyor. As indicated below, there is no reasonable alternative to rail transport.

Barge

There is no direct barge transportation route from Montana to the project site. Barges could only be used to transport coal over some intermediate distance and would require a transfer terminal in the Minneapolis-St. Paul area. Because such a terminal was proposed and rejected by permitting agencies in Minnesota, barge transport has been eliminated as a reasonable alternative.

Truck

Transport of coal by truck would require an average of one 25-ton capacity truck arriving at the plant every 2 1/2 minutes for 24 hours per day.* Although such a trucking schedule is possible, it offers no apparent advantage to other methods more appropriate to moving large quantities of coal and could result in more significant environmental impacts (e.g., traffic impacts and transportation-related energy consumption).

Conveyors

Use of conveyors is limited to transporting materials over relatively short distances. This approach is, therefore, not technically feasible for the proposed project and is not considered a reasonable alternative.

Coal Slurry Pipeline

A coal slurry pipeline is a technically feasible method for moving large quantities of coal, though it would involve some problems such as

*R. W. Beck Calculation based on annual coal consumption of 5,708,000 tons per year for Units 3 and 4.

the availability of water as a transport medium, potential uncertainties associated with satisfying engineering, environmental and construction requirements by 1981, and environmental construction costs. Potential advantages would be avoiding environmental impacts associated with rail use (hazards at road crossings, noise, pollution from diesel engines) and possible lower operating (transport) costs per ton of coal.

The relative advantages of rail vs. slurry pipeline transport are shown in Table 10.5-1. Because of the above-mentioned disadvantages, a coal slurry pipeline is not considered a reasonable alternative to rail transportation. A coal slurry pipeline may be considered to be a reasonable alternative. This alternative, however, is highly dependent on state and federal policies involving water use, eminent domain and other factors.

TABLE 10.5-1

COMPARISON OF RAIL VS. SLURRY PIPELINE FOR TRANSPORT OF COAL

	Railroad	Pipeline
Land Requirements length	750 miles* (1,210 km)	682 miles* (1,100 km)
Water Consumption	--	8,000 acre-ft* (9.87×10^6 m^3)
Energy Consumption	4.5×10^{12} Btu/yr*	1.13×10^{12} Btu/yr*
Transportation Cost	$4.63/ton**	$3.99-5.19/ton***

*R. W. Beck and Associate, May 1977 Technical Work Paper No. 14, Alternative Fuels and Fuel Transportation

**Matschler, P. H., et al. 1973 "Comparitive Transportaion Costs of Supplying Low-Sulfur Fuels to mid-western and Eastern Domestic Energy Markets," U.S. Bureau of Mines Circular 8614.

***Williams Brothers, Inc., November 1970. Preliminary Sutdy of Coal Transportation From Montana to Minnesota for NSP.

10.6 Supplemental Fuels

There are a number of possible fuels that could be used to supplement the primary fuel for the power plant and which constitute an unused and/or recoverable resource. These include: peat, municipal waste (trash) and wood waste. For a variety of reasons, however, none of these possible fuels are reasonable supplements for use at Units 3 and 4.

Peat

Minnesota has the largest known peat deposits in the United States (Iron Range Resources and Rehabilitation 1958). Peat has been used as a primary fuel at several installations in Europe. However, peat is not considered a reasonable supplementary fuel due to the lack of experience in using it for such purposes in a pulverized-coal fired boiler such as proposed for SHERCO Units 3 and 4.

Municipal Waste

Municipal waste is being burned in pulverized-coal fired boilers at a number of power plants around the country, and more facilities to burn it as auxiliary fuel are being designed and constructed (County Sanitation District of Los Angeles County, CA 1976). These facilities are typically located in urban or suburban areas where the quantities of solid waste generated and the difficulty of using traditional (landfill) disposal methods may combine to make the alternative of auxiliary fuel production systems attractive for economic and environmental reasons.

While use of municipal waste is attractive as a means of avoiding environmental problems associated with landfill operations (lack of suitable land, effects on groundwater, etc.) and of recycling to produce needed energy, the waste requires processing before it can be combusted. Construction of processing and handling equipment is probably not cost effective for Units 3 and 4, since the volume of municipal wastes generated in the rural area near the plant is very low. Furthermore, there would appear to be sufficient area available for needed landfill sites. Thus, use of municipal waste as a supplementary fuel is not considered a reasonable alternative.

Wood Waste

Minnesota has a substantial wood industry located in the northern part of the state. The possibility of using wood waste at SHERCO was considered, however, the plant is located far from the wood producing area. Also, there are existing or proposed power plants located closer to the wood industry and are therefore better able to use wood waste as a supplemental fuel. Considering these factors, burning of wood waste at SHERCO is not considered a reasonable alternative.

10.7 Solid Waste Disposal

The three major types of solid waste generated by plant operation will be SO_2 scrubber sludge, fly ash and bottom ash. Alternatives are related to joint disposal of these wastes, use of wet vs. dry disposal methods, processing wastes to improve their potential for reclamation and on-site vs. off-site disposal. The alternatives available are discussed below, and the one seemingly reasonable alternative is described.

10.7.1 Discounted Alternatives

Bottom Ash Disposal

The proposed (and conventional) method of transporting bottom ash to a nearby disposal site is by wet sluicing. It is possible to dewater the bottom ash after collecting it from the boilers and then transport it to a disposal site. Dry collection has no net advantage over the proposed method and is not considered as a reasonable alternative.

Joint disposal of bottom ash with fly ash is not considered a reasonable alternative for two reasons: (1) this approach precludes possible re-use of bottom ash as an additive to asphalt mixtures or for other construction purposes, and (2) EPA's new source performance standards (EPA 1974) effectively mandate dry fly ash disposal and/or separation of the two systems in order to comply with regulations governing discharges of total suspended solids.

Fly Ash and Scrubber Sludge Disposal

The proposed particulate (fly ash) and SO_2 scrubber system for Units 3 and 4 removes these pollutants simultaneously and does not afford the opportunity to remove fly ash as a dry material or to separate it from the scrubber sludge. However, most new power plants that do remove fly ash separately from the scrubber sludge provide facilities to mix the two together in a common disposal site, since the properties of the two materials are such that the combination is preferable in terms of disposal characteristics and pollution potential (see discussion of fixation below). Therefore, neither dry nor separate fly ash disposal is considered a reasonable alternative.

Off-Site Disposal

The desirability of off-site versus on-site disposal of scrubber sludge is related to the possibility of disposing of it at a site that is suitable for reclamation. No potential nearby disposal sites have been identified which are large enough to accept the quantities of waste material to be generated by Units 3 and 4. Therefore, off-site disposal is not considered a reasonable alternative.

10.7.2 Reasonable Alternatives

Fixation of scrubber sludge and fly ash (by addition of certain chemicals) offers the possibility of significant benefits with respect to the physical properties of the sludge/fly ash, its pollution potential and the reclamation potential of the disposal site. The end result of fixation processes is production of a material having physical properties ranging from soil-like to those of low-strength concrete, depending upon the process used and the degree of fixation desired. The fixed material has a low permeability and may act to promote chemical bonding of heavy metals in the sludge, thus reducing the pollution potential of any leachate that may be produced.

It is quite possible, however, that the sludge produced at a power plant, when mixed with fly ash, will undergo a reaction similar to that produced by the commercial fixation processes. The characteristics of sludge produced by SHERCO Units 1 and 2 are being evaluated in order to determine whether it is undergoing self-fixation. If so, chemical fixation may not be required to permit reclamation.

10.8 Water Supply and Management

Surface water (the Mississippi River) is the proposed source of supply for Units 3 and 4. However, the Minnesota Department of Natural Resources (DNR) has proposed restricting water withdrawls from the Mississippi River when river flows fall below 2,000 cfs. The river flow will be below the proposed limit about 12% of the time (Beck 1977d). This could curtail operation of Units 3 and 4 unless there is some alternative water source or supply. Alternatives described below include underground and surface storage as well as use of groundwater.

10.8.1 Discounted Alternatives

The possibility of storing water underground was considered, but the physical characteristics of the subsurface in the vicinity of the plant site is not appropriate for this purpose. For this reason, underground storage is not a reasonable alternative.

10.8.2 Reasonable Alternatives

Surface Storage

The topography in the site vicinity makes it very unlikely that a natural dam and reservoir site exists in the area. Some type of diked structure would have to be constructed to store the water.

A water storage reservoir constructed on-site can also be used to provide condenser cooling for the power plant, thus making joint use of the reservoir and possibly resulting in overall savings in the capital and operating costs of the plant. It should be noted, however, that the land requirements for the pond are a major constraint to its development unless NSP is able to purchase suitable additional property for this purpose.

Groundwater

Construction of a large well field may be feasible, depending upon aquifer characteristics. An intensive groundwater testing program would have to be started, and this alternative would have to be compared with water storage options.

The important advantage of groundwater use is that it presumably would not be affected by water withdrawal restrictions proposed by DNR. However, the construction and operation of such a system would probably not be cost competitive with the proposed surface supply approach.

10.9 LIST OF REFERENCES

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11. COORDINATION OF THE EIS EFFORT WITH OTHER GOVERNMENT BODIES AND INTERESTED GROUPS

11.1 Impact on State Government of Any Federal Controls Associated with the Proposed Action

Minnesota and federal laws and regulations relating to the proposed SHERCO Units 3 and 4 interact in many areas. However, there does not appear to be any significant areas of conflict between the two sets of laws and regulations.

11.1.1 Federal Versus Minnesota EIS

The two federal agencies most directly involved with the proposed project are the Army Corps of Engineers (COE) and the Environmental Protection Agency (EPA). Large steam electric generating stations are generally affected by two programs of the COE; the first relates to construction of water intake structures and resultant alterations in the channel characteristics of navigable waters, and the second relates to appropriation and consumption (i.e., net appropriation) of water from navigable waters. Since the proposed Units 3 and 4 will use the existing intake structure of Units 1 and 2, no new construction permit is needed from the COE. The consumption of water by SHERCO will increase if the Units 3 and 4 use wet cooling towers as proposed by NSP.

The EPA has determined that its involvement in the proposed Units 3 and 4 does not involve major federal actions (Adamkus 1976). Therefore, the EPA will not draft a federal EIS for NSP's proposed Units 3 and 4.

11.1.2 Effects of Federal Air, Water and Noise Pollutions Laws and Regulations upon Comparable Minnesota Laws and Regulations

The federal authority over air, water and noise pollution derives primarily from the commerce clause of the U.S. Constitution. In theory, this power is limited to activities affecting commerce among the states. In practice, however, the power touches nearly every aspect of the U.S. economy, including the externalities of environmental contaminants

(Soper 1974). The federal authority over air, water and noise pollution is not, however, plenary. Minnesota's authority to regulate air, water and noise pollution derives from the Minnesota Constitution and from the powers reserved to all states by Amendment X of the U.S. Constitution.

Air Quality Laws and Regulations

The EPA's authority over air pollution generally takes the form of approval and supervisory control. The EPA ambient air quality standards (AAQS) and emission regulations set maximum levels, which are to be met nation-wide within certain time limits. The states retain the authority to establish regulations more restrictive, but they cannot cause the relaxation of the federal regulations.

The initial efforts of the EPA under the Clean Air Act Amendments of 1970 were directed toward establishment of the AAQS. Many regions of the country, and more specifically St. Louis County, are not yet in compliance with the AAQS. In Minnesota, the AAQS and most other air pollution control programs are implemented and enforced by the MPCA. Therefore, noncompliance is a problem primarily to be corrected by MPCA action. For example, the EPA has had no direct involvement in the formulation of the Air Quality Stipulation Agreement between the MPCA and NSP to reduce the particulate and acid mist emissions (MPCA 1976) of SHERCO. In severe cases of air pollution where state control schemes are ineffective, the EPA can assume direct control, place the major emitters on compliance schedules and monitor the progress. This has not been done in Minnesota.

The program for the regulation of emissions from new stationary sources, such as the proposed Units 3 and 4, was implemented pursuant to the Clean Air Act to bring air pollution within the concentrations established by the AAQS. The EPA has promulgated emission regulations (New Source Performance Standards or NSPS) for 19 categories of stationary sources. The MPCA has adopted most of these verbatim, including the one for large steam electric generating stations. Consequently, the NSPS which apply to the proposed project will be enforced by the MPCA and will require no federal involvement. The same is true for

the regulation of emissions containing acutely toxic or hazardous emissions. However, there are no hazardous emission standards, federal or state, which apply to SHERCO.

As a result of a recent lawsuit, the EPA is now required to ensure that air which is currently less polluted than the levels established by the AAQS remains at that "pristine" level of purity. This Prevention of Significant Deterioration (PSD) program has not been adopted by or delegated to the MPCA. Rather, the EPA still directly administers the program. The PSD regulations create the requirement that NSP submit information to the EPA from which the EPA can determine whether the proposed Units 3 and 4 will significantly deteriorate the air quality in the vicinity of the SHERCO station. Based on the information, the EPA will grant or deny the PSD permit for the proposed units. This EPA action is not of the magnitude which requires a federal EIS, but under the current PSD regulations construction cannot begin on the proposed units until NSP has been granted the PSD permit. The final EPS decision on the PSD permit is expected in June 1977. The denial of this permit would supercede any approval granted by the MPCA or other Minnesota agencies.

Water Quality Laws and Regulations

Minnesota agencies have had water pollution control powers over a longer period of time than have federal agencies. The Federal Water Pollution Control Act of 1972 (FWPCA) has, however, established a uniform, nation-wide scheme within which the MPCA programs now operate. Once again, the MPCA administers the program while the EPA retains approval and supervisory control.

The FWPCA established a 1983 goal of swimmable and fishable waters and a 1985 goal of zero discharge. The MPCA has encoded these ambiguous goals into water quality standards which limit the concentrations or ranges of various compounds or characteristics. The EPA has little involvement in this program, except to review MPCA water quality inventory reports (MPCA 1976) and other indications of progress toward the FWPCA goals.

The principal mechanism used to achieve the water quality goals is to reduce the discharge of pollutants by new and existing point sources. This program, called the National Pollutant Discharge Elimination System (NPDES), is administered in Minnesota by the MPCA. The program establishes the requirement of an NPDES permit for every major source of polluted effluents. The NPDES permits are issued by the MPCA, with the EPA retaining a veto authority over each permit.

Noise Control Laws and Regulations

Noise emitted by stationary sources is a transient phenomenon which seldom causes interstate problems. Consequently, the federal government's role in controlling noise is limited to noise emissions from transportation related sources and from new products moved through interstate commerce. Therefore, the MPCA has the only substantial authority over noise emitted by the SHERCO station.

11.1.3 List of References

Adamkus, V. V., Deputy Regional Administrator, Region V, U.S. Environmental Protection Agency, Chicago, November 8, 1976. Personal communication to Peter L. Gove, Executive Director, Minnesota Pollution Control Agency.

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Minnesota Pollution Control Agency, June 25, 1976. "In the Matter of Minnesota Power & Light Company, Clay Boswell Steam Electric Generating Station, Cohasset, Minnesota, Air Quality Stipulation Agreement.

Federal Water Pollution Control Act, Public Law No. 92-500, 86 Stat. 816, 33 U.S. Code §§ 1251 et. seq. (1972).

Minnesota Pollution Control Agency, Division of Water Quality, 1976a. 1976 Minnesota Water Quality Inventory, Report to Congress Under FWPCA § 305(6).

11.2 Multistate Responsibilities Associated with the Proposed Action

Because the SHERCO station lies will within Minnesota borders, there are no formal multistate responsibilities associated with the proposed action. There are, however, many multistate implications.

The coal to be used by proposed Units 3 and 4 will come from Montana. It will be transported by unit train from Montana to the SHERCO station via the State of North Dakota.

The air pollutant emission of the SHERCO station may be transported beyond Minnesota's boundaries under certain weather conditions. The magnitude and effect of this incremental increase in air pollution in adjacent regions cannot be calculated, but the multistate impact of the proposed units and other steam electric generating stations currently planned or under construction will not be significant.

NSP's proposed action of using mechanical draft cooling towers will increase the water consumption of the SHERCO station, reducing the Mississippi River's flow. This reduction will be negligible as the Mississippi River leaves the state. The addition of the proposed SHERCO units will result in the discharge of additional effluents into the river. The construction of many power plants along the Mississippi River will consume river water and discharge effluents. The cumulative impacts of these power plants will be significant.

Construction of the proposed units will have benefits beyond the state through the purchase of machinery and construction materials. The proposed action has national implications by providing energy to the taconite mining industry which, in turn, provides a major share of the ore for United States steel production.

11.3 Coordination Effort

The following groups were consulted in the development of the draft EIS.

11.3.1 State Legislators

The Honorable Ed Schrom
State Senator, Dist. 16

The Honorable Joe Niehaus
State Representative, Dist. 16A

The Honorable B. J. Brinkman
State Representative, Dist. 16B

The Honorable Jack Kleinbaum
State Senator, Dist. 17

The Honorable Al Patton
State Representative, Dist. 17A

The Honorable James Pehler
State Representative, Dist. 17B

The Honorable Robert Dunn
State Senator, Dist. 18

The Honorable Claudia M. Meier
State Representative, Dist. 18A

The Honorable Bob McEachern
State Representative, Dist. 18B

The Honorable Jerald C. Anderson
State Senator, Dist. 19

The Honorable John T. Clawson
State Representative, Dist. 19A

The Honorable Tom Mangan
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The Honorable John Bernhagen
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The Honorable Harold J. Dahl
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The Honorable Earl W. Renneke
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The Honorable Raymond J. Albrecht
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The Honorable Carl M. Johnson
State Representative, Dist. 23B

The Honorable Clarence M. Purfeerst
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The Honorable Robert E. Vanasek
State Representative, Dist. 24A

The Honorable Orv Birnstihl
State Representative, Dist. 24B

The Honorable Robert J. Schmitz
State Senator, Dist. 36

The Honorable Lyndon R. Carlson
State Representative, Dist. 44A

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The Honorable Al Kowalczyk
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The Honorable Bill Schreiber
State Representative, Dist. 45A

The Honorable William P. Luther
State Representative, Dist. 45B

The Honorable David D. Schaaf
State Senator, Dist. 46

The Honorable Paul McCarron
State Representative, Dist. 46A

The Honorable Wayne Simoneau
State Representative, Dist. 46B

The Honorable Gene Merriam
State Senator, Dist. 47

The Honorable Joel Jacobs
State Representative, Dist. 47A

The Honorable Gordon Voss
State Representative, Dist. 47B

The Honorable Robert O. Ashbach
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The Honorable Steven G. Novak
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The Honorable B. J. Philbrook
State Representative, Dist. 48B

The Honorable John Milton
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The Honorable Howard J. Neisen
State Representative, Dist. 49A

The Honorable Maurice McCollar
State Representative, Dist. 49B

The Honorable Jerome M. Hughes
State Senator, Dist. 50

The Honorable Michael J. George
State Representative, Dist. 50A

The Honorable Dick Kostohryz
State Representative, Dist. 50B

The Honorable Robert J. Brown
State Senator, Dist. 51

The Honorable Gary Laidig
State Representative, Dist. 51A

The Honorable Michael Sieben
State Representative, Dist. 51B

The Honorable J. Robert Stassen
State Senator, Dist. 52

The Honorable James P. Metzen
State Representative, Dist. 52A

The Honorable Harry Sieben, Jr.
State Representative, Dist. 52B

The Honorable Howard A. Knutson
State Senator, Dist. 53

The Honorable Ray Kempe
State Representative, Dist. 53A

The Honorable Robert C. Jensen
State Representative, Dist. 53B

The Honorable Edward Gearty
State Senator, Dist. 54

The Honorable Carl Kroening
State Representative, Dist. 54A

The Honorable James I. Rice
State Representative, Dist. 54B

The Honorable Eugene Stokowski
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The Honorable Stanley J. Fudro
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The Honorable John J. Sarna
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The Honorable James R. Casserly
State Representative, Dist. 56A

The Honorable Allan H. Spear
State Senator, Dist. 57

The Honorable Martin Olav Sabo
State Representative, Dist. 57B

The Honorable William D. Dean
State Representative, Dist. 58A

The Honorable Stephen Keefe
State Senator, Dist. 59

The Honorable Ken Nelson
State Representative, Dist. 59B

The Honorable Ralph Jopp
State Representative, Dist. 36A

The Honorable W. G. Kirchner
State Senator, Dist. 37

The Honorable James C. Swanson
State Representative, Dist. 37B

The Honorable Bruce D. Williamson
State Representative, Dist. 38A

The Honorable Otto Bang
State Senator, Dist. 39

The Honorable Ray O. Pleasant
State Representative, Dist. 39B

The Honorable Douglas R. Ewald
State Representative, Dist. 40A

The Honorable B. Robert Lewis
State Senator, Dist. 41

The Honorable Robert J. Tennessen
State Senator, Dist. 56

The Honorable Tom Berg
State Representative, Dist. 56B

The Honorable Phyllis Kahn
State Representative, Dist. 57A

The Honorable Harmon T. Ogdahl
State Senator, Dist. 58

The Honorable Arne Carlson
State Representative, Dist. 58B

The Honorable Linda Berglin
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The Honorable Jack Davies
State Senator, Dist. 60

The Honorable Ted L. Suss
State Representative, Dist. 36B

The Honorable Shirley Hokanson
State Representative, Dist. 37A

The Honorable Jerome V. Blatz
State Senator, Dist. 38

The Honorable Lyle Abeln
State Representative, Dist. 38B

The Honorable Mary Forsythe
State Representative, Dist. 39A

The Honorable John Keefe
State Senator, Dist. 40

The Honorable Jerry Knickerbocker
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The Honorable John Arlandson
State Representative, Dist. 41A

The Honorable Pete Petrafeso
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The Honorable Tad Jude
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The Honorable Rolf Nelson
State Senator, Dist. 43

The Honorable Richard J. Parish
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The Honorable Janet Clark
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The Honorable Wesley J. Skoglund
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The Honorable Joseph T. O'Neill
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The Honorable Ron Seiloff
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The Honorable Peter Stumpf
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The Honorable Nicholas D. Coleman
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The Honorable Donald M. Moe
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The Honorable Bruce F. Vento
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The Honorable Stanley A. Enebo
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The Honorable Frank Knoll
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The Honorable Fred C. Norton
State Representative, Dist. 65A

The Honorable John C. Chenoweth
State Senator, Dist. 66

The Honorable Randy Cameron Kelly
State Representative, Dist. 66B

The Honorable Arnold E. Kempe
State Representative, Dist. 67A

The Honorable John Tomlinson
State Representative, Dist. 67B

11.3.2 State Government

Ronnie Brooks, Special Assistant to Governer Rudy Perpich

Minnesota Environmental Quality Board

Minnesota Department of Agriculture

Minnesota Department of Economic Development

Minnesota Department of Education

Minnesota Department of Employment Services

Minnesota Department of Health

Minnesota Department of Natural Resources

Minnesota Department of Public Service

Minnesota Department of Transportation

Minnesota Energy Agency

Minnesota Geological Survey

Minnesota Land Management System

Minnesota State Planning Agency

Minnesota Regional Development Commission

University of Minnesota

11.3.3 Counties

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Mr. Arthur Poll
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Mr. John Kading
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Department of Public Works

Mr. David Fricke
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Mr. Mike E. O'Bannon
Anoka County Commissioner (Dist. 1)

Mr. Edward E. Fields
Anoka County Commissioner (Dist. 2)

Mr. Robert C. Burman
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Mr. Albert A. Kordiak
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Mr. Al Zeppelt
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Mr. Roy Herbst
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Mr. Ralph Bloomgren
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Mr. Robert E. Hupfer
Isanti County Commissioner (Dist. 4)

Mr. Glen Johnson
Isanti County Commissioner (Dist. 5)

Mr. James O'Meara
Le Sueur County Commissioner
(Dist. 2)

Mr. Clarence Miller
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Mr. LeRoy H. Johnson
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Mr. Marcel Kelash
Benton County Commissioner (Dist. 2)

Mr. Earl A. Bukowski
Benton County Commissioner (Dist. 4)

Mr. Wayne Holtmeier
Carver County Commissioner (Dist. 1)

Mr. Earl F. Gnan
Carver County Commissioner (Dist. 3)

Mr. Edward P. Schneider
Chairman, Carver County Commission

Mr. Tom Ticen
Hennepin County Commissioner (Dist. 2)

Mr. John E. Derus
Hennepin County Commissioner (Dist. 4)

Mr. Roderick Ericson
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Mr. Edgar Hass
Isanti County Commissioner (Dist. 3)

Mr. William E. Soderberg
Isanti County Commissioner (Dist. 5)

Mr. Henry A. Simon
Le Sueur County Commissioner (Dist. 1)

Mr. Robert J. Casey
Le Sueur County Commissioner
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Mr. David Lloyd
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Mr. Ernie Bullert
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Mr. Milo Wacker
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Mr. Lyndon Nelson
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Mr. George A. Rice
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Mr. Lawrence H. Johnson
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Mr. Jake Koppendrayer
Mille Lacs County Commissioner
(Dist. 1)

Mr. Keith Trimble
Mille Lacs County Commissioner
(Dist. 2)

Mr. John D. McBroom
Mille Lacs County Commissioner
(Dist. 3)

Mr. E. A. Strelow
Mille Lacs County Commissioner
(Dist. 4)

Mr. Walter Habeck
Mille Lacs County Commissioner
(Dist. 5)

Mr. Michael M. Hyduke
Nicollet County Commissioner (Dist. 1)

Mr. Stanley Gilbertson
Nicollet County Commissioner
(Dist. 2)

Mr. Lyle B. Overson
Nicollet County Commissioner
(Dist. 3)

Mr. Clayton E. Peterson
Nicollet County Commissioner
(Dist. 4)

Mr. Ray Eckes
Nicollet County Commissioner
(Dist. 5)

Mr. Martin Hachfeld
Rice County Commissioner (Dist. 1)

Mr. Charles Miller
Rice County Commissioner (Dist. 2)

Mr. William D. Wells
Rice County Commissioner (Dist. 3)

Mr. Dan Minnick
Rice County Commissioner (Dist. 4)

Mr. Lawrence J. Valek
Rice County Commissioner (Dist. 5)

Mr. William Konlarski
Scott County Commissioner (Dist. 1)

Mr. Anthony Worm
Scott County Commissioner (Dist. 2)

Mr. Dennis L. Hron
Scott County Commissioner (Dist. 3)

Mr. Marvin Oldenburg
Scott County Commissioner (Dist. 4)

Mr. Roland H. Boegeman
Scott County Commissioner (Dist. 5)

Mr. John E. Nord
Sherburne County Commissioner
(Dist. 1)

Mr. Lyle R. Smith
Sherburne County Commissioner
(Dist. 2)

Mr. Milton Stensrud
Sherburne County Commissioner
(Dist. 3)

Mr. Clarence A. Petersen
Sherburne County Commissioner
(Dist. 4)

Mr. Roger Marty Marturano
Sherburne County Commissioner
(Dist. 5)

Mr. LeRoy L. Pinske
Sibley County Commissioner
(Dist. 1)

Mr. Richard J. Hebeisen
Sibley County Commissioner (Dist. 2)

Mr. Melvin C. Wichelman
Sibley County Commissioner (Dist. 3)

Mr. Milton Frank
Sibley County Commissioner (Dist. 4)

Mr. Clarence E. Anderly
Sibley County Commissioner (Dist. 5)

Mr. Bob Gambrino
Stearns County Commissioner (Dist. 1)

Mr. Ed Vos
Stearns County Commissioner (Dist. 2)

Ms. Leverne Plantenberg
Stearns County Commissioner (Dist. 3)

Mr. Keith Maurer
Stearns County Commissioner (Dist. 4)

Mr. Henry Dickhaus
Stearns County Commissioner (Dist. 5)

Mr. Paul McAlpine
Wright County Commissioner (Dist. 1)

Mr. Lowell Zachman
Wright County Commissioner (Dist. 2)

Mr. Walter Barfnecht
Wright County Commissioner (Dist. 3)

Mr. G. H. Burkland
Wright County Commissioner (Dist. 4)

Mr. LeRoy Engstrom
Wright County Commissioner (Dist. 5)

11.3.4 Regional Development Commission

Mr. John Sem
Executive Director, RDC 4

Mr. Robert F. Benner
Executive Director, RDC 5

Mr. Eugene Hippe
Executive Director, RDC 6E

Mr. John Hill
Executive Director, RDC 7E

Mr. Otto Schmid
Executive Director, RDC 7W

Mr. Mark Atchison
Executive Director, RDC 8

Mr. Dean Doyscher
Executive Director, RDC 9

Mr. Rolf Middleton
Executive Director, RDC 10

Mr. Robert Jorvig
Executive Director, RDC 11

11.3.5 Incorporated Municipalities in Sibley and Sherburne Counties

Mayor
City of Arlington

Mayor
City of Becker

Mayor
City of Big Lake

Mayor
City of Clear Lake

Mayor
City of Elk River

Mayor
City of Gibbon

Mayor
City of Green Isle

Mayor
City of Henderson

Mr. Dennis Graham
Clerk, Jessenland Township

Mayor
City of New Auburn

Mayor
City of St. Cloud

Mayor
City of Winthrop

Mayor
City of Zimmerman

11.3.6 Federal Government

U.S. Army Corps of Engineers

U.S. Department of Agriculture

U.S. Soil Conservation Service

Forest Service

U.S. Department of the Interior

Bureau of Sport Fisheries and Wildlife

U.S. Geological Survey

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

11.3.7 Northern States Power Company

R. W. Beck and Associates

Environmental Research Company

Environmental Research & Technology, Inc.

Brauer & Associates

Central Minnesota Regional Development Commission

Central Minnesota Health Planning Association

Northern Environmental Council

Clear Air; Clear Water, Unlimited

Becker Planning Commission

Sherburne County

Wright County

Stearns County

Benton County

City of St. Cloud Health Department

City of Monticello, George McVehil

City of Becker

11.3.8 Libraries

Annandale Public Library

Belle Plaine Public Library

Buffalo Public Library

Glencoe Public Library

Henderson Public Library

Le Sueur Public Library

Monticello Public Library

11.3.9 Project's Interested Persons

Ms. Jean Benda, President
Jackson-Sherburne League of Women Voters

Ms. Dee Halberg, President
St. Cloud Area League of Women Voters

Ms. Karen Deitering, President
Buffalo League of Women Voters

Mr. Gilbert Wolfe

Ms. Pam Johnson
General Assignment Reporter

Mr. W. A. Peltier

Mr. Donald Monahan

Ms. Sylvia Barnes