KOCH REFINING COMPANY CRUDE EXPANSION PROJECT

Rosemount, Minnesota

January 1985

Minnesota
Pollution Control Agency

DRAFT ENVIRONMENTAL IMPACT STATEMENT

COVER SHEET
DRAFT ENVIRONMENTAL IMPACT STATEMENT
KOCH REFINING COMPANY
CRUDE EXPANSION PROJECT

Responsible Government Unit:	Minnesota Pollution Control Agency (MPCA)
Project Title:	Koch Refining Company Crude Expansion Project
Project Location:	Rosemount, Minnesota, Dakota County
Agency Contact Person:	Ms. Marlene Voita Minnesota Pollution Control Agency Office of Planning and Review 1935 West County Road B2 Roseville, Minnesota 55113 (612) 296-7796
Proposer:	Koch Refining Company P.O. Box 64596 St. Paul, Minnesota 55164 Thomas Segar (612) 437-0701

Abstract:

The Koch Refining Company's Crude Expansion Project will involve the construction of new facilities and expansion of existing facilities at a refinery complex in the Pine Bend Industrial District in the City of Rosemount, Minnesota.

The expansion will enable the refinery to increase production of gasoline, home heating oil, jet fuel, and asphalt. The construction will occur over the next 3 to 5 years and will increase the refinery crude capacity by about 50 percent, from 137,000 barrels per day B/D to 207,000 B/D.

Public Meeting Date:	February 20, 1985
Comments due on the draft EIS:	March 6, 1985

GLT499/36

SUMMARY

SUMMARY

This Draft Environmental Impact Statement (EIS) for the Koch Refining Company Crude Expansion Project was prepared by the staff of the Minnesota Pollution Control Agency (MPCA), with the assistance of an engineering/environmental consulting firm, CH2M HILL CENTRAL, INC. The MPCA staff and the Koch Refining Company jointly agreed that the Crude Expansion Project warranted the preparation of an environmental impact statement. Environmental review of the expansion began in February 1984 with the distribution of an Environmental Assessment Worksheet (EAW) on the project. This draft EIS, and the process used to prepare it, complies with the Minnesota Environmental Quality Board (EQB) Environmental Review Program rules.

1.0 DESCRIPTION OF THE PROPOSED PROJECT

The proposed Crude Expansion Project will be located at the Koch Refining Company's refinery in the Pine Bend Industrial District in the City of Rosemount, Minnesota. Sufficient land is available at the existing refinery complex to accommodate the entire expansion.

An increase in refinery crude capacity of approximately 50 percent, from 137,000 barrels per day (B/D) to 207,000 B/D will occur with the expansion. The project will enable the refinery, which is operating at or near capacity, to increase production of gasoline, home heating oil, jet fuel, and asphalt from sour crude oil. New facilities will be constructed and many existing facilities will be expanded at a cost of approximately $200 million. Project construction will occur over the next 3 to 5 years in two phases. The first phase, scheduled for construction in the spring of 1985, will increase production to 175,000 B/D by 1986. The second phase, scheduled to be completed in 1988, will increase production to 207,000 B/D.

The Koch Refining Company will continue to rely on Western Canadian crude as its principal source of sour crude oil for the expansion. The increased refined petroleum products will be shipped to Upper Midwest markets by existing transportation networks, that is, product pipelines, barge, truck, and railroad.

Once the proposed expansion is completed, total refinery employment is expected to increase from about 600 employees to 870 employees. Other refinery-related employment would also be affected by the expansion. Turnaround employment, for example, will increase from 112 to 150 full-time equivalents, and construction employment will average 500 workers over the construction period.

2.0 ENVIRONMENTAL EFFECTS

Environmental issues and concerns related to the project were raised by the general public and government agencies during the development of the scope of the EIS. The key project issues that were incorporated into the scope of the EIS and that have been addressed in this document are:

- Air quality impacts of expansion
- The effect of expansion on wastewater treatment facilities and the discharge of effluent to the Mississippi River
- Impact on socioeconomic factors
- Traffic impacts in the vicinity of the refinery
- Potential noise impacts
- Effects of expansion on groundwater use and groundwater quality
- Effects of the refinery expansion on solid and hazardous waste management facilities

The environmental effects of the project with respect to these issues are explored in detail in the EIS and are summarized below.

Because of the importance of the air quality issue a separate volume has been prepared for that topic containing all the background data. In addition, a more extensive technical report is available for the groundwater quality and solid and hazardous waste topics. These reports are available for review at the MPCA offices in Roseville, Minnesota.

2.1 AIR QUALITY

In general, the Koch Refining Company Crude Expansion Project will favorably affect air emissions. The annual emissions of sulfur dioxide (SO_2), particulates, and hydrocarbons will decrease significantly, while emissions of nitrogen oxides (NO_x) and carbon monoxide (CO) will increase only slightly. The amounts of toxic air pollutants emitted by the refinery are expected to change after the refinery expansion. Ambient concentrations of benzene and toluene will increase by 14 percent and 7 percent, respectively, while ambient concentrations of other measured toxic pollutants will decrease from 10 to 80 percent. Only formaldehyde is predicted to exceed acceptable concentration guidelines. Odor violations occur at the existing refinery and can be expected to continue after expansion. They, however, will occur with less frequency, because emissions of odor producing compounds such as hydrocarbons are calculated to decrease.

2.2 WATER QUALITY

The expanded refinery will generate additional quantities of wastewater for treatment and ultimate discharge to the Mississippi River. The additional wastewater treatment requirements will be met by expansion of the existing wastewater treatment facilities consistent with state and federal regulations governing the discharge of wastewater. For most water quality parameters, for example, BOD_5, COD, oil and grease, TSS, the amount of pollutants discharged will increase 50 to 80 percent. One notable exception is that ammonia-nitrogen discharges will decrease significantly. All projected discharges, however, are calculated to be below applicable discharge limits.

2.3 SOCIOECONOMICS

The Crude Expansion Project will cause refinery personnel to increase from 586 to 870 employees, turnaround employment to increase from 112 to 150 full-time equivalents, and construction employment to average 500 workers over the construction period. The direct economic impacts from increased payroll and Minnesota purchases of supplies and services will be about $40 million annually by 1986, and $12 million after 1988. Spinoff benefits from the infusion of these dollars into the economy will result in further economic gains totaling $43 million annually in 1986 and $13 million in 1988. The expansion project will produce $20 million in additional federal taxes and almost $7 million in Minnesota taxes during the construction phase. On a long-term basis these figures are about $9 million and $3 million, respectively. The expansion is predicted to have no effect on the availability of housing, municipal services, or property values.

2.4 TRANSPORTATION

The Crude Expansion Project will increase traffic volumes on U.S. Highway 52 and Highway 55 by 1.8 and 4.2 percent, respectively. The impacts from the project on the road system will be nominal. The refinery's north frontage road intersection with U.S. Highway 52 will experience some turning movement delays. This condition will not require any physical changes to the road network. Several management practices, however, that would alleviate peak-hour traffic volumes are recommended.

2.5 NOISE

The proposed expansion will not adversely affect the noise environment in the area surrounding the refinery. The noise level from the expanded refinery will increase approximately 1.8 dB. This increase in refinery noise will have a negligible impact on nearby residential receptors.

2.6 GROUNDWATER AVAILABILITY

The Crude Expansion Project will require more process water to refine the additional crude. Present well capacity and water right appropriations are adequate to serve the needs of the expansion without alteration. An analysis was made to determine if increased groundwater usage would cause water table drawdown. It was concluded from the analysis that minor changes in water levels (10 to 20 feet) caused by additional refinery pumpage will probably not affect local water users with high capacity wells. The impact to small water users with wells in shallower aquifers cannot be assessed without more detailed study.

2.7 SOLID AND HAZARDOUS WASTES

With the proposed expansion, the amount of hazardous waste to be landfarmed will be reduced. The reduction in hazardous waste amounts will be the result of expanded recycling capacity and reduction of water content. Proportionally, greater volumes of hazardous waste from both the existing and expanded facilities (wastes that are now being landfarmed) will be recycled with the expansion of the No. 3 Coker and the addition of the No. 4 Coker. Total waste generation will also be reduced through enhancements in the slop oil recovery system. Reduction in the water content of the waste is another aspect of the proposed expansion. With the installation of sludge dewatering equipment, Koch will be able to significantly reduce the amount of water in the waste it sends to the landfarm for treatment. Reduction in the water content will beneficially affect landfarm performance.

Limited data for the landfarm suggest that the facility has had some operational problems. With the expansion, the waste loading rate per unit area will decrease, thereby the performance of the landfarm is expected to improve.

2.8 GROUNDWATER QUALITY

General industrial development in the area of the Koch Refining Company has adversely affected groundwater quality. There are insufficient data, however, to clearly delineate the sources of the contamination. Therefore, it has been difficult to evaluate Koch Refining Company's absolute impact on groundwater quality in the area. This situation will be addressed further by the MPCA staff in future Superfund investigations planned in the area.

3.0 ALTERNATIVE ACTIONS

One requirement of the EQB rules is that alternatives to the proposed action be evaluated in the EIS, including the alternative of no action, or no project. The draft EIS contains a description and evaluation of four alternative actions to the proposed action. Alternative actions were suggested through the development of the EIS scope and were evaluated by MPCA staff. The four alternatives that were incorporated into the EIS scope and were evaluated as possible options to the Koch Refining Company's preferred project are:

- The No Action Alternative: The Koch refinery would remain static at a capacity of 137,000 B/D.
- The Limited Expansion Alternative: The Koch refinery would increase capacity to 175,000 B/D, the equivalent of the proposed project's first phase.
- The Change in Crude Alternative: The Koch refinery would increase capacity to 207,000 B/D by adding 70,000 B/D of light crude refining capacity at a cost of about $100 million.
- The Change In Product Mix Alternative: The Koch refinery would increase capacity to 207,000 B/D, but alter its product mix from lighter end (gasolines) to heavier end (asphalt) products at a cost of about $100 million.

The proposed project and the four alternative actions were comparatively evaluated using a numerical evaluation system. Through this system, the proposed project and the alternative actions were measured against key environmental issues to determine relative environmental acceptability. The analysis indicated their order of environmental acceptability to be:

- No Action
- Proposed Project
- Limited Expansion
- Change In Crude
- Change In Product Mix

The evaluation indicates that the proposed project has greater environmental acceptability when compared to the No Action Alternative in the areas of air quality and socioeconomics. The No Action Alternative demonstrates greater environmental acceptability than the proposed project in the areas of traffic, noise, and groundwater and surface water quality. Overall, the analysis suggests that the proposed project could be accomplished with minimal overall impact to the environment, even when compared to the No Action Alternative.

GLT505/3

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

GLT509/8

CHAPTER 1

INTRODUCTION

Chapter 1.0
INTRODUCTION

The Minnesota Pollution Control Agency (MPCA) has prepared this draft Environmental Impact Statement (EIS) on Koch Refining Company's Crude Expansion Project in Rosemount under the requirements of the Environmental Quality Board (EQB) Environmental Review Program Rules, Minnesota Rules Part 4410.0300-4410.7800. The EIS is being prepared by the MPCA on a discretionary basis pursuant to Minnesota Rule Part 4410.2000.

The Agency and the proposer, Koch Refining Company, jointly agreed that the preparation of an EIS was warranted because of the project's magnitude and potential environmental effects, and public interest in the project.

The draft EIS is a product of an extensive effort by the MPCA staff, a hired consultant (CH2M HILL, INC.), and the proposer. The names of the individuals participating in the preparation of the draft EIS are listed in Appendix A.

The MPCA authorized the distribution of this draft EIS for public review and comment in January 1985 to receive public input on the adequacy of the document. A public informational meeting will be held in Rosemount on February 19, 1985. The comment period on the draft EIS will end on March 5, 1985. All comments received during the public review period will be addressed by the MPCA staff and incorporated into the final EIS.

1.1 PURPOSE AND CONTENT OF THE EIS

It is recognized by the State of Minnesota through the Minnesota Environmental Policy Act, that the restoration and maintenance of environmental quality is critical to our welfare, and that human activities can have a significant impact on the environment. The major purpose of environmental review and the preparation of the EIS is to foster an understanding of the impacts that a proposed project will have on the environment. Through the review of the documents prepared, it is hoped that the project proposer, governmental decision-makers, and the public will be provided with useful information on the impacts of the project.

It is not the purpose of the EIS to justify the approval or disapproval of a project. Rather, the EIS is to be used by governmental units as a guide in making permitting decisions. It is hoped that adverse environmental effects can thus be avoided or minimized.

To insure that the significant issues associated with a particular project are evaluated in an EIS, the EQB Environmental Review Program Rules require that the scope of issues to be evaluated be defined. Defining the scope also reduces the bulk of an EIS by limiting analysis to only those issues that are relevant to the project at hand and by delineating the level of detail that is appropriate for each issue. The MPCA issued an Environmental Assessment Worksheet (EAW) on the Koch expansion in February of 1984 to provide the public with initial information on the project. Comments were accepted on the EAW for a 30-day period. In addition a public meeting was held in March 1984 to solicit input on issues that should be addressed in the EIS. All comments received were used by the MPCA staff to develop the Scoping Decision Document for the project, which was adopted by the MPCA in April 1984. This EIS was prepared to conform with that Scoping Decision Document.

This draft EIS also conforms with the EQB rules regarding EIS form and content. As such, the document contains a cover sheet, summary, table of contents, list of preparers, appendixes, and list of governmental approvals required for the project. It also contains a discussion of project and project alternative environmental, economic, employment, and sociological impacts, and mitigation measures.

This document is divided into four chapters. The first chapter, the introduction, contains information on the environmental review process, the background of the proposed project, the project issues and concerns, and required permits/approvals for the project. Chapter 2, the project description, includes a description of the existing and the proposed expanded refinery operations and includes a summary of the transportation, processing, pollution control, and supporting facilities for the two operating conditions. Environmental impacts and mitigation for the existing and expanded refinery are discussed in Chapter 3. The discussions are grouped under air quality, water quality, socioeconomic, transportation, noise, solid and hazardous waste, groundwater availability, and groundwater quality. An evaluation of the proposed project and four alternatives identified through the development of the scope of the EIS is presented in Chapter 4.

1.2 PROJECT BACKGROUND

The Koch Refining Company's Crude Expansion Project will consist of the construction of new facilities and expansion of existing facilities at its refinery complex in the Pine Bend Industrial District in the City of Rosemount, Minnesota.

The expansion is being proposed to enable the refinery, which currently has been operating at or near capacity, to increase production of gasoline, home heating oil, jet fuel, and asphalt. The expansion will occur over the next 3 to 5 years and will increase the refinery crude capacity by about 50 percent, from 137,000 barrels per day (B/D) to 207,000 B/D. The expansion will occur in two phases. The first phase, scheduled for construction in the spring of 1985, will increase production to 175,000 B/D by 1986, and the second phase will increase production to 207,000 B/D by 1988. When the proposed expansion is completed in 1988, total refinery employment is expected to increase from 586 to 870 employees. Other refinery-related employment would also increase with the expansion. Turnaround employment will increase from 112 to 150 full-time equivalents, and construction employment over the construction period will average 500 workers.

1.2.1 HISTORY OF THE REFINERY

When the oil refinery operation began operation at the Pine Bend site in 1955, Great Northern Oil Company (GNOC) owned the then 25,000 barrel per day sour crude refinery. In 1969, GNOC became a subsidiary of Koch Industries. Three years later, the name of the refinery was changed to Koch Refining Company.

Koch Refining Company was the first refinery in the world to process Western Canadian crude, a sour crude containing more than 2 percent sulfur. Sour crude is more difficult to refine than low-sulfur crudes and usually requires a more capital-intensive refining process.

Koch developed its sour crude refining process because the majority of the world's developing oil reserves consisted of medium to high sulfur crudes. The company believes the refining industry will be processing predominantly sour crude oil in the future rather than the low-sulfur crude that has been so predominant in the past.

Over the years, Koch has developed the expertise to efficiently process sour crude to produce a high proportion of the more useful and valuable light end products, such as gasoline and home heating fuel. Koch's product mix is similar to sweet crude refineries, whose product is more commensurate with consumer demand. Koch's product mix is unlike that of many other sour crude refineries, whose product mix consists of a high percentage of the less desirable heavy ends, such as asphalt.

The principal petroleum products produced at the 137,000 B/D refinery are leaded and unleaded gasoline, home heating oil, commercial and industrial heating oils, transportation fuels, jet fuel, petroleum coke, asphalt, and sulfur byproducts. These products are shipped to customers in Minnesota and the surrounding Upper Midwest States via pipeline, truck, barge and rail car transport.

Exact product quantities are considered confidential, but a percentage of the total product now produced at the refinery is provided in Table 1-1. The percentage mix of products shown in the table will remain the same after the expansion.

Table 1-1
PRODUCT MIX

Product	Nominal % Yield	Description
Gasoline	54	Approximately 50% unleaded gasoline and includes military jet fuel
Middle Distillates	27	Residential heating oil, commercial heating oil, jet fuel, kerosene, diesel fuel
Residual Oil and Asphalt	11	Industrial boiler fuel
Others	8	Petroleum coke, sulfur, and carbon dioxide

1.2.2 HISTORY OF PETROLEUM SUPPLIES IN THE UPPER MIDWEST

The supply and utilization patterns of refined petroleum products in Minnesota and the Upper Midwest States show a trend toward sharply reduced refinery capacity and stabilizing demand. If this trend continues, the shortfall in regional production would tend to escalate the increase in the price of petroleum products.

As shown in Table 1-2, there has been a 25 percent decrease in refining capacity since 1980 in the Upper Midwest States which supply petroleum products to Minnesota. The decrease in crude oil refinery capacity is due to the decision by oil refiners to consolidate and streamline operations by eliminating uneconomic facilities. This trend toward eliminating smaller, more inefficient refineries is expected to continue as leaded gasoline production is phased out and as increasingly costly pollution control systems are required.

Table 1-2
MID-UNITED STATES REFINING CAPACITY
CRUDE OIL CAPACITY

State	January 1, 1980 No.	January 1, 1980 B/DC[a]	January 1, 1983 No.	January 1, 1983 B/DC[a]
Illinois	11	1,206,000	7	964,500
Kansas	11	461,000	7	320,000
Minnesota	3	218,000	2	202,500
Missouri	1	104,000	0	0
Nebraska	1	6,000	0	0
North Dakota	3	66,000	2	60,800
Oklahoma	12	560,000	9	416,700
Wisconsin	1	40,000	1	39,000
	43	2,661,000	28	2,003,500

[a]B/DC barrels per day capacity.
Note: Oil and Gas Journal and Natural Petroleum Research Association

Table 1-3
HISTORIC AND PROJECTED CONSUMPTION OF PETROLEUM
IN THE KOCH REFINING COMPANY PRIMARY MARKET AREA
(Trillion Btu)

	1970[a]	1978[a]	1982[a]	1985[b]	1990[b]	2000[b]
Minnesota	546	648	503	518	490	503
Wisconsin	551	656	460	474	448	460
Iowa	382	461	370	381	360	370
North Dakota	125	129	136	140	132	136
South Dakota	117	124	109	112	106	109
	1,721	2,018	1,578	1,625	1,536	1,578

[a]State Energy Data Report, U.S. Department of Energy, May 1984.

[b]Projected consumption of petroleum products for the Upper Midwest are expected to parallel national consumption trends estimated at 12.38 million B/D in 1982, 12.66 million B/D in 1985, 11.96 million B/D in 1990, and 12.38 million B/D in 2000 by Perman and Getz.

Petroleum product consumption patterns in the five-state area served by Koch Refining Company products are shown in Table 1-3. Koch's current production of 137,000 barrels per day (B/D) provides about 16 percent of the 1,578 trillion British Thermal Units (Btu) of refined petroleum products consumed in this market area.

Although petroleum use has shown a decline in recent years, the continuation of this decline is not forecasted. Based upon the most recent projections for future demand, it is expected that consumption will only nominally change throughout the next 15 years, but continued development of cost-effective conservation and alternative energy resources will keep the rate of increase for refined petroleum products at moderate levels.

If the trend toward decreased refinery capacity in the Upper Midwest region continues, the market will be met by distant refineries in other areas of the country, which will result in higher transportation costs and potentially more costly and less stable crude oil supplies.

1.2.3 PROJECT PURPOSE

The expansion has been proposed because existing refinery capacity in the Upper Midwest States is insufficient to satisfy the demand for refined petroleum products. In recent years in the Upper Midwest, there has been a 25 percent decrease in refinery capacity while consumption has only decreased by 6 percent.

The Koch Refining Company expansion will help offset potential shortfalls in supply in the Midwest caused by the anticipated reduction in regional refinery capacity. The expansion will produce 408 trillion Btu's per year of refined petroleum product locally available, up from Koch's present production of 256 trillion Btu's. To consumers in Minnesota, as well as those in surrounding states, this will mean a more readily available supply of product and less dependence on refinery capacity in other states where supplies may be affected by refinery shutdowns and transportation problems.

The proposed expansion will also allow Koch to make the process changes required to improve operating efficiency and increase production of unleaded gasoline. The expansion will involve installation of state-of-the-art process equipment to make Koch's overall operation more efficient. In the area of energy conservation, for example, the expansion will allow Koch to continue to reduce the amount of energy consumed per barrel of crude processed at the refinery. Over the past 10 years, Koch has reduced its process energy consumption by 25 percent. The expansion will allow this downward trend to continue.

Restrictions on leaded gasoline production are expected to have a significant economic impact upon energy costs and the petroleum refining industry. Industrywide, it is estimated that conversion to unleaded gasoline production will cost $995 million. While it is reasonable to expect that these costs will be passed on to the consumer, some refineries will find the process of conversion a severe economic hardship. With the expansion, Koch will be able to incorporate the additional capital expenditures associated with further conversion to unleaded gasoline production into its overall expansion, and thereby offset the potential for significant negative economic impact.

In summary, the overall purpose of Koch's expansion project is to increase capacity in its Rosemount facility to ensure a continuing, long-term supply of refined petroleum products to Upper Midwest customers at competitive prices.

The Koch Refining Company will continue to evaluate its business position in the face of a growing demand for petroleum products. In the future, if opportunities warrant it, Koch may further expand the refinery at Pine Bend to meet market conditions.

1.3 PROJECT SITE DESCRIPTION

1.3.1 SITE LOCATION AND LAND USE IN THE SURROUNDING AREA

Koch's Pine Bend refinery is located on a 600-acre tract in the Pine Bend Industrial District in Rosemount, Minnesota. Situated at the junction of U.S. Highway 52 and State Highway 55, the refinery is 8 miles northwest of the Town of Hastings (population 12,800), 6 miles northeast of the Rosemount city center (population 5,100) and 13 miles south of downtown St. Paul (Figures 1-1 and 1-2). Despite its proximity to the Twin Cities, the surrounding are is primarily agricultural, though a significant portion of it is devoted to the other industries of the Pine Bend Industrial District.

The proposed expansion of process, pollution control and storage facilities will be located within the existing 600-acre refinery complex. This 600-acre area presently contains the refinery process units, air pollution control facilities, product and crude oil storage tanks, wastewater treatment facilities, a hazardous waste landfarm treatment facility, and the support facilities necessary to operate the refinery. Koch Refining Company also owns 400 acres east of U.S. Highway 52 that are largely undeveloped, with the exception of

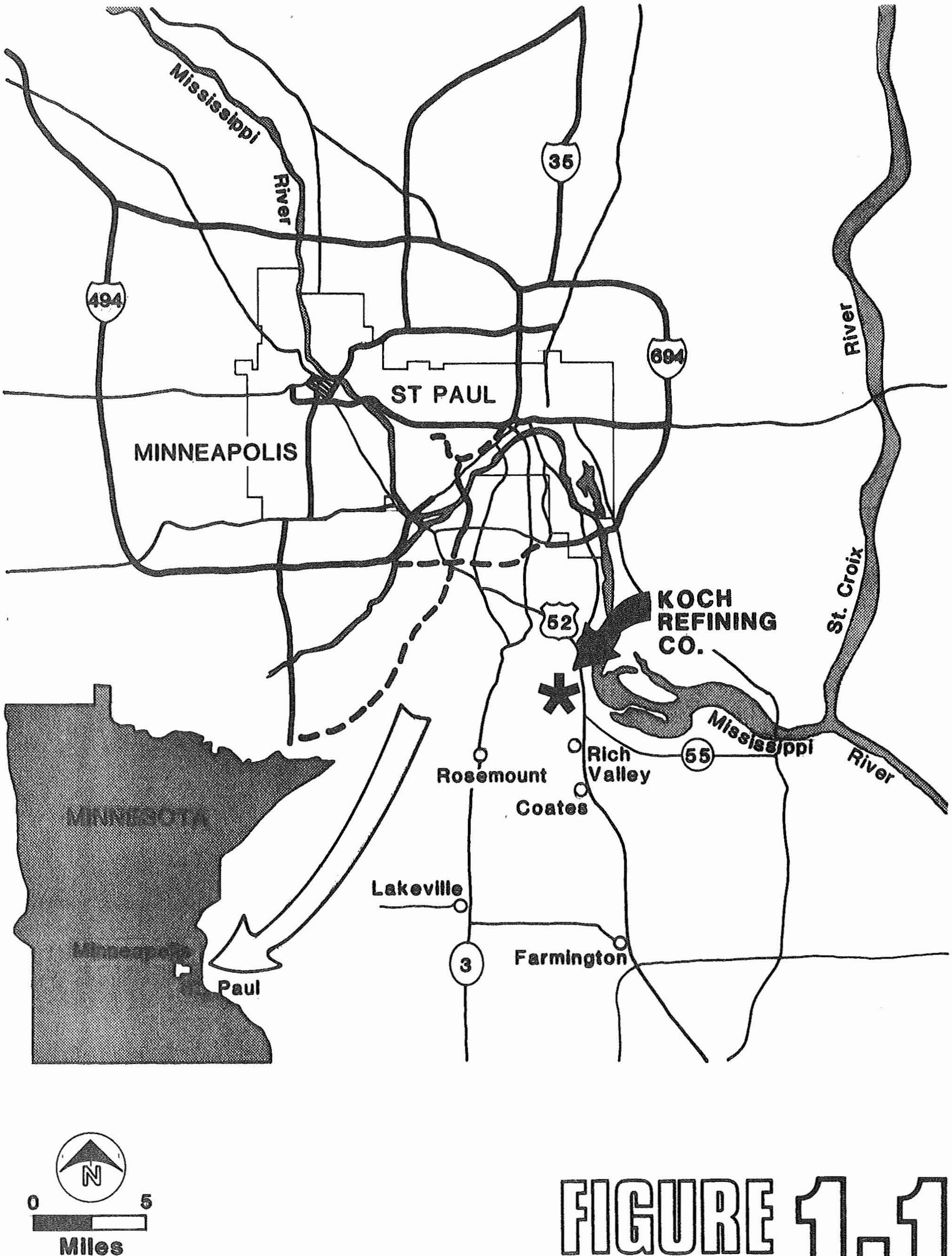


FIGURE 1-1

VICINITY MAP

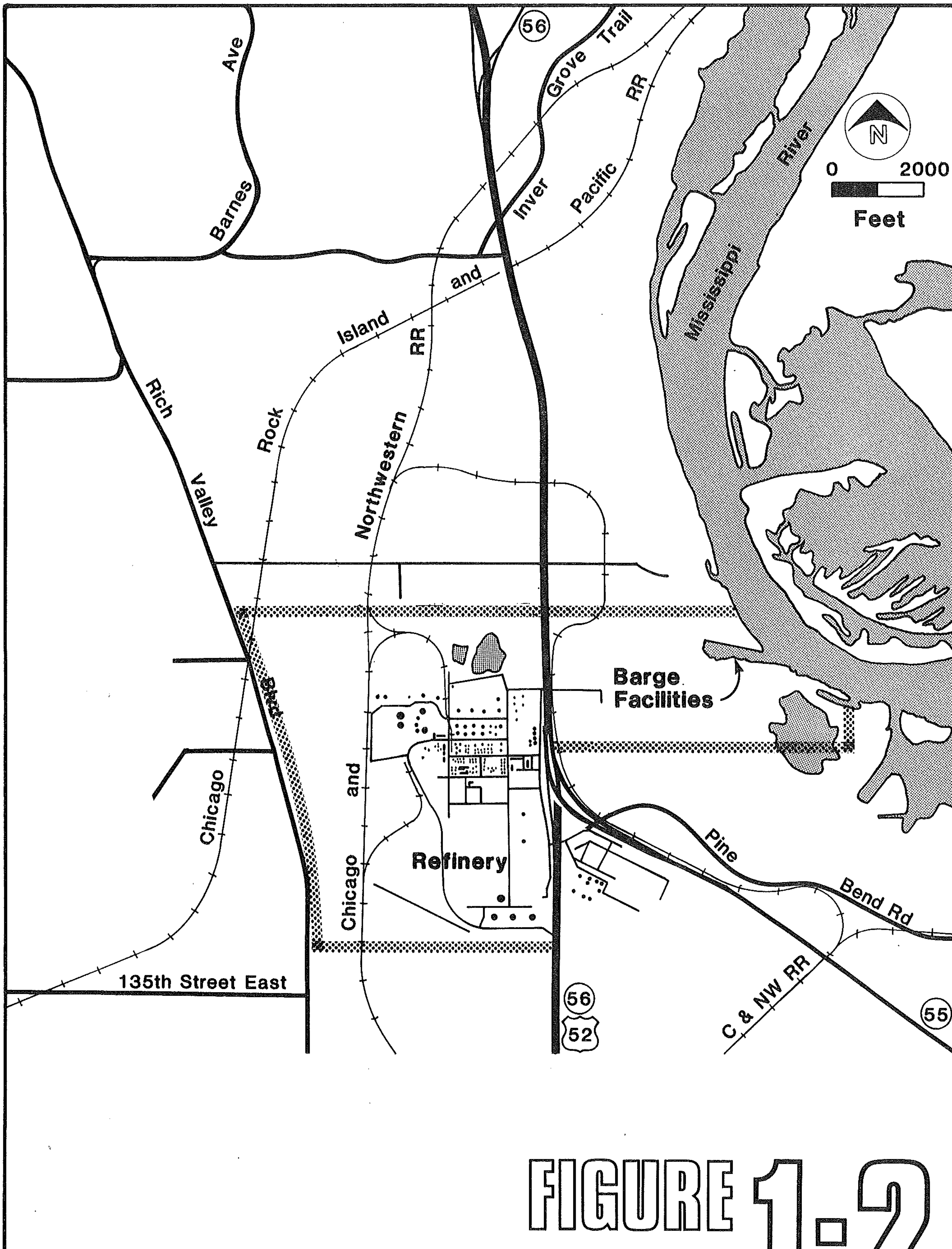


FIGURE 1-2

PROJECT AREA MAP

the barge facilities located next to the Mississippi River and used for loading refined products.

The Koch refinery was the first industrial facility to be developed in the Pine Bend Industrial District. The District was formed in 1954 by the purchase of approximately 6,000 acres by the Chicago and Northwestern Railroad. In the past three decades industrial development has flourished in the Pine Bend Area. Now, some 30 industries--from trucking companies to fertilizer plants--are within a 5-mile radius of the junction of U.S. Highway 52 and State Highway 55. A complete list of the major industries is shown in Table 1-4. Major industrial development near the Koch refinery includes:

- N-REN Corp., a fertilizer manufacturing facility and Spectro Alloys, a scrap aluminum recovery facility located to the southeast.
- CF Industries fertilizer storage facilities located to the east.
- Northern States Power Company's Inver Hills Peaking Plant, Pabst Corporation Meat Freezing Plant, and Union Carbide located to the north.
- Farmer's Union Oil Blending facilities located to the northeast.
- The Pine Bend Sanitary Landfill located to the north.

Even with the location of many industries in the Pine Bend Industrial District, the majority of land in the eastern area of Rosemount has been and continues to be agricultural in nature. Two small residential subdivisions are nearby: one 2 miles southwest of the refinery, and the other 1 mile northwest. The southwest subdivision contains 13 houses; the northwest subdivision has only 3 houses. The southwest subdivision is owned by the Koch Refining Company for employee use. Other houses are scattered across the agricultural lands or along the roads west and south of the facility. The nearest residences are located about 1 mile north, 1/2 mile west, and 3/4 miles south of the refinery property.

The Koch refinery is situated on land zoned general industrial. The Rosemount zoning ordinance has established this zoning classification, which has a 25-acre minimum lot size, to provide locations where industries requiring larger sites can operate within minimum restrictions and without adversely affecting surrounding land uses. In the City of Rosemount, the potential for high density commercial or residential uses in the vicinity of the refinery has been minimized through the density requirements of the agricultural zone bordering

Table 1-4
PINE BEND INDUSTRIES

1. A-1 Concrete Unit Step Co.
2. Bituminous Roadways, Inc.
3. Cardox
4. Cenex Fertilizer Storage
5. CF Industries Fertilizer Storage
6. Crosby-American Landfill
7. Dowell Industrial Services
8. Farmers Union Oil Blending and Truck Servicing
9. Halliburtom Services
10. Hilton Firebrick
11. Koch Sulfuric Acid Unit
12. Lenertz Trucking
13. Liquid Carbonics
14. Mapco Pipeline Co.
15. Markham Sand and Gravel
16. MWCC Rosemount WWTP
17. N-REN Corporation
18. NSP Peaking Plant
19. NW Coop Mills
20. Pabst Meat Freezing Plant
21. Pine Bend Sanitary Landfill
22. Rosemount Die Casting
23. Ruan Trucking
24. Schneider Trailers
25. Solberg Sand and Gravel
26. Spector Alloys
27. Suburban Gas Co.
28. Union Carbide Air Separation Plant
29. U of M Research Center
30. Wayne Trucking
31. Wenzel Engineering & Construction Co., & Storage Facilities

GLT499/9

the plant. While the minimum lot size in the agricultural zone is 2.5 acres, the density requirement limits new construction to four houses per 40 acres. In effect, this places a 10-acre minimum lot size on new rural residential developments. Future land use plans also support only low density development near the Koch facility. These land use plans call for the entire eastern portion of Rosemount to remain dedicated to agricultural use.

Existing and planned land uses north of Koch refinery in the City of Inver Grove Heights follow a pattern similar to Rosemount; however, the pressures of urbanization may be somewhat greater. Inver Grove Heights is a growing community located in an area defined in the Metropolitan Council's Metropolitan Development Framework as an "Area of Planned Urbanization." The southern one-half of the community (that area adjacent to the Koch facility) is located in the general rural use region.

The 1980 Inver Grove Heights Land Use Plan shows that land in the immediate vicinity of the Koch facility is generally zoned industrial, limited industrial, and rural residential (with a 5-acre minimum lot size). These areas are not served by metropolitan or municipal services and the city has been successful in maintaining the objective of large lot development. As in the City of Rosemount, Inver Grove Heights zoning ordinances and the orientation of various land uses provide buffering that will help to minimize potential conflicts between high density land uses and heavy industrial land uses.

1.3.2 ENVIRONMENTAL SETTING OF THE SITE

The refinery is situated in terrain best defined as gently rolling upland. Local relief throughout the area varies slightly, usually no more than 100 feet. The most significant variation in topography occurs where the land surface steeply slopes to the Mississippi River located about 3/4 mile east of the refinery to form a well defined river valley.

The Koch Refinery is located in an area which has experienced adverse air quality partly because of the refinery operation. The Pine Bend area is designated as not attaining the sulfur dioxide ambient air quality standards (AAQS). Improvements in refinery operations, however, have led to improved air quality. The MPCA is now requesting that the U.S. EPA redesignate the Pine Bend area to attainment for the sulfur AAQS. Ambient odor concentrations in the immediate refinery area are also above standards. Finally, the area is designated as not attaining particulate matter AAQS; however, this problem is attributed to area sources and encompasses significant portions of the Twin Cities area.

The refinery is located in the southeastern quadrant of a geologic basin known as the Twin Cities basin. This is a relatively stable geologic basin that has been without major tectonic movement for several million years. The area is underlain by a sequence of sandstones, shales and limestones of Palezoic age overlain by recent deposits of sands and gravels from the last glaciation. The major water-bearing units within this geologic sequence are the sandy limestones and dolomites from the Prairie du Chien group and the overlying glacial and postglacial deposits. In general, water supply yields are very good from the formations both in terms of water quality and quantity. Regionally, the direction of groundwater flow is toward the Mississippi River to the northeast.

A groundwater contamination problem exists in the area around the refinery. U.S. EPA and MPCA records cite the presence of volatile organic chemicals, metals, and nitrates above expected background levels in wells both upgradient and downgradient of the Koch refinery. Numerous possible sources of contamination in the area are being investigated.

The wildlife habitat in the area nearby the refinery is rated as limited. The industrial nature of the site and abutting lands support only those species accustomed to human disturbances such as rock doves, pigeons, sparrows, starlings, ground squirrels, and cottontail rabbits. Other species may be observed, but it is doubtful if their habitat requirements could be met near the site. No known state or federal threatened or endangered species have been observed near the site.

1.4 ISSUES AND CONCERNS

Under the Minnesota Environmental Quality Board rules, the public and interested parties have an opportunity at the beginning of the environmental impact statement process to express their project-related issues and concerns. In March 1984, a public scoping meeting was held in Rosemount for the purpose of providing input into identifying the significant issues associated with the expansion project.

These major issues and concerns identified and evaluated in this EIS are:

- Air quality impacts of the expansion, including the effect of refinery expansion on compliance with federal and state air quality regulations

- The effect of the expansion on wastewater treatment facilities and discharge of effluent to the Mississippi River

- Impact on socioeconomic factors

- Traffic impacts in the vicinity of the site, particularly on U.S. Highway 52
- Potential noise impacts from the expanded refinery
- Effect of the expansion on groundwater quality
- Effect of additional water use on groundwater resources in the area
- Effect of the expansion on solid and hazardous waste generation and practices

1.5 PERMITS

Before constructing the Crude Expansion Project, Koch Refining Company must apply for and receive the following regulatory permits:

Table 1-5
PERMITS AND APPROVALS

Level of Government	Type of Permit	Status
State of Minnesota Minnesota Pollution Control Agency (MPCA) Division of Air Quality	o Air Emission Facility[a] Installation and Operating Permit including Prevention of Significant Deterioration (PSD) Review for NO_x	o Permit input is being developed concurrently with the EIS
MPCA Division of Water Quality	o Amendment to the refinery's existing National Pollution Discharge Elimination System (NPDES) permit No. MN0000418	Same as above
	o Storage tank(s) Installation permit	To be applied for
City of Rosemount	o Building permit for tanks and structures	To be applied for
Dakota County Department of Health Services	o Onsite treatment system permit	To be applied for

[a] A separate permit will be issued for Phase 1 and Phase 2 of the project.

CHAPTER 2

PROJECT DESCRIPTION

Chapter 2.0
PROJECT DESCRIPTION

The proposed expansion will consist of the construction of new facilities and the expansion of existing facilities at the Koch Refining Company's refinery complex in Rosemount, Minnesota. The proposal, basically an expansion of an existing refinery, can best be understood by describing the existing facility and then explaining how the expansion would change present operations. This chapter has two parts: the existing refinery is described in the first and the proposed refinery expansion in the second. The refinery operation consists of four elements that are used in describing both the existing refinery and the expansion. The four elements are:

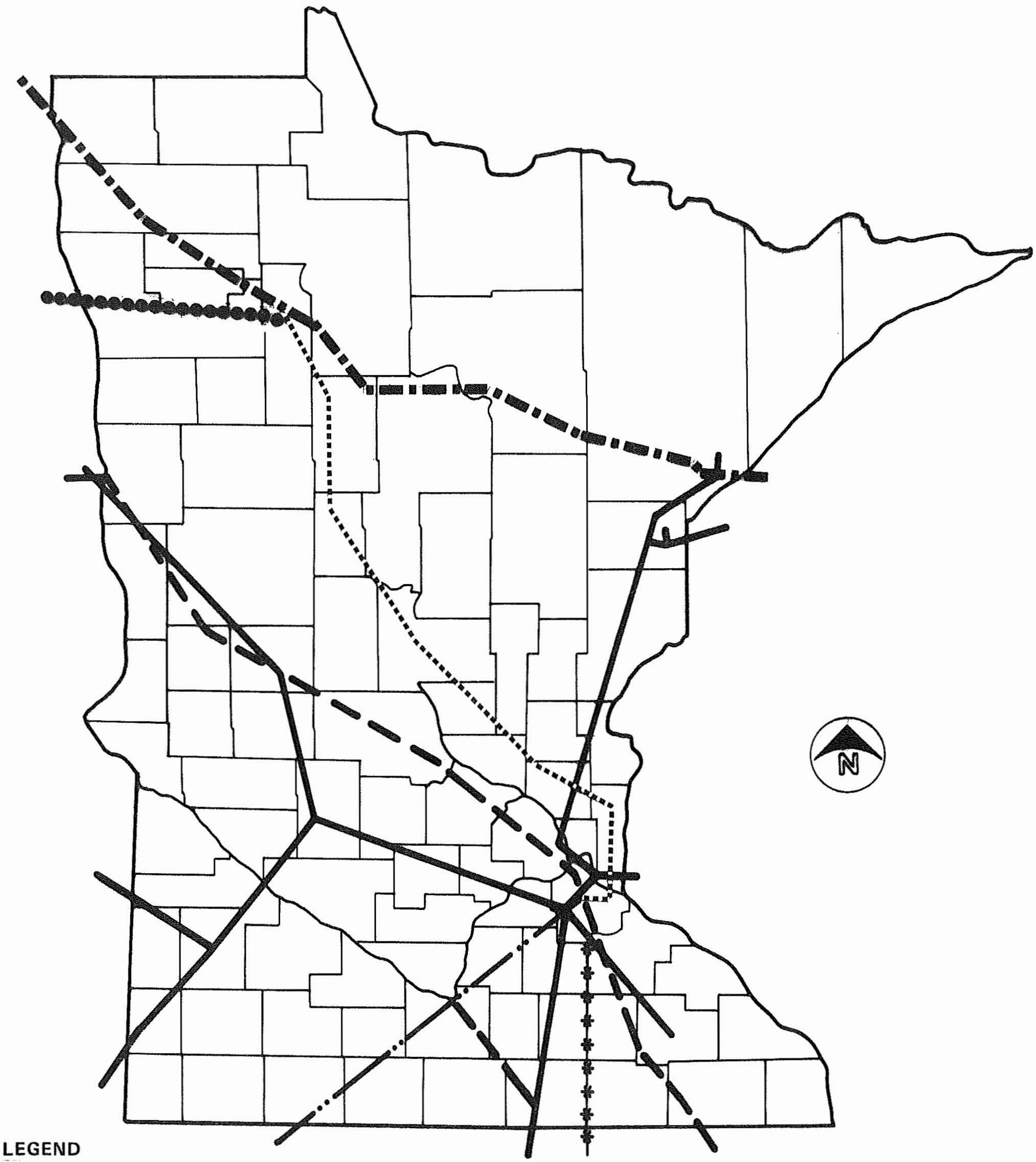
- The transportation of crude oil to and refined products from the refinery
- The processing of the crude oil into saleable products
- The pollution control facilities that abate releases of pollutants
- The basic utilities and facilities that support the refinery operation

2.1 THE EXISTING REFINERY

2.1.1 ELEMENT ONE - TRANSPORTATION OF CRUDE OIL AND REFINED PRODUCT

Crude oil is transported to the Koch refinery solely by pipeline. Western Canadian crude, the primary source of crude oil, is transported by the Interprovincial and Lake Head Pipelines and then transferred to the Minnesota Pipeline that delivers to Koch Refining Company and the Ashland Oil Company in St. Paul Park (see Figure 2-1). Secondary sources of crude come from St. Louis, Missouri, (worldwide crude supplies) and North Dakota. The St. Louis crude is delivered to Koch by the Wood River Pipeline, and the North Dakota crude is delivered by the Minnesota pipeline. Incoming crude oil is stored in tanks with a rated capacity of 6,900,000 barrels in the southern portion of the facility.

Refined products leave the refinery by pipeline, the primary means of transport, and by truck, rail, and barge. The principal pipelines include the Williams Company pipeline distribution network, the Mobil pipeline, and the Koch pipelines.



LEGEND

- WOOD RIVER PIPELINE
- AMERICAN OIL CO.
- MINNESOTA PIPELINE CO.
- WILLIAMS COMPANY PIPELINE
- LAKEHEAD PIPELINE CO.
- MID AMERICA PIPELINE CO.
- PORTAL PIPELINE CO.

FIGURE 2-1

MAJOR MINNESOTA PIPELINES

Truck transportation, the second most important means of product transport, is currently estimated to be 400 loads per day. Trucks arrive at the refinery from U.S. Highway 52 and State Highway 55. Roadway improvements have recently been completed by the Minnesota Department of Transportation to improve access to and traffic flow adjacent to the refinery. The improvements have included the relocation of the south entrance of the access road to the refinery along U.S. Highway 52 to prevent conflicting traffic movements between U.S. Highway 52 and State Highway 55. Other improvements include addition of turn lanes and truck acceleration lanes in the area.

Refined products are also shipped by barge to the Twin Cities and customers along the Mississippi River in Minnesota, Wisconsin, and states farther south. Koch owns and operates barge facilities on the Mississippi River east of the refinery (Figure 1-2). The barge facilities consist of five loading docks used year-round. Products move from the refinery by pipeline to the barge slips for loading.

The barge slips are excavated from the river bank perpendicular to the river. This configuration optimizes spill control because only the mouth of the slip is exposed to the river. Other spill control techniques employed during barge loading include placing a boom across the barge-slip-mouth to contain a potential spill and sometimes the use of booms around the barges. Although spills have occurred in the slip, no spillage has ever escaped to the river. If a spill occurs, both vacuum trucks and absorbent pads are used to remove the oil.

A relatively small amount of products leave by rail. Service is provided by the Chicago & Northwestern and the Soo Line Railroads.

The daily capacity of each transportation mode is summarized in Table 2-1.

Table 2-1
PRODUCT TRANSPORT: DAILY CAPACITY BY TRANSPORTATION MODE

Product Pipelines	
Williams Company	152,000 B/D[a]
Mobil, St. Paul	
Koch Fuels, Wisconsin	
Barge Facilities	
Product Loading	30,000 B/D
Truck/Rail Loading Facilities	
Gasoline, Distillate, and Asphalt (Truck)	160,000 B/D
Petroleum Coke (Truck and Rail)	5,000 T/D[b]

[a]B/D - Barrels per day
[b]T/D - Tons per day

2.1.2 ELEMENT TWO - CRUDE OIL PROCESSING

The heart of the refinery operation is the crude oil processing. In this section, an overview of Koch's petroleum and products is presented, together with a discussion of the basic refining processes and facilities.

Types of Products

Before crude oils are refined into useful products, they are brownish-green to black liquids consisting primarily of carbon and hydrogen. Crudes can be separated or fractionated into many individual compounds ranging from light components, such as methane, to heavy materials such as asphalts. Light crudes contain up to 75 percent gasoline and are very fluid. Some of the heavier crudes such as asphaltic crude contain no gasoline and are so viscous that heating is required before they can be pumped.

The following products are produced at the Koch refinery:

Gasoline. Motor gasolines are complex mixtures of liquid hydrocarbons with boiling ranges from 100°F to 400°F and with vapor pressures of about 10 pounds per square inch (psi). Primarily three grades of gasoline are produced--regular, unleaded regular, and unleaded premium.

Residual Oils. Residual fuel oils are the heavier and more viscous oils consisting of heavy liquid "ends" (resids) and solids (pitch) remaining after lighter products are removed in the fractionation process. Unless these heavy ends are "cracked" into lighter products, they are used as boiler fuels (No. 6 fuel oil), with the heaviest ends used in asphalt production.

Distillate Fuels. Distillate fuels are petroleum stocks that boil in the range of 350°F to 700°F and have flash points (temperature at which sufficient vapors evolve to form a combustible mixture with air) of 120°F or higher. Distillates include kerosene, midrange heating oils, diesel fuels, and certain jet fuels.

Byproducts. Refining byproducts include petroleum coke, sulfur, and liquid carbon dioxide. Petroleum coke, which is similar to anthracite coal, is sold as a fuel to thermal power facilities or other industries. Elemental sulfur and food grade liquid carbon dioxide are also produced and sold to various industries.

The Refining Process

The existing refinery has been operating at or near capacity in 1982 and 1983. During 1983, it reached an operating capacity of 96 percent. Table 2-2 shows how much crude oil was processed from 1977 to 1983.

Table 2-2
KOCH REFINING CRUDE THROUGHPUT

Year	1,000's bbl's
1977	39,130[a]
1978	42,561
1979	45,967
1980	38,012[a]
1981	40,589
1982	45,523
1983	47,797

[a]The relatively low throughput reflects significant maintenance requirements or modifications in process equipment causing extended periods of shutdown.

The process used to refine crude oil consists of four basic steps:

- The first step, distillation, separates the crude oil into various fractions of hydrocarbon streams based on the boiling point differences of the material.
- The second step, cracking, fractures the heavier bottom of the barrel residues from the distillation process. This cracking produces further light and intermediate products and a solid byproduct, petroleum coke.
- The third step, polymerization, combines lighter materials into larger molecules for gasoline octane blending.
- The final step, reforming, changes the molecular structure of a portion of the gasoline fractions to produce higher octane components for blending to required leaded and unleaded gasoline specifications. The final activity in the refining process is to blend the intermediate product streams to produce unleaded regular, unleaded premium, and regular gasolines. The octane level in the leaded regular gasoline is achieved by adding tetraethylead to a blend of lower octane intermediate streams.

A basic refinery block flow diagram is shown in Figures 2-2 and 2-3. The principal process facilities are described below and a layout of the refinery is shown in Figure 2-4.

Step 1: Distillation.

Atmospheric and Vacuum Distillation Unit. Crude oil is first separated into various fractions during the atmospheric and vacuum distillation processes. Products produced by the atmospheric distillation process are lighter petroleum products such as light ends, naphthas, and distillates. Products produced by the vacuum distillation unit are the heaviest fractions of crude oil such as fuel oils and asphalts.

Once the products leave the atmospheric and vacuum distillation units, they are further refined by the following processes.

Gas Plant Processing. Lighter petroleum components are then sent to gas plants for further separation. In the gas plants, propane and butane are separated from ethane and methane products or fuel gases. These fuel gases are similar to natural gas and are used onsite to fire various boilers and heaters.

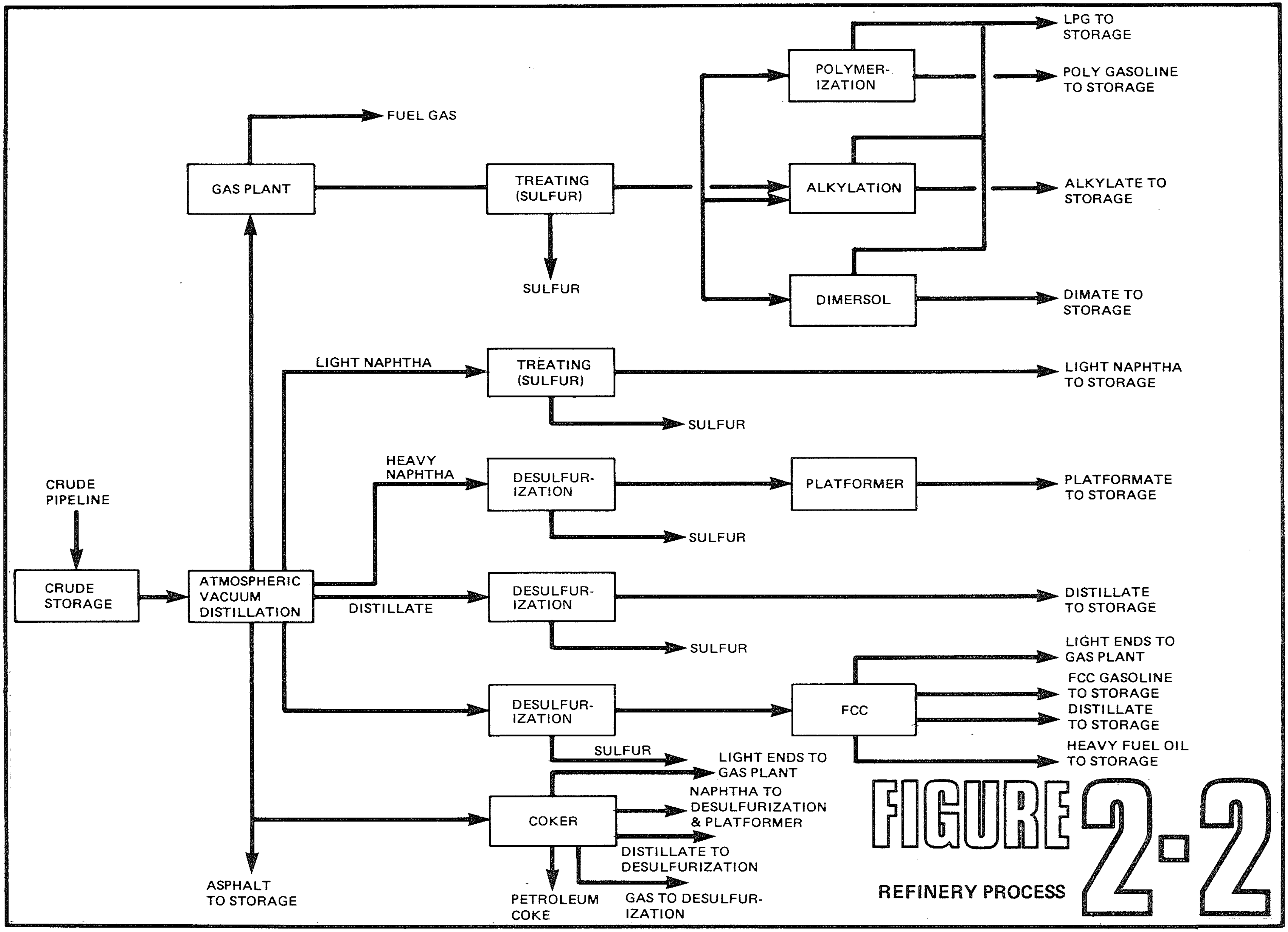


FIGURE 2-2

REFINERY PROCESS

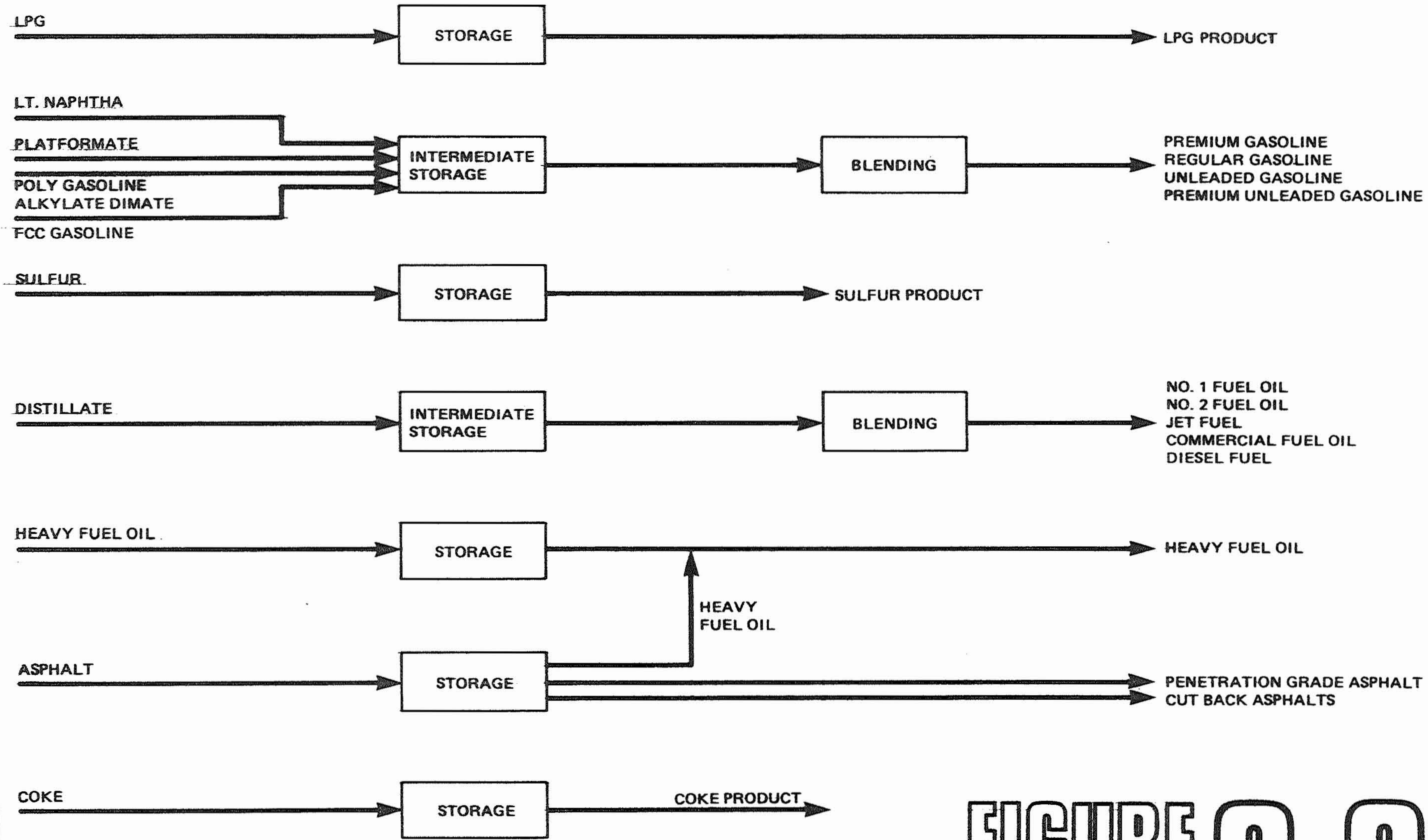


FIGURE 2-3
REFINERY STORAGE AND BLENDING

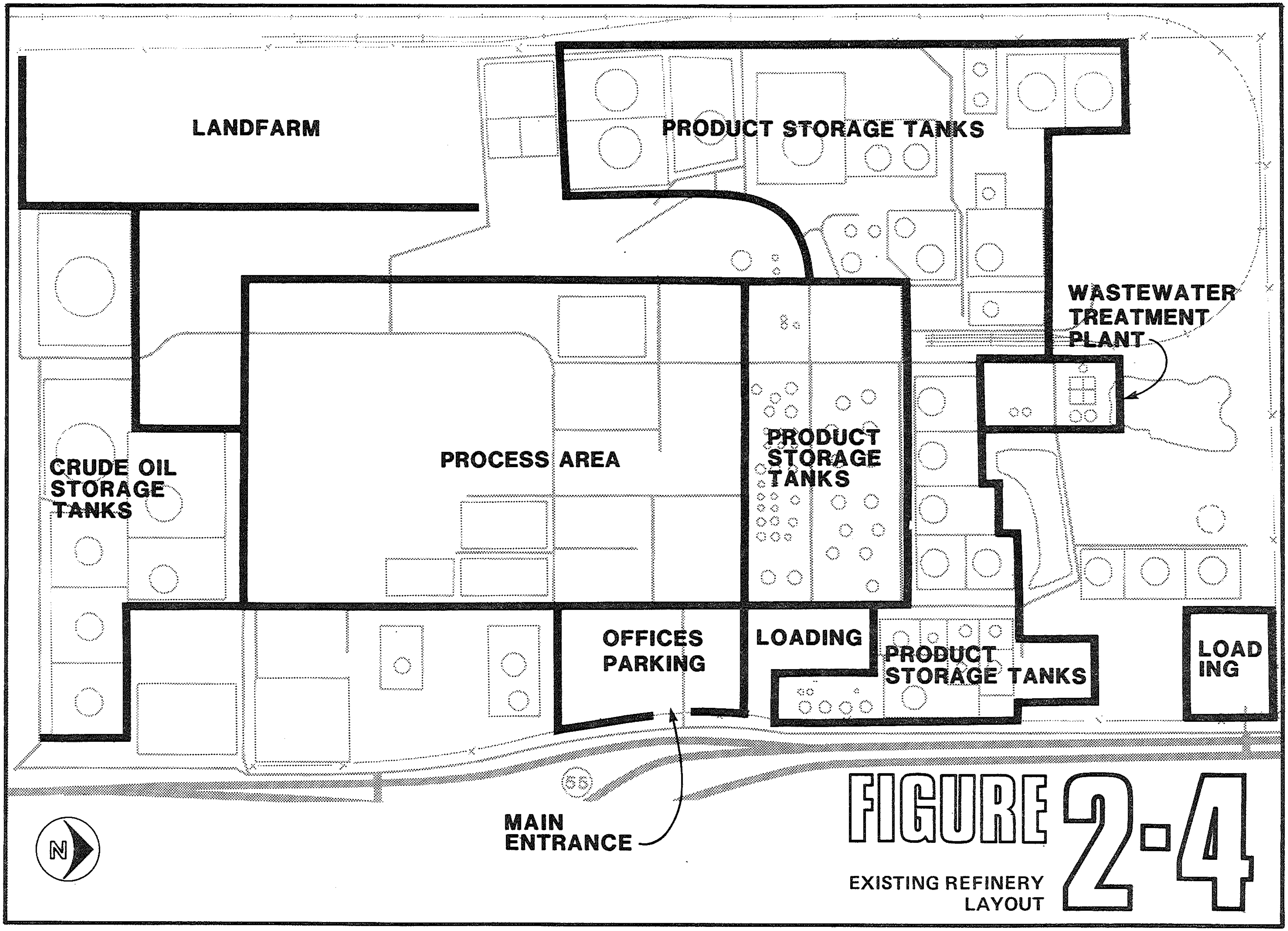


FIGURE 2-4

EXISTING REFINERY LAYOUT

The propanes and butanes are taken off at the gas plants, and sent to sulfur treatment facilities to remove sulfur compounds. The sulfur compounds extracted from the gas are then treated to produce a commercial grade sulfur. The propanes and butanes are stored onsite and used for the polymerization process discussed below.

Light Naphtha Processing. Light naphtha, which is essentially a natural gasoline, is sent to a naphtha processing unit for sulfur removal. The light naphthas are then sent to intermediate storage tanks before blending with a final gasoline product.

Distillate Processing. Intermediate streams coming off the crude unit are separated into products of specific boiling ranges from low temperature boiling products like No. 1 fuel oil to high temperature boiling fractions like diesel fuel. These various distillate products are sent to the desulfurization unit and then to intermediate storage before blending.

Step 2: Cracking.

Gas Oil Processing. Gas oils are the heavier parts of raw crude oil. Gas oils coming off the vacuum distillation unit are first desulfurized and then sent to the fluid catalytic cracker unit (FCC), where the gas oil is further upgraded through heating, pressure, and a catalyst. The FCC unit breaks down the hydrocarbon molecules in the gas oils to produce a range of products from gasoline to heavy fuel oils that are then sent to intermediate storage.

Asphalt Processing. Asphalt is the heaviest hydrocarbon fraction separated from the crude oil in the vacuum distillation unit.

Asphalt can be further processed to produce gasolines and fuels through a delayed coking process. In this thermal cracking process, asphalt is heated to 900°F yielding products similar to those produced in atmospheric and vacuum distillation.

The heaviest fraction produced in the coking process is petroleum coke--a solid material similar to anthracite coal.

Step 3: Polymerization.

Propane and butane stripped of sulfur compounds are mixed with specialty catalysts to promote the forming of heavier hydrocarbons fractions to be used in gasoline blending.

Step 4: Reforming.

Heavy Naphtha Processing. Heavy naphthas that have an octane rating too low for internal combustion engines are sent to a catalytic reformer that restructures the molecules using a platinum catalyst, temperature, and pressure to make a higher octane gasoline. It is then sent to intermediate storage tanks.

Storage and Blending. Once the crudes have been refined, the resulting products are transported and stored in intermediate product storage tanks just north of the process area. These intermediate products are blended to produce the three gasoline types. The final product is stored in storage tanks to the north, northeast, and the northwest of the intermediate product storage tank area.

During the blending process tetraethylead, (TEL--an organic lead compound in solution in the solvent phase of ethylene dibromide and ethylene dichloride) a gasoline antiknock additive, is blended with the motor fuels. Because of the toxic properties of the organic lead and its solvents, tetraethylead is carefully handled under vacuum to prevent releases to the environment.

TEL arrives at the refinery in railroad cars in quantities of 73,000 to 80,000 lbs. The railcars are under vacuum and as a safety precaution the vacuum is checked with a pressure gauge before the unloading line is attached. The contents of the railcar are transferred to a 180,000 lb onsite storage tank by placing a vacuum on the tank. After the transfer is completed, the tank car is washed with gasoline and a vacuum is placed on the car before it is returned to the vendor.

The TEL mixture is stored in the onsite tank under vacuum to prevent a vapor release. Blending TEL into the motor fuel is accomplished by educing it from the alkylead storage tank and transferring it directly into the gasoline as the fuel is pumped from intermediate to final storage tanks.

The entire transfer and storage of the tetraalkylead compound under vacuum prevents the release of the mixture to the environment and prevents personnel exposure to the compound.

2.1.3 ELEMENT THREE - POLLUTION CONTROL FACILITIES

Several pollution control systems are used at the refinery to minimize or remove pollutants in air emissions, wastewater discharges, and the disposal of solid and hazardous wastes. Each of these pollution control systems is described below. Further details regarding specific outputs of wastes, emission volumes or quality, and compliance with various discharge requirements are provided in Chapter 3 under the respective headings of Air Quality, Water Quality, and Solid and Hazardous Wastes.

Generally, the compliance records for each of the pollution control systems have been varied. For example, during the past 2 years there have been violations of standards included in Koch's National Pollution Discharge Elimination System (NPDES) permit. The most frequent violations have been for exceeding the total suspended solids limitations followed in order of frequency by violations of the 5-day biological oxygen demand limitations. Infrequently, ammonia, phenol, and hexavalent chromium standards have also been exceeded at the wastewater treatment plant.

In the area of hazardous waste management, Koch has recently upgraded the groundwater monitoring systems for its onsite disposal facilities. These improvements bring the facilities into compliance with the current U.S EPA and Minnesota Hazardous Waste Program Interim Status Standards under which they are currently operating.

The existing refinery is in compliance with most applicable air quality regulations. The refinery complies with applicable air pollution control technology requirements, daily sulfur dioxide (SO_2) emission limits, visibility (opacity) limits, and monitoring and reporting requirements. Violations occur in two areas: odors from the refinery are in excess of the state ambient odor standards, and emissions from the refinery contribute to violations of the state ambient nonmethane hydrocarbon standard.

Wastewater Treatment

The refinery generates three wastewater streams requiring treatment prior to discharge to the Mississippi River. They are: 1) process water, 2) noncontact (cooling) water, and 3) stormwater. The combined wastewater flow is treated at the refinery's wastewater treatment plant (WWTP) before discharge to the river. The quality of this discharge is regulated by an NPDES permit, and is routinely monitored for compliance. In 1983, treated effluent was discharged to the Mississippi River at an average rate of 2.26 million gallons per day (mgd) and at a maximum rate of 4.0 mgd. About 90 percent of this flow is process water and noncontact water. The remaining 10 percent is stormwater originating from the landfarm and a portion of the process area.

The WWTP has been in operation since 1977 and has a design capacity of 2.5 mgd. Major components of the existing wastewater treatment facility include flow equalization facilities, pretreatment facilities for removal of oil and grease, equalization basins for influent mixing, and conventional activated sludge treatment facilities.

Flow Equalization. A diversion box at the head of the wastewater treatment plant is used to divert excess wastewater flow to the shot pond. The purpose of this unit process is to prevent hydraulic overloading of downstream treatment processes during periods of high flow and to augment the system during periods of low wastewater flow.

Wastewater Pretreatment. Successful biological degradation of waste constituents in the refinery wastewater is dependent upon successful pretreatment for removal of oil and grease, which have a detrimental effect on activated sludge performance. The existing pretreatment facilities consist of two American Petroleum Institute (API) oil/water separator channels and a dissolved air flotation (DAF) unit.

The API separator is a gravity and skimming device used to remove the bulk of oil from the influent water. The recovered oil is called slop oil, which is treated and returned to process units as a raw material similar to the incoming crude oil. Some oil and water sludges are unrecoverable and are treated at the refinery's onsite landfarm.

The second pretreatment step occurs at the DAF unit. With the addition of coagulating agents, high pressure air is released in the form of fine bubbles which lift and float remaining oily constituents to the surface of the DAF unit where they are skimmed off. This skimming is called dissolved air float or DAF float, which is also returned for process use. After DAF treatment, the wastewater enters the activated sludge basin for biological degradation of the wastewater constituents.

Equalization Basins. Equalization provides for mixing of influent wastewater prior to the activated sludge system so that any change in constituent concentration in the influent wastewater takes place very slowly and over a long period of time. The activated sludge then becomes acclimated to successfully treat the waste constituent.

In the Koch WWTP, two equalization basins precede the DAF unit so that both the DAF unit and activated sludge system benefit from influent mixing. Equalization basins have static aerators to promote mixing.

Activated Sludge Treatment. The purpose of activated sludge treatment is to reduce the organic constituents in wastewater to an acceptable level prior to discharge. In two aeration basins, wastewater and recycled activated sludge are contacted in order to provide a condition for the growth and metabolism of microorganisms that consume the organic materials in the wastewater.

Effluent from the aeration basins flows to two clarifiers. In the clarifiers treated wastewater rises and is discharged whereas the activated sludge settles to the bottom where it is collected. Most of the sludge is recycled to the front of the aeration basins to provide a continuing biomass that allows contact of influent waste constituents.

WWTP Chemical Additives. Several different organic or inorganic chemicals are added to wastewater streams in the treatment plant. These chemicals are used to neutralize low or high pH water streams, coagulate and flocculate solids, or to provide essential nutrients for bacteria in the activated sludge treatment area.

Air Pollution Controls

The refinery's air emissions are controlled by air pollution control equipment and management practices. The principal air emission controls are: 1) sulfur recovery units that convert hydrogen sulfide to sulfur while minimizing sulfur dioxide emissions to the atmosphere, 2) carbon monoxide boilers that convert carbon monoxide to carbon dioxide, 3) low nitrogen oxide (NOx) burners that reduce NOx emissions, 4) a flare system that combusts hydrocarbons to carbon dioxide and water, 5) floating roofs on gasoline storage tanks that reduce hydrocarbon emissions, and 6) bottom truck loading which reduces hydrocarbon emissions during filling operations.

A complete list of air pollution control facilities at the existing refinery, their purpose, capacities, and performance, are shown in Table 2-3.

Solid and Hazardous Waste Disposal

Koch currently generates approximately 10,000 tons of process wastes per year. Slightly more than half of this waste is nonhazardous industrial wastes with the balance being classified as hazardous under both state and federal definitions. The various types of regularly generated wastes from the refinery are summarized in Table 2-4. Other miscellaneous generated wastes are summarized in Table 2-5. About 95 percent of the wastes are generated from the wastewater treatment facility and associated processes.

A land treatment facility or landfarm serves as Koch's primary solid and hazardous waste facility. Nearly all of the generated wastes are disposed of onsite by this method. The landfarm is located in the southwest corner of the refinery as shown in Figure 2-4. The area shown totals 31 acres and approximately 16 acres are currently in use. Oily wastes applied to the landfarm facility are biologically degraded by acclimated and naturally occurring microorganisms. Operating

Table 2-3
AIR POLLUTION CONTROL FACILITIES FOR EXISTING REFINERY

Facility	Purpose	Capacity	Performance	Comments
No. 1/2 SRU	Convert H_2S to sulfur to	70 LT/D	96% @ 50 LT/D eff. by series oper.	1975/83 modifications
No. 3 SRU	minimize SO_2 emissions to	170 LT/D	NSPS = 99.9% eff.	1979 SIP
No. 4 SRU	atmosphere	234 LT/D	LAER = 99.95% eff.	1983 stipulation
SCOT	Tail gas rec. unit Nos. 3&4 SRU	404 LT/D	NSPS = 99.95% eff.	1983 permit
CO Boilers	Combust CO from FCC Regen to CO_2	53,800 B/D	99.99% eff.	
Low NO_x burners	Reduce NO_x emissions	As needed	Better than NSPS	New & repl heater burners
Flare system	Combust HC's to CO_2 & H_2O	137,000 B/D	Protect personnel, equip., envir.	
Flare gas recovery	Recover & use as fuel gas	-	Treat to NSPS w/fuel gas	Reduces routine flaring
Floating Roofs	Reduce HC emissions from crude oil, gasoline storage tanks	Per individual tank	99+% reduction	Voluntary retrofit of existing tanks
Bottom loading	Reduce HC emissions from gasoline truck loading	-	60% reduction over top loading	Voluntary retrofit

GLT263/47

Table 2-4
SUMMARY OF WASTE CHARACTERISTICS, AND QUANTITIES

Source/Water	Designation[a]	Average Quantities[b] (ton/yr)	Comments
Wastewater Treatment Plant			
API Separator Sludge	Hazardous	61	Entire quantity landfarmed
Equalization Basin Sludge	Nonhazardous	1,038	Generated biannually - all landfarmed
Dissolved Air Flotation Float	Hazardous	1,289	Approx. 3,800 tons/yr recycled at Coker, the balance listed is landfarmed
Slop Oil Emulsion Solids	Hazardous	2,805	Entire quantity landfarmed
Activated Sludge Basin Sludge	-	179	Entire quantity landfarmed, nutrient and microbe source
Aerobic Digestion Sludge	Nonhazardous	3,818	Entire quantity landfarmed, nutrient and microbe source
Total		9,190	
Process Equipment Wastes and Tank Bottoms			
Flareline and Drum Sludges	Hazardous	185	Entire quantity landfarmed
Heat exchanger bundle cleaning sludges	Hazardous	34	Landfarmed if acceptable to treatment, remainder is drummed and shipped to offsite disposal facility
Alkylation Acid Storage	Hazardous	37	Entire quantity, landfarmed following neutralization
Spent Poly Catalyst	Hazardous	40	Entire quantity landfarmed nutrient source
Spent Flake Caustic	Hazardous	1	Added to landfarm prior to 1982, currently used at WWTP
Spent Amines	Nonhazardous	90	Entire quantity landfarmed
Neutralizer Sludge	Nonhazardous	181	Entire quantity landfarmed, used to maintain soil pH
Cooling Tower Sludge	-	50	Entire quantity landfarmed
Nickel Filter Solids	Hazardous	3	Drummed and shipped to offsite disposal facility.
PCB Wastes	Hazardous	§1	Drummed and shipped to offsite disposal facility or incinerator
Leaded Tank Bottom	Hazardous	10	Volume reduction and chemical oxidation drummed and shipped to offsite disposal facility
Nonlead Tank Bottom	Hazardous	—[c]	
Total		721	
Oil Spill Cleanups	Nonhazardous	22	Contaminated soils are landfarmed, other materials drummed and shipped to offsite disposal facility.

[a]Designation are based upon KRC handling practices.
[b]Quantities are based upon KRC estimates and materials handling records.
[c]Included with flareline and drum sludges.

Table 2-5
MISCELLANEOUS WASTES

Waste	Designation[a]	Quantity[b]	Comments
Stormwater Pond Sediment	Nonhazardous	2,400 yds^3/cleaning	Cleaning once every on to two years. Disposed onsite as fill material.
Firewater Pond Sediment (Final Lagoon)	Nonhazardous	25,000 yd^3/cleaning	Cleaning once every 7 to 10 years. Removed waste has been chemically fixed and is stored onsite for dike construction at the tank farms.
WWTP Lagoon Sludge (Old WWTP Lagoons)	Hazardous	6,000 yd^3	One time generation at the time of lagoon closing. Removed waste has been chemically fixed rendering it nonhazardous. Presently stored onsite or is used in dike construction at the tank farms.
Terate Waste	Hazardous	1 ton	One time generation. Drummed and shipped offsite to disposal facility.

[a] Designations are based on KRC handling practices.
[b] Quantities are based upon KRC estimates and material handling records.

GLT495/36

conditions at the landfarm are maintained to provide an acceptable environment for waste treatment.

Landfarm operating activities include:

- Waste application by spray bar and movable drain pipes on a vacuum tank to distribute the wastes onto treatment cells
- Incorporation of waste into the soil by a vehicle with a large mechanical rotating screw (Brown Bear) to windrow the soil and provide aeration and moisture control
- Periodic aeration and turning of soil windrows during decomposition - specifically during the period of May through November
- Precipitation removal and moisture control by 1) temporary ditching to allow spring snowmelt to flow to an adjacent containment basin and 2) during the operating season by vacuum truck removal of water, and working the soil with the Brown Bear to enhance evaporation
- Preventing water from running onto or off the landfarm by using elevated berms around individual cells
- Enhancing the microbiological population by periodic addition of activated sludge
- Nutrient adjustment by periodic addition of fertilizer and lime according to agricultural recommendations
- Control of soil pH by the addition of refinery byproducts and agricultural lime

Monitoring of landfarm performance is accomplished by a groundwater monitoring network, upgradient and downgradient from the facilities. Unsaturated zone monitoring is also employed utilizing soil corings and vacuum pressure lysimeters.

The Koch landfarm is currently regulated under interim status standards of both state and federal hazardous waste programs. The hazardous waste programs allow facilities existing prior to enactment of the regulations to continue operation under the interim status standards until a decision is made regarding a final permit for the facility. Koch has been granted interim status for the entire 31-acre landfarm. For a facility to receive a permit it must provide a permit application that shows the facility is capable of meeting facility standards. A hazardous waste permit application has recently been submitted for the refinery; however, a treatment demonstration is required for the landfarm and is yet to be completed. The anticipated time to complete the treatment demonstration and the permit review process is 5 years. Therefore, Koch will continue to operate under the interim status standards for a considerable time.

Minnesota rules for solid waste and for groundwater protection are also applicable to the landfarm. Since the interim status requirements are more stringent than these requirements, by being in compliance with the interim status standards, Koch is essentially in compliance with these other requirements.

Regularly generated wastes that are not landfarmed are placed in 55-gallon drums and shipped to approved disposal sites or incinerator facilities located out-of-state. These wastes average less than 100 drums per year. A container storage facility is located onsite for storage of wastes awaiting shipment. The container storage facility is presently in compliance with interim status hazardous waste requirements. The hazardous waste permit will also include requirements for facilities for drummed waste storage.

Several other wastes are stored or disposed of onsite. One of these is "spent bauxite," which is disposed of in an onsite solid waste disposal area regulated under MPCA permit SW-226. The disposal area, located on the sulfuric acid unit property, is used for disposal of solid wastes from alum (aluminum sulfate) production. Alum, used in drinking water purification, is produced from sulfuric acid and bauxite ore. The unreacted silica and aluminum silicate in the bauxite ore are disposed of as "spent bauxite." The crude oil expansion would have no effect on this operation.

Chemical fixation has been used to treat WWTP lagoon sludge and fire water basin solids (permits HW-1 and SW-256, respectively). These treated wastes are stored onsite for future construction of retention dikes around storage tanks. The WWTP lagoon sludge resulted from closure of two wastewater treatment lagoons. The firewater basin solids are removed every 7 to 10 years. Permits HW-1 and SW-256 were for one-time treatment only. However, there are existing permits to allow for the treatment of waste by chemical fixation, and Koch plans to use this treatment method in the future.

Lastly, solid waste is generated by removing accumulated sediment in Koch's stormwater retention pond. The pond is cleaned approximately once every 2 years and the waste is utilized in various locations in the refinery as fill material.

2.1.4 ELEMENT FOUR - SUPPORT FACILITIES

The refinery is a self-contained facility with its own internal streets and roads, industrial water supply wells, storm sewers, fire fighting facilities, and other utilities and services necessary for operation. External requirements are electrical service provided by Northern States Power, natural gas provided by Peoples Natural Gas Company, telephone service by United Telephone, and garbage service provided by an independent hauler.

The refinery's water supply is provided by seven industrial wells permitted to appropriate 8,060 acre-feet of groundwater per year. Annual consumption has ranged from about 3,800 acre-feet to over 5,000 acre-feet per year.

Domestic sewage generated from onsite facilities is disposed of in nine septic tank/drain field systems on the plant site. Refuse is hauled by an independent hauler and disposed of at the nearby Pine Bend Landfill.

Onsite security is provided by cyclone fencing and full-time security guards. Access to the refinery is controlled by the security system.

Fire protection is provided by onsite equipment and trained refinery employees. Fire fighting equipment includes two apparatus trucks and a four-wheel-drive grass fire rig. There are 145 strategically located fire hydrants. Fire fighting training is provided to all new employees and refresher training is provided to current employees. Although Koch is generally self-sufficient with its fire fighting capabilities, it does maintain fire fighter assistance agreements with the Cities of Rosemount and Hastings.

2.2 PROPOSED REFINERY EXPANSION

The proposed expansion would involve the addition of both new facilities and the modification of existing facilities at Koch's refinery to achieve a 50 percent increase in production capacity. The expansion as it affects each of the four basic elements of the existing refinery operation is described below.

2.2.1 ELEMENT ONE - TRANSPORTATION OF CRUDE OIL AND REFINED PRODUCTS

Koch Refining Company will rely largely on the present network for transportation of the expanded refinery's crude oil and refined products.

Crude oil will continue to arrive in existing pipelines for the expanded refinery. The Minnesota pipeline will carry crude from Canada and North Dakota, and the Wood River pipeline from the south. Western Canadian crude will continue to be the primary source of crude oil, with North Dakota and St. Louis serving as secondary sources. Adequate pipeline capacity exists to handle the increased volume, assuming the ratio of Canadian/St. Louis crude purchases is maintained. The Minnesota Pipeline Company is pursuing plans to increase the capacity of its pipeline. This would allow both the Koch Refining Company and the Ashland Oil Company an opportunity to purchase a greater percentage of Western Canadian crude.

Products from the expanded facility would continue to leave the refinery by truck, barge, rail, and pipeline. Additional capacity exists in product pipelines and rail facilities to accommodate increased product transport. The expansion will cause more refined products to be shipped by barges. Increased barge movements of refined products, however, will be offset by the elimination of arriving crude barges (discontinued in 1982). Therefore, the barge facilities will be adequate for the expansion.

Truck transportation of refined products will increase about 50 percent, from an estimated 400 loads per day (1984) to about 600 loads per day with a peak rate of over 800 loads per day. Presently, truck loading facilities are sufficient in capacity to accommodate this increase.

2.2.2 ELEMENT TWO - CRUDE OIL PROCESSING

Koch Refining Company's proposed expansion involves the construction of new facilities and the expansion of existing facilities to allow for increased production of its current mix of refined petroleum products (Table 1-1). The total expansion will increase capacity by 50 percent or 70,000 barrels per day. The increase of the facility size will have no effect on the processing steps shown in Figures 2-2 and 2-3.

The proposed expansion will take place in two phases, each costing about $100 million. The first phase will increase production to 175,000 B/D and the second phase will push production to 207,000 B/D. The first phase, which will occur during 1985 and 1986, consists of the construction of the following new or expanded process units:

- Provide new 70,000 B/D crude and vacuum distillation equipment consisting of a crude oil atmospheric distillation tower, a vacuum distillation tower, a desalter unit used to separate brine from crude oil, and a naphtha stabilizer.

- Convert the existing No. 2 ultraformer to isomerization for conversion of naphtha to unleaded gasoline blending stocks, 10,000 B/D.

- Expand the No. 3 coker unit from 20,000 B/D to 30,000 B/D.

- Expand the flare gas recovery.

- Provide additional crude oil storage.

- Provide additional refined product storage.

The second phase, which will occur during 1987 and 1988, consists of the following:

- Provide a new 70,000 B/D preflash tower.

- Expand the fluid catalytic cracker (FCC) from 53,800 B/D to 65,000 B/D.

- Construct new 20,000 B/D capacity coker (No. 4 coker).

- Add a 20 million standard cubic foot per day (20 mmscfd) hydrogen plant. Hydrogen is a principal chemical reactant to remove sulfur from the process streams. Hydrogen is produced at Koch by reacting natural gas and steam into hydrogen and carbon dioxide.

- Add a No. 5 sulfur recovery unit with a 100 long tons per day capacity. This sulfur recovery unit will have a tailgas recovery unit, called a Shell Claus Offgas Treating (SCOT) unit, to meet EPA New Source Performance Standards (NSPS).

Figure 2-5 shows the location of these improvements and Table 2-6 shows the current and proposed capacity modifications for the refinery.

2.2.3 ELEMENT THREE - POLLUTION CONTROL FACILITIES

Modifications to the refinery's pollution control facilities will occur as a result of the expansion. The combined value of these improvements will be about 25 percent of the total project cost. Further details concerning their efficiency, performance, and compliance with relevant regulations are provided in Chapter 3.

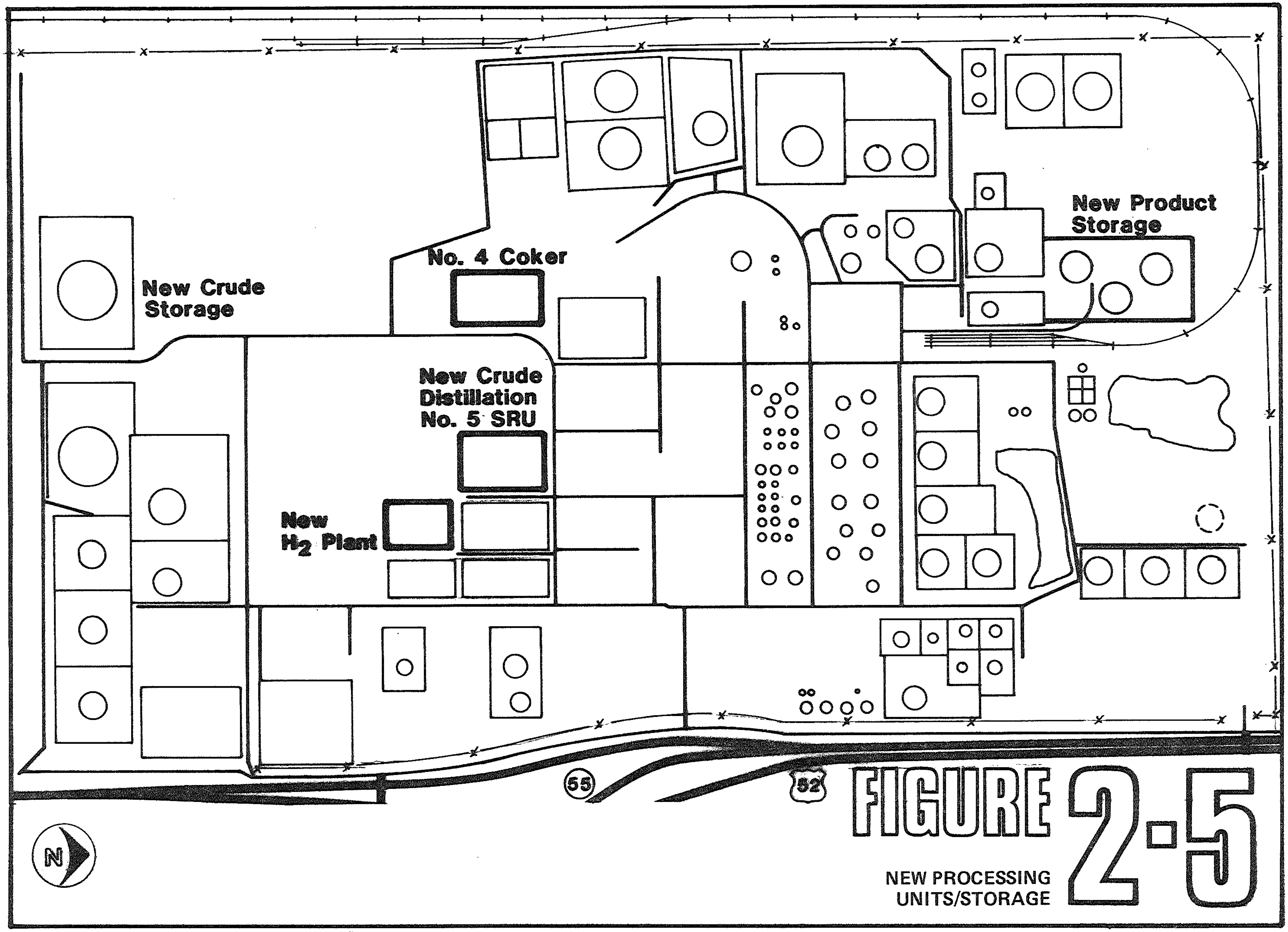


FIGURE 2-5

NEW PROCESSING
UNITS/STORAGE

Table 2-6
PROCESS UNIT DESIGN CAPACITIES

Process Unit	Existing Design Capacity B/D	New Facilities	Total After Expansion
Crude Rate (desalting)	137,000	70,000	207,000
Atmospheric Distillation	137,000	70,000	207,000
Vacuum Distillation	80,000	40,000	120,000
Catalytic Cracking	53,800	11,200	65,000
Thermal Cracking	45,000	30,000	75,000
Reforming	46,000	--	46,000
Polymerization	12,600	--	12,600
Asphalt Production	45,000	20,000	65,000
Hydrogen Production	20 MMCFD	20 MMCFD	40 MMCFD
Desulfurization/Hydrotreating	106,500	--	106,500
Sulfur Recovery	454 LT/D	100 LT/D	554 LT/D

GLT263/46

Wastewater Treatment

The wastewater generated from the expanded refining facility will have the same general characteristics as the existing process wastewater. Treatment of wastewater to meet new total facility effluent limitations will be accomplished by expanding and optimizing existing wastewater treatment plant facilities. The total facility effluent limitations will include Best Available Technology (BAT) and Best Conventional Pollutant Control Technology (BCT) for the existing refinery, New Source Performance Standards (NSPS) for the new refining facilities, and MPCA limitations, where applicable.

The expanded WWTP will be designed and constructed to treat both increases in process water and stormwater runoff. Wastewater flows to the WWTP from the expanded refinery are projected to be 4.3 mgd of process water and 1.0 mgd of noncontact water. Stormwater will also be a component of the wastewater flow. In August 1984, U.S. EPA proposed rules that would require the treatment of contaminated stormwater runoff. EPA defines "contaminated runoff" as "runoff that comes into contact with any raw material, intermediate product or waste product located on a petroleum refinery." Under this proposal, the Koch Refining Company would be required to treat in excess of 300 million gallons per year of stormwater runoff following refinery expansion. Therefore, the expanded WWTP will include capacity for treating all contaminated runoff (0.9 mgd) from the 420-acre refinery area.

Based on preliminary engineering information, it is anticipated that the following WWTP unit processes will be expanded to accommodate the increased flow: 1) pretreatment facilities, 2) equalization basins, and 3) activated sludge basins. The original WWTP design anticipated increases in future flows and provided for expansion of each of these units.

In the existing pretreatment facilities, consisting of two API oil/water separator channels and a dissolved air flotation (DAF) unit, space was reserved for an additional DAF unit and related treatment tanks.

There are presently two equalization basins that provide for mixing of influent wastewater prior to DAF and activated sludge treatment. In 1977, space was reserved for two additional basins, one or two that could be used as equalization basins, or else one or two that could be used as activated sludge basins.

The existing activated sludge system consists of two aeration basins and two clarification units. As described above, there is plot space for one or two additional aeration basins depending on the configuration recommended to provide optimal treatment of the increased wastewater flow. Plot space is also available for an additional clarification unit.

Air Pollution Controls

New source performance standards (NSPS) have been developed for petroleum refineries. The refinery equipment that is required to meet NSPS limits includes the FCC unit catalyst regenerators, fuel gas combustion devices, Claus sulfur recovery plants, hydrocarbon storage tanks, compressors, valves, pumps, pressure relief devices, sampling systems, flanges, connections, open-ended lines and control equipment such as vapor recovery systems, flares, and closed vent systems. In addition, fuel burning equipment, such as boilers of a specific size, is required to meet NSPS emission standards. The Koch Refining Company has proposed to install equipment that will meet NSPS requirements on all new refinery processes, equipment, and storage tanks. Table 2-7 lists the principal pollution control facilities to be provided with expansion.

Solid and Hazardous Waste Disposal

The volume of solid and hazardous waste requiring disposal with the expansion is estimated to increase slightly from historic conditions (1982), but will be less than current conditions (1984). The volume of oil to be landspread will decrease because of a waste volume reduction due to the expansion of coker No. 3 and the addition of coker No. 4, and enhancements in the slop oil recovery system.

The proposed expansion will result in a net reduction in the water content of the waste going to the landfarm. Installation of sludge dewatering equipment will significantly reduce the amount of water to be sent to the landfarm for treatment.

The overall effect of the expansion will be a net reduction in the volume of waste disposed of at the landfarm on a yearly basis. Koch's estimate is that the landfarm life will be reduced by 20 percent because of increased metal loading.

2.2.4 ELEMENT FOUR - SUPPORT FACILITIES

The refinery's principal support facilities consist of the water supply, domestic sewage and electrical service systems. The water supply system is capable of serving the expansion without major modification. The domestic sewage system will be expanded to meet the demands of an increased work force. The refining electrical service has adequate transmission facilities, but substation modifications will be required to increase capacity.

Table 2-7
AIR POLLUTION CONTROL FACILITIES FOR REFINERY EXPANSION

Facility	Purpose	Capacity	Performance	Comments
No. 5 SRU	Convert H_2S to S, reduce SO_2	100 LT/D	NSP - 99.9% eff	
SCOT	TGRU for No. 5 SRU	100 LT/D		
Low NOx Burners	Reduce NOx emissions	As needed	Better than NSPS	New & replacement heat burners
Flare System Exp	Safety system with minimum visable impact	70,000 B/D	State-of-the-art in smokeless & non-radiating flare technology	
Floating Roofs	Reduce HC emissions from storage tanks	Per individual tank	98+% control	All new crude oil & gasoline tanks
Related Facilities				
Energy recovery & fuel gas generation	Reduce or replace fuel oil as fuel in heaters and boilers	-	Fuel gas at NSPS is 0.1 gr/DSCF	Cracking processes yield fuel gas
Flare gas recovery exp	Recovery & use as fuel gas	-	Treat to NSPS w/fuel gas	Reduces routine flaring

GLT495/20

Water Supply

The refinery's water supply needs are expected to increase to about 5,500 acre-feet annually. Historically, the water demand for the refinery has been between 3,850 acre-feet and 5,040 acre-feet. The permitted appropriation for Koch is 8,060 acre-feet of groundwater per year for the operation of the existing facilities. No modification of the permitted appropriation will be necessary for the expansion.

Existing water supply wells and mains are adequately sized for future water supply needs. The water distribution network, however, will be extended to new facilities onsite.

Domestic Sewage

Septic tanks and drain fields will be added or expanded to accommodate the increased number of refinery employees. The location and construction of these facilities will comply with the Minnesota Onsite Treatment System standards enforced by the MPCA and the Dakota County Department of Health Services. The increase in employment will require that about four new septic tank/drain fields be added. The size and location of these systems will be determined during the permitting process.

Electrical Power

The power needs for the expanded refinery are projected to be 57,000,000 kWh per month. This represents an increase of 16,000,000 kWh per month. Power usage calculated on a production basis, however, indicates that the expanded refinery will use 8 percent less electricity per barrel than the existing facility. The present transmission facilities are adequate to serve the increased load; however, additional substation capacity will be necessary.

GLT263/45

CHAPTER 3

ENVIRONMENTAL IMPACTS AND MITIGATION

Chapter 3.0
ENVIRONMENTAL IMPACTS AND MITIGATION

This chapter describes the environmental effects of implementing the proposed crude expansion project. The discussion of environmental effects has been directed to those issues and concerns enumerated in Chapter 1. The related environmental topics have been presented individually, describing existing conditions, impacts, and possible mitigating measures.

For each of the individual topics, the analysis describes the relevant direct and indirect impacts, as well as adverse and beneficial effects, of the proposed project. Whenever possible, the significance of the impact is given quantitative support. When quantification is not possible or is difficult, other means are used to describe the impact, such as its extent, relative importance, or duration.

This chapter addresses the impacts from implementing the proposed project only. A comparative evaluation of the proposed project and the alternatives is presented in Chapter 4.

GLT505/6

3.1 AIR QUALITY

Air quality is one of the most important issues in the evaluation of the Crude Expansion Project. This section contains a description of existing air quality conditions in the project area, air quality impacts, and possible mitigating measures for the expansion. The existing air quality is described for criteria pollutants, noncriteria (toxic) pollutants, and odors; the impact discussion parallels each of these topics for easy comparison. Under "Impacts," malfunctions and responses to emergencies are discussed. The section ends with the discussion of mitigation.

3.1.1 EXISTING CONDITIONS

Criteria Pollutants

Seven air pollutants, known as "criteria pollutants" are regulated by national and state ambient air quality standards. These pollutants include particulate matter, sulfur oxides (SO_x), nitrogen oxides (NO_x), lead, carbon monoxide (CO), hydrocarbons, and ozone. The standards and regulations that apply to the criteria pollutants are discussed in this section along with a description of pollutants emitted from the refinery.

Standards and Regulations. The Minnesota Pollution Control Agency (MPCA) is responsible for the development and enforcement of the ambient air quality standards and regulations by which the crude refinery expansion project will be evaluated. National and state ambient air quality standards are presented in Table 3-1 (Minnesota Code of Agency Rules, Title 6). Primary air quality standards are pollution levels established to protect the public health, while secondary standards exist to prevent harmful public welfare effects such as vegetation damage and visibility degradation.

Areas where ambient air quality standards are exceeded are defined as nonattainment areas. The Koch Refining Company crude oil refinery is located in a designated sulfur dioxide primary nonattainment area. Procedures and analyses are being undertaken by the MPCA and the Koch Refining Company to have the area redesignated as attainment for the SO_2 ambient air quality standards because there have been no primary standard violations since 1982. After the analyses are completed, it will take the U.S. EPA about a year to review and approve the redesignation.

The Minnesota Acid Deposition Control Act requires that a deposition standard be adopted by the state by January 1, 1986. There is no official interim state policy regarding an SO_2 emissions ceiling as it would relate to state efforts to control acid deposition. However, until the acid deposition control strategy is adopted, the MPCA is arguing against

Table 3-1
AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	National Standards				MPCA Standards			
		Primary		Secondary		Primary		Secondary	
		µg/m³	ppm	µg/m³	ppm	µg/m³	ppm	µg/m³	ppm
Particulates	Annual Geometric Mean[a]	75	--	60	--	75	--	60	--
	24-hour Maximum[b]	260	--	150	--	260	--	150	--
Sulfur Dioxide	Annual Average[a]	80	0.03	--	--	80	0.03	60	0.02
	24-hour Maximum[b]	365	0.14	--	--	365	0.14	365	0.14
	3-hour Maximum[b]	--	--	1,300	0.50	1300	0.50	1,300	0.50[f]
	1-hour Maximum[b]	--	--	--	--	1300	0.05	--	--
Nitrogen Dioxide	Annual Average[a]	100	0.05	100	0.05	100	0.05	100	0.05
Carbon Monoxide	8-hour Maximum[b]	--	9	--	9	--	9	--	9
	1-hour Maximum[b]	--	35	--	35	--	30	--	30
Ozone	1-hour Maximum[b]	235	0.12	235	0.12	235	0.12	235	0.12
Lead	Calendar Quarter	1.5	--	1.5	--	--	--	--	--
Hydrocarbons (nonmethane)	3-hour Maximum[b,c]	--	--	--	--	160	0.24	160	0.24
Hydrogen Sulfide	0.5-hour Maximum[d]	--	--	--	--	70	0.05	--	--
	0.5-hour Maximum[e]	--	--	--	--	42	0.03		

Source: U.S. Environmental Protection Agency and Minnesota Pollution Control Agency.

[a]Never to be exceeded.

[b]Not to be exceeded more than once per year.

[c]Applies to hours 0600 to 0900.

[d]Not to be exceeded more than twice per year.

[e]Not to be exceeded more than twice in any 5 consecutive days.
[f]Applies to Air Quality Control Regions 128, 131, and 133.

GLT505/78

net SO_2 emissions increases from facilities because of possible future conflicts with the 1986 control strategy.

The MPCA is going to review the state hydrocarbon standard as a part of the mid-1985 acid deposition standard setting process. The hydrocarbon standard was originally adopted as part of an ozone control strategy. More sophisticated approaches to ozone control are available today. It is the MPCA's intent to eliminate the hydrocarbon standard as being inappropriate for ozone control. EPA eliminated the federal hydrocarbon standard in 1983 (Federal Register 1/5/83, pp. 628-9). The decision by the MPCA whether to keep or eliminate the hydrocarbon standard is expected by the end of 1985.

The crude refinery is located in an area of nonattainment of the secondary particulate standard. Based on the MPCA analysis of the situation, area sources and not industrial point sources of particulate matter are the most significant contributors to the nonattainment problem.

New or modified sources of air pollution in the state are required to obtain permits from the MPCA to install and operate. Before air pollution permits are issued, the MPCA reviews proposed projects for compliance with all applicable regulations. The proposed crude refinery expansion must demonstrate compliance with state standards of performance specific to petroleum refineries (MR 7005.2100 to 7005.2160) and storage vessels (MR 7005.1260 to 7005.1280). Provisions for compliance with continuous monitoring, testing, reporting, and breakdown regulations (MR 7005.1850 to 7005.1880); with emergency episode regulations (MR 7005.2950 to 7005.3006); with odor regulations (MR 7005.0900 to 7005.0960); and with visible emissions regulations (MR 7005.1100 to 7005.1130) must be included in the proposed project (Minnesota Code of Agency Rules, Title 6).

Emissions of SO_2 and particulates from the refinery modification will be evaluated for compliance with the Offset Rule (MR 7005.3010 to 7005.3060). Facility modifications located in nonattainment areas are subject to offset requirements if there is a significant net increase in emissions for sources of 100 tons per year of the nonattainment pollutant. A significant net increase is defined as 40 tons per year for SO_2 emissions and 25 tons per year for particulate emissions (Minnesota Code of Agency Rules, Title 6).

The MPCA has authority for reviewing projects under Prevention of Significant Deterioration (PSD) regulations. Major sources located in attainment areas are subject to PSD regulations. The proposed project is a major source according to the PSD definition. Best available control technology (BACT) will be required for the regulated pollutants emitted with significant emission increases. Significant emission increases applicable to the refinery under PSD regulations are defined as greater than 40 tons per year of NO_x, 100 tons per year of CO, 40 tons per year of VOC, 10 tons per year of hydrogen sulfide, and 10 tons per year of reduced sulfur compounds (including H_2S). Dispersion modeling is required, and monitoring for the pollutants of concern can be required as part of the PSD review process.

Ambient Monitoring Data. The MPCA operates a continuous monitoring station southeast of the intersection of Minnesota Highway 55 and U.S. Highway 52, approximately 1,000 feet from the main refinery operations (Figure 3-1). Air quality data are collected for sulfur dioxide and particulates on a year-round basis. Hydrocarbon measurements were made during the summer of 1983. Continuous meteorological data (wind speed and direction, and temperature) are also collected at this site. No recent data for nitrogen dioxide, carbon monoxide, ozone, or lead concentrations are available within the project area. Some historical lead data and regional ozone data are available. Copies of the 1983 MPCA monitoring data reports are presented in the Air Quality Technical Report - Appendix A.

Particulates. A summary of the 1983 and 1984 particulate monitoring data collected at the MPCA station is presented in Table 3-2. The monitored concentrations are below primary particulate standards. One concentration equaled the 24-hour secondary particulate standard of 150 micrograms per cubic meter ($\mu g/m^3$). No measurement exceeded the secondary standards; therefore, violation levels were not monitored during this time period.

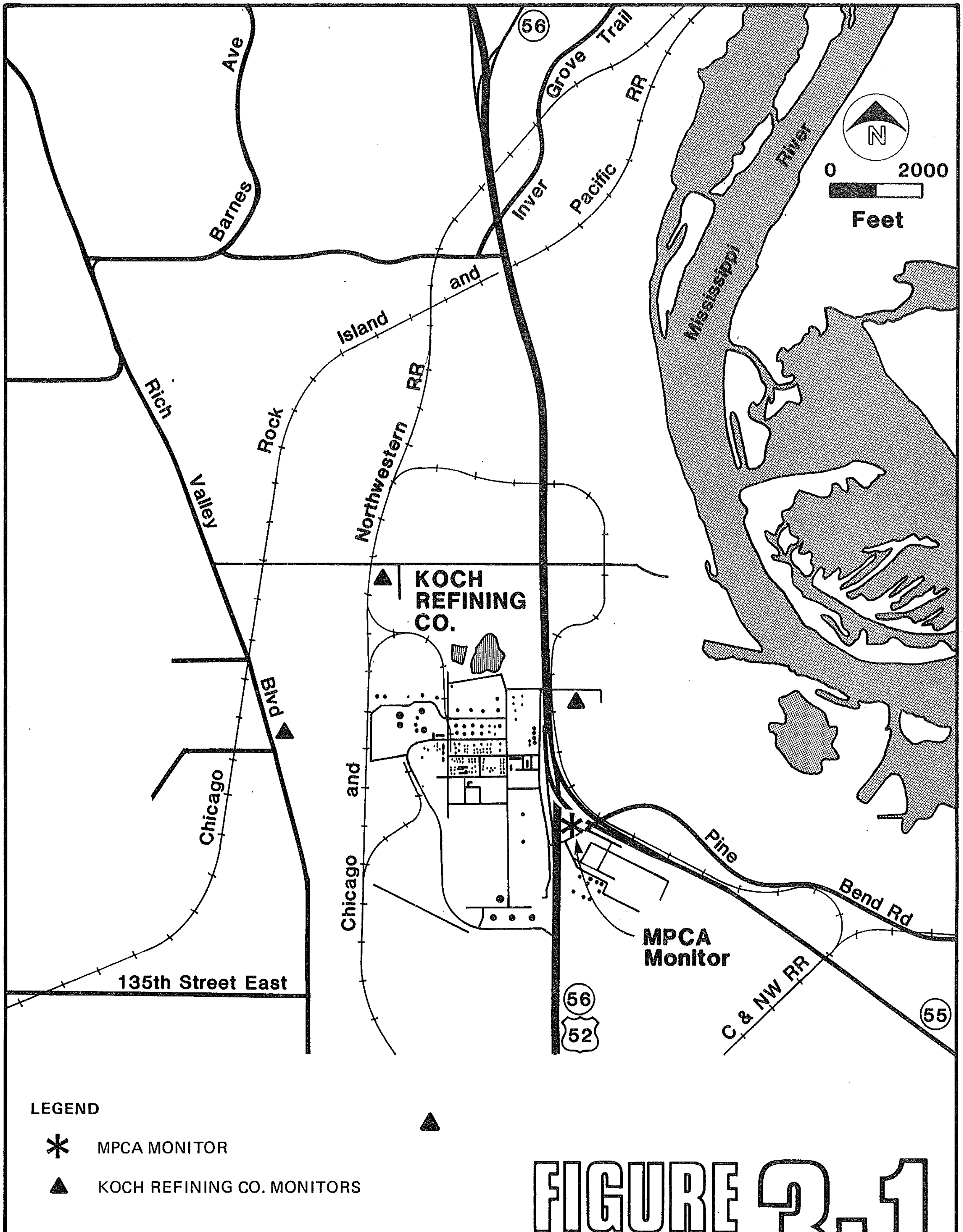


FIGURE 3-1

AMBIENT AIR QUALITY
CONTINUOUS MONITOR LOCATION

Table 3-2
PARTICULATE MONITORING DATA SUMMARY

Month	24-Hour Maximum Concentration (μg/m³) 1983	1984
January	60	79
February	81	65
March	98	65
April	64	143
May	138	92
June	110	108
July	150	75
August	115	106
September	124	40
October	93	--
November	43	--
December	67	--
Annual Geometric Mean (μg/m³)	53	57[a]

Source: Minnesota Pollution Control Agency, Site 0420.

[a]Partial year of data.

Sulfur Dioxide. There are five SO_2 monitoring sites within the project area: the MPCA site and four sites operated by the Koch Refining Company. A summary of monitoring data collected at these sites is presented in Table 3-3. The 1983 annual average SO_2 concentration at the MPCA site was 0.009 parts per million (ppm), which is well below the primary (0.03 ppm) and secondary (0.02 ppm) standards. One average SO_2 concentration in excess of the 24-hour standard (0.14 ppm) was measured at the MPCA site. One SO_2 concentration above the 1-hour standard (0.50 ppm) was recorded at the MPCA monitoring station. Exceeding the standards once during a year does not constitute a violation.

Four SO_2 monitoring stations are operated by the Koch Refining Company on or near refinery property. The Koch monitoring network is a result of a stipulation agreement between the MPCA and Koch and provides information to support SO_2 nonattainment area redesignation efforts and to monitor emergency response situations. Each fluorescent SO_2 analyzer uses a computer to collect and analyze data and has a backup strip chart recorder. Data from each monitor are directly telemetered to the Koch refinery and MPCA offices. Operational procedures are based on PSD ambient monitoring

Table 3-3
SULFUR DIOXIDE MONITORING DATA SUMMARY

Year	Annual Average (ppm)	24-hour Averages[a] Maximum (ppm)	24-hour Averages[a] Second Highest (ppm)	3-hour Averages[a] Maximum (ppm)	3-hour Averages[a] Second Highest (ppm)	1-hour Averages Maximum (ppm)	1-hour Averages Second Highest (ppm)
1983							
MPCA Site[b]	0.009	0.154	0.103	0.355	0.318	0.550[c]	0.406
KRC NE Site[d,e]	0.007	0.083	0.071	0.211	0.172	0.329	0.293
KRC NW Site[d,e]	0.002	0.056	0.032	0.110	0.096	0.146	0.126
KRC W Site[d,e]	0.001	0.028	0.013	0.166	0.081	0.248	0.153
KRC S Site[d,e]	0.002	0.032	0.017	0.053	0.043	0.068	0.057
1984							
MPCA Site[b,e]	0.012	0.102	0.098	0.207	0.197	0.279	0.255

Source: Minnesota Pollution Control Agency.

[a]Block averages.

[b]MPCA monitoring station, Site 0420.

[c]Violation level measured for 1 hour only.

[d]Koch Refining Company site.

[e]Partial year of data.

GLT505/80

guidelines and the EPA Quality Assurance Handbook for Air Pollution Measurement Systems. Quarterly reports are prepared and submitted to the MPCA. The Koch Refining Company's SO_2 and meteorological data collection sites began operation in July 1983. Data collected at these stations are below violation levels and less than those measured at the MPCA site (Table 3-3). The four Koch SO_2 monitors were not in operation during the period of elevated 1-hour and 3-hour SO_2 concentrations that were recorded at the MPCA site.

Hydrocarbons. Hydrocarbon concentrations were monitored at the MPCA site during the 1983 summer period of May through October. This monitoring was performed to provide background data for a toxic air pollutant assessment at the refinery. Table 3-4 is a summary of these hydrocarbon monitoring data. Hydrocarbons are divided into two basic groups, methane and nonmethane. Nonmethane hydrocarbons tend to be more reactive in the atmosphere and participate in the formation of photochemical oxidants (e.g., ozone). Volatile organic compounds (VOC) contribute to the nonmethane portion of ambient hydrocarbon levels. The highest nonmethane hydrocarbon concentration monitored during normal refinery operating conditions was a 1-hour average of 16.5 ppm (Table 3-4). The state nonmethane hydrocarbon standard of 0.24 ppm applies to the 3-hour time period between 0600 and 0900. The standard was set to prevent ozone formation rather than any direct nonmethane hydrocarbon effects. The highest and second highest nonmethane hydrocarbon concentrations monitored for that time period in 1983 were 7.30 ppm and 3.57 ppm, respectively. Several violations of the state standard were recorded during the 1983 monitoring program.

Ozone monitoring data are not available within the study area. The MPCA uses the ozone station to the southeast near Hastings, Minnesota, (Site 6011) to monitor regional ozone trends. Ozone data collected at the Hastings site are summarized in Table 3-5. No concentrations above the 1-hour average 0.12 ppm ozone standard were recorded during the 4-year period. No violations of the ozone standard have been monitored anywhere in the state for the past 5 years.

Lead. Monitoring data for ambient lead within the study area are limited to measurements taken in 1972 through 1975. These historical lead data are presented in Table 3-6. The highest lead concentration averaged over one calendar quarter occurred in the first quarter of 1973. The highest calendar quarter lead concentration was 0.76 $\mu g/m^3$, which is about half of the 1.5 $\mu g/m^3$ standard for the same averaging period. The ambient lead concentration is most likely dominated by automobile emissions. With the present and future lead phase down programs, the current and future ambient concentrations should be less than those measured a decade ago.

Table 3-4
HYDROCARBON MONITORING DATA SUMMARY

1983	One-Hour Averages (ppm) Nonmethane Maximum	Nonmethane Second Highest	Methane Maximum	Methane Second Highest
May	6.0	6.0	4.6	3.2
June	9.4	8.8	4.0	3.6
July	14.3	9.1	5.1	4.7
August[a]	16.5[b]	16.3	3.6	3.5
September	12.3	10.2	4.3	4.3
October	11.9	8.0	4.7	3.5

Source: Minnesota Pollution Control Agency, Site 0420.

[a]Maximum 3-hour average nonmethane hydrocarbon concentration is 7.3 ppm between the hours of 0600 and 0900.

[b]Highest monitored value during normal refinery operating conditions.

Table 3-5
REGIONAL OZONE MONITORING DATA[a]

Year	Annual Average (ppm)	One-Hour Average Maximum (ppm)	One-Hour Average Second Highest (ppm)
1984[b]	0.032	0.103	0.101
1983	0.028	0.116	0.103
1982	0.029	0.093	0.085
1981	0.022	0.092	0.089

Source: Minnesota Pollution Control Agency.

[a]Site 6011 near Hastings, Minnesota.

[b]Partial year of data.

Table 3-6
HISTORICAL LEAD MONITORING DATA

Month	Concentration (μg/m³) 1972	1973	1974	1975
January	ND[a]	1.292	0.268	0.297
February	ND	0.330	0.298	0.305
March	ND	0.650	0.183	0.283
April	ND	0.132	0.088	0.343
May	ND	ND	0.315	0.055
June	0.001	ND	0.043	ND
July	0.007	ND	0.130	ND
August	0.010	ND	0.173	ND
September	0.004	0.790	0.299	ND
October	0.004	0.484	0.319	ND
November	0.010	0.362	0.165	ND
December	0.016	0.208	0.623	ND
Annual Average[b]	0.007	0.531	0.242	0.257

Source: Minnesota Pollution Control Agency, Site 0420.

[a]No data.

[b]Based on one sample per month.

Table 3-7
EXISTING REFINERY EMISSIONS

Pollutant	Ending 1982 (ton/year)	Before-Expansion (ton/year)[a]	Net Change (ton/year)
Particulates	1,532	1,465	-67
Sulfur Dioxide	11,899[b]	10,048[b]	-1,851
Hydrocarbons[c]	3,344	3,344	0
Nitrogen Oxides	3,070	3,090	20
Carbon Monoxide	229	237	8

Source: Koch Refining Company.

[a]Includes three permitted projects constructed after 1982 but before the proposed expansion project.

[b]Includes fuel gas combustion.

[c]Includes emissions from boilers, heaters, storage tanks, truck loading, fugitive sources, and API separator.

Refinery Emissions. Criteria pollutants emitted from the refinery include particulates, SO_2, NO_x, CO, and hydrocarbons. With the exception of hydrocarbons and fugitive dust, these pollutants primarily result from refinery process and combustion units (e.g., boilers and heaters). Koch Refining Company provided the emission estimates presented in Table 3-7. Emissions were calculated for two time periods, ending 1982 and before-expansion. Estimates at the end of 1982 are based on sources existing at that time, which were emitting pollutants at rates allowable by permits. The critical plant site emission limit is detailed in the State Implementation Plan as 32.5 tons of SO_2 per day.

Three additional sources, permitted for construction after 1982, are part of the existing refinery. These three sources are the No. 38 hydrotreater, the No. 4 sulfur recovery unit (SRU), and the No. 3 coker. Refinery emissions resulting from construction of these three sources are listed under before-expansion emissions in Table 3-7, even though the No. 38 hydrotreater is still under construction. The reductions in before-expansion SO_2 and particulate emissions from ending 1982 levels are the result of more efficient controls and less residual oil combustion.

An evaluation was made of the emission estimates provided by the Koch Refining Company. Emission factors published by the EPA were compared against the factors used to generate refinery emission estimates. The refinery factors are close to, or slightly higher than, the factors published by EPA (EPA, AP-42). For example, the EPA's SO_2 factor for residual oil combustion is 1.83 pounds of SO_2 per million British Thermal Units Btu, and the comparable refinery factor is 2.03 pounds of SO_2 per million Btu. The EPA's calculated factor for refinery gas SO_2 emissions is 0.0071 pounds of SO_2 per million Btu, which is slightly less than the 0.0077 pounds of SO_2 per million Btu used by the Koch Refining Company. The No. 4 SRU is controlled to lowest achievable emission rates of 1.9 pounds of SO_2 per long ton of sulfur. All new heaters use low NO_x burners that emit 0.10 pounds of NO_x per million Btu.

Spot checks for heat balance and fuel gas generation also were made. No serious discrepancies were found in the data provided. Emission factor checks, heat balances, and production rate evaluations were used to review the total refinery emission estimates. Based on these evaluation techniques and the support information provided, the Koch Refining Company's estimates for criteria pollutant emissions appear to be reasonable.

Toxic Air Quality Pollutants

Seven toxic air pollutants were selected by the MPCA staff for detailed evaluation in terms of the refinery expansion. An initial list of potential noncriteria contaminants was developed based on information on Koch's product gasoline component mix and process emission information contained in the literature. (U.S. EPA, "Compilation of Air Pollutant Emission Factors," Research Triangle Park, N.C. AP-42; and R.G. Wetherold and P.D. Rosebrook, "Assessment of Atmospheric Emissions from Petroleum Refining: Volumes 1 and 2," Radiar Corporation, EPA-600/2-80-075, April 1980.) Seven compounds were selected based on expected relative concentrations, and the ability to accurately sample for them in the field. Two of the compounds selected are carcinogenic, and five of them have relatively low threshold limit values (TLV). The toxics that were selected include anthracene, benzene, biphenyl, formaldehyde, hydrogen sulfide, toluene, and xylene.

Standards. Federal and state agencies have not established ambient air quality standards for toxic air pollutants. The EPA and many states are performing studies to establish toxic standards, but the issues are very complex and the work is not complete. Michigan is one of the few states to have established review criteria. Most of the standards for toxics have been developed for worker exposure as threshold limit values. Threshold limit values (TLV) for the pollutants of concern are presented in Table 3-8.

TLV's have recently been used to determine acceptable levels of air pollutants in ambient air. Although there are arguments against this approach, the weight of scientific data supporting the TLV's makes their use attractive as a foundation for extrapolating acceptable exposures in ambient air.

The Michigan Department of Natural Resources has developed technical methods for determining acceptable emission rates from noncriteria pollutant sources. The MPCA is currently using the Michigan Policy and other risk assessment policies in assessing the risk of new sources. For noncarcinogenic pollutants, acceptable concentrations at or beyond the source property line must be less than 0.04 $\mu m/m^3$, or less than 1 percent of the TLV, or within safety factors calculated using a toxicity model. Using 1 percent of the most stringent TLV for each pollutant (Table 3-8), Michigan's acceptable ambient concentrations (AAC) were calculated and are presented in Table 3-9. For comparison, the results of another AAC calculation method are also listed in Table 3-9 for evaluation of noncancerous health effects. In this method, the AAC's are determined by adjusting occupational health standards with a margin of safety. There are problems associated with the use of TLV's in the derivation of safe ambient exposure levels. Safe ambient exposure levels should be based on continuous

Table 3-8
TOXIC AIR POLLUTANT THRESHOLD
LIMIT VALUES (ppm)[a]

Agency	Anthracene	Benzene	Biphenyl	Formaldehyde	Hydrogen Sulfide	Toluene	Xylene
OSHA[b]	NL[c]	10	0.2	3	20[d]	200	100
NIOSH[e]	NL[c]	10	0.2	2	20[d]	100 (200)[d]	100
ACGIH[f]	0.025[g]	10	0.2	2	10	100	100

Source: OSHA, NIOSH, ACGIH.

[a]8-hour time weighted average (TWA) values.

[b]Occupational Safety and Health Administration.

[c]No level.

[d]Ceiling value never to be exceeded.

[e]National Institute for Occupational Safety and Health.

[f]American Conference of Governmental Industrial Hygienists.

[g]Based on coal tar pitch volatiles TLV of 0.2 mg/m^3 (selected with MPCA).

GLT505/85

Table 3-9
GUIDELINES FOR ACCEPTABLE AMBIENT
TOXIC POLLUTANT CONCENTRATIONS

Pollutant	Michigan Program[a] (ppb)	Annual AAC[b,c] (ppb)	24-Hour AAC[b,d] (ppb)
Anthracene	0.25	0.057	0.17
Benzene	0.45[e]	22.8	66.7
Biphenyl	2.00	0.46	1.33
Formaldehyde	1.14[e]	4.6	13.3
Hydrogen Sulfide	100	22.8	66.7
Toluene	1,000	228	667
Xylene	1,000	228	667

[a]Michigan methods for calculating allowable emission rates is based on 1% of TLV for noncarcinogenic pollutants.

[b]Acceptable Ambient Concentration (AAC) representing threshold effects.

[c]Annual AAC = TLV/438. Includes a safety factor of 100 and 8,760/2,000 annual hours of exposure adjustment for non-cancerous health effects.

[d]24-hour ACC = TLV/150. Includes a safety factor of 50 and 24/8 daily hours of exposure adjustment for noncancerous health effects.

[e]Maximum annual concentration calculated from inhalation potency and 10^{-5} acceptable risk. Assumes a 60-kg person breathing at 20 m^3/day over a 70-year exposure for cancer risk assessment.

exposure while TLV's are based on 8-hour worker exposures. Factors are used to calculate AAC's from TLV's that are designed to compensate for the exposure differences. Time adjustment factors are the ratio of ambient exposure hours to the hours of worker exposure (i.e., the daily adjustment factor is 24 hours/day divided by 8 hours/day, and the annual adjustment factor is 8,760 hours/year divided by 2,000 hours/year). In addition to time adjustments, safety factors are used to account for the differences between continuous ambient exposures and interrupted worker exposures. Adjusting the TLV for the difference in averaging time and incorporating a safety factor results in the AAC.

The Michigan technical approach to carcinogenic pollutants involves risk assessment. The Minnesota Department of Health commonly uses less then one excess depth in 100,000 (10^{-5}) per year as the acceptable risk in Minnesota. Risk is a function of the potency and dose (ground level concentration) of the chemical inhaled.

Benzene and formaldehyde are known or suspected human carcinogens. The potency slope for benzene is 0.020700 milligrams/kilogram per day $(mg/kg/ day)^{-1}$ and for formaldehyde is 0.0214 $(mg/kg/day)^{-1}$. New research is being conducted on the potency of formaldehyde. There is some uncertainty about the reported potency slope for formaldehyde. Until the new research is complete, a better potency number is not available. A maximum allowable annual concentration can be calculated by combining the acceptable risk and potency slope information for each pollutant. The maximum annual ground level concentration at or beyond the property line must not exceed 1.14 ppb for formaldehyde or 0.45 ppb for benzene in order to comply with the acceptable cancer risk level (10^{-5}). The calculations for these concentrations are presented in The Air Quality Technical Report - Appendix C.

Ambient Monitoring Data. A toxic air pollutant monitoring study was conducted by CH2M HILL, INC., at the crude oil refinery from October 22 through October 27, 1984. Methodologies for sampling and testing were selected in advance by the MPCA staff and CH2M HILL, INC. The report describing the methodologies and results of the monitoring program is presented in The Air Quality Technical Report - Appendix B. Air samples were collected at various locations just off the refinery property. Sampling locations were selected according to wind directions during the sampling period. Wind speeds were very strong, in the 5- to 20-miles per hour (mph) range, every day. Wind directions were generally southerly (southeast to southwest) and persistent. Ambient temperatures averaged about 50°F and ranged from 37°F to 70°F.

The pollutants sampled in the monitoring program included anthracene, benzene, biphenyl, formaldehyde, hydrogen sulfide, toluene, and xylene. There are several problems inherent in all short-term ambient monitoring programs that can be identified before evaluating the results. Measured concentrations are representative of conditions at one location at the time of sampling and are not necessarily representative of worst case air quality conditions. Concentrations would probably be higher under different meteorological conditions (e.g., lower wind speeds). Monitored concentrations in this study are short-period, less than 1-hour average concentrations. Ambient concentrations may be lower for the longer, 24-hour or annual averaging times.

The maximum concentrations of toxic air pollutants measured downwind of the refinery are listed in Table 3-10. All of the measured concentrations, except for anthracene and formaldehyde, are less than the most stringent guidelines for acceptable toxic pollutant concentrations (Table 3-9). The anthracene concentration of 0.070 ppb is greater than the annual AAC of 0.057 ppb, but much less than the other two guideline concentrations (Table 3-9).

The most stringent guideline concentration for formaldehyde is 1.14 ppb as an annual ground level concentration (Table 3-9). The maximum measured downwind formaldehyde concentration of 4.0 ppb exceeds this guideline, but is less than the other two guideline concentrations. An upwind formaldehyde concentration of 6.0 ppb also was measured, indicating the potential presence of other formaldehyde sources contributing to area concentrations.

Hydrogen sulfide monitoring data were collected at the MPCA monitoring station during 1972 through 1974. The maximum H_2S concentration measured at the MPCA station was 7 ppb. The recent 1984 ambient monitoring program recorded a 7.8 ppb maximum H_2S concentration. Both of these values are less than the guideline concentrations listed in Table 3-9, and less than the state standard of 30 ppb, but are greater than the odor threshold concentration of 0.5 ppb.

Refinery Emissions. Total nonmethane hydrocarbon (NMHC) emission estimates for the refinery were supplied by the Koch Refining Company. Organic noncriteria air pollutant emissions presented in Table 3-11 were calculated using several methods. Emissions of benzene, xylene, and toluene from storage tanks, truck loading, and fugitive sources were calculated using the Koch Refining Company's vapor composition of the product. The molecular percent times the molecular weight of the component divided by the total vapor molecular weight yields the fraction by weight of the component in vapor. These weight fraction calculations were performed for two temperatures (50°F and 110°F) and are listed in The Air Quality Technical Report - Appendix C.

Table 3-10
MONITORED AMBIENT TOXIC AIR POLLUTANT CONCENTRATIONS[a]

Pollutant	Maximum Measured Concentration (ppb)[b]
Anthracene	0.070
Benzene	0.35
Biphenyl	0.026
Formaldehyde	4.0[c]
Hydrogen Sulfide	7.8
Toluene	0.087
Xylene	BDL[d]

[a]Monitoring conducted downwind of the refinery and off refinery property.

[b]Short averaging times (<1 hour).

[c]This is the maximum downwind formaldehyde concentration. An upwind concentration of 6.0 ppb also was measured.

[d]Below detection limit of one ppb.

GLT505/87

Table 3-11
NONMETHANE HYDROCARBON AND SELECTED TOXIC AIR EMISSIONS
(1982--ton/year)

Source	NMHC[a]	Anthracene	Benzene	Biphenyl	Formaldehyde	Hydrogen Sulfide	Toluene	Xylene
Storage Tanks	825	0.02	4.37	0.20	--[b]	ND[c]	5.20	1.65
Truck Loading	607	0.01	3.22	0.15	--	ND	3.82	1.21
Fugitive	781	0.02	5.78	0.19	--	ND	8.43	3.44
API Separator	1,091	0.43	0.85	1.91	--	ND	2.34	2.34
Boilers, Heaters	40	--	--	--	7.61	--	--	--
Total	3,344	0.48	14.22	2.45	7.61	ND	19.79	8.64

[a]Nonmethane hydrocarbon (NMHC) emission totals provided by the Koch Refining Company. Includes toxic organic air pollutant emissions.

[b]-- indicates that the source is not a significant emitter of this pollutant.

[c]No data. Information not available to quantify emission of hydrogen sulfide.

GLT505/88

Anthracene and biphenyl emissions were estimated using information in an EPA-funded report on petroleum refining. The weight percentages of anthracene and biphenyl in total NMHC emissions were applied to the NMHC emission estimates supplied by the Koch Refining Company. These weight percentages are presented in The Air Quality Technical Report - Appendix C. The API separator emissions of benzene, toluene, xylene, biphenyl, and anthracene were calculated using the same procedure.

Formaldehyde emissions occur from combustion processes including boilers, heaters and the fluid catalytic cracking (FCC) CO boiler. The percent by weight of formaldehyde emitted from each of these sources was used to calculate the emissions presented in Table 3-10.

Hydrogen sulfide can be emitted from several refinery sources, including crude oil storage, sulfur recovery, distillation, catalytic reforming, chemical sweetening, FCC, and coking. However, no information is available to assist in the quantification of hydrogen sulfide emissions from petroleum refineries.

A calculation method was used to estimate toxic air pollutant concentrations for comparison with the monitored values. Concentrations are calculated with this method that might exist if the proportion of the organic toxic pollutant emissions in the nonmethane hydrocarbon emissions is maintained in the ambient air. The maximum 1-hour nonmethane hydrocarbon concentration measured at the MPCA station is 16.5 ppm (Table 3-4). Before expansion, nonmethane hydrocarbon refinery emissions totaled 3,344 tons/year (Table 3-11). The ratio of toxic pollutant emissions to nonmethane hydrocarbon emissions was calculated from the emission information in Table 3-11. Assuming the 16.5 ppm hydrocarbon concentration was entirely due to refinery emissions, toxic pollutant concentrations were calculated as the product of the emission ratio and the maximum hydrocarbon concentration (16.5 ppm). The resulting concentrations, presented in Table 3-12, are intended for comparison purposes and represent an upper bound for short-term exposure from refinery emissions. Average exposure can be expected to be a factor of 10 to 100 less.

Table 3-12
CALCULATED TOXIC AIR POLLUTANT CONCENTRATIONS[a]

Pollutant	Annual Emissions (ton/year)	Concentration (ppb)
NMHC	3,344	16,500[b]
Anthracene	0.48	2.37
Benzene	14.22	70.16
Biphenyl	2.45	12.09
Formaldehyde	7.61	37.55
Toluene	19.79	97.65
Xylene	8.64	42.63

[a] Calculated as:
(Toxic pollutant emissions ÷ NMHC Emissions) x 16,500 ppb

[b] Maximum 1983 one-hour average nonmethane hydrocarbon concentration measured at MPCA site 0420.

Odor

Regulations and Standards. The state regulation controlling odors in the ambient air (MR 7005.0900 to 7005.0960) limits emissions from odor sources and is defined in terms of odor concentration units. An odor concentration unit is the amount of odor-free air (standard cubic feet) necessary to dilute each cubic foot of contaminated air so that at least 50 percent of the odor concentration test panel does not detect any odor in the mixture (Minnesota Code of Agency Rules, Title 6).

The regulation states that no odor source shall emit contaminants that cause odor outside the facility's property line in excess of the following:

- One odor unit in areas zoned residential, recreational, institutional, retail sales, hotel, or education
- Two odor units in areas zoned light industrial
- Four odor units in areas not previously mentioned

Ambient Monitoring Data. Odor testing was conducted by Interpoll, Inc., an MPCA-approved odor testing company, on October 23, 24, and 25, 1984. Two odor samples were collected each morning between 10 and 11 a.m. and returned to the laboratory for an odor panel evaluation in accordance with ASTM 1391-57. The samples were evaluated the same day they were collected. Test sites were selected just off the refinery property according to wind direction. A map locating the test sites is presented in The Air Quality Technical Report - Appendix B. Sampling on the first day occurred east of the refinery and occurred to the north on the other two days.

The results of the odor tests are summarized in Table 3-13. A copy of the odor panel report as provided by Interpoll, Inc., is presented in The Air Quality Technical Report - Appendix D. The maximum ambient odor levels of 30 and 35 odor units per standard cubic foot were measured on October 24, 1984. These levels are in excess of the limit of 4 odor concentration units for areas outside the facility's property. A simplified air pollution dispersion equation for ground level sources can be used to estimate an odor concentration at locations farther from the property line. The measured 35 odor concentration units can correspond to approximately 5 odor concentration units at locations approximately 200 meters farther away from the refinery's northern border.

Table 3-13
ODOR TEST RESULTS

Sample Identification	Offsite Location	Date	Odor Concentration Units
1291-01	East of Refinery	10-23-84	2.0
1291-02	East of Refinery	10-23-84	0.5
1299-01	North of Refinery	10-24-84	30
1299-02	North of Refinery	10-24-84	35
1302-01	North of Refinery	10-25-84	8.6
1302-02	North of Refinery	10-25-84	3.7

Source: Interpoll, Inc., November 5, 1984.

Refinery Emissions. Air pollutants associated with petroleum refinery odors include hydrocarbons, mercaptans, and reduced sulfur compounds like hydrogen sulfide. Mercaptans are organic compounds that contain sulfur. Information available to quantify refinery mercaptan and reduced sulfur compound emissions is limited; therefore, the Koch Refining Company could not provide emission estimates for these pollutants. Nonmethane hydrocarbon emission estimates were provided and are discussed in the criteria and toxic pollutant sections of this report. The existing nonmethane hydrocarbon emission estimate is 3,344 tons per year.

3.1.2 IMPACTS

The impact on air quality of the proposed crude oil refinery expansion are described in this section. Criteria pollutants, toxic pollutants, and odors are discussed as separate topics for easy comparison with Existing Conditions. In addition, past and expected future malfunctions at the refinery are discussed together with emergency responses procedures.

Criteria Pollutants

Emissions. A summary of criteria pollutant emissions after the Phase 1 (1986) and Phase 2 refinery expansion (approximately 1988) is presented in Table 3-14. Emissions are based on calculations completed by the Koch Refining Company and were evaluated using heat balance and fuel gas generation information.

Table 3-14
AFTER EXPANSION CRITERIA POLLUTANT EMISSIONS

Pollutant	Emissions (ton/year)	Net Change[a] (ton/year)	Percent Change[b]
Particulates	1,141	-324	-22
Sulfur Dioxide	7,234	-2,813	-28
Hydrocarbons (nonmethane)	2,800	-544	-16
Nitrogen Oxides	3,177	87	3
Carbon Monoxide	251	14	6

Source: Koch Refining Company.

[a] After expansion emissions minus preexpansion emissions (Table 7).

[b] (Net change ÷ preexpansion emissions) x 100.

Particulate and sulfur dioxide emissions are expected to decrease by 22 and 28 percent, respectively, after the refinery expansion. These decreases are primarily the result of more stringent control and a decrease in fuel oil combustion along with an increase in fuel gas combustion.

Nonmethane hydrocarbon emissions are calculated to decrease about 16 percent over existing conditions. Included in the hydrocarbon emission decrease is an assumed 50 percent increase in emissions from truck loading. The assumption is based on the 50 percent increase in refinery production after the expansion. Fugitive sources of hydrocarbon emissions will be controlled with the implementation of a leak detection and monitoring program for the expansion phases of the refinery. Covers will be installed on the existing and future API separators to control hydrocarbon emissions from these sources.

Nitrogen oxide emissions will increase by approximately 87 tons per year over preexpansion conditions, or by 107 tons per year over ending 1982 conditions (Table 3-7). Because the increase in NO_x emissions is greater than 40 tons per year, a PSD permit will be required for the project. Air quality modeling results for NO_x indicate that project impacts are less than significant and that no preconstruction monitoring is required.

An increase in carbon monoxide emissions of 14 tons per year is expected. This increase is relatively small and should not significantly alter existing carbon monoxide levels in the area. It is well below the 100-ton/year increase requiring PSD review.

In summary, the annual emissions of SO_2, particulates, and hydrocarbons decrease significantly and NO_x and CO increase slightly.

Controls. The area surrounding the refinery is an attainment area for nitrogen oxides and carbon monoxide. The area is currently unclassified for ozone but a request to redesignate it as attainment is anticipated in the near future. The area is a nonattainment area for the secondary particulate standard. The area's status with respect to sulfur dioxide is currently being evaluated. The area was designated as an SO_2 nonattainment area, but modifications to a process that has lowered sulfur dioxide emissions has resulted in compliance with the ambient air quality standards for the last 2 years. Modeling efforts are being evaluated by the MPCA and will be evaluated by EPA to determine whether predicted ambient concentrations in all areas near the refinery meet air quality standards.

A federal Prevention of Significant Deterioration (PSD) permit is required for the major modification of a major stationary source. A major stationary source is defined as one that when operating at full capacity with control equipment will emit 100 tons/year or more of any pollutant regulated by the Clean Air Act. A major modification is any physical change in, or change in the operation of, a major source that would result in a significant net emission increase of any regulated pollutant. These provisions are included in the August 7, 1980, Federal Register.

The federal regulations provide that a major modification (one that would result in a significant net emission increase at the source) shall apply BACT for each pollutant subject to regulation under the Clean Air Act. This requirement applies to each proposed emission unit at which a net emission increase in the pollutant would occur as a result of a physical change or a change in the method of operation in the unit.

BACT is an emission limitation (including a visible emission standard) that is based on the maximum degree of reduction of each pollutant subject to regulation under the Clean Air Act that would be emitted from any proposed major stationary source or major modification. The EPA administration, on a case-by-case basis, takes into account energy, environmental, and economic impacts in its determination of BACT for each source or modification. BACT can be applied to production processes or can include available methods, systems, and techniques for fuel cleaning, treatment, or combustion. In no event shall application of BACT result in emissions of any pollutant that would exceed the emissions allowed by any applicable standard under 40 CFR, Parts 60 and 61.

It is apparent from Table 3-14 that the only pollutant that will trigger a PSD review and the application of BACT is the increase in nitrogen oxides. The other emissions result in net decreases, or increases that are less than the significance rates defined by the EPA.

The BACT control scheme that has been generally accepted in the past for NO_x emissions is to use specially designed combustors in the boilers and heaters that result in lowered NO_x emissions. Virtually all of the NO_x generated at the refinery comes from the combustion of fuel in heaters and boilers. The Koch Refining Company has made a commitment to use low NO_x burners in the proposed refinery expansion to reduce NO_x emissions to below NSPS.

The MPCA regulation (Offset Rule) governing construction of new or modified sources in nonattainment areas requires lowest achievable emission rate (LAER) controls and emission offsets for these sources (MR 7005.3010 to 7005.3060). The modification must result in a significant net increase in emissions of the nonattainment pollutant. This is defined as 40 tons/year for SO_2 and 25 tons/year for particulates. The refinery expansion results in SO_2 and particulate emission decreases; therefore, offsets and LAER controls are not required.

The area around the refinery is not a designated nonattainment area for ozone or hydrocarbons even though hydrocarbon levels exceeding the state hydrocarbon standard were monitored. If it were an ozone nonattainment area, permitting requirements would include offsets and LAER for a 40-ton/year increase in nonmethane hydrocarbons.

In addition to the PSD and Offset Rule review, there is a requirement for all new sources as defined by the Clean Air Act to meet new source performance standards (NSPS). These new source performance standards define emission limitations for specific process equipment. The State of Minnesota will evaluate the proposed refinery expansion and will issue a permit if the proposal meets Minnesota's regulatory requirements. One of the criteria the state will use in its evaluation is whether the proposed individual process equipment meets NSPS, even though the state does not require a PSD review.

New source performance standards have been developed for petroleum refineries (40 CFR 60.100 to 60.115). Refinery equipment that is required to meet NSPS limits includes FCC unit catalyst regenerators, fuel gas combustion devices, Claus sulfur recovery plants, hydrocarbon storage tanks, compressors, valves, pumps, pressure relief devices, sampling systems, flanges, connections, open-ended lines and control equipment such as vapor recovery systems, flares, and closed vent systems. In addition, fuel-burning equipment, such as boilers of a specific size, is required to meet NSPS emission standards. The Koch Refining Company has proposed to install equipment that will meet NSPS requirements on all new refinery processes, equipment, and storage tanks.

Emission Monitoring. Federal and state rules require performance monitoring of process and pollution control equipment to determine compliance with the regulations. The Koch Refining Company operates continuous emission monitors (CEM) for opacity, SO_2, O_2, and H_2S at the existing refinery. CEM's are proposed to be installed and certified on new equipment as required by regulation during the expansion. Quarterly reports are submitted to MPCA that summarize daily SO_2 emissions and list CEM excess emissions including the reasons for the excursions. Similar information for CEM's installed during the expansion will be included in future quarterly reports.

Operators of new and existing FCC regenerators are required to operate a CEM for the measurement of opacity. Opacity may not exceed 30 percent except for 3 minutes in any hour. The average coke burnoff rate and FCC regenerator hours of operation must be recorded daily. The Koch Refining Company operates one opacity monitor at the existing refinery.

New fuel gas combustion devices must not burn any fuel gas with H_2S in excess of 0.10 grains per dry standard cubic foot (equal to 230 mg/dscm). Only one analyzer is operated at the refinery to monitor H_2S in fuel gas, but new analyzers will be installed as required with expansion design. H_2S in fuel gas is an indicator of SO_2 emissions after combustion.

Performance standards and permit emission limits are established for the four sulfur recovery plants. CEM's are operated to demonstrate compliance with these SO_2 limits. An SO_2 analyzer and an oxygen analyzer are used to monitor the tail gas recovery emissions from the No. 3 and 4 sulfur recovery units because the SO_2 limit is based on the oxygen content of the exhaust.

A tail gas analyzer on the No. 1 and 2 sulfur recovery units was modified to measure H_2S and SO_2 in order to calculate the SO_2 emission rate from the incinerator stack. Certification tests on the analyzer will be performed within 90 days of startup of the units.

Analyzers and strip chart recorders will be installed and certified on all new sulfur recovery plants at the refinery. Strip chart records for each analyzer are maintained in a file onsite. Analyzer installation records, certification tests, and calibration and repair records also are maintained. The refinery CEM system, when certified, will comply with the emission monitoring and reporting requirements of the MPCA (MR 7005.2100 to 7005.2160 and 7005.1850 to 7005.1880).

Ambient Impacts. Criteria pollutant ambient impacts due to the expansion are discussed with respect to particulates, sulfur dioxide, hydrocarbons, and nitrogen oxide.

Particulates. Particulate emissions as a result of project construction are expected to decrease. The facility is located within an area that is in nonattainment of the secondary particulate standard. Area sources, not industrial sources, are believed to be the primary contributors to the nonattainment designation. Although a general air quality benefit can be expected with particulate emission decreases, the nonattainment status of the area may not be affected. No particulate modeling to determine ambient concentrations was performed.

Sulfur Dioxide. An areawide air quality benefit is expected to result from the 2,813-ton/year decrease in SO_2 emissions. However, the impact of SO_2 emission reductions on ambient concentrations at specific receptors can only be estimated using dispersion modeling. As discussed in the Existing Conditions section, MPCA and the Koch Refining Company are modeling annual and short-term impacts from the refinery and two other facilities in support of efforts to redesignate the SO_2 nonattainment area. The results of this modeling are summarized in Table 3-15.

Table 3-15
HIGHEST MODELED SO_2 CONCENTRATIONS (ug/m³)
OFF REFINERY PROPERTY

	End of 1982	End of 1984	After Phase I	After Phase II
1 Hour 2nd High	1,286	1,158	1,181	1,178
3 Hour 2nd High	855	751	729	718
24 Hour 2nd High	389	360	327	321
Annual Average	26	a	a	a

Note:

1, 3, and 24-hour results from RAM Urban model with adjustment for calms. Annual average from CDM model.

[a]Not modeled by expected to be less than predicted 1982 annual average.

The RAM urban model was selected to evaluate SO_2 conditions in the study area. The EPA recommended for redesignation modeling that a 605-receptor grid and 5 years of hourly meteorlogical data be used in each modeling plan. Agreements between EPA, MPCA, and Koch Refining Company were made at the beginning of the redesignation process regarding the modeling approach. Koch Refining Company has completed the short-term modeling analysis. The 3-hour and 24-hour federal and state standards show modeled attainment. All modeling results will undergo review and approval by EPA and MPCA before redesignation can proceed. A more detailed description of the SO_2 modeling is provided in Appendix E of the Technical Air Quality Report.

Initial results predicted violation of state 1-hour standard in the area immediately southeast of the sulfuric acid plant under current operations. Through negotiations with the MPCA, however, it was concluded that the RAM model did not accurately model 3 hours during the 5-year modeling period with wide variations in wind direction. With an adjustment for these hours, attainment is demonstrated for the state 1-hour standard even under current conditions. Modelling results with the adjustment show no violation of SO_2 standards under current conditions or after expansion of the refinery. It is the MPCA's recommendation that KOCH reorient its ambient monitoring network to measure actual SO_2 levels in the area southeast of the sulfuric acid plant.

The Koch Refining Company modeling results were used to determine postexpansion impacts relative to existing conditions. Predicted SO_2 concentrations at specified receptors using 5 years of meteorological data were compared for post-expansion and pre-expansion SO_2 emission conditions. Results of this comparison are presented in The Air Quality Technical Report in Appendix E. Modeled SO_2 concentrations are predicted to decrease after refinery expansion relative to the before-expansion impacts. The magnitude of the reduction ranges from 4 to 24 percent over all averaging times. Modeling results show a net improvement in SO_2 air quality after construction of the proposed Phase 1 and Phase 2 refinery expansion.

Annual average SO_2 concentrations were modeled by MPCA using the Climatological Dispersion Model (CDM). Five years worth of meteorological data were used. Using 1982 emissions, the area is predicted to be well within standards. As emissions after 1982 decrease, future years were not modelled.

Hydrocarbons. Nonmethane hydrocarbon emissions are estimated to decrease by 16 percent after expansion (Table 3-14). The state nonmethane hydrocarbon 3-hour standard is 0.24 ppm, not to be exceeded more than once per year and applicable to the hours between 0600 and 0900. This standard was established in the early 1970's as a guide to predicting ozone violations. Elevated hydrocarbon levels early in the day are an indication that elevated ozone levels can occur downwind. The 1983 second highest monitored nonmethane hydrocarbon concentration between 0600 and 0900 was 3.57 ppm. A 16 percent decrease in nonmethane hydrocarbon emissions could produce a 3.00-ppm concentration for the same period. Continued excesses above the state standard are predicted. EPA no longer has a hydrocarbon standard. A more sophisticated modeling approach is now used to evaluate the hydrocarbon/ozone relationship rather than a blanket precursor standard.

The Air Quality Division of the MPCA currently considers the hydrocarbon standard inappropriate for ozone control and will review and possibly eliminate the standard in the near future.

Even with maximum control technology applied to hydrocarbon emissions, the refinery would probably not meet the state hydrocarbon standard.

A direct relationship between hydrocarbon emissions and ozone formation does not exist because of the complexity of the atmospheric chemistry involved. A change in hydrocarbon emissions does not necessarily produce an equivalent change in ozone. In general, the decrease in hydrocarbon levels probably will not significantly affect ozone levels downwind of the refinery.

Nitrogen Oxide. Modeling was performed by the Koch Refining Company to predict nitrogen oxide concentrations at specific receptor locations around the refinery. The CDMQC model was used to predict annual average NO_x concentrations at 605 receptors from 1973 through 1977. The maximum predicted increase in NO_x annual concentrations after the expansion is 0.6 $\mu g/m^3$, which is considered to be less than significant in terms of PSD review criteria. Additional modeling and monitoring data in support of a PSD permit should not be necessary, but BACT will be required.

Toxic Air Pollutants

Emissions. Emissions of toxic air pollutants after the refinery expansion are summarized in Table 3-16. Koch Refining Company is proposing to install covers on all existing and future API separators reducing hydrocarbon emissions from this source by 94 percent. A 50 percent increase in emissions from truck loading was assumed. The proposed leak detection and monitoring program to control fugitive hydrocarbon emissions from the expansion phases will also control toxic emissions from these sources. The effectiveness of this program is estimated to be 48 percent on reducing expansion emissions. Emissions of benzene, and toluene are expected to increase with project development. Anthracene, biphenyl, and xylene emissions will decrease and formaldehyde emissions will remain at existing levels.

Ambient Impacts. Ambient toxic air pollutant concentrations are expected to change after the refinery expansion. The amount of change is assumed to equal the estimated change in emissions for each toxic pollutant (Table 3-16). Predicted after-expansion toxic pollutant concentrations are presented in Table 3-17.

Using the short-term monitoring (Table 3-10) as a reference, formaldehyde concentrations are predicted to continue to exceed the most stringent acceptable concentration guideline listed in Table 3-9. The other six toxic pollutants will be less than the guideline concentrations. Existing and after expansion concentrations of formaldehyde are greater than the stringent guideline but are less than the other two guideline values. There is no expected increase in formaldehyde concentrations after the refinery expansion. Monitoring

Table 3-16
AFTER EXPANSION NONMETHANE HYDROCARBON AND SELECTED TOXIC AIR EMISSIONS
(ton/year)

Source	NMHC[a]	Anthracene	Benzene	Biphenyl	Formaldehyde	Hydrogen Sulfide	Toluene	Xylene
Storage Tanks	828	0.02	4.39	0.20	--[b]	ND[c]	5.22	1.66
Truck Loading	910	0.02	4.83	0.22	--	ND	5.74	1.82
Fugitive	924	0.02	6.84	0.23	--	ND	9.97	4.06
API Separators	98	0.04	0.08	0.17	--	ND	0.21	0.21
Boilers, Heaters	40	--	--	--	7.61	--	--	--
Total	2,800	0.10	16.14	0.82	7.61	ND	21.14	7.75
Percent Change from Existing[d]	-16	-79	+14	-67	0	ND	+7	-10

Source: Koch Refining Company.
[a]Nonmethane hydrocarbons (NMHC) include toxic organic air pollutant emissions.
[b]-- indicates that the source is not a significant emitter of this pollutant.
[c]No data. Information not available to quantify emissions of hydrogen sulfide.
[d]Percent change calculated as [(future emissions minus existing emissions) ÷ existing emissions] x 100.

Table 3-17
PREDICTED AFTER EXPANSION TOXIC POLLUTANT CONCENTRATIONS

Pollutant	Predicted Concentration[a] (ppb)	Change From Existing (%)
Anthracene	0.015	-79
Benzene	0.40	+14
Biphenyl	0.009	-67
Formaldehyde	4.0	0
Hydrogen Sulfide	6.6	-16[b]
Toluene	0.093	+7
Xylene	BDL[c]	-10

[a]Predicted concentrations calculated from existing measured concentrations (Table 3-10) and the expected change in toxic emissions (Table 3-16).
[b]Emission estimates of H_2S are not available. Assumed future H_2S would change by the same percentage as nonmethane hydrocarbon emissions (Table 3-16).
[c]Measured xylene concentration is below the detection limit (Table 3-10).

results showed the upwind concentration of formaldehyde to exceed concentrations measured downwind of the refinery (The Air Quality Technical Report - Appendix B). Sources of formaldehyde emissions, other than the refinery, appear to be contributing to ambient formaldehyde concentrations in the area. Benzene concentrations are predicted to increase from 0.35 ppb to 0.40 ppb. The most stringent guideline concentration for benzene is 0.45 ppb as an annual ground level concentration (Table 3-9).

Odors

The pollutants associated with odors from refineries are hydrocarbons, mercaptans, hydrogen sulfide, and other sulfur compounds. Emissions of nonmethane hydrocarbons are calculated to decrease by about 16 percent after the refinery expansion when compared to existing conditions. Emissions estimates are not available for the other pollutants of concern, therefore odor concentrations are estimated to change in a direct ratio to hydrocarbon emissions. Odor violation levels of 35 odor concentration units were measured under existing conditions. Because of hydrocarbon emission reductions, odor concentrations of 29 odor concentration units are estimated to occur with construction of the proposed project. Odor violations can be expected to continue after the expansion.

There is not a one-to-one relationship between odor concentration and the perceived intensity of an odor by a human observer. The relationship takes the form of the following equation:

$$I = kC^x$$

where: I = Intensity
C = Odor concentration
k,x = Adjustment factors specific to each pollutant where x§1

Exponents (values of x) for this odor power function have been found as high as 0.72 but exponents in the 0.10 to 0.20 range are not unusual. Assuming the odor concentration decreases by 16 percent with refinery expansion, the decrease in perceived odor intensity would range between 2 percent and 12 percent for exponents of 0.10 to 0.72.

Odors from the refinery result from a mixture of pollutants and not a single odorant. There are additive and interactive effects on odors in mixtures that change odor strength and perceived intensity. However, the odor strength of mixtures formed from two to five odors of equal strength only slightly exceeds the odor strength of a single odor.

Malfunctions and Responses

Malfunctions. The Koch Refining Company is required by regulation to report control and process equipment breakdowns to the MPCA (MR 7005.1850 to 7005.1880). The notification report must include the breakdown cause and estimated duration. All practical steps to reduce air pollutant emissions during a breakdown must be taken. The MPCA can require additional controls or operation modifications to equipment with unreasonable breakdown frequencies and excessive emissions.

A literature search was conducted to collect information about malfunctions experienced at other refineries and the resulting air pollution emissions. There was no information available that defines typical refinery malfunctions. Industries do not generally prepare this type of data for public distribution. The EPA did not have any information regarding malfunctions at refineries and associated emissions.

A list of shutdowns and breakdowns that occurred at the Koch Refining Company refinery in 1982 and 1983 is presented in Appendix F of the Technical Air Quality Report. There were 27 failures in 1982 and 16 failures in 1983. Twenty-three of these failures resulted in visible or smoky flare emissions. Approximately 13 of the breakdowns involved the sulfur recovery units or associated equipment. Reduced control efficiency or increased SO_2 emissions resulted. The duration of the failures varied according to the nature of repair required. In many cases, backup systems or operational changes reduced emissions within a few minutes. For example, compressor failures appear to be common so the refinery has backup compressors available. The transfer time between compressors is 1 to 6 hours, but visible emissions occur for only about 15 minutes at the beginning and end of each transfer.

The most significant breakdown at the refinery in terms of air pollution impact was the electric power failure in 1982. Within a matter of minutes, the refinery experienced two power outages, which effected an almost total refinery shutdown. Automatic controls stop process flows and release process gases and liquids to the safety flare system when power is lost. In this case, the controls could not be reset before power was lost again. The electric power loss caused a high rate of flaring, a heater fire, and a shutdown of all fuel gas compressors resulting in contamination and plugging of the sulfur plant catalyst beds. Because of the rerouting of process streams to storage tanks, odors increased. This power outage was the first one in 8 years. The refinery has two separate electric service feeder systems as a safety measure to control power failures, but both systems failed. The power outage occurred on August 19, 1982, and full operation of the sulfur recovery units did not occur until after the scheduled September 11, 1982, turnaround. No SO_2 violations were measured during the August 1982 power failure but excesses were measured during the September 1982 repair period.

Turnarounds are scheduled periods of maintenance that take place about once a year. Major turnarounds are scheduled every 3 years for FCC shutdown and maintenance. Gases are diverted to the flare system during controlled shutdown and startup, and increased emissions result.

The refinery expansion is proposed to increase the capacity by 50 percent. More equipment and higher throughput on some existing equipment will be used in the expansion design. Therefore, the potential for an increase in the number of refinery upsets per year will be higher. The average number of breakdowns per year is 22 for the 1982-1983 period. The 50 percent expansion probably will produce fewer than 33 breakdowns per year. The effect on public health should not alter because operations shutdown is required by regulation if the public health is at risk.

The chance of a major fire, explosion, or spill is always present in refinery operations. Emissions of SO_2, CO, NO_x, hydrocarbons, hydrogen sulfide, ammonia, tetraethyl lead, or other chemicals involved in refining crude oil could result. The safety equipment and emergency response procedures at the refinery are also designed to minimize the environmental impacts of these catastrophic events.

Emergency Responses. Sulfur Dioxide Emergency Episodes can be declared by the MPCA if SO_2 concentrations exceed prescribed levels for a 24-hour average and are expected to remain at those levels for at least 12 hours (MR 7005.2950 to 7005.3006). The SO_2 emergency episode levels are:

Alert	300 ppb
Warning	600 ppb
Emergency	800 ppb
Significant Harm	1,000 ppb

Each major source of SO_2 within the state must maintain a formal plan stating its proposed response to each episode condition. The Koch Refining Company's planned responses to SO_2 episodes are divided into two groups, episodes resulting from localized meteorological conditions and episodes resulting from inversion meteorological conditions. A localized condition refers to an increase in ambient SO_2 concentration where meteorological conditions indicate that sources in a small geographic area are most probably the cause. The response is to identify the sources by modeling while optimizing sulfur recovery unit efficiencies and reducing refinery fuel oil combustion in the boiler and heaters. If warning, emergency, or significant harm levels are reached, a refinery upset condition must be the cause and corrective action must be taken to repair the source.

During regional inversion conditions, the alert episode response is the same as under localized conditions. For warning episodes, refinery operation will be optimized for minimum sulfur production by switching to the lowest sulfur crude, reducing coker rates, and using the most efficient SRU. For emergency episodes, similar steps will be taken at reduced production rates. Refinery shutdown will be performed and coordinated with the MPCA in the event of significant harm episodes.

The Koch Refining Company's Episode Plan appears to comply with MPCA regulations by taking progressively more stringent steps to reduce SO_2 emissions from the refinery at each episode level.

Spill prevention, contingency planning, and fire control procedures have been developed by the Koch Refining Company for the operational hazards inherent to petroleum refining. A Spill Prevention Control and Countermeasure (SPCC) Plan is maintained for various hazardous materials in accordance with EPA regulation. The SPCC plan has been amended to incorporate the contingency plan requirements of an RCRA hazardous waste facility. This plan must demonstrate the company's ability to effectively respond to fires, explosions, and unplanned releases of materials or wastes. The SPCC/Contingency plan was submitted for agency review and approval as a section in the Part B hazardous waste facility application. The SPCC/Contingency plan includes descriptions of emergency response procedures, emergency coordinators, a list of emergency equipment, and discussions of arrangements with local fire and police departments, hospitals, and emergency response contractors. The plan's emergency responses are designed to reduce the magnitude and duration of an emergency situation and the resulting environmental impacts.

A Pine Bend Area Notification Plan exists as a voluntary plan between Koch Refining Company and local police departments. The modification plan was established as a result of the August 1982 power failure. This plan states that Koch Refining Company will notify the local police department if ambient SO_2 concentrations exceed 500 ppb as a 1-hour average and are expected to exist for at least 3 hours more, or if a major malfunction occurs. Major refinery malfunctions are defined as a major electric power failure, a major fire, or fluid catalytic cracker reversal. The local police department will notify residents in the affected areas. The SO_2 concentration will be measured at the refinery ambient monitors. The 1-hour average notification level is equal to the state's 1-hour ambient standard. Koch Refining Company initiated the first phase of the notification plan only once since it was established. The local police department was notified of a potential problem at the refinery. The problem was solved before the police had to notify residents.

3.1.3 MITIGATION

Air quality impacts of the proposed expansion are both positive and negative. Significant particulate and SO_2 emission reductions will improve air quality for these pollutants as a result of project construction. Emissions of NO_x will increase with the refinery expansion. This emissions increase will be reduced by using BACT; it is predicted to have little effect on ambient NO_x concentrations in the study area.

The potential existed for significant negative air quality impacts from hydrocarbon emissions. However, Koch Refining Company is proposing to control hydrocarbon emissions to less than existing levels to mitigate the negative impacts. Sources of hydrocarbon emissions at the refinery include process equipment, process drains, compressors, oil-water separators, and other fugitive sources, such as valves, flanges, and pumps. Most of the process hydrocarbon emissions are effectively controlled in refineries.

One of the better mitigation measures for reducing the fugitive source emissions of hydrocarbons, toxic pollutants, and odors is a comprehensive program for leak detection and inspection, maintenance, and repair. The Koch Refining Company is preparing to implement such a program as required by NSPS regulations for the proposed expansion. The effectiveness of this leak detection and inspection program is estimated to be about 48 percent for a nonmethane hydrocarbon emission reduction of 189 tons/years. On the existing portion of the refinery, relief valves have already been connected to the flare system as a safety and mitigation measure.

Oil-water separators are significant sources of hydrocarbon and odors. Another mitigation measure for reducing hydrocarbon emissions is to cover the API separators. Koch Refining Company will install covers on all existing and future API separators at the facility. Covers reduce the emission factor from the separators by 94 percent to 0.3 pounds of hydrocarbons per 1,000 gallons for a nonmethane hydrocarbon reduction of 1,538 tons/year. Covers and traps can be used to reduce emissions from open process drains. Safety is a prime consideration when enclosing any hydrocarbon source and safety measures will be included in all cover designs.

The proposed hydrocarbon control measures will reduce the odor impact and all of the toxic air pollutants evaluated, except benzene and toluene. Benzene and toluene emissions are estimated to increase by 14 percent and 7 percent, respectively, even with the nonmethane hydrocarbon mitigation measures. The benzene and toluene emissions increases and resulting impacts are less with the mitigation measures than without. In addition, the MPCA may require toxic air pollutant monitoring as a condition to the refinery expansion air quality permit.

Additional mitigation measures for controlling nonmethane hydrocarbon emissions, odors, and toxic emissions may include installing vapor recovery on the truck loading operations and using a leak detection and monitoring program for the existing facility as well as the proposed expansion. Negotiations are underway between MPCA and Koch Refining Company regarding the air quality benefit and economic impact relationships of these additional measures.

Further monitoring studies are recommended to more fully define existing conditions with respect to compliance with the state 1 hour SO_2 and odor standards, and existing concentrations of toxic air pollutants.

Because of uncertainties in modeling procedures for the 1-hour state SO_2 standard, it is recommended that the monitoring network be reoriented to place a monitor immediately southeast of the Koch sulfuric acid plant. The existing stipulation agreement between Koch and MPCA allows for such a change.

Both the air toxics and odor evaluations contained in this section were based upon very short-term monitoring. In order to gain a better understanding of average air toxicant exposure, a long-term study should be undertaken. The air toxicant study when combined with further odor testing should indicate the chemical cause of odors and point towards further controls, if appropriate.

3.2 WATER QUALITY

Process wastewater and stormwater are collected and treated in Koch Refining Company's wastewater treatment facilities. The treated wastewater is combined with noncontact cooling waters and discharged to the Mississippi River at river mile 824.4. This section contains a description of ambient water quality, and wastewater treatment plant operation, performance, and impacts for current and future refinery operation.

3.2.1 EXISTING CONDITIONS

In 1983, combined discharges at the Koch wastewater treatment plant (WWTP) outfall averaged 2.3 million gallons per day (mgd) with a maximum discharge of 4.0 mgd. In the information that follows, existing water quality in the vicinity of the Koch WWTP outfall is characterized and state and federal regulations controlling these discharges are reviewed. Further, existing wastewater treatment plant unit process operations, performance, and impacts on river water quality are examined.

Water Quality Standards

The MPCA has established water quality standards for designated water uses for all waters within Minnesota. All rivers in the state have been assigned one or more water use classifications as listed in Chapter 7050 (formerly 6 MCAR, Section 4.8025) of the Minnesota Rules.

The Koch WWTP plant discharges into a segment of the Mississippi River with assigned water use classifications 2B and 3B. These waters are sufficient in quality to permit the propagation and maintenance of sport and commercial fishes and are suitable for aquatic recreation of all kinds, including bathing. Further, the quality is suitable for general industrial purposes, except for food processing, with only a moderate degree of treatment. Applicable water quality standards for this segment of the river are listed in Tables 3-18 and 3-19.

Table 3-18
WATER QUALITY STANDARD FOR TEMPERATURE
LAKE ITASCA TO LOCK & DAM NO. 2 AT HASTINGS
KOCH REFINING EIS

Month	°F/°C[a]
January	40/4.4
February	40/4.4
March	48/8.9
April	60/15.6
May	72/22.2
June	78/25.6
July	83/28.3
August	83/28.3
September	78/25.6
October	68/20
November	50/10
December	40/4.4

[a]Maximum allowable temperature.

Existing Water Quality

The U.S. Geological Survey (USGS) and Metropolitan Waste Control Commission (MWCC) maintain a network of water quality monitoring stations on the Mississippi River in the Minneapolis-St. Paul metropolitan area. The closest station is 2 miles upstream of the Koch WWTP outfall (UM 824.4) at Grey Cloud Island (UM 826.6). For analysis purposes, water quality at this station will be considered representative of background water quality in the vicinity of the Koch WWTP outfall.

Table 3-20 contains a summary of the 1983 data for automatic water quality monitoring equipment at the Grey Cloud Island station. The automatic monitoring equipment records instantaneous measurements at 15-minute intervals. Table 3-21 summarizes physiochemical monitoring data collected at the Grey Cloud Island station during 1983.

Water quality data collected at the Grey Cloud Island station in 1983 was generally in compliance with the water quality standards listed in Tables 3-18 and 3-19. Exceptions occurred in July through September when dissolved oxygen (DO) values

Table 3-19
WATER QUALITY STANDARDS

Parameter[a]	Water Quality Standard
DO, minimum	5[b], 5/4[c]
pH, min-max	6.0-9.0
Turbidity, NTU	25
Ammonia-N, un-ionized	0.04
Fecal Coliform, no./100 ml	200[d]
Total Residual Chlorine	0.005[e]
Hardness (as $CaCO_3$)	250
Arsenic	0.05
Copper	0.01[f]
Barium	1
Cadmium	0.01
Chromium	0.05
Lead	0.05
Selenium	0.01
Silver	0.05
Phenol	0.01[g]
Cyanide	0.02
Fluoride	1.5
Chloride	100
Radioactive Material	(h)
Oil	0.5

[a] Concentration expressed as mg/L unless otherwise noted.
[b] Not less than 5 mg/L instantaneous minimum at all times, except see note c; required compliance is 50 percent for those days at which the river flow is equal to the 7Q10.
[c] From the outlet of the Metro WWTP (Mile 835) to Lock and Dam 2 at Hastings (Mile 815), the standard is 5 mg/L (April 1-November 30) and 4 mg/L (December 1-March 31).
[d] 200/100 ml as a monthly geometric mean based on five or more samples per month, nor exceed 2000/100 ml in more than 10 percent of samples during any month. Applies only between March 1 and October 31.
[e] Applies to conditions of continuous exposure, i.e., where chlorinated effluents are discharged for more than 2 hours per 24 hours.
[f] 0.01 mg/L or not greater than 1/10 the 96-hour TLM value.
[g] Limit designated and none that could impart odor or taste to fish flesh or other fresh-water edible products such as crayfish, clams, prawns, and like creatures.
[h] Not to exceed the lowest concentration permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.

GLT495/2

Table 3-20
1983 MONTHLY AVERAGES OF DAILY MEANS AND ABSOLUTE RANGES AUTOMATIC
MONITOR OF MISSISSIPPI RIVER AT GREY CLOUD ISLAND

	Dissolved Oxygen (mg/l)		Temperature (°C)		pH		Specific Conductance (umhos/cm)	
Month	Mean/Min-Max	N[a]	Mean/Min-Max	N[a]	Mean/Min-Max	N[a]	Mean/Min-Max	N[a]
January	12.7/10.0-13.7	31	0.7/0.4-1.2	31	7.8/7.3-8.3	31	601/542-651	31
February	11.6/10.3-12.8	28	0.7/0.0-2.0	28	7.8/7.6-8.1	28	596/467-659	28
March	10.6/6.9-15.2	19	2.4/1.0-4.2	25	7.6/7.3-8.0	25	547/435-708	25
April	10.0/7.9-15.5	27	7.3/3.2-14.7	30	7.8/7.4-8.7	30	638/602-683	30
May	8.1/6.0-9.5	31	15.9/13.0-18.9	31	7.9/7.6-8.2	31	613/536-659	31
June	7.3/5.3-9.3	27	20.6/16.6-23.8	27	8.1/7.8-8.4	27	575/480-642	27
July	5.5/1.1-7.2	31	25.9/21.9-29.1	31	8.0/7.5-8.2	31	537/443-620	31
August	5.2/2.4-7.0	29	26.3/24.3-29.3	31	7.8/6.7-8.8	31	493/417-560	31
September	7.0/2.7-9.9	30	19.2/11.8-27.7	30	7.9/6.6-9.1	24	495/446-531	30
October	9.5/5.7-11.4	28	11.7/8.3-19.1	31	8.2/8.1-8.3	14	486/424-526	31
November	9.9/8.3-12.2	22	6.2/3.9-9.5	22	8.2/8.0-8.4	19	511/467-562	22
December	13.5/12.0-15.3	9	0.3/0.0-0.8	9	7.8/7.6-8.1	9	620/575-660	9

[a]Number of days reporting.

GLT495/26

TABLE 3-21 (Page 1 of 4)
1983 PHYSICO-CHEMICAL MONITORING DATA
MISSISSIPPI RIVER AT GREY CLOUD ISLAND

DATE	HOUR	TEMPER-ATURE °C	DISSOLVED OXYGEN MG/L	DISSOLVED OXYGEN PERCENT SATURATION	PH	TURBIDITY NTU	FECAL COLIFORM #/100ML	TOTAL AMMONIA NITROGEN MG/L	UNIONIZED AMMONIA NITROGEN MG/L
JAN 04	950	0.0	13.2	93	7.80	1.2	2700	0.90	0.005
18	1030	0.0	13.7	96	7.70	3.9	2000	0.86	0.003
FEB 02	1020	0.0	13.0	91	7.70	3.2	1120	0.88	0.004
15	935	0.5	12.3	88	7.76	2.8	1950	0.12	< 0.001
MAR 02	853	2.0	13.0	97	7.60	18.0	20	0.78	0.003
08	1030	2.5	12.1	92	7.71	47.0	135	0.40	0.002
15	925	2.5	12.8	97	8.18	14.0	18	0.38	0.006
22	950	2.0	13.4	100	8.05	8.2	12	1.90	0.023
APR 05	930	6.0	12.2	100	8.10	34.0	58	0.70	0.012
12	928	6.5	11.2	93	8.16	12.0	54	0.38	0.007
19	935	6.0	11.7	96	8.19	14.0	180	0.40	0.008
26	1005	13.0	10.4	101	8.52	26.0	228	0.50	0.036
MAY 03	930	13.0	9.6	93	8.43	19.0	104	0.32	0.019
11	932	14.0	9.1	90	8.14	16.0	693	0.20	0.007
18	915	15.0	9.1	92	7.98	13.0	70	0.17	0.004
25	1008	16.0	9.0	93	8.21	10.0	104	0.42	0.019
JUN 07	942	16.5	9.4	98	8.41	7.0	92	0.23	0.017
16	930	20.5	8.2	92	8.90	13.0	384	0.24	0.059
22	938	22.0	7.9	109	8.11	23.0	475	0.14	0.008
28	935	23.0	6.7	80	8.01	21.0	300	0.13	0.006
JUL 08	940	23.5	7.5	87	7.68	16.0	95	0.14	0.003
13	1000	26.0	7.0	88	7.87	16.0	136	0.08	0.003
20	1025	26.0	6.1	76	7.71	22.0	1580	0.20	0.006
29	1025	26.0	6.5	81	7.97	16.0	273	0.30	0.016
AUG 02	948	26.0	7.7	96	8.12	23.0	130	0.40	0.029
09	1026	28.0	7.4	97	8.20	7.2	148	0.42	0.042
16	933	25.8	7.0	88	8.03	12.0	92	0.74	0.044
23	950	24.0	6.1	74	7.79	9.1	450	0.60	0.019
SEP 08	1029	22.5	6.1	72	7.92	8.6	610	0.36	0.014
12	941	21.5	6.3	73	8.02	8.1	300	0.52	0.023
21	1028	15.3	8.3	85	7.83	8.5	193	0.44	0.008
27	1110	15.5	10.4	106	8.37	5.6	128	0.47	0.029
OCT 04	940	18.0	8.0	86	8.34	7.8	76	0.46	0.032
13	1030	12.0	9.4	89	8.00	7.2	93	0.26	0.005
18	923	10.1	10.2	93	8.30	6.2	31	0.21	0.007
25	1130	9.5	11.2	101	8.08	9.1	20	0.38	0.008
NOV 02	1050	11.1	10.8	100	8.04	6.5	1680	0.58	0.012
15	855	5.0	12.1	97	7.97	4.9	> 600	0.84	0.010
30	1000	0.0	12.6	89	8.27	7.4	2300	0.90	0.013
DEC 13	1015	1.5	13.5	99	8.03	4.8	2100	0.98	0.010
28	1050	1.1	10.4	75	8.36	0.9	20	0.22	0.004

TABLE 3-21 (Page 2 of 4)

DATE	CONDUC-TIVITY U/CM	ORTHO PHOS-PHORUS MG/L	PARTICULATE PHOSPHORUS MG/L	TOTAL KJELDAHL NITROGEN MG/L	PARTICULATE KJELDAHL NITROGEN MG/L	CHLORINE RESIDUAL MG/L
JAN 04	630	0.12	0.02	1.45	0.10	0.00
FEB 02	634	0.10	0.02	2.10	0.09	0.00
MAR 02	459	0.03	0.08	2.65	0.26	0.00
APR 05	615	0.07	0.09	1.80	0.31	0.00
MAY 03	689	0.03	0.09	1.60	0.36	0.05
JUN 07	634	0.05	0.11	1.90	0.48	0.10
JUL 08	295	0.10	0.09	1.50	0.32	0.05
AUG 02	582	0.11	0.12	1.70	0.56	0.00
SEP 08	483	0.19	0.08	1.65	0.31	0.00
OCT 04	507	0.08	0.08	2.15	0.42	0.00
NOV 02	526	0.22	0.06	2.00	0.26	0.00
30	623	0.07	0.07	2.10	0.31	

DATE	CHLORIDE MG/L	SULFATE MG/L	SOLUBLE SODIUM MG/L	SOLUBLE POTAS-SIUM MG/L	SOLUBLE CALCIUM MG/L	SOLUBLE MAGNESIUM MG/L	ALKA-LINITY MG/L	CARBON DIOXIDE MG/L	BICAR-BONATE MG/L	CARBON-ATE MG/L
FEB 02			13.4	2.1	44	18	227	9	277	0
MAY 03	21.0	132	14.0	3.0	62	27	193	2	236	0
AUG 02	17.6	56	13.0	3.4	70	25	207	3	253	0
NOV 02	19.5	41	15.0	3.0	57	20	182	3	223	0

DATE	GREASE AND OIL (mg/l)	PARAMETER	BOD - SERIES Unfiltered, Uninhibited	Unfiltered, Inhibited	Filtered, Uninhibited	Filtered, Inhibited
MAY 25	18	Ultimate BOD, mg/l	12.9	6.9	8.9	3.9
		Ultimate BOD, Day 5 Reading, mg/l	4.40	3.60	2.00	1.95
		Bottle Deoxygenation Rate, Base 10	0.04	0.05	0.02	0.04
		Total 5-Day BOD (BOD_5), mg/l	4.5	3.6		
AUG 22		Ultimate BOD, mg/l	11.9	5.5	11.6	4.6
		Ultimate BOD, Day 5 Reading, mg/l	3.40	2.65	2.50	2.25
		Bottle Deoxygenation Rate, Base 10	0.03	0.05	0.02	0.04
		Total 5-Day BOD (BOD_5), mg/l	3.3	3.4		

TABLE 3-21 (Page 3 of 4)

DATE	NITRITE NITROGEN MG/L	NITRATE NITROGEN MG/L	TOTAL PHOS-PHORUS MG/L	TOTAL BOD5 MG/L	CARBON-ACEOUS BOD5 MG/L	TOTAL SUSPENDED SOLIDS MG/L	VOLATILE SUSPENDED SOLIDS MG/L	TOTAL DISSOLVED SOLIDS MG/L	CHLORO-PHYLL-a UG/L	VIABLE CHLORO-PHYLL-a PERCENT
JAN 04	0.03	3.10	0.18	2.6	1.8	8	2	502	7.7	94
18	0.04	3.05	0.15	3.8	2.1	5	2	422	7.9	71
FEB 02	0.03	2.65	0.16	3.9	1.6	4	4	406	7.5	97
15	0.03	2.00	0.16	2.4	1.7	3	2	404	2.7	86
MAR 02	0.05	4.50	0.27	2.8	2.2	63	14	336	7.1	100
15	0.05	4.40	0.20	2.5	1.9	41	6	366	8.3	93
APR 05	0.04	5.90	0.21	2.8	2.4	57	4	412	20.0	76
19	0.04	6.55	0.16	2.6	2.0	48	6	411	20.0	87
MAY 03	0.04	3.45	1.60	2.8	2.5	48	8	458	35.0	93
18	0.05	4.15	0.15	2.2	3.2	54	8	467	36.0	86
JUN 07	0.07	3.40	0.15	3.3	2.3	28	7	462	66.0	95
22	0.04	3.90	0.25	3.0	2.0	149	22	405	20.0	64
JUL 08	0.08	3.75	1.50	2.6	2.0	75	10	341	18.0	87
20	0.06	2.05	0.28	3.4	2.3	92	13	487	23.0	73
AUG 02	0.04	1.30	0.23	4.2	3.0	57	10	433	54.0	80
16	0.03	0.35	0.21	4.0	3.2	27	7	320	64.0	69
SEP 08	0.08	0.90	0.27	4.3	2.4	25	7	325	34.0	69
21	0.07	0.70	0.24	4.9	3.5	22	4	338	39.0	75
OCT 04	0.05	1.15	0.25	3.5	2.1	24	4	340	62.0	84
18	0.04	0.85	0.19	2.6	1.8	21	5	284	36.0	81
NOV 02	0.06	1.15	0.20	3.8	2.0	21	4	336	42.0	76
15	0.02	0.95	0.22	2.3	1.4	14	5	327	38.0	90
30	0.05	2.20	0.22	3.2	2.5	15	4	385	15.0	88
DEC 13	0.04	2.20	0.18	3.3	2.5	7	3	408	6.7	79

TABLE 3-21 (Page 4 of 4)

TRACE METALS, TOTAL (UG/L)

DATE	AG	AS	CD	CR	CU	HG	NI	PB	TL	ZN	HARDNESS (MG/L)	CYANIDE	TOTAL PHENOLS
FEB 02	< 0.2	1.0	1.7	1.8	2.2	< 0.2	5.0	1.3	< 1.0	14	237	< 20	< 1
APR 05	< 0.2	1.8	1.9	2.4	4.5	< 0.2	4.7	1.0	< 1.0	40	306	< 20	2
JUN 07	< 0.2	< 1.0	0.7	1.5	3.4	< 0.2	2.6	1.4	< 1.0	20	317	< 20	< 1
AUG 30	< 0.2	2.1	0.2	2.2	7.9	< 0.2	6.3	4.3	< 1.0	14	210	< 20	1
OCT 04	< 0.2	1.2	0.2	3.1	4.3	< 0.2	3.9	1.2	< 1.0	7	238	< 20	1
DEC 28	< 0.2	< 1.0	1.8	< 1.0	11.9	< 0.2	3.6	2.4	< 1.0	30	280	< 20	< 1

TRACE METALS, DISSOLVED (UG/L)

DATE	AG	AS	CD	CR	CU	HG	NI	PB	TL	ZN	TOTAL CHROMIUM +6 (UG/L)
AUG 30	< 0.2	1.7	0.15	< 1.2	3.4	< 0.2	6.0	< 1.0	< 1.0	10	< 2.2

fell below and temperature values rose above standards regularly. Low DO values in this segment of the river are generally attributed to operations at the Metropolitan Waste Treatment Plant (MWTP) upstream (UM 835) of the Grey Cloud Island monitoring station. Elevated water temperatures may result from numerous upstream discharges.

Regulatory Requirements

Current discharges from the Koch Refinery WWTP must comply with federal Best Practicable Technology (BPT) and Best Available Technology (BAT) guidelines for the petroleum industry and State of Minnesota effluent limitations for interstate waters.

New federal BPT guidelines establish effluent limitations for conventional pollutants. For the petroleum industry, conventional pollutants are: biological oxygen demand (BOD_5), total suspended solids (TSS), pH, fecal coliform, and oil and grease.

BAT guidelines establish effluent limitations for the following toxic pollutants in the petroleum industry: phenol, total chromium, and hexavalent chromium. Current BPT and BAT guidelines apply to process water and noncontact water and are production-based limitations that consider factors such as refinery capacity and process configuration. These guidelines yield mass based limitations.

Minnesota effluent limitation guidelines require a minimum of secondary treatment for all process waters discharged to surface waters. Additionally, the discharge effluent must meet the minimum requirements outlined in Table 3-22. Unlike federal standards, the state limitations are concentration based.

Effluent limitations for process wastewater established by the current NPDES permit are shown in Table 3-23. Effluent limitations are based on an average process water and noncontact cooling water flow of 2.8 mgd. The NPDES permit also contains limitations for treated stormwater discharges. Stormwater limitations are based on mass loadings per 1,000 gallons of flow.

Although state effluent guidelines provide for regulation of the discharge of fecal coliform organisms and turbidity, the current NPDES permit does not require effluent monitoring for these substances. These parameters are not expected to be present in significant quantities in the Koch WWTP effluent. Similarly, routine monitoring for priority pollutants is not required. Monitoring in 1983 for selected priority pollutant compounds indicated that these compounds were not

Table 3-22
MINNESOTA EFFLUENT LIMITATION GUIDELINES

Substance or Characteristic	Limiting Concentration or Range
BOD_5[a]	25 mg/L
Fecal coliform[b]	200 organisms/100 ml
Total suspended solids[a]	30 mg/L
Oil	Free of visible oil[c]
Turbidity	25
pH range	6.0-9.0
Unspecified toxic or corrosive substances	None at levels acutely toxic to humans or other animals or plant life, or directly damaging to real property

[a]The arithmetic mean concentration shall not exceed the stated values in a period of 30 consecutive days.

[b]Applicable March 1 through October 1.

[c]Numerical limits of 10 mg/L for monthly average and 20 mg/L for daily maximum value.

GLT495/1

Table 3-23
EXISTING NPDES PERMIT EFFLUENT LIMITATIONS
FOR EXISTING FACILITIES

Parameter[a]	Thirty (30)[b] Consecutive Day Average (kg/day)	Daily Maximum[b] (kg/day)
BOD_5	265	530
Total Suspended Solids	318	636
Ammonia (as N)	441	969
COD	5,641	10,871
Oil & Grease	106	212
Phenolic Compounds	5.3	10.9
Sulfide	4.3	9.5
Total Chromium	12.9	22
Hexavalent Chromium	0.8	1.8
Ammonia (Un-ionized)	-[c]	
pH	-[d]	
Temperature	-[e]	

[a]Effluent limitations based on process water flow of 2.8 mgd.
[b]Permit also contains additional allocations for stormwater discharge. Stormwater limitation based on mass loadings per 1,000 gallons of flow.
[c]Effective July 1, 1985, daily maximum concentration shall not exceed 1 mg/L.
[d]The pH shall not be less than 6.5 nor greater than 8.5 as measured by daily 24-hour composite sample and shall also be monitored continuously and shall be within range of 6.0 to 9.0 no less than 99 percent of the time measured on a monthly basis.
[e]Shall not exceed 100°F.

GLT495/13

present in significant quantities. A single sampling for priority pollutants will be required at the time of the permit modification for the refinery expansion. Future monitoring requirements for priority pollutants will be dependent on the results from that sampling episode.

Changes in the federal guidelines have been proposed since issuance of the Koch NPDES permit. These proposals would set future Best Conventional Technology (BCT) requirements for toxic pollutants equal to existing BPT requirements and make BAT requirements for nonconventional pollutants more stringent. Additionally, the new proposals would require treatment of contaminated stormwater runoff (omitted in original regulations) prior to discharge. EPA proposed defining "contaminated runoff" as "runoff that comes into contact with any raw material, intermediate product or waste product located on the petroleum refining property." The discharge of contaminated runoff must meet proposed numerical effluent limitations.

Based on the proposed changes in BAT standards, a revised NPDES permit for the existing facilities has been developed and is shown in Table 3-24. The revised effluent limitations include an allocation for treated stormwater runoff from 378 acres of refinery property.

Wastewater Treatment Plant Description

Major components of the existing wastewater treatment plant include flow equalization facilities, pretreatment facilities for removal of oil and grease, equalization basins for influent mixing, and conventional activated sludge treatment facilities. The WWTP has a treatment design capacity of 2.5 mgd and has been in operation since 1977. A detailed flow diagram of the WWTP is shown in Figure 3-2. The existing WWTP has a total hydraulic design capacity of 8,000 gallons per minute (gpm) (11.5 mgd). At the diversion box, a maximum of 1,750 gpm (2.5 mgd) is allowed to pass forward to wastewater treatment units while up to 6,750 gpm (9 mgd) may be diverted to the shot pond. Wastewater treatment unit sizes and design criteria are summarized in Table 3-25. The major components of the WWTP are described below.

Flow Equalization. A diversion box at the head of the wastewater treatment plant is used to divert excess wastewater flow to the shot pond. This unit process prevents hydraulic overloading of downstream treatment processes during periods of high flow and augments the system during periods of low wastewater flow.

Wastewater Pretreatment. Successful biological degradation of waste constituents in the refinery wastewater is dependent

Table 3-24
REVISED NPDES PERMIT EFFLUENT LIMITATIONS
FOR EXISTING FACILITIES

Parameter[a]	Thirty (30) Consecutive Day Average (kg/day)	Daily Maximum (kg/day)
BOD_5	337	668
Total Suspended Solids	380	733
Ammonia (as N)	441	969
COD	6,158	11,905
Oil & Grease	129	257
Phenolic Compounds	4.9	19.1
Sulfide	4.3	9.5
Total Chromium	5.7	16.5
Hexavalent Chromium	0.50	1.12
Ammonia (Un-ionized)	-[b]	
pH	-[c]	
Temperature	-[d]	

[a] Effluent limitations based on process water flow of 2.8 mgd and 0.76 mgd of treated stormwater runoff.
[b] Effective July 1, 1985, daily maximum concentration shall not exceed 1 mg/L.
[c] Shall be monitored continuously and shall be within range of 6.0 to 9.0 no less than 99 percent of the time measured on a monthly basis.
[d] Shall not exceed 100°F.

GLT495/16

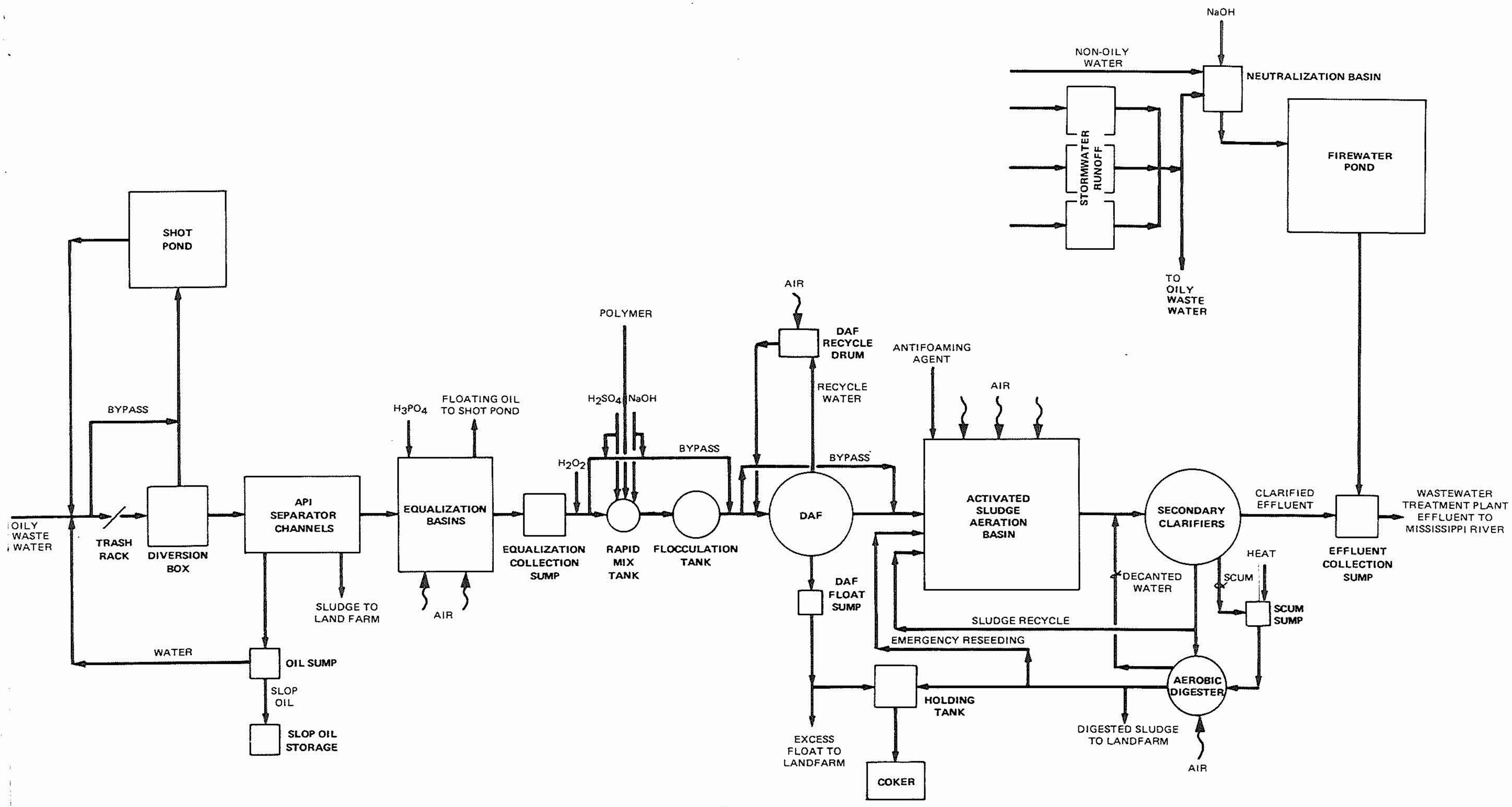


FIGURE 3-2

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

Table 3-25
DESIGN CRITERIA FOR EXISTING UNIT PROCESS

Unit/Tank	No. of Units	Shape	Dimensions	Design Capacity	Operating Volume	Detention Time at Max Flow	Air Requirements	Operation
Trash Rack	2	inclined	CONFIDENTIAL	4,000 gpm per rack	CONFIDENTIAL	CONFIDENTIAL	-	Manually cleaned.
Diversion Box	1			8,000 gpm			-	At max flow: 1,750 gpm forward, 6,250 gpm to shot pond.
API Separator	2	rectangular		875 gpm per channel			-	Operated in parallel.
Equalization Basins	2	square		875 gpm per basin			625 scfm per basin	Operated in parallel.
Rapid Mix Tank	1	circular		1,750 gpm			30 scfm (backup)	
Flocculation Tank	1	circular		1,750 gpm			-	Anionic polymer dosage: 1 mg/L.
Dissolved Air Flotation	1	circular, flat bottom		1,750 gpm				
DAF Recycle Drum	1	cylindrical		-			25 scfm @ 80 psig	
A.S. Aeration Basin	2	square		875 gpm per basin			A: 2,940 scfm B: 2,160 scfm	DO level of 1-2 mg/L minimum. MLSS at 4,000-6,000 mg/L.
Secondary Clarifier	2	circular, cone bottom		1,059 gpm per tank (including recycle)			-	Expected recycle rate of 184 gpm total, minimum 0.8 wt % solids.
Aerobic Digester	1	circular		11,664 gpd (expected wasting)		-	570 scfm	Operated in "fill and draw" manner, DO should be maintained @ 1-2 mg/L, expected effluent of 2,318 gpd @ 3 wt % solids.

Note: For columns listed as CONFIDENTIAL, information is proprietary but has been submitted to MPCA for review.

upon successful pretreatment for removal of oil and grease, which have a detrimental effect on activated sludge performance. The existing pretreatment facilities consist of two American Petroleum Institute (API) oil/water separator channels and a dissolved air flotation (DAF) unit.

The API separator is a gravity/skimming operation which removes most of the oil from the influent water. The recovered oil from the API separator is called slop oil, which is treated and returned to process units as a raw material similar to incoming crude oil.

The second step of pretreatment is DAF. With the addition of coagulating agents, high pressure air is released in the form of fine bubbles which lift and float remaining oily constituents to the surface of the DAF unit where they are skimmed off. This skimming is called dissolved air float or DAF float, which is also returned for process use. After DAF treatment, the wastewater enters the activated sludge basin for biological degradation of the wastewater constituents.

<u>Equalization Basins</u>. Equalization provides for mixing of influent wastewater prior to entry into the activated sludge system so that any change in constituent concentration in the influent wastewater takes place very slowly and over a long period of time. The activated sludge can then become acclimated to successfully treat the waste constituents.

In the Koch WWTP, two equalization basins precede the DAF unit so that both the DAF unit and activated sludge system benefit from influent mixing. To promote mixing, equalization basins are equipped with static aerators.

<u>Activated Sludge Treatment</u>. The purpose of activated sludge treatment is to reduce the organic constituents in wastewater to an acceptable level prior to discharge. In the two aeration basins, wastewater and recycled activated sludge are contacted to provide a condition for the growth and metabolism of microorganisms that consume the organic materials in the wastewater.

Effluent from the aeration basins flows to two clarifiers which function to separate the activated sludge solids from the treated wastewater. The clarified wastewater rises to the top of the clarifier and is discharged. The activated sludge solids settle to the bottom of the clarifier. Most of the settled solids (activated sludge) is recycled to the inlet of the aeration basin to provide a continuing biomass for contact with influent wastewater constituents. The remaining activated sludge is pumped to an aerobic digester, which further stabilizes or treats the activated sludge by an oxidation process. After stabilization in the aerobic digester, the sludge is taken to the landfarm for disposal.

WWTP Chemical Additives. Several different organic or inorganic chemicals are added to wastewater streams in the treatment plant. These chemicals are used to neutralize high or low pH streams, coagulate and flocculate solids, or to provide essential nutrients for bacteria in the activated sludge treatment area. Each chemical and its purpose is described in Table 3-26.

Wastewater Treatment Plant Performance

Performance at the existing Koch WWTP plant was evaluated by reviewing plant operating data and NPDES monitoring data. Effluent sampling and analysis data are collected to verify that the WWTP discharge is in compliance with the refinery NPDES permit. Combined effluent samples are collected from the effluent discharged to the Mississippi River. Table 3-27 summarizes effluent monitoring for regulated parameters.

Operating data are collected at locations in the plant to evaluate the performance of individual unit operations for selected parameters. Operating data collected in 1983 are summarized in Table 3-28 and compared to typical industry values for comparable operations.

Average effluent values for oil and grease are higher than typical industry values, for the API separator and DAF units, However, average removal efficiencies are within the range of industry values. The operating data indicate that the implementation of steps to lower influent oil and grease concentrations will reduce effluent concentrations of these pollutants.

For the activated sludge area, average BOD_5 was within typical industry values while effluent COD was higher than industry averages. However, average removal efficiency for both BOD_5 and COD were within the range of industry values. Operating data to further characterize treatment plant performance are unavailable.

As previously mentioned, NPDES monitoring data are collected to verify that the WWTP discharges are complying with the NPDES permit. The current NPDES permit became effective January 1, 1983. Table 3-29 summarizes monthly data from January 1983 to June 1984.

Table 3-30 summarizes the compliance/noncompliance record for Koch refinery from January 1983 to October 1984. During this 22-month period, the MPCA would consider that there was significant noncompliance for 8 months. The MPCA views this as a relatively poor record of compliance with effluent limitations especially in comparison with compliance records of other major industries in the State of Minnesota.

Table 3-26
WASTEWATER TREATMENT PLANT CHEMICAL ADDITIVES

Additive	Function	Application
Sodium Hydroxide ($NaOH$)	pH adjustment	Added to control pH of oil water exiting API oil/water separator. Can also be added at rapid mix tank or DAF unit. Added as required to maintain wastewater pH in the moderately alkaline range. Also added at neutralization basin to nonoily water.
Sulfuric Acid (H_2SO_4)	pH adjustment	Added to neutralize highly alkaline oily and nonoily wastewater streams.
Nalcolyte 8103	Coagulation and flocculation	A liquid polyamine that electrostatically destabilizes and coagulates suspended and colloidal matter in the rapid mix and flocculation tanks.
Nalcolyte 8173		Powdered acrylic polymer added to wastewater after coagulation as a flocculant. Flocculation is the agglomeration of coagulated solids into larger particles which can then be separated from the wastewater in the DAF unit.
Phosphoric Acid (H_3PO_4)	Nutrient	Added to activated sludge as a source of phosphorous because wastewater is deficient in this nutrient. The acid is added at a rate calculated to maintain a ratio of 1 lb phosphorous per 100 lbs biological oxygen demand (BOD_5) in DAF effluent.
Hydrogen Peroxide (H_2O_2)	Oxidant	Oxidizes oxygen demanding sulfides to the innocuous sulfate which does not demand oxygen in the receiving water. Added at influent line to rapid mix tank.
71D-5 Antifoam	Antifoaming agent	If severe foaming occurs in aeration basins, operational problems can result. Added as needed to supress severe foaming. Added directly into aeration basin.

Table 3-27
KOCH REFINING EFFLUENT MONITORING

Parameter	Frequency of Analysis	Sample Type
BOD_5	Twice per week	24-hour composite
TSS	Twice per week	24-hour composite
Ammonia as N	Twice per week	24-hour composite
COD	Twice per week	24-hour composite
Oil and grease	Twice per week	Grab
Chromium, total	Three per week	24-hour composite
Chromium, hexavalent	Three per week	24-hour composite
Phenolics	Three per week	24-hour composite
Sulfide	Twice per week	24-hour composite
Flow	Continuous	24-hour total
pH	Continuous	

GLT495/7

Table 3-28
KOCH WWTP OPERATING DATA, 1983

Unit	Plant Operating Data	Typical[a] Industry Performance
API Separator	Effluent Oil & Grease[a]	
	Minimum: 29.3 mg/L	
	Maximum: 2,213 mg/L	20-100 mg/L
	Average: 288.3 mg/L	
DAF	Effluent Oil & Grease	
	Minimum: 7.0 mg/L	
	Maximum: 239.2 mg/L	5-20 mg/L
	Average: 35.1 mg/L	
	Oil & Grease Removal Efficiency	
	Minimum: 25%	
	Maximum: 97%	70-85%
	Average: 81%	
Activated Sludge Basins & Clarifiers	Effluent BOD_5	
	Minimum: 2.5 mg/L	
	Maximum: 129.6 mg/L	5-50 mg/L
	Average: 32.7 mg/L	
	BOD_5 Removal Efficiency	
	Minimum: 77%	
	Maximum: 99%	80-99%
	Average: 92%	
Activated Sludge Basin & Clarifiers	Effluent COD	
	Minimum: 61 mg/L	
	Maximum: 1,080 mg/L	30-200 mg/L
	Average: 261 mg/L	
	COD Removal Efficiency	
	Minimum: 28%	
	Maximum: 90%	50-95%
	Average: 69%	

[a]Source: U.S. EPA, "Development Document for the Petroleum Refining Point Source Category," EPA-440/1-74-014-a.
[b]Based on equalization basin effluent concentration.

GLT495/18

Table 3-29
SUMMARY OF NPDES MONTHLY DATA JANUARY 1983 THROUGH JUNE 1984

Parameter[a]	Permitted Daily Average	Mean of Daily Averages	Range of Daily Averages	Permitted Daily Maximum	Mean of Daily Maximums	Range of Daily Maximums
BOD_5	265	217.8	131.1 - 326.0	530	448	239.0 - 766.0
TSS	318	269.5	114.8 - 623.0	636	612	196.0 - 2,379.0
Ammonia (as N)	441	315.0	82.4 - 543.0	969	762.4	348.1 - 1,728.0
COD	5,641	1,368.8	458.0 - 3,270.0	10,871	2,467.5	841.0 - 11,835.0
Oil and Grease	106	39.5	21.0 - 103.8	212	106.6	35.2 - 357.0
Sulfide	4.3	0.5	0.0 - 2.1	9.5	2.6	0.0 - 9.5
Chromium, Total	12.9	1.0	0.3 - 3.1	22	1.8	0.4 - 4.8
Chromium, hexavalent	0.8	0.3	0.0 - 2.0	1.8	0.7	0.0 - 3.4
Phenolics	5.3	1.9	0.2 - 21.6	10.9	15.2	0.6 - 236.0

[a]Values in kg/day.

GLT495/21

Table 3-30 (page 1 of 5)
RECORD OF COMPLIANCE WITH PERMIT EFFLUENT LIMITATIONS

Month	Number of Violations	Violation	Comments
January 1983	1	Average hexavalent chromium discharges were 1.9 kg/day exceeding limitation of 1.8 kg/day.	Cause unknown. MPCA considered violations to be minor.
February 1983	0	In compliance with all limitations.	
March 1983	1	Maximum pH of 8.7 exceeded former pH limit of 8.5.	Cause unknown. MPCA considered violation to be minor. Would not be in violation of current pH limits.
April 1983	0	In compliance with all limitations.	
May 1983	1	Maximum pH of 9.8 exceeded former pH limit of 8.5. High pH approximately 7 hours.	Attributed to failure of valve in caustic feed system. MPCA considered violation to be significant.
June 1983	0	In compliance with all limitations.	
July 1983	1	Ammonia discharge of 1,728 kg/day exceeded daily maximum limit of 969 kg/day.	Ammonia violation attributed to malfunction at the sour water stripper. MPCA considered ammonia violation to be significant.
August 1983	14	Average BOD_5 discharges were 300 kg/day exceeding effluent limitation of 265 kg/day. BOD_5 discharge of 661 kg/day exceeded daily maximum limit of 530 kg/day. Average ammonia discharges were	Ammonia violation attributed to malfunction at the sour water stripper and improper tank cleaning. TSS violations due to accidental discharge of sediment in final lagoon.

Month	Number of Violations	Violation	Comments
August 1983		543 kg/day exceeding 441 kg/day limitation.	pH would not exceed new limit. All other violations considered significant by MPCA. MPCA.
		Ammonia discharges exceeded the daily maximum limit of 969 kg/day three times. The maximum discharge was 1,675 kg/day.	
		TSS discharges exceeded the daily maximum limit of 636 kg/day twice. The maximum discharge was 751 kg/day.	
		COD discharge of 11,835 kg/day exceeded daily maximum limit of 10,871 kg/day.	
		Average phenolics discharges were 21.6 kg/day exceeding limitation of 5.3 kg/day.	
		Phenolic discharge twice exceeded the daily maximum limit of 10.9 kg/day. The maximum discharge was 236 kg/day.	
		Maximum pH of 9.0 exceeded former pH limit of 8.5.	
September 1983	7	Average BOD_5 discharges were 326 kg/day exceeding 265 kg/day limitation.	Violations attributed in part to preparations for a maintenance turnaround that caused an upset in the WWTP. MPCA considered all violations to be significant.
		BOD_5 discharge of 623 kg/day exceeded daily maximum limit of 530 kg/day.	

Month	Number of Violations	Violation	Comments
September 1983 (continued)		Average hexavalent chromium discharges were 2.0 kg/day exceeding 0.8 kg/day limitation. Hexavalent chromium discharges exceeded the daily maximum limit of 1.8 kg/day four times. The maximum concentration was 3.4 kg/day.	
October 1983	0	In compliance with all limitations.	
November 1983	2	BOD_5 discharge of 766 kg/day exceeded daily maximum limit of 530 kg/day. TSS discharge of 1,122 kg/day exceeded daily maximum limit of 636 kg/day.	Violations attributed to temporary carryover of solids in final clarifiers. MPCA does not consider violations to be especially significant.
December 1983	5	Average BOD_5 discharges were 315 kg/day exceeding 265 kg/day limitation. BOD_5 discharges exceeded the daily maximum limit of 530 kg/day twice. The maximum discharge was 764 kg/day. TSS discharge of 871 kg/day exceeded daily maximum limit of 636 kg/day. Average ammonia discharges were 454 kg/day exceeding 441 kg/day limit. Oil and grease discharge of 400 kg/day exceeded daily maximum limit of 212 kg/day.	Koch attributed violations to treatment plant upsets caused by severe cold weather in the latter half of the month. MPCA considered all violations to be significant.

Month	Number of Violations	Violation	Comments
January 1984	5	Average TSS discharges were 623 kg/day exceeding 318 kg/day limit. TSS discharges exceeded the exceeded the daily maximum limit of 636 kg/day three times. The maximium discharge was 2,379 kg/day. Oil and grease discharges twice exceeded the daily maximum limit of 212 kg/day. The maximum discharge was 357 kg/day.	Koch attributed violations to treatment plant upsets caused by severe weather. MPCA considered violations significant.
February 1984	3	Average TSS discharges were 325 kg/day exceeding 318 kg/day limit. TSS discharge of 784 kg/day exceeded daily maximum limit of 636 kg/day. Hexavalent chromium discharge of 2.1 kg/day exceeded daily maximum limit of 1.8 kg/day.	TSS violations attributed to sludge bulking that was a result of the cold weather. Violations not considered especially significant.
March 1984	2	Average TSS discharges were were 330 kg/day exceeding 318 kg/day limit. Maximum pH of 8.6 exceeded former pH limit of 8.5.	Neither violation considered significant by MPCA.
April 1984	0	In compliance with all limitations.	
May 1984	2	Average TSS discharges were 470 kg/day exceeding 318 kg/day limit. Average ammonia discharges were 502 kg/day exceeding 441 kg/day limit.	Violations attributed to maintenance in one equalization basin in April that resulted in unbalanced flow. MPCA considered violations to be significant.

Month	Number of Violations	Violations	Comments
June 1984	1	Average TSS discharges were 326 kg/day exceeding 318 kg/day limit.	MPCA did not consider violation to be significant.
July 1984		Average BOD_5 discharges were 268 kg/day exceeding 265 kg/day limit. Oil and grease discharge of 215 kg/day exceeded daily maximum limit of 212 kg/day. Ammonia discharge of 1,029 kg/d exceeded daily maximum limit of 969 kg/day. pH of 5.5 was below limit of 6.0 for approximately 3 hours.	pH violations attributed to leaking valve. MPCA considered pH violation to be significant and BOD_5 ammonia and oil and grease violations insignificant.
August 1984	0	In compliance with all limitations.	
September 1984	0	In compliance with all limitations.	
October 1984	4	Average TSS discharges were 395 kg/day exceeding 318 kg/day limit. TSS discharges exceeded daily maximum limit of 636 kg/day twice. The maximum discharge was 850 kg/day. Oil and grease discharge of 215 kg/day exceeded daily maximum limit of 212 kg/day.	MPCA did not consider violations to be significant.

GLT499/7-5

TSS limitations were most frequently violated followed in rank order of frequency by BOD_5 and ammonia limitations. In addition, on some of these occasions, the MPCA expects that the effluent was acutely toxic because of high concentrations of un-ionized ammonia.

Most of the violations have been attributed to equipment malfunctions, maintenance activities, production unit upsets, and cold weather conditions. Partly because of the relatively high frequency of violations, the MPCA does not consider these circumstances to be reasonable or acceptable. The MPCA has pursued enforcement action against Koch Refining Company for violations of the NPDES permit as exemplified by a Notice of Violation issued in December of 1983. Koch responded to this notice by stating that scheduling of maintenance activities would be improved. However, the MPCA believes that additional improvements would be necessary to enhance the performance of the existing wastewater treatment plant. The proposed expansion of production will require an expansion of wastewater treatment plant capabilities to accommodate the increased flows and loadings. In its review of the treatment plant expansion plan, the MPCA will assure that previous problems causing permit violations are corrected.

Koch believes that BOD_5 and TSS violations are generally the result of incomplete oil removal by the pretreatment operations. When excess oil passes through the pretreatment facilities, it interferes with activated sludge and clarifier performance. Koch is currently evaluating the use of mechanical oil/water separators as an alternative to the existing gravimetric (API) separators.

Koch is installing facilities within the refinery to reduce the quantity of ammonia discharged to the wastewater treatment plant. The new equipment is expected to reduce total ammonia discharges by 50 to 75 percent. It is expected that this reduction will allow the final discharges to meet the future effluent limitations of 1 milligrams per liter (mg/L) for un-ionized ammonia. The wastewater treatment plant expansion plan will also be evaluated to determine if final pH adjustment will be necessary to shift the ammonia chemical equilibriums to consistently achieve the 1 mg/L un-ionized ammonia limitation.

<u>Existing Wastewater Treatment Plant Effects</u>

The existing Koch WWTP outfall discharges to the Mississippi River at river mile UM 824.4. The impact of this discharge on water quality will vary seasonally and with changes in WWTP and refinery operations. Important factors are stream flow and pollutant loadings. A mass balance approach was used to determine the maximum impact of Koch WWTP discharges in the vicinity of the Koch outfall for regulated parameters. The following assumptions were used in this analysis:

- o Background concentrations in the river are equal to the mean value of grab samples collected at the Grey Cloud Island water quality monitoring station (UM 826.6) during 1983 (see Table 3-20).
- o River flow is equal to the 7-day, 10-year low flow (7Q10) for this segment of the Mississippi River. The 7Q10 below the outfall (UM 836.3) of the MWTP (including MWTP discharges) was used as an estimate for the 7Q10. This flow is 2,104 cubic feet per second (1,360 mgd).
- o Pollutant loadings to the river are equal to the mean of the monthly daily maximum values shown in Table 3-29.

This methodology will suggest an impact much greater than that normally expected from the Koch discharge because of the low value of stream flow employed and because the maximum expected daily loading is assumed to last for 7 consecutive days.

The results of this analysis are shown in Table 3-31. The impact value represents the rise in ambient river water concentration for each substance following dilution. The highest impact in comparison to background concentrations is shown under conditions of extreme loading and low flow for ammonia, total chromium, and phenolics. Ammonia loadings to the river should be reduced significantly following startup of refinery in-plant facilities to reduce ammonia concentrations in the WWTP influent. Although ambient river water concentrations will rise under extreme conditions, the rise represents a small portion of the water quality criteria for total chromium and therefore does not represent a significant degradation in water quality.

Table 3-31
IMPACT OF EXISTING FACILITIES

Parameter	Mean of Daily Maximum (kg/day)	Background Level	Water Quality Criteria	Impact from Koch Outfall	Percent of Background	Percent of WQC
BOD_5	448	3.20 mg/L		0.09 mg/L	3	
TSS	612	38 mg/L		0.12 mg/L	0.3	
Ammonia (as N)	762.4	0.47 mg/L		0.15 mg/L	32	
COD	2,468	-		0.48 mg/L	-	
Oil & Grease	107	-	0.5 mg/L	0.021 mg/L	-	4
Sulfide	2.6	-		0.00051 mg/L	-	
Chromium, total	1.8	1.8 ug/L	50 ug/L	0.36 ug/L	20	0.7
Chromium, hexavalent	0.7	-	0.29 ug/L	0.14 ug/L	-	48
Phenolics	15.2	1 ug/L	10 ug/L	2.9 ug/L	290	29

Comparison of the impact value to water quality criteria shows the highest impact under extreme conditions for hexavalent chromium and phenolics. Impacts from these two discharges were calculated under less extreme conditions, using average daily discharges for the existing facility (Table 3-29) rather than maximum daily discharges. Under lower discharge levels, impacts from hexavalent chromium and phenol discharges are reduced to 20 and 4 percent of their respective water quality criteria.

The above analysis does not consider other factors which influence the downstream loadings of some pollutants. Both ammonia and BOD_5 will be reduced at downstream locations because of natural processes. With ammonia, the most significant impact will occur at the point of discharge. Therefore, the mass balance approach represents the maximum impact of ammonia discharges. For BOD_5, the maximum impact on river water quality will occur downstream and be represented by a drop in dissolved oxygen levels. At a rise in BOD_5 of 0.09 mg/L, the impact on downstream dissolved oxygen levels should be insignificant.

3.2.2 IMPACTS

The expanded refinery will generate additional quantities of wastewater for treatment and ultimate discharge to the Mississippi River. The additional wastewater treatment requirements will be met by expansion of the existing facilities and addition of new WWTP units. In the information that follows, anticipated increases in wastewater flows and pollutant discharges will be identified and state and federal regulations governing these discharges reviewed.

Regulatory Requirements

Additional oily and noncontact process water discharges must comply with New Source Performance Standards (NSPS) and State of Minnesota effluent limitations for interstate waters. Additional stormwater discharges must comply with federal BPT/BCT and proposed BAT standards and State of Minnesota effluent limitations.

Based on applicable guidelines, a NPDES permit has been developed for the expanded refinery. Table 3-32 includes a summary of the proposed NPDES permit limits. When state and federal limitations overlap, the more stringent limitation is applied. Added limitations for BOD, TSS, cyanide, oil and grease, and un-ionized ammonia are more stringent than NSPS because Minnesota standards are more limiting.

In addition to the limitations outlined in Table 3-32, effluent limitations on free cyanide (or cyanide amenable to chlorination) may be incorporated into the NPDES permit. The basis for this limitation is a state requirement limiting the discharge of toxic substances below levels that are toxic to animals. The proposed limitation would be an effluent concentration of 137 ug/L. Further, un-ionized ammonia and free cyanide effluent limitations may be subject to an additive formula. An additive formula would restrict effluent concentrations of these two substance as follows:

$$\frac{X_{CN}}{S_{CN}} + \frac{X_{NH3}}{S_{NH3}} \leq 1.0$$

where:

X_{CN} = effluent concentration of free cyanide
X_{NH3} = effluent concentration of un-ionized ammonia
S_{CN} = effluent limitation for cyanide (137 micrograms per liter [ug/L])
S_{NH3} = effluent limitation for un-ionized ammonia (1,000 ug/L)

This type of formula is designed to account for the additive effects of multiple toxic substances. The additive formula is used only if the measured effluent concentrations exceed 20 percent of their respective limits.

Table 3-32

SUMMARY OF EFFLUENT LIMITATION CALCULATIONS FOR EXPANDED FACILITIES

	30-Day Average Discharge (kg/day)					
Parameter	Revised Permit for Existing Facilities	Additional Stormwater Allocation BAT/BCT[a]	Additional Stormwater Allocation MPCA[a]	Allocation for New Sources NSPS[b]	Allocation for New Sources MPCA[b]	NPDES Permit Limitations for Expanded Facilities[c]
BOD_5	337	9	9	262	237	583
COD	6,158	61		1,772		7,991
Oil and Grease	129	3	34	79	95	211
TSS	380	7	10	212	284	599
Ammonia (as N)	441			254		695
Sulfide	4.3			1		5.3
Phenolics	4.9	0.1		2		6.0[d]
Chromium, total	5.7	0.1		4		7.1[d]
Chromium, hexavalent	0.50	0.01		0.27		0.62[d]

[a]Based on 0.09 mgd additional stormwater (for 27 inch/year average precipitation over 44 acres).
[b]Based on 70,000 B/D expansion with 207,000 B/D total throughput.
[c]Based on most stringent criteria applied to new source and additional stormwater added to revised existing permit limits.
[d]Permit limit for expanded facility based on BAT for total facility because BAT more stringent than NSPS.

GLT495/25-1

Table 3-32 (continued)

Parameter	Revised Permit for Existing Facilities	Maximum Daily Discharge (kg/day) Additional Stormwater Allocation BAT/BCT[a]	Additional Stormwater Allocation MPCA[a]	Allocation for New Sources NSPS[b]	Allocation for New Sources MPCA[b]	NPDES Permit Limitations for Expanded Facilities[c]
BOD_5	668	16	17	491	473	1,157
COD	11,905	122		3,512		15,539
Oil and Grease	257	5	68	144	189	406
TSS	733	11	20	338	568	1,082
Ammonia (as N)	969			558		1,527
Sulfide	9.5			3.1		12.6
Phenolics	19.1	0.1		4.1		23.2
Chromium, total	16.5	0.2		7.1		20.4[d]
Chromium, hexavalent	1.12	0.02		0.61		1.38[d]
Ammonia, unionized						e
Temperature						f
pH						g

[a] Based on 0.09 mgd additional stormwater for 27 inch/year average precipitation over 44 acres).
[b] Based on 70,000 B/D expansion with 207,000 B/D total throughput.
[c] Based on most stringent criteria applied to new source and additional stormwater added to revised existing permit limits.
[d] Permit limit for expanded facility based on BAT for total facility because BAT more stringent than NSPS.
[e] Daily maximum concentration shall not exceed 1 mg/L.
[f] Shall not exceed 100°F.
[g] Shall be monitored continuously and shall be within 6.0 to 9.0 no less than 99 percent of the time as measured on a monthly basis.

GLT495/25-2

In 1984, Koch conducted testing for total and free cyanide in its influent and effluent wastewater from the existing facilities. On several occasions, effluent concentrations of free cyanide exceeded the proposed effluent limitation.

Projected Loadings to Wastewater Treatment Plant

Koch's crude expansion project consists of increasing the refining capacity by approximately 50 percent. The expanded refinery will process the same type of crude (sour crude) and produce the same type of products as the existing refinery. Therefore, the wastewater generated from the new facilities is expected to have the same general characteristics as the existing process wastewater.

Additional process equipment will produce additional volumes of oily and noncontact process waters. Additional stormwater collection from existing and new process areas will also be required. Table 3-33 compares predicted flows for the expanded refinery to the flows on which the current permit is based. Koch has stated that refinery unit processes that will be expanded are more wastewater intensive than the refinery as a whole, therefore predicted increases in wastewater flow are proportionately greater than the increase in refining capacity.

Table 3-33
FUTURE WASTEWATER FLOWS

Stream	Average[a] Flow (mgd)	Koch[b] Projected Flow (mgd)
Oily process water	2.4	4.3
Noncontact water	0.4	1.0
Stormwater	-	0.9[c]

[a]Basis of current permit.
[b]Estimates provided by Koch.
[c]0.75 mgd attributable to existing facilities.

Wastewater Treatment Plant Improvements

The Koch Refining Company plans to meet the additional wastewater treatment plant requirements through expansion of its existing treatment plant. The existing wastewater treatment plant was constructed and began operation in 1977. During the WWTP design and construction phases, provisions were made for plot space for additional pretreatment facilities, equalization basins, and activated sludge units. Plot space for additional facilities is shown in Figure 3-3.

The existing pretreatment facilities consist of two API oil/water separator channels and a dissolved air flotation (DAF) unit. WWTP plot space was reserved for an additional DAF unit and related treatment tanks. Koch is also evaluating the use of mechanical oil/water separators as an alternative to the existing gravimetric (API) separators.

Equalization basins provide mixing of influent wastewater prior to DAF and activated sludge treatment. Currently, two basins are used for equalization purposes. In 1977, WWTP plot space was reserved for two additional basins, one or two which could be used as equalization basins, or alternatively, one or two which could be used as activated sludge basins.

The existing activated sludge system consists of two aeration basins and two clarification units. As described above, plot space is available for one or two additional aeration basins depending on the configuration recommended to provide optimal treatment of the increased wastewater flow. Plot space is also available for an additional clarification unit.

Currently, waste solids that are discharged to the landfarming process contain an excessive amount of water. Koch will be adding a dewatering system(s) to remove excess water. Either centrifugation (basket or solid bowl) or belt filter pressing will be employed. Both types of equipment are capable of increasing the solids contents of waste solids. For example, waste activated sludge can generally be dewatered from a solids level of 1 to 2 percent to 14 to 16 percent with proper operation of the dewatering equipment.

The input stream to the dewatering system will be the waste solids from the wastewater treatment plant. The output from the dewatering system will be solids cake and a centrate or filtrate stream. The solids cake will be sent to the landfarming operation and the centrate or filtrate stream will be returned to the inlet of the wastewater treatment system.

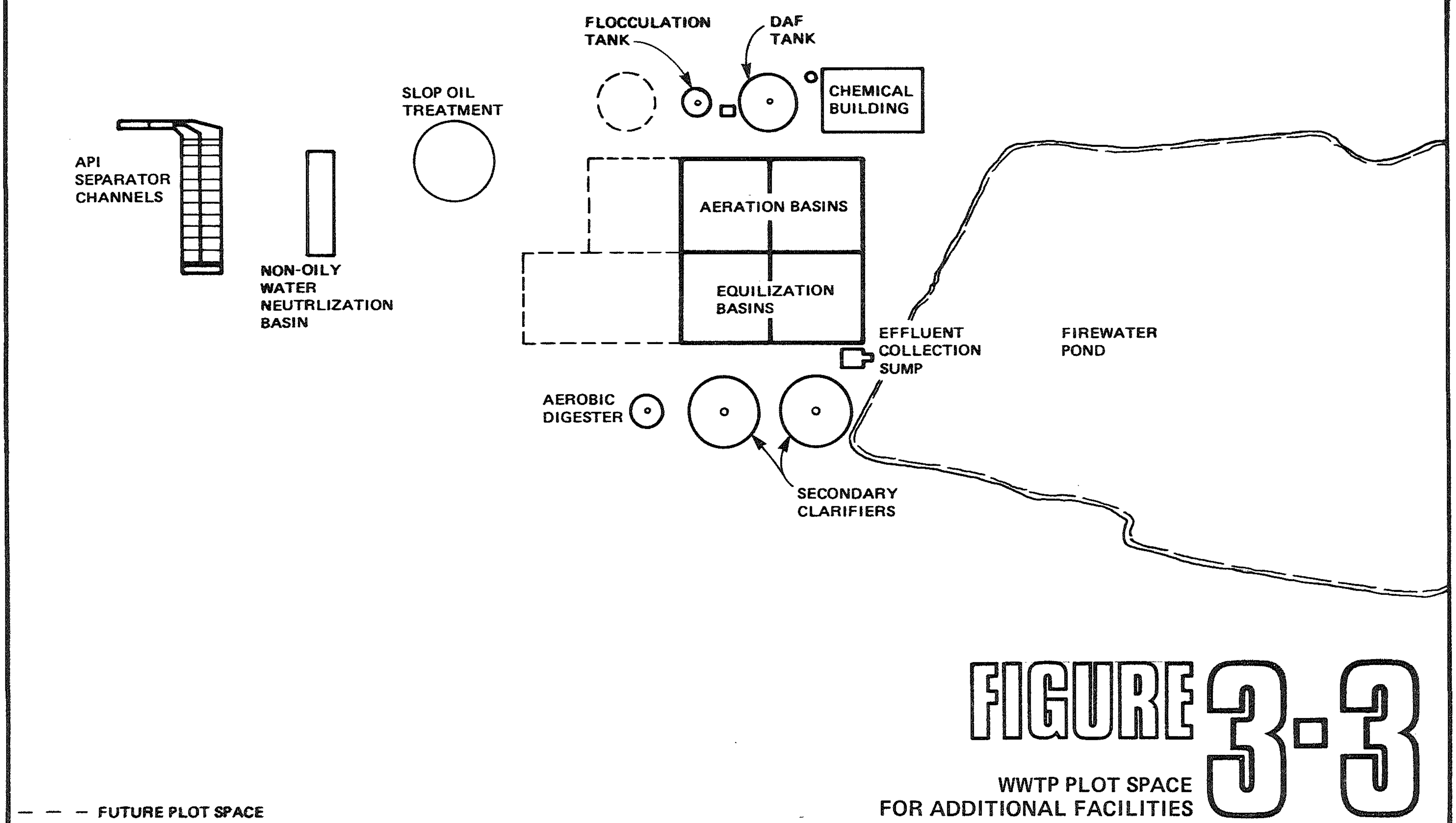


FIGURE 3-3

WWTP PLOT SPACE
FOR ADDITIONAL FACILITIES

The overall impact of the dewatering system will be significant decrease in the amount of water sent to the landfarming operation. A secondary impact will be an additional low-flow waste stream to the wastewater treatment system.

Wastewater Treatment Plant Discharges

In Table 3-34, Koch's projected discharges from the expanded wastewater treatment plant are compared to existing discharges and future NPDES permit levels. For most parameters, the level of discharge has increased more than refinery capacity. However, all projected discharges are below NPDES permit levels.

Table 3-34 indicates a significant reduction in ammonia-nitrogen discharges. This reduction reflects in-plant facilities currently being installed to reduce the quantity of ammonia discharged to the WWTP in order to comply with future unionized ammonia effluent limitations of 1 mg/L.

Water Quality Impacts

A mass balance approach similar to that used to evaluate the impact of current discharges on river water quality was used to evaluate the impact of future discharges. Assumptions used in this analysis were:

- Background concentrations in the river are equal to the mean value of grab samples collected at the Grey Cloud Island water quality monitoring station in 1983 (see Table 3-20).
- River flow is equal to the 7-day, 10-year low flow (7Q10) for this segment of the Mississippi River. A 7Q10 of 2,104 cubic feet per second (1,360 mgd) was assumed to be equal to the 7Q10 for this segment of the river. This value is the 7Q10 below the outfall of the MWTP.
- Pollutant discharges are equal to the maximum daily effluent limitation for each parameter (Table 3-32).

As was the case with the impact analysis for existing discharges, this methodology will suggest an impact much greater than that normally expected from future Koch discharges because of the low value of streamflow employed and because the maximum expected daily loading is assumed to last for 7 consecutive days.

Results of the impacts analysis are shown in Table 3-35. The highest impact in comparison to background concentrations occurs under conditions of extreme loading and low flow for ammonia, total chromium, and phenolics. The maximum

Table 3-34
FUTURE WATER POLLUTANT DISCHARGES

Parameter	Current[a] Discharge (kg/day)	Koch[b] Projected Discharge (kg/day)	NPDES Average Discharge Limit (kg/day)
BOD_5	218	493	583
COD	1,358	2,052	7,991
Oil and Grease	40	67	211
TSS	270	443	599
Ammonia (as N)	315	124	695
Phenolics	1.9	2.5	6.0
Sulfide	0.5	2.5	5.3
Chromium, total	1.0	2.5	7.1

[a] Based on NPDES monitoring reports, January 1983 through June 1984.
[b] Estimates provided by Koch Refining.

GLT495/23

Table 3-35
IMPACT OF EXPANDED FACILITIES

Parameter	Maximum Daily Discharge (kg/day)	Background Level	Water Quality Criteria	Maximum Impact from Koch Outfall	Percent of Background	Percent of WQC
BOD_5	1,157	3.20 mg/L	-	0.22 mg/L	7	-
TSS	1,082	38 mg/L	-	0.21 mg/L	0.6	-
Ammonia (as N)	1,527	0.47 mg/L	-	0.30 mg/L	64	-
COD	15,539	-	-	3.0 mg/L	-	-
Oil & Grease	406	-	0.5 mg/L	0.080 mg/L	-	16
Sulfide	12.6	-	-	0.0025 mg/L	-	-
Chromium, total	20.4	1.8 ug/L	50 ug/L	4.0 ug/L	223	8.0
Chromium, hexavalent	1.38		0.29 ug/L	0.27 mg/L	-	93
Phenolics	23.2	1 ug/L	10 ug/L	4.6 ug/L	460	46

GLT495/28

daily ammonia limitation is not representative of future discharges. To meet the MPCA limitation for un-ionized ammonia, total ammonia discharges will be less than one-tenth of the maximum daily limitation (Table 3-34). At this level, the rise in ambient river water concentration of total ammonia would be 6 percent, even under extreme conditions of discharge and flow. Also because of natural processes occurring downstream, the ammonia impact would be reduced further. Although ambient river water concentration will double under extreme conditions, the rise is only 8 percent of the water quality criteria for total chromium.

Comparison of the impact value to water quality criteria shows the highest impact under extreme conditions for oil and grease, hexavalent chromium, and phenolics. Impacts from these three discharges were calculated under less extreme conditions, using average daily effluent limitations for each parameter (Table 3-32). With lower discharge levels, impacts from oil and grease, hexavalent chromium, and phenolics are reduced to 8, 41, and 12 percent of their respective water quality criteria.

3.2.3 MITIGATION

Koch's past compliance record indicates that the existing treatment plant is being operated at or above capacity. Following expansion, wastewater flows are expected to increase by approximately 100 percent (Table 3-33), indicating that wastewater treatment capacity must roughly double.

The Koch Refining Company has hired an engineering consultant to develop the expansion plan for the existing WWTP. The expansion plan, including the design of the wastewater treatment plant, will be submitted to the MPCA as part of Koch's request for modification of the NPDES permit during the first quarter of 1985. The MPCA will evaluate the proposed expansion design to determine the capability of the expanded WWTP to comply with effluent limitations and will approve, modify, or reject the plan accordingly. The expansion plan must be approved before a modified NPDES permit will be issued.

3.3 SOCIOECONOMICS

Economic and social impacts associated with the crude expansion project are presented in this section. Existing conditions are described for refinery employment, and the refinery effects on the economy and community services. Impacts are evaluated with respect to the effect of the expansion on employment, secondary economic benefits, taxes, community services, and housing.

3.3.1 EXISTING CONDITIONS

Setting

Koch's Pine Bend refinery is located on a 600-acre tract in the Pine Bend Industrial District in Rosemount, Minnesota. Situated at the junction of U.S. Highway 52 and State Highway 55, the refinery is 8 miles northwest of the Town of Hastings (population 12,800), 6 miles northeast of the Rosemount city center (population 5,100) and 13 miles south of downtown St. Paul. Despite its proximity to the Twin Cities, the surrounding area is primarily agricultural, though a significant portion of it is devoted to the other industries of the Pine Bend Industrial District.

Two small residential subdivisions are nearby: one 2 miles southwest of the refinery, and the other 1 mile northwest. The southwest subdivision contains 13 houses; the northwest subdivision has only 3 houses. The southwest subdivision is owned by the Koch Refining Company for employee use. Other houses are scattered across the agricultural lands or along the roads west and south of the facility.

Current Operations and Employment

Koch's Pine Bend facility currently has a capacity of 137,000 barrels of crude oil per day. In 1983, it employed 586 people (in four shifts) with an aggregate payroll of $19 million. It pays approximately $840,000 per year in property taxes on real property valued at $19 million and assessed at $8.2 million. Since it opened in 1955, the Pine Bend refinery has experienced repeated increases in both capital base and employment, some because of capacity increases; others because of the installation of more sophisticated pollution control equipment.

Koch employs three types of workers: construction workers, turnaround employees, and plant personnel. Construction workers are hired through independent contractors for specific construction projects. From 1973 through 1983, Koch's modernization and pollution control activities provided the equivalent of 2,640 person-years of construction employment (an average of 240 full-time equivalents per year).

Like construction workers, turnaround workers are also provided by independent contractors. Called upon for short, but intensive bursts of equipment overhaul, turnaround workers may number as high as 1,000 or more for periods of a month or so. Since the number of such employees is somewhat misleading, turnaround labor must be measured in units of full-time equivalents. In the 11 years from 1973 through 1983, Koch provided an average of 67 full-time equivalent turnaround positions. Since 1980, this number has averaged 99 per year with a steady upward trend. For 1983, it was 125 turnaround workers. Since turnaround employment has been growing, but somewhat erratically, the arithmetic average of these two values will be used in this analysis: baseline turnaround employment is determined to be 112 full-time equivalents.

Koch's own payroll employees are easier to analyze. Since employment averaged 586 in 1983, this value will be used as baseline refinery employment.

Koch's employment history (since 1973) is summarized in Table 3-36, which includes data for all three types of workers, as well as payroll amounts for the refinery workers.

Spinoff Effects

Koch's employment and construction operations have two effects on the Minnesota economy. The first effect is direct and obvious; the employees themselves benefit. The economic benefits do not end there, however, for these workers spend money to create income and jobs in other sectors of the Minnesota economy. Recipients of this spinoff income also spend part of what they receive, creating yet another generation of economic benefits. These spinoffs continue through an indefinite number of cycles. Since they serve to multiply the original influx of jobs and money, these spinoffs are traditionally called the multiplier effect. A coefficient called the "multiplier" can be calculated to determine the total effect of each dollar of first-round spending.

The size of the multiplier depends on what percentage of their incomes the various beneficiaries spend. Money which is not spent is withdrawn from the spending cycle. The larger the withdrawals, the smaller the multiplier. Withdrawals from the Minnesota spending cycle fall into three categories:

- Taxes
- Savings
- Out-of-state purchases

The rate of withdrawal for each of these categories is provided in Appendix B.

Table 3-36
KOCH REFINING COMPANY EMPLOYMENT HISTORY

Date	Number of Refinery Employees	Payroll ($ millions)	Number of Turnaround Employees[a]	Construction Employees[a]	Total Direct Employment
1973	379	6.4	29	10	418
1974	409	5.3	23	40	472
1975	418	6.8	31	140	589
1976	446	7.8	40	180	666
1977	471	9.1	66	140	677
1978	475	10.2	79	190	744
1979	508	11.3	69	220	797
1980	513	13.3	102	280	895
1981	571	16.0	60	390	1021
1982	581	17.6	108	480	1169
1983	586	19.0	125	570	1281
Predicted					
1986	730[b]	23.7[c]	150	500	1,380
1988 and beyond	870[b]	28.1[c]	150	0[d]	1,020

NOTES:
Source: Koch Refining Company press release dated November 16, 1983.
[a]Measured in full-time equivalents.
[b]Extrapolated from historical refinery throughput (Table 2-2) and historical employment figures using a "least-square" method. Source: CH2M HILL.
[c]Based on 1983 average salary rates.
[d]It is unknown how many additional construction workers will be working on ongoing projects.

GLT263/90

Using the information from Appendix B, a Koch-payroll multiplier can be calculated for the Minnesota economy. In the first round, each dollar of the payroll is income to the Koch employees. They spend 50.2 percent of this income locally, giving a second-round effect of 50.2 cents per dollar earned. This second-round income will be received by people in a large number of income categories. Subsequent rounds of the spending cycle will therefore involve the average withdrawal rate of 47.4 percent (Table B-1, Appendix B). These numbers can be combined to produce a single multiplier. A withdrawal rate of 47.4 percent corresponds to a multiplier of 2.11. Since the statewide economy is fueled by only 50.2 percent of Koch's payroll, the spinoff benefit multiplier is 50.2 percent of 2.11, or 1.06. Adding 1.00 to account for the benefits to Koch's own employees produces a net payroll multiplier of 2.06. Each dollar of Koch's payroll, therefore, produces $1.00 in direct benefit and $1.06 in spinoff benefits.

In addition to its payroll, Koch also provides other direct economic benefits to the Minnesota economy. Although Koch does not purchase its raw materials locally, it does purchase 40 percent of its operating supplies in Minnesota. These purchases provide income to owners and employees of local businesses, increasing their local spending through a multiplier effect similar to Kochs. In this case, the correct withdrawal rate is 47.4 percent (the statewide average) for all rounds of the spending cycle, and Koch's local purchase multiplier is 2.11.

Community Services

The City of Rosemount is small and several miles from the refinery. Except for the employees residing in the Koch-owned subdivision, a large number of Koch's employees are scattered throughout the Twin Cities metropolitan area. They therefore present no geographically concentrated demands for schools, police, fire protection, housing, or any other social services.

Similarly, the Koch refinery itself appears to present little burden to local social services. It has its own security service (primarily to control entrance to the site) and provides its own fire protection through onsite equipment and trained refinery employees. The equipment includes two apparatus trucks and a four- wheel-drive, grass-fire rig plus 145 strategically placed fire hydrants. In the event of a large fire, Koch maintains fire-fighter assistance agreements with the Cities of Hastings and Rosemount. Since large fires are rare and other industrial facilities are also in the area, these agreements are unlikely to significantly influence either city's choice of fire protection equipment.

3.3.2 IMPACTS

The proposed expansion will increase Koch's capacity from 137,000 barrels of crude per day to 207,000 barrels per day (a 51 percent increase). Construction will take place over a 3- to 5-year period at a total cost of nearly $200 million. All construction will occur on the existing 600-acre site.

Once the new facilities are completed, total refining employment is expected to increase from 586 to 870 employees. Turnaround employment will increase from 112 to 150 full-time equivalents, and construction employment will average 500 workers over the construction period.

These employment projections are summarized in Table 3-36, along with Koch's employment history. Projections are given for two dates: 1986 (midway through the anticipated construction period) and 1988 (after construction is completed).

Direct Economic Impacts

In 1983, Koch's employees earned an average annual wage of $32,400. Using this wage and the employment projections in Table 3-36, it is predicted that Koch's expansion will produce a payroll increase of $4.7 million in 1986 and $9 million by 1988. If Koch's local purchases of operating supplies and services rise proportionally to its capacity, they will increase by 50 percent.

In addition, construction and turnaround activities will increase local incomes. According to the Bureau of the Census, Minnesota's heavy-construction workers made an average annual wage of $30,750 in 1981, which corresponds to $35,200 in 1984. Koch's 500 new construction employees will, therefore, earn a total payroll of $17.6 million per year. Similarly, the 38 new full-time equivalent turnaround employees (who are also heavy-construction workers) will earn a total of $1.3 million per year. These effects are summarized in Table 3-37. It is assumed that all direct employment impacts occur in Minnesota.

An additional direct economic impact from the expansion will be the purchase of construction material both during initial construction and during turnaround operations. Koch's total construction expenditures, for example, will approach $200 million. Of this, $53 million will be for labor. Another $16 million will be for contractor overhead. Of the remaining $131 million, roughly 20 percent is likely to be spent on local equipment purchases. Counting contractor overhead as local materials purchases, Koch's new construction will produce annual Minnesota purchases of roughly $14.1 million during the construction period (Table 3-37).

Turnaround activities are also accompanied by equipment purchases and contractor overhead. As with new construction,

Table 3-37
DIRECT ECONOMIC IMPACTS FROM THE PROPOSED EXPANSION

Source of Impact	Construction Phase Impact (1986) ($ millions)	Long-Term Impact (1988) ($ millions)
Koch's Payroll Increase	4.7	9.1
New Turnaround Employment	1.3	1.3
New Construction Employment	17.6	0
Increased Purchases of Operating Supplies	Unknown	Unknown
Minnesota Purchases of Turnaround Materials	1.9	1.9
Minnesota Purchases of Construction Materials	14.1	0
TOTAL	39.6[a]	12.3

[a]Note that this figure is fairly sensitive to the assumed level of in-state construction material purchases. If that figure is reduced from 20 percent of total material expenditures to 10 percent, this figure is reduced to 32.6 million.

GLT263/91

turnaround expenses are approximately 25 percent labor, and 8 percent contractor overhead. In this case, however, little heavy equipment is purchased and local material purchases are 40 percent of total material purchased. Thus, again counting contractor overhead as a local purchase of goods and services, new turnaround activities will produce a continuous flow of $1.9 million in local purchases (Table 3-37).

Spinoff Benefits

Each of the direct economic benefits discussed in the preceding section will have spinoff benefits. For Koch's payroll expenditures, the appropriate multiplier is 2.06, while for supply and construction material purchases, the multiplier is 2.11. The multiplier for turnaround and construction payrolls will be the same as that for Koch's own payroll since all three sets of employees fall into the same income bracket.

The results of these multiplier calculations are presented in Tables 3-38 and 3-39. Table 3-38 encompasses only spinoff benefits; Table 3-39 includes both direct and spinoff benefits.

These benefits can also be expressed in terms of job creation. Average wage earnings in the Twin Cities metropolitan area are approximately $19,400 per worker. (See Table 3-40 for a derivation.) Since nationwide statistics indicate that only 60 percent of total income is wage and salary income, this means that every $32,300 of spinoff income produces one job. Using this as a conversion factor, Table 3-38 can be expressed according to numbers of new spinoff jobs. The result of this conversion is presented in Table 3-41. Table 3-42 presents the same data, but also includes direct employment by Koch and its contractors. The results indicate that the Koch expansion will create over 2,400 new Minnesota jobs during each of the construction years, and approximately 760 jobs on a long-term basis.

Tax Effects

Tax effects of the expansion are direct and indirect. Direct tax effects include taxes paid by Koch and its employees. Indirect tax effects include taxes paid by the recipients of spinoff benefits.

Direct tax effects are summarized in Table 3-43. It should be remembered that the values in this table represent changes from the status quo; they do not represent total tax payments. Furthermore, the federal tax statistics include only payments by Minnesotans. Payments by non-Minnesotans (who will receive very large direct and indirect benefits because out-of-state purchases and leakages from the Minnesota economy) will be substantially larger. Therefore, the federal tax payments

Table 3-38
SPINOFF BENEFITS FROM THE PROPOSED EXPANSION

Source of Benefits	Construction Phase Benefits (1986) ($ millions)	Long-Term Benefits (1988) ($ millions)
Koch's Payroll Increase	5.0	9.6
New Turnaround Employment	1.4	1.3
New Construction Employment	18.7	0
Increased Purchases of Operating Supplies	Unknown	Unknown
Minnesota Purchases of Turnaround Materials	2.1	2.1
Minnesota Purchases of Construction Materials	15.7	0
TOTAL	42.9[a]	13.1

[a] Note that a reduction of in-state new construction material purchases from 20 percent to 10 percent of total new construction material purchases would reduce this figure to $35.1 million.

GLT263/92

Table 3-39
TOTAL ECONOMIC BENEFITS FROM THE PROPOSED EXPANSION

Source of Benefits	Construction Phase Amount (1986) ($ millions)	Long-Term Amount (1988) ($ millions)
Koch's Payroll Increase	9.7	18.7
New Turnaround Employment	2.7	2.7
New Construction Employment	36.3	0
Increased Purchases of Operating Supplies	Unknown	Unknown
Minnesota Purchases of Turnaround Materials	4.0	4.0
Minnesota Purchases of Construction Materials	29.8	0
TOTAL	82.5[a]	25.4

[a] Note that a reduction of in-state new construction material purchases from 20 percent to 10 percent of total new construction material purchases would reduce this figure to $67.6 million.

GLT263/97

Table 3-40
AVERAGE WAGE AND SALARY EARNINGS IN THE TWIN CITIES METROPOLITAN REGION

County[a]	Employment (1981)	Average Earnings (1981)[b]	Average Earnings (1984)[c]
Anoka	2,007	$ 9,140	$10,600
Carver	8,543	13,730	15,900
Chicago	4,518	10,890	12,600
Dakota	59,157	14,660	17,000
Hennepin	553,628	16,650	19,300
Ramsey	235,051	16,720	19,400
St. Croix (WI)	8,995	11,290	13,100
Scott	11,059	14,110	16,400
Wright	9,695	10,450	12,100
Total	892,653	$16,670	$19,400[c]

Notes:
Source: U.S. Bureau of the Census, "County Business Patterns," 1981.
[a]These counties make up the Minneapolis/St. Paul SMSA.
[b]These figures exclude some categories of earnings, most notably self-employed farmers.
[c]Calculated using an index of 1.16. This was obtained by comparing nationwide average weekly wages for 1981 and 1984. Source: U.S. Department of Commerce, Bureau of Economic Analysis, "Survey of Current Business."

GLT263/98

Table 3-41
SPINOFF JOB CREATION FROM THE PROPOSED EXPANSION

Source of Benefits	Construction Phase Jobs (1986)	Long-Term Jobs (1988)
Koch's Payroll Increase	143	275
New Turnaround Employment	39	39
New Construction Employment	532	0
Increased Purchases of Operating Supplies	Unknown	Unknown
Minnesota Purchases of Turnaround Materials	67	67
Minnesota Purchases of Construction Materials	503	0
TOTAL	1284[a]	381

[a] Note that a reduction of in-state new construction material purchases from 20 percent to 10 percent would reduce this figure to 1032.

GLT263/99

Table 3-42
TOTAL JOB CREATION BY THE PROPOSED EXPANSION

Source of Jobs	Construction Phase Jobs (1986)	Long-Term Jobs (1988)
Koch's Payroll Increase	287	557
New Turnaround Employment	77	77
New Construction Employment	1032	0
Increased Purchases of Operating Supplies	Unknown	Unknown
Minnesota Purchases of Turnaround Materials	126	126
Minnesota Purchases of Construction Materials	939	0
TOTAL	2461[a]	760

[a] Note that a reduction of in-state new construction material purchases from 20 percent to 10 percent would reduce this figure to 1992.

GLT263/100

Table 3-43

DIRECT CHANGES IN TAXES FROM THE PROPOSED EXPANSION

Source of Taxes	Construction Phase (1986)	Long-Term (1988
FEDERAL TAXES (Minnesota taxpayers only)[a]		
Social Security[b]		
Employer contributions	$2,300,000	$ 800,000
Employee contributions	2,200,000	800,000
Federal Income Tax[b]		
Corporate	Unknown[c]	Unknown[c]
Employees and suppliers	6,000,000	1,900,000
Superfund Feedstock Tax	No change[d]	200,000[d]
TOTAL	$10,500,000	$3,700,000
MINNESOTA TAXES[c]		
Income Tax[b]		
Koch	Unknown[c]	Unknown[c]
Employees and suppliers	$1,430,000	$ 580,000
Sales Tax[b]		
By Koch	960,000	110,000
By employees and suppliers	760,000	330,000
Property Tax[b]		
Koch	No change[g]	No change[g]
Employees and suppliers	730,000	320,000
Minnesota Superfund Tax	No change[h]	No change[h]
TOTAL	$3,900,000[i]	$1,300,000[i]

NOTES:

Sources: Tables B-1 and 3-37. Unknown values have been treated as zero's.

[a] Numbers in this section are rounded to the nearest $100,000.

[b] These figures include construction and turnaround employees. All workers are considered to fall in the $30,000 to $39,999 bracket, but below the cut-off for Social Security withholding.

[c] These amounts cannot be calculated without knowledge of Koch's expected profits. Since Koch is a privately held corporation, profit information is unavailable.

[d] Based on a tax rate of .79 cents per barrel, under the assumption of full utilization of new capacity. It is assumed that the additional capacity is not yet available in 1986.

[e] Numbers in this section are rounded to the nearest $10,000.

[f] Suppliers' corporate income taxes are estimated using statewide averages.

[g] Koch's property taxes are based on the value of real property. Process equipment is excluded from taxation. The expansion involves mostly process equipment, so it will have little impact on real property values.

[h] Koch engages in hazardous waste treatment and disposal. It, therefore, pays Minnesota Superfund taxes.

[i] This sum has been rounded to the nearest $100,000.

listed in Table 3-43 should only be used to indicate impacts on Minnesotans, not impacts on the federal government.

Not all components of Table 3-43 can be determined. Corporate income taxes, for example, can only be calculated if corporate profits are known. For Koch, this information is unavailable. Koch expects to make additional profits, but it is a privately held corporation, and its profit rates are not public information. Table 3-43 notes that these figures are unavailable and omits them from its totals. Similarly, the effects of local operating supply purchases have also been omitted.

Indirect tax effects are depicted in Table 3-44. For simplicity, some of the categories appearing in Table 3-43 have been aggregated.

In Table 3-45, the direct and indirect effects have been added together. This table shows that during the construction phase, the Koch expansion will produce $20.3 million in additional federal taxes (paid by Minnesota residents) and $6.7 million in Minnesota taxes. On a long-term basis, these figures are $8.7 million and $2.8 million, respectively.

Housing and Social Services

The proposed expansion is unlikely to have major impacts on the nearby towns. Like Koch's current employees, Koch's new employees are likely to live throughout the Twin Cities metropolitan area. Some of them will probably move to the southern parts of that region (including Rosemount, Hastings, and Inver Grove Heights), but such a migration is likely to be gradual as well as insignificant compared to the populations of the affected cities. Furthermore, it will be more than offset by the fact that Rosemount's third-largest employer, Brockway Glass, will be closing its Rosemount plant on January 1, 1985, with a loss of 450 jobs.

Koch's new employees will therefore place little additional burden on the supplies of housing or social services in the nearby municipalities. Any migration toward Rosemount is likely to be offset by the exodus of Brockway's unemployed workers. The Koch expansion will be a stabilizing rather than a destabilizing influence. Furthermore, Koch's expansion will have no significant net influence on the Twin Cities as a whole. Most of its new employees will almost certainly be already residing there.

Similarly, construction and turnaround workers are unlikely to relocate as a result of the proposed expansion. Since their jobs are short-term, it is likely that they will commute from their present Twin Cities residences.

Table 3-44
CHANGES IN TAXES DUE TO SPINOFF EFFECTS

Source of Taxes	Construction Phase (1986)	Long-Term (1988)
FEDERAL TAXES (Minnesota taxpayers only)		
Social Security	$3,500,000	$1,100,000
Federal Income Tax	6,300,000	1,900,000
TOTAL	$9,800,000[a]	$3,000,000[a]
MINNESOTA TAXES		
Income Tax	$2,500,000	$ 760,000
Sales Tax	1,400,000	420,000
Porperty Tax	1,000,000	310,000
TOTAL	$4,900,000[a]	$1,500,000[a]

NOTES:
Sources: Tables B-1 and B-2. Statewide average tax rates were used.
See notes accompanying Table 3-43.
[a]Error due to roundoff.

GLT263/102

Table 3-45
CHANGES IN TAXES FROM PROPOSED EXPANSION

Source of Taxes	Construction Phase (1986)	Long-Term (1988)
FEDERAL TAXES (Minnesota taxpayers only)		
Social Security	$ 8,000,000	$2,700,000
Federal Income Tax	12,300,000	3,800,000
	No Change	No Change
TOTAL	$20,300,000[a]	$6,700,000
MINNESOTA TAXES		
Income Tax	$3,900,000	$1,300,000
Sales Tax	3,100,000	900,000
Property Tax	1,700,000	600,000
Minnesota Superfund Tax	No Change	No Change
TOTAL	$8,700,000	$2,800,000

NOTES:
Sources: Tables 3-39 and 3-40.

GLT263/103

Visual Impacts and Property Values

The existing refinery already has significant visual impacts on the surrounding terrain. It can be seen for miles, particularly across the flat lands to the south and southeast. At night it is brightly illuminated, and its flare gas flame can be seen from as far away as the City of Hastings.

The expansion would increase the complexity of the refinery's skyline, thereby making its visual impact more intrusive, particularly at night. In most of the surrounding regions this is unlikely to be an important effect, however. Some people may find the present refinery to be visually offensive while others may find it attractive, but they are unlikely to distinguish between the impacts of the present facility and the incremental impacts of the expansion.

A few nearby residents, however, may be somewhat more strongly affected. While most of the surrounding area is buffered on the north, east, and south by the Mississippi River or by other plants in the Pine Bend Industrial District, the western edge of Koch's property abuts nonindustrial property. This area is mostly agricultural and is zoned against high-density residential housing, but the scattered rural residences west of the facility still experience strong visual impacts The refinery sits slightly to the west of the crest of a 60-foot hill. Viewed from the valley or the crest of the next range of hills, the present facility is an impressive sight, particularly at night or in the rays of the rising sun. Because the refinery complex so dominates the visual horizon, changes in its profile will be particularly noticeable to people residing in that region. It is hard to say whether those people will view the changes with dislike, curiosity, or pleasure, but they will notice them. This may have some impact on property values, particularly in the small subdivision west of the refinery. It was constructed next to the existing facility, however, so the threat of an expansion should already have been incorporated into its property values.

The region of heavy visual impact is shown in Figure 3-4. The 2-square-mile region contains between 30 to 40 residences. About half of these residences have a view of the refinery. The net effect on these residences is likely to be small, especially since the refinery expansion will be accompanied by improved abatement techniques that are intended to ensure (at a minimum) no adverse changes in air quality. Furthermore, there is a chance that Koch's increased employment will produce an increased demand for nearby residences, thereby offsetting any property value depression from other causes.

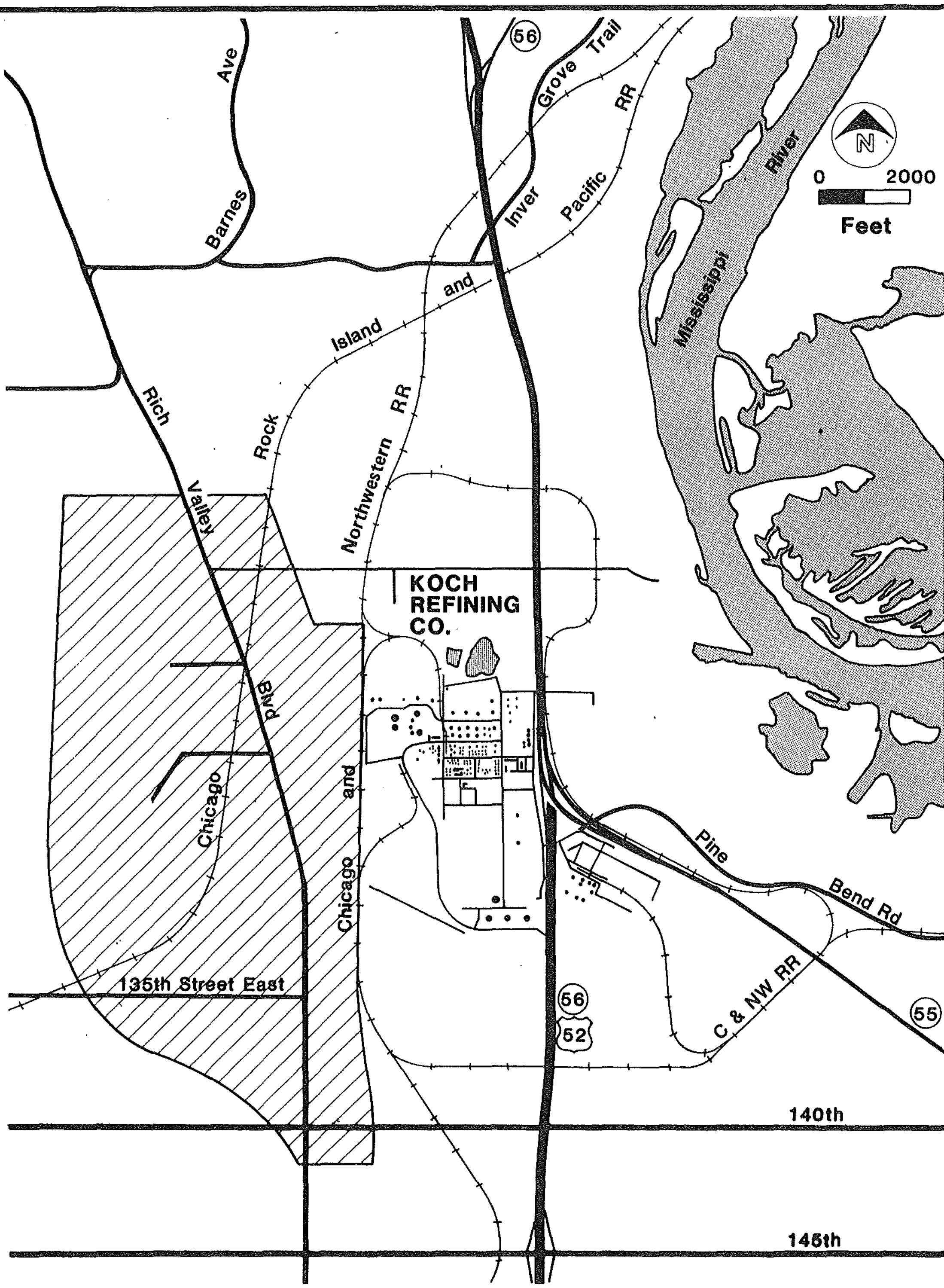


FIGURE 3-4

VISUAL IMPACT AREA

3.3.3 MITIGATION

The socioeconomic effects of the proposed refining expansion are mostly beneficial. The few negative effects (increased demands on local social services and aesthetic impacts on nearby properties) are generally small and may be offset by other factors. Therefore, no mitigating measures are considered necessary.

On a national level, the Koch Refinery expansion is unlikely to produce significant net employment-related benefits. The refining industry has recently been a gradually shrinking industry. From 1979 to 1983, national consumption of oil products fell 16.4 percent. Given this trend, expansion of its Pine Bend refinery should be viewed as a movement of refining capacity from existing refining centers to the markets of the Upper Midwest. This movement will reduce that region's need to import refinery shipments by existing refineries, ultimately leading out-of-state refineries to retire aging and underutilized equipment, rather than replace it. Jobs will have shifted to Minnesota, but this shift will not be without its costs to other regions.

3.4 TRANSPORTATION

In this section, the effects of the proposed expansion on the local highway system are studied. Transportation impacts from this project are associated with shipping additional refined products, trips generated by additional construction and refinery employees, and the potential for refinery-caused fog to affect traffic safety. The primary emphasis of this analysis is on the highway and road system.

3.4.1 EXISTING CONDITIONS

Streets and Roads

The project site is located on the west side of U.S. Highway 52 (State Highway 56) where it joins State Highway 55 in the Pine Bend Industrial District, 8 miles northwest of Hastings. Access to the refinery site is provided by a frontage road west of Highway 52. The frontage road intersects U.S. Highway 52 at the north and south ends of the site. Traffic on the frontage road is controlled by stop signs at both intersections.

There are 11 gates to the site from the frontage road and its intersections with Highway 52. Of these, seven gates are used to separate various types of truck and auto traffic. Four gates are not used.

Both intersections of the frontage road and U.S. Highway 52 provide separate lanes for right and left turning movements in and out of the site. The north intersection is a full four-approach intersection with room for three lanes on the minor approaches. However, since traffic volume on the east leg is extremely small during the morning and evening peak hours, it operates as a T-intersection. Both U.S. Highway 52 approaches have two through lanes: one left turn lane and one right turn lane. There is also an eastbound to northbound left turn acceleration lane and an eastbound to southbound right turn acceleration lane. The south frontage road intersection with U.S. Highway 52 is the same as the north intersection, except that there is no approach from the east.

There are no sidewalks or bicycle facilities on or near the site. There is no demand for these facilities, because of the industrial and agricultural character of the area.

Acceleration lanes at the frontage road intersections have been constructed within the past 2 years. The frontage road approaches to U.S. Highway 52 have also been improved to better facilitate truck turning movements and vehicular storage. No other improvements are planned for any of the roads or highways in the vicinity of the project.

Traffic Operations

The frontage road, intersecting U.S. Highway 52, provides access to and from the refinery site. Due to the industrial nature of the site considerable truck traffic is generated.

Private auto traffic generated by the site is almost 100 percent employee-related. Since the direct and indirect employee requirements of the site vary monthly, this study will focus on the period of maximum traffic generation, which occurs when refinery maintenance takes place.

Figure 3-5 shows existing traffic volumes on U.S. Highway 52 next to the site and at the site access frontage road intersections. Volumes on the frontage road are for the maximum case traffic situations, or periods of peak refinery employment. Volumes on U.S. Highway 52 are based on available Minnesota Department of Transportation traffic counts and represent average daily traffic.

Safety

Sight distances for all approaches at both access road intersections are excellent, and grades are less than 3 percent. Horizontal alignment in the vicinity of the project site access is virtually straight. No apparent or unusual conditions (i.e., fog) exist in the area that contribute to vehicular accident rates. These favorable physical conditions are supported by an accident rate in the project area that is 14 percent lower than the district average for similar roadways, or 1.2 versus 1.4 accidents per million vehicle miles.

Given the physical conditions and lower-than-average accident rate, no traffic safety problems are assumed to exist in the project site vicinity.

Roadway Capacity and Level-of-Service (LOS)

Roadway capacity is based on several physical conditions such as lane width, clearance from the edge of traveled way, horizontal and vertical alignment, and whether the road is two-way or a divided highway. Given the ideal conditions of U.S. Highway 52 next to the site, its capacity is approximately 2,000 vehicles per lane, per hour. With the corresponding peak-hour volumes on this roadway section, the level-of-service (LOS), or quality of traffic flow, is extremely good, or LOS-A.

The frontage road intersections are the critical locations of access to the project site. Since the capacity of an intersection that is stop-controlled depends on the main street volumes, the intersection operation is normally

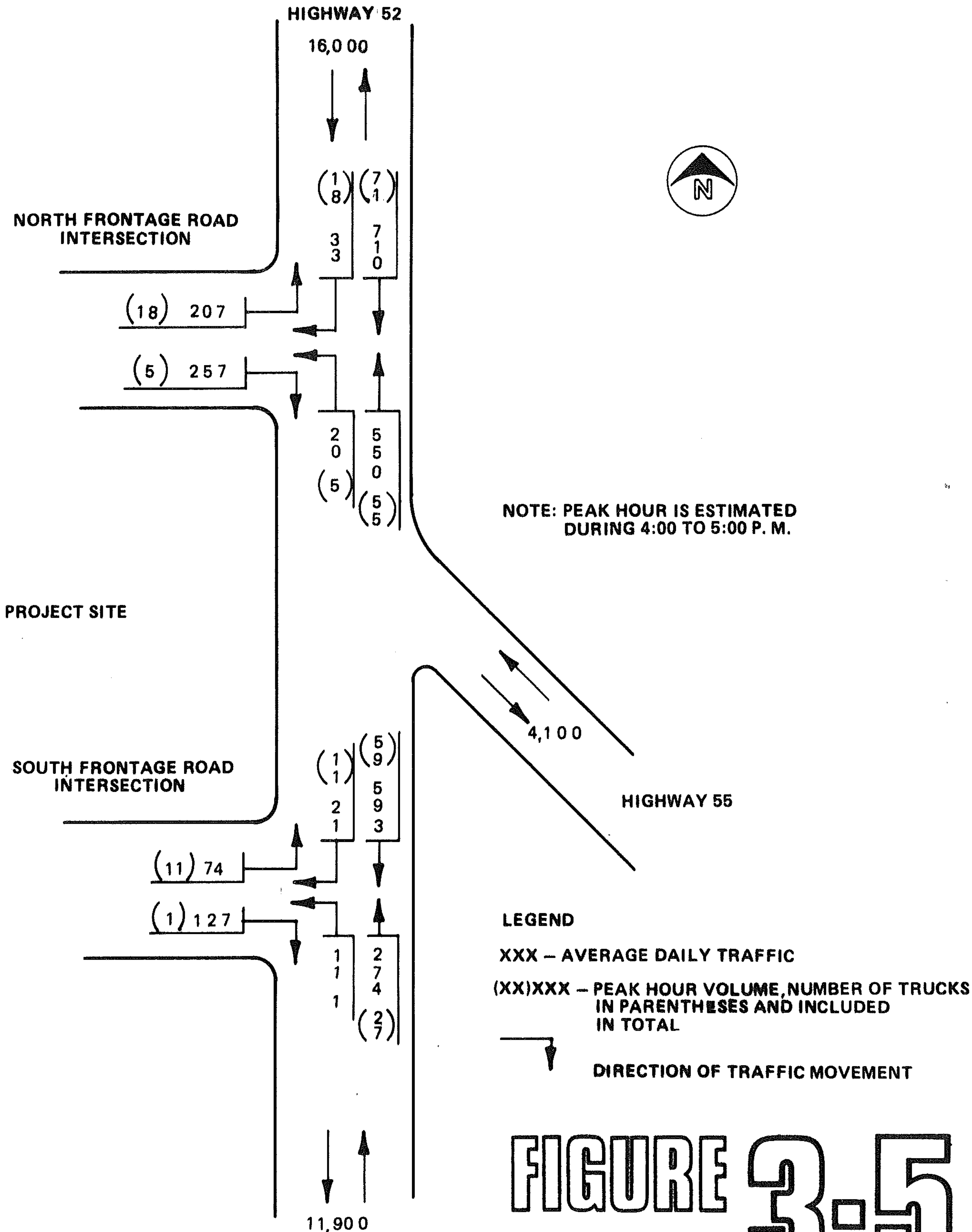


FIGURE 3-5

EXISTING TRAFFIC VOLUMES

expressed in a LOS format. Based on the physical conditions and existing worst case traffic volumes, LOS at both frontage road intersections has been calculated.

Overall traffic operations at both locations are relatively good. Table 3-46 provides a detailed description of peak-hour turning movement analysis. Only two problems exist: 1) northbound left turns at the north intersection are shown to experience very long delays in the morning; however, in actuality some of this traffic probably uses the south intersection, and 2) similar problems occur for all eastbound traffic during the afternoon peak hour.

Other Transportation Facilities

Other transportation facilities that move goods to and from the site include a barge facility, rail facilities, and pipelines.

Presently, all crude oil is brought onto the site by pipeline. Barge facilities located on the Mississippi River have additional capacity to transport crude oil to the site. However, these barge facilities are presently used to transport only refined products from the site, and no plans exist to change this operation.

A rail line of the Chicago and Northwestern Railroad is located on the western edge of the site. Sidings from the line enter at the north and south ends of the site. Both the Chicago and Northwestern Railroad and the Soo Line use these facilities.

Refined products primarily leave the site through three pipelines and by barge. A small amount of heavy oils, sulfur, and approximately 25 percent of the petroleum coke production leave the site by rail.

3.4.2 IMPACTS

The traffic impacts of the project will result from the increase in number of truck and private auto trips to and from the site. Truck traffic volume will increase proportionally to the increase in production. The volume of private auto trips will increase proportionally to increases in numbers of full-time employees. Peak construction and turnaround employment are not expected to increase from 1983 conditions.

The proposed project will be completed in 1988, therefore future traffic impacts are analyzed for 1988 background traffic. Background traffic for 1988 is shown in Figure 3-6. These traffic volumes are based on local growth forecasts made by the Minnesota Department of Transportation and existing site-generated traffic.

Table 3-46
SUMMARY OF EXISTING PEAK HOUR TRAFFIC OPERATIONS

Location	Time	Traffic Movement	Volume[a]	LOS[b]--Comments
North intersection of frontage road with U.S. Highway 52	7-8 a.m.	Southbound through	600	A--Good operations
		Southbound right turn	207	A--Good operation
		Eastbound left turn	33	C--Average operation, normal delays
		Eastbound right turn	25	A--Good operation
		Northbound left turn	194	E--Poor operation, very long delays
		Northbound through	658	A--Good operation
	4-5 p.m.	Southbound through	710	A--Good operation
		Southbound right turn	15	A--Good operation
		Eastbound left turn	207	D--Average to poor operation, long delays
		Eastbound right turn	252	D--Average to poor operation, long delays
		Northbound left turn	20	B--Good to average operation, short delays
South intersection of frontage road with U.S. Highway 52	7-8 a.m.	Northbound through	550	A--Good operation
		Southbound through	374	A--Good operation
		Southbound right turn	137	A--Good operation
		Eastbound left turn	16	B--Good to average operations, short delays
		Eastbound right turn	11	A--Good operation
		Northbound left turn	127	A--Good operation
		Northbound through	571	A--Good operation
		Southbound through	593	A--Good operation
		Southbound right turn	21	A--Good operation
		Eastbound left turn	74	C--Average operation, normal delays
		Eastbound right turn	127	B--Good to average operation, short delays
		Northbound left turn	11	A--Good operation
		Northbound through	274	A--Good operation

[a]Traffic volumes for U.S. Highway 52 represent average daily traffic and are based on actual counts taken by the Minnesota Department of Transportation. Traffic volumes for the frontage road represent the worst-case condition when maximum contract and temporary employment occurs. These volumes are based on total maximum employment and actual truck volume counts.
[b]LOS is Level-of-Service. It is based on a traffic operation analysis for unsignalized intersections as described in Transportation Research Circular 212, Transportation Research Board, National Academy of Sciences.

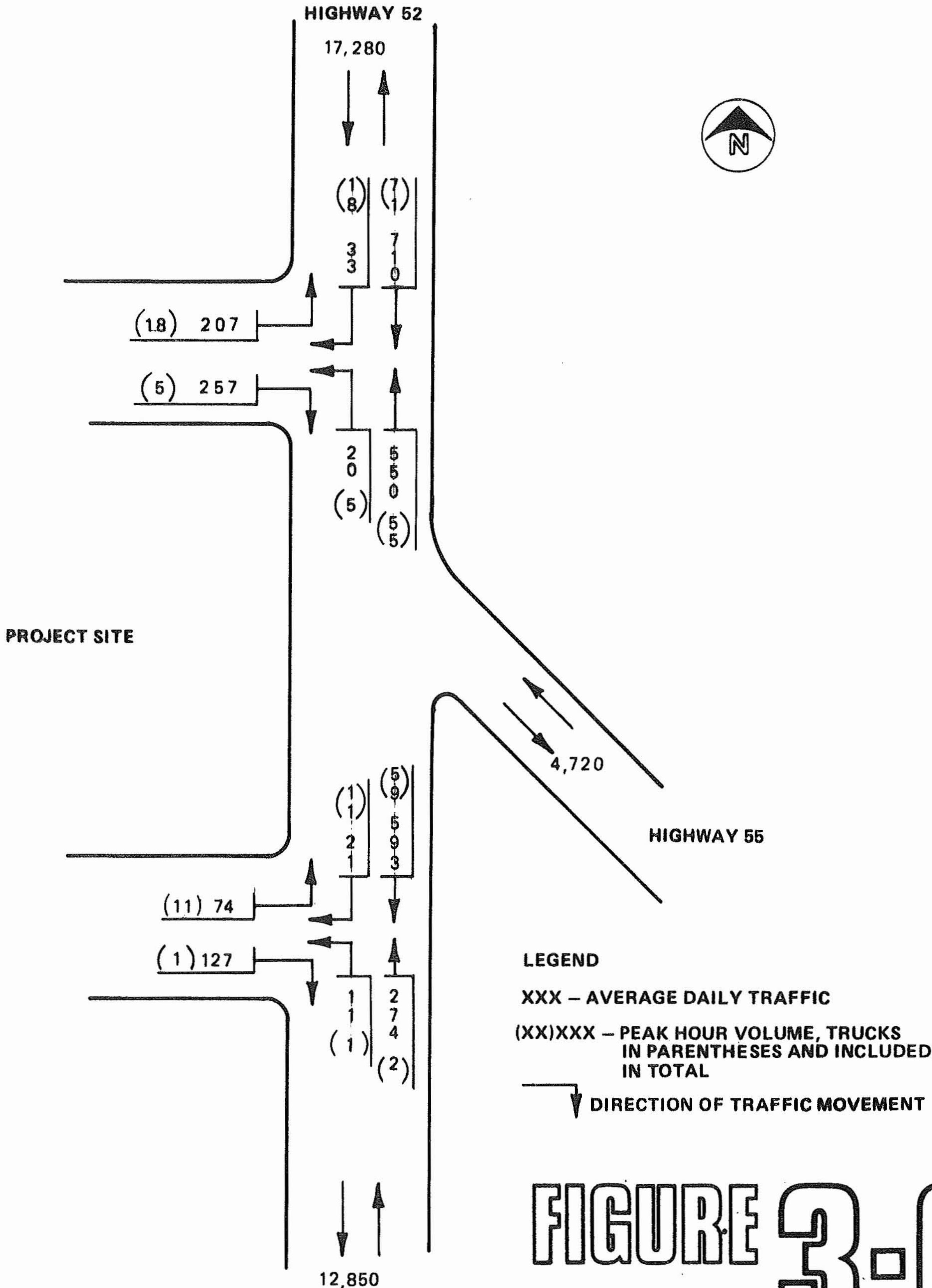


FIGURE 3-6

1988 TRAFFIC VOLUMES WITHOUT PROJECT

A comparison of future background traffic to existing conditions shows that there will be considerable delay for left turns into the site during the morning peak hour and for all exiting traffic during the afternoon peak hour at the north intersection. The south intersection is not expected to experience serious delays.

Expected daily traffic volumes generated by the expansion will increase approximately 20.2 percent with completion of the project. The impacts on daily traffic volumes of U.S. Highways 52 and 55 will be between a 1.8 and 4.2 percent increase. The distribution of this additional traffic on existing facilities, and the expected background traffic at project completion, is shown in Figure 3-7. Table 3-47 summarizes the daily traffic volumes and their impacts.

Table 3-47
SUMMARY OF AVERAGE DAILY TRAFFIC IMPACTS[a]

Location	Traffic Volume		Additional Traffic	
	Without Project	With Project	Volume	Percent
U.S. Highway 52, north of site	17,280	17,800	520	3.0
U.S. Highway 52, south of site	12,850	13,080	230	1.8
Highway 55, east of site	4,720	4,920	200	4.2

[a]Based on worst-case, project-generated traffic conditions.

The average increase in total traffic during peak hour conditions will be 8 percent. Table 3-48 provides a detailed analysis of the impacts on the U.S. Highway 52 north and south frontage road intersections.

This traffic impact summary shows that the critical traffic movements will be at the north intersection during the evening peak hour. The eastbound left and right turning traffic movements there will not increase proportionally more than other movements. They will be affected the most because they conflict with all other intersection movements. Eastbound right turns will experience longer delays; however, the demand of this movement will not exceed available capacity. Eastbound left turns will also experience longer delays and will exceed the available capacity by approximately 30 vehicles during the peak hour.

The impacts of the project on traffic at the south intersection will be nominal. The main reason for this is the

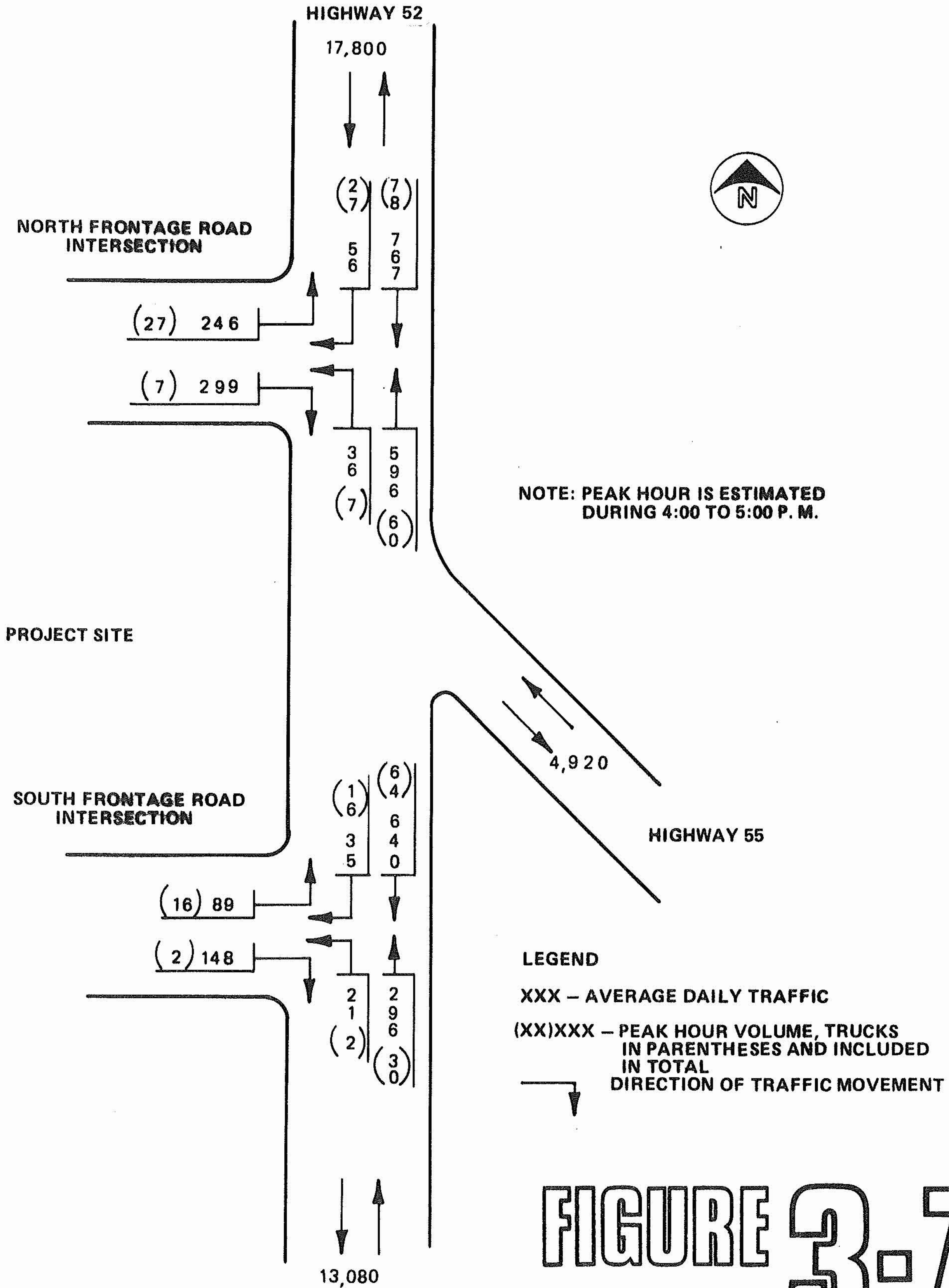


FIGURE 3-7

1988 TRAFFIC VOLUMES WITH PROJECT

Table 3-48
SUMMARY OF PEAK HOUR TRAFFIC IMPACTS

Location	Time	Traffic Movement	1988 Volume[a] Without Project	1988 Volume[a] With Project	Percent Change	LOS[b] Comments Without Project	LOS[b] Comments With Project
North intersection of of Frontage Road with U.S. Highway 52	7-8 a.m.	Southbound through	648	648	--	A--Good operation	A--Good operation
		Southbound right turn	207	247	19.3	A--Good operation	A--Good operation
		Eastbound left turn	33	59	78.8	E--Poor operation, very long delays	E--Poor operation, very long delays
		Eastbound right turn	25	37	48.0	B--Good to average operation, short delays	B--Good to average opration, short delays
		Northbound left turn	194	226	16.5	C--Average operation, normal delays	D--Average to poor operation, long delays
		Northbound through	711	711	--	A--Good operation	A--Good operation
	4-5 p.m.	Southbound through	767	767	--	A--Good operation	A--Good operation
		Southbound right turn	33	56	69.7	A--Good operation	A--Good operation
		Eastbound left turn	207	246	18.8	E--Poor operation, very long delays	F--Demand exceeds capacity
		Eastbound right turn	257	299	16.3	D--Average to Poor operation, long delays	E--Poor operation, very long delays
		Northbound left turn	20	36	80.0	B--Good to average operation, short delays	B--Good to average operation, short delays
		Northbound through	596	596	--	A--Good operation	A--Good operation
South intersection of Frontage Road with U.S. Highway 52	7-8 a.m.	Southbound through	404	404	--	A--Good operation	A--Good operation
		Southbound right turn	137	162	18.2	A--Good operation	A--Good operation
		Eastbound left turn	16	24	50.6	C--Average operation, normal delays	C--Average operation, normal delays
		Eastbound right turn	11	17	54.5	A--Good operation	A--Good operation
		Northbound left turn	127	148	16.5	A--Good operation	B--Good to average operation, short delays
		Northbound through	617	617	--	A--Good operation	A--Good operation
	4-5 p.m.	Southbound through	640	640	--	A--Good operation	A--Good operation
		Southbound right turn	21	35	66.7	A--Good operation	A--Good operation
		Eastbound left turn	74	89	20.2	C--Average opertion, normal delays	C--Average operation, normal delays
		Eastbound right turn	127	148	16.5	B--Good to average operation, short delays	B--Good to average operation, short delays
		Northbound left turn	11	21	90.9	A--Good operation	A--Good operation
		Northbound through	296	296	--	A--Good operation	A--Good operation

[a]Traffic volumes for U.S. Highway 52 represent average daily traffic and are based on actual counts taken by the Minnesota Department of Transportation. Traffic volumes for the frontage road represents the worst-case condition when maximum contract and temporary employment occurs. These volumes are based on total maximum employment and actual truck volume counts.
[b]LOS is Level-of-Service. LOS is based on a traffic operation analysis for unsignalized intersections as described in Transportation Research Circular 212, Transportation Research Board, National Academy of Sciences.

GLT263/89

lower through traffic volumes on U.S. Highway 52. Analysis of the expected traffic operations, as shown in Table 3-48, indicates that available capacity will exist when the north intersection demand reaches critical levels. Specifically, eastbound left turns in the morning and eastbound left and right turns in the evening at the north intersection could be relocated to the south intersection with the following results shown in Table 3-49.

Table 3-49
POTENTIAL TO EQUALIZE TRAFFIC IMPACTS

Location	Time	Movement	Demand Above LOS-D	Available Capacity	Equalized LOS[a]
North intersection	7-8 a.m.	Eastbound left turn	(87)		D
South intersection	7-8 a.m.	Eastbound left turn		114	D
North intersection	4-5 p.m.	Eastbound left turn	(128)		D/E[b]
South intersection	4-5 p.m.	Eastbound right turn		110	D/E[b]
North intersection	4-5 p.m.	Eastbound right turn	(16)		D
South intersection	4-5 p.m.	Eastbound right turn		200	C

[a]LOS is Level-of-Service.
[b]Dual LOS indicates the operation will be on the border between both.

The refinery does emit water vapor through various stacks and vents. Upon entering the outside atmosphere, especially in cool, humid weather, the plume will condense, forming a fog in the immediate area of the vent. The duration of the condensed plume is dependent upon the exhaust gas volume, humidity and temperature, and outside temperature and humidity. At the completion of Phase II, under appropriate atmospheric conditions, it is predicted that a condensed plume(s) will form a maximum distance of 400 feet from the refinery before reevaporation.

The occurrence and duration of conditions conducive to fog development will be primarily in the fall and spring months as well as some winter episodes. The maximum area of impact will be only 400 feet from the refinery, therefore the potential to affect travel on U.S. Highway 52 would be limited, since the distance between the refinery and the property boundary is greater than 400 feet.

Other transportation facilities will not be affected. Additional capacity exists in product pipelines and rail facilities to accommodate increased product transport from the expanded refinery. With this expansion, more refined products will be shipped by barges. Increased barge movements of refined products has been offset, however, by the decrease in arriving crude barges. The barge facilities will be adequate for the expansion, because the number of barge movements would not be any greater than pre-1982 conditions when barges were used for crude and refined product shipments.

3.4.3 MITIGATION

Since the physical roadway conditions have already been improved to represent the maximum capacity at the intersections, other types of mitigation measures should be undertaken. These should include ways to spread out the peak-hour volumes to reduce maximum delays. For example, Koch currently staggers full-time employees and construction worker start times or uses carpooling. The company should also investigate ways to transfer some of the critical traffic movements from the north to the south intersection. Specific mitigation measures that address these two strategies and other ways to reduce expected traffic impacts are listed below:

- Designate all construction workers to enter U.S. Highway 52 via the south intersection.
- Designate all southbound truck traffic to exit the south intersection.
- Provide pavement markings on the frontage road that indicate separate right and left turning lanes at intersections.

3.5 NOISE

A noise assessment was conducted to evaluate the potential impact of the proposed crude expansion on noise levels at nearby residences. The analysis was based on available literature sources, applicable noise standards, and actual field measurements of ambient noise conditions. Noise impacts due to project-related traffic and construction activities are predicted for the expanded refinery.

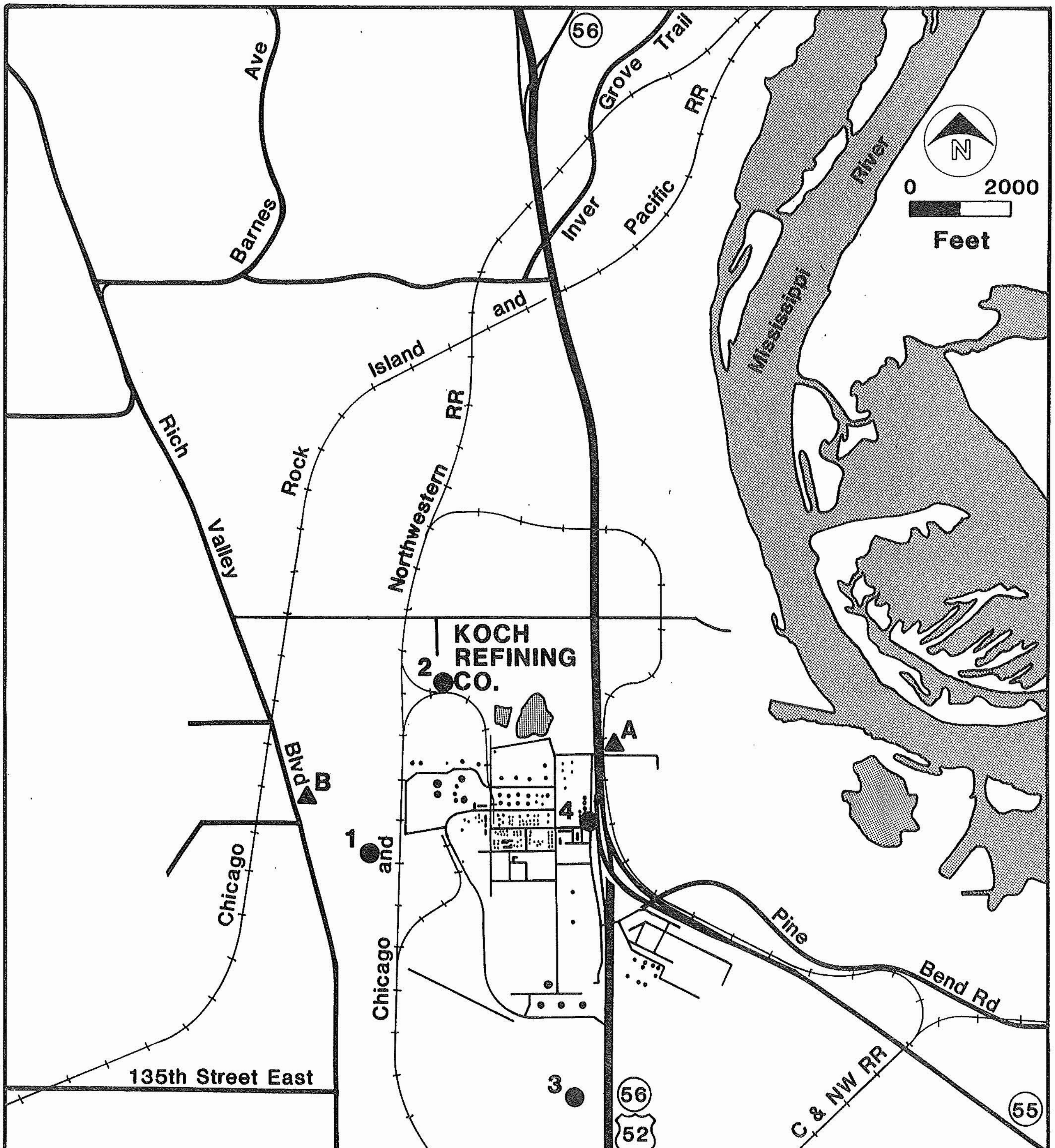
3.5.1 EXISTING CONDITIONS

Measured noise levels at the site reveal that the refinery operation is fairly quiet. Most noise in the area is generated by highway and railroad traffic. The refinery, being located in an industrial area, is generally well-buffered from noise-sensitive areas. It is flanked on the east by U.S. Highway 52 and on the west by the Chicago and Northwestern Railroad tracks. The nearest residence is on Koch-owned property 200 feet east of U.S. Highway 52 and 2,000 feet from any noise-producing areas of the refinery, (Figure 3-8 - Location "A"). The nearest privately owned residence is along Rich Valley Boulevard just west of the refinery property line, and 4,000 feet west of the production area of the refinery (Figure 3-8, location "B").

Noise Measurements

Noise measurements were taken near the plant property line on all four sides of the refinery using a Digital Acoustics Model DA607P airport/community noise analyzer. The noise analyzer was operated automatically for 24 hours at Location 1 (Figure 3-8), 50 feet west of the plant property line which is about 2,000 feet west of the main production area of the refinery. One-hour daytime noise measurements were taken at Location 2 at the north property line of the refinery, 3,000 feet north of the production area. Location 3 is 2,000 feet south of the refinery property line and a mile south of the refinery production area, and Location 4 is between the access road and the highway on the east side of the refinery. The results of these sound measurements are shown in Table 3-50.

The measured daytime noise levels at Location 1 are strongly influenced by the traffic on the Chicago Northwestern rail line since noise measurements were taken only 50 feet from the railroad tracks. At night when rail traffic had subsided, the measured noise levels were significantly lower and are probably more representative of the noise attributable to the refinery.



LEGEND

● NOISE MEASUREMENT LOCATION

▲ RESIDENCE

FIGURE 3-8

NOISE MEASUREMENTS

Table 3-50
MEASURED NOISE LEVELS

Location	Noise Level dBA Day L50[c]	L10[d]	Night L50	L10
1) West Property Line[a] Near C&NW Rail Line	59	71	34	35
2) Near North Property[b] Line	55	64	--	--
3) About One Mile South[b] of Plant	58	63	--	--
4) Between Frontage[b] Road and Highway East of Plant	60	65	--	--

Notes: Noise measurements were made with a Digital Acoustics Model DAG07P airport/community noise analyzer.
[a]Day: Max hour from 24-hour sample.
Night: Typical level after railroad noise subsided.
[b]One hour daytime sample.
[c]L50 = Noise level exceeded 50 percent of 1 hour.
[d]L10 = Noise level exceeded 10 percent of 1 hour.

At Location 2, the predominant noise observed was the refinery and wind noise. At Location 3, the refinery was not audible; the predominant noises were the operations of a gravel pit, wind, and the highway. At Location 4, the noise was predominantly due to the highway and frontage road traffic.

Koch is presently constructing the Unit 38 Gas Oil Hydrotreater. The Hydrotreater is a major construction project and noise emitted from construction activities is reflected in all of the surrounding site noise measurements.

Noise Standards

The Minnesota standards for noise levels in residential areas and industrial areas are shown in Table 3-51. The measured property line noise levels are significantly below the standards for an industrial area.

The residences to the west of the plant are flanked by the Chicago and Rock Island Railroad 900 feet to the west, and the Chicago and Northwest Railroad to the east. As indicated by the noise measurements, the noise contribution of the refinery at this site is negligible. The predominant noise levels are due to the railroads.

Table 3-51
MINNESOTA STATE NOISE STANDARDS

	Noise Level dBA			
	Day		Night	
Location	L50	L10	L10	L50
Industrial Areas (NAC 3)[a]	75	80	75	80
Residential Areas (NAC 1)	60	65	50	55

[a]NAC - Noise Area Classification

The noise at the residence east of the refinery is predominantly due to traffic on the state highway. Modeling of existing peak-hour traffic noise shows a L50 noise level of 66 dBA, and a L10 level of 75 dBA. The contribution of the refinery noise at this location is negligible in comparison.

Abnormal operations at the refinery, such as a relief valve discharging, can produce noise levels that may be objectionable at the receptors. However, this is an infrequent occurrence and is normally of short duration. Therefore, it would not come under the requirements of applicable noise regulations.

3.5.2 IMPACTS

Refinery Operation

The crude expansion project will increase the refinery's crude oil capacity by approximately 50 percent using unit processes similar to those in the existing facility. For this analysis, it was assumed that the sound power level at the refinery will also increase by 50 percent. With this assumption, the noise level at the plant will increase only slightly, approximately 1.8 dB.

The current noise levels at residential receptor "A" east of the refinery are above standards because of highway traffic, This slight increase in refinery noise will have a negligible impact.

At the residential receptors west of the refinery, the existing noise level is well below the standards. A slight increase in refinery noise will not contribute to noise levels in excess of the standards.

Traffic

The expansion project will generate additional employee, service, and product-related vehicular traffic. The projected increase in traffic due to the project will be less than 10 percent of the current traffic volume. Based on this modest increase in highway traffic, the additional vehicle-trips will have a negligible impact on existing noise levels.

Construction

The primary noise associated with construction activities is expected to be the engine noise from trucks and construction equipment. Construction noise should not be objectionable, because the refinery is located in an industrial area with high ambient noise levels.

3.5.3 MITIGATION

Because the Koch expansion project will result in a negligible increase in noise levels at the analyzed receptors, no specific noise mitigation measures are considered necessary.

In general, new plant equipment will be selected and designed to minimize the increase of in-plant noise. This will require such general measures as proper sizing and selection of flow control valves, noise control on the intake and exhaust of gas turbines and internal combustion engines, and other noise reduction measures consistent with good engineering design practice.

Though construction noise is not expected to be a problem, the impacts of construction noise can be mitigated by such measures as scheduling the noisest portions of construction in the daytime hours and monitoring construction equipment to assure that mufflers and other noise control measures are functioning properly.

3.6 GROUNDWATER AVAILABILITY

The purpose of the groundwater availability analysis is to evaluate the effect of the expansion on groundwater resources (in particular local users) in the Pine Bend area. This section contains a discussion about local hydrogeology, an analysis of current and future groundwater water usage by Koch Refining Company, and a discussion of the effects of projected groundwater usage.

3.6.1 EXISTING CONDITIONS

Hydrogeology

The hydrogeology surrounding the Koch refinery consists of a series of alternating aquifers and aquitards. Figure 3-9 summarizes the water-bearing characteristics of the geologic deposits in the region. Based on hydrogeology and well construction in the area, the discussion will center on two hydrostratigraphic units located below the project site, Unit 1 and Unit 2.

The upper hydrostratigraphic unit (Unit 1) is composed of the Prairie du Chien Group and Jordan Sandstone. Unit 1 is underlain by an aquitard or confining unit, composed of the St. Lawrence Formation and portions of the Franconia Formation. The lower hydrostratigraphic unit in the area, Unit 2, is composed of portions of the Franconia Formation, Ironton Sandstone, Galesville Sandstone, the Eau Claire Formation (an aquitard), Mt. Simon Sandstone, and Hinckley Sandstone. Unit 1 (the Prairie du Chien-Jordan aquifer) has high yields and is the principal aquifer in the region. Unit 2 contains two aquifers that provide moderate to high yields. The lower aquifer within Unit 2 is the Mt. Simon-Hinckley, which is the second most important aquifer in the region.

Wells in the area (Figure 3-10) are generally completed in (screened in or open to) either Unit 1, or all or part of Unit 2. Specific capacity data obtained from area Minnesota Geological Survey well logs indicate that Unit 1 may be up to three times more productive than Unit 2.

Regionally, groundwater flow is generally from west/southwest to east/northeast. Figure 3-11 illustrates the regional water table and top of bedrock. The water table surface depicted in this figure ignores the effect of local pumpage on water levels. The direction of flow in the Mt. Simon-Hinckley aquifer (part of Unit 2) is slightly different than that shown in Figure 3-11. The regional groundwater discharge area is the Mississippi River, which is located a mile northeast of the Koch refining process area (Figure 3-11).

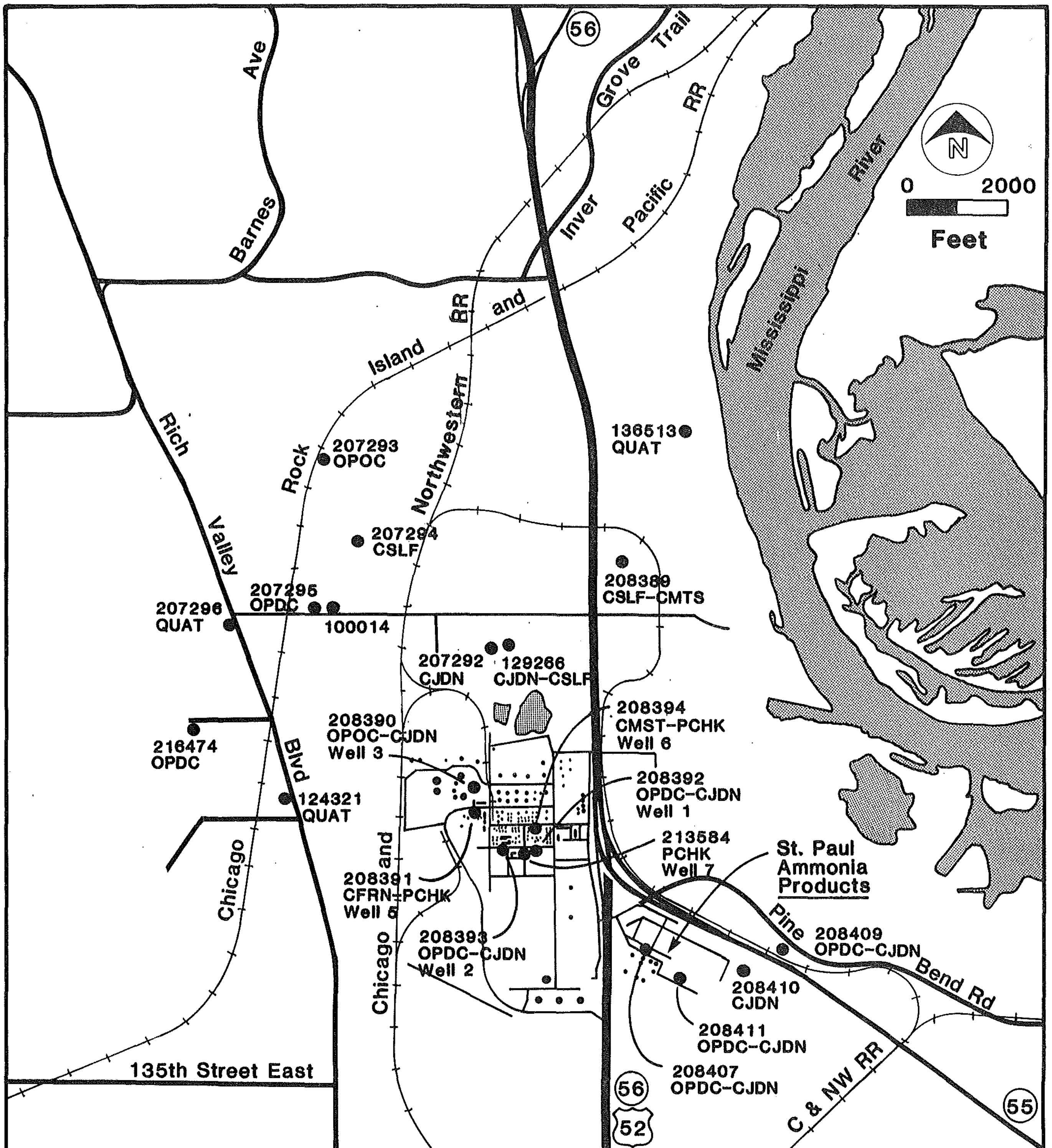
System	Rock Unit		Approx. thickness (in feet)	General Description	Graphic Column	Water - Bearing Characteristics
Quaternary	Undifferentiated* glacial deposits		0-500	Glacial till outwash, and valley train sand and gravel lake deposits, and alluvium of several ages and several provenances, vertical and horizontal distribution of units is complex		Distribution of aquifers and confining beds is poorly known; sand and gravel aquifers that yield moderate to large amounts of water are common in buried bedrock valleys
Ordovician	St. Peter Sandstone*		0-150	Sandstone, light-gray, massively bedded, well sorted, med -gr., poorly cemented, quartzose; approx. 20-ft -thick silty to shaly bed near base		Aquifer: moderate yields Confining bed
	Prairie du Chien Group	Shakopee Formation	50	Dolostone, buff, thin- to thick-bedded, silt- and sand-rich, med -gr, thin sandstone beds near base		Aquifer: high yields from fractures in dolostone and from poorly cemented sandstone, principal aquifer of the Twin City basin
		Oneota Dolomite	100	Dolostone, buff, thin- to thick-bedded, vuggy, med -gr., silt-size dolomite matrix		
Cambrian	Jordan Sandstone		90	Sandstone, light-gray, massively bedded, med - to coarse-gr., well sorted, poorly cemented, quartzose		
	St. Lawrence Formation		50	Dolostone, gray to tan, silty or sandy, argillaceous, glauconitic in upper part		Confining bed
	Franconia Formation		155	Sandstone, greenish-gray, thin-bedded, fine- to coarse-gr., silty to dolomitic, commonly glauconitic, an upper aquifer (Reno) is a fine-gr. sandstone		Aquifer: low yields Confining bed
	Ironton Sandstone		30	Sandstone, light-gray, poorly to well sorted, med -gr., silt-rich, quartzose		Aquifer: moderate to high yields
	Galesville Sandstone		35	Sandstone, light-gray, well sorted, fine- to med -gr., quartzose		
	Eau Claire Formation		to 130	Sandstone, red, fine- to med.-gr., silty, glauconitic; interbedded with grayish-green to red, fissile shale		Confining bed
	Mt. Simon Sandstone		160	Sandstone, light-gray, fine- to coarse-gr., quartzose; thin shale beds in upper part		Aquifer: moderate to high yields, second most important aquifer of Twin City basin
Keweenawan	Hinckley Sandstone		75	Sandstone, tan, med.- to coarse-gr., arkosic		
	Fond du Lac Formation and older sedimentary rocks		to 4,000	Sandstone and siltstone, fine-gr., well cemented, arkosic; interbedded with red to green micaceous shale		Confining bed
	Metamorphic and Igneous Rocks		to 20,000	Mostly mafic, lava flows with thin interflow sediments		

* FORMATIONS ARE EITHER NOT LOCALLY PRESENT OR A LARGE PRODUCER OF WATER.

Source: Hoagberg, R.K. 1972. Groundwater Resources of Minnesota. p. 598-602. In Geology of Minnesota: A Centennial Volume, P.K. Sims, G.B. Morey (eds.) Minnesota Geological Survey, University of Minnesota, Minneapolis, MN.

FIGURE 3-9

WATER-BEARING CHARACTERISTICS OF GEOLOGIC UNITS

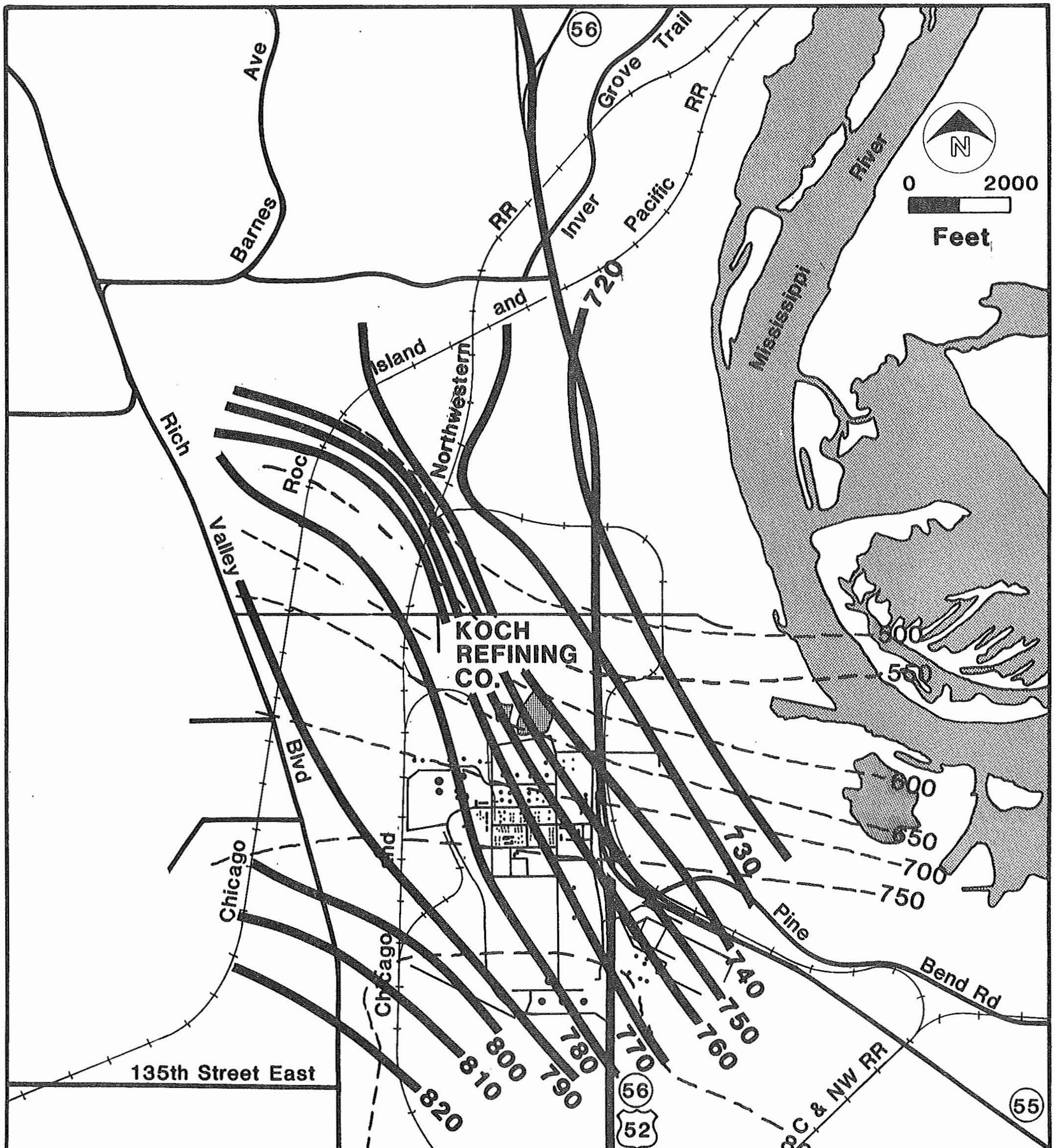


LEGEND

● WELL LOCATION

FIGURE 3-10

WELLS IN THE IMMEDIATE VICINITY OF KOCH REFINERY



LEGEND

– – – LINE OF EQUAL ELEVATION OF TOP OF BEDROCK (from Reeder & Norvitch 1974)

▬▬ LINE OF EQUAL ELEVATION OF WATER TABLE (modified from Sunde 1984)

FIGURE 3-11

REGIONAL WATER TABLE AND TOP OF BEDROCK CONTOUR MAP

Groundwater is an important resource in the area since it is used for both industry (high capacity wells) and private water supplies. The nearest industrial well is located about 4,000 feet to the southeast of the refinery (St. Paul Ammonia Products, Figure 3-10) while the nearest high capacity private well is located about 3,000 feet to the north of the refining process area.

Existing Groundwater Conditions

Current groundwater level data are not available for the area surrounding the Koch refinery, but estimates of the effects of pumping at the refinery can be made. Seven wells are currently in use at the refinery. Well Nos. 1, 2 and 3 withdraw water from Unit 1 and well Nos. 5, 6, 7, and 8 withdraw water from Unit 2. Pumping data for all wells are available, but the complete network of wells has only been used for the last 2 years; as such, complete records are only available for 1982 and 1983.

The mean pumping rates from each hydrostratigraphic unit for the years 1982-83 were used to assess the impact of current refinery groundwater use. These values are:

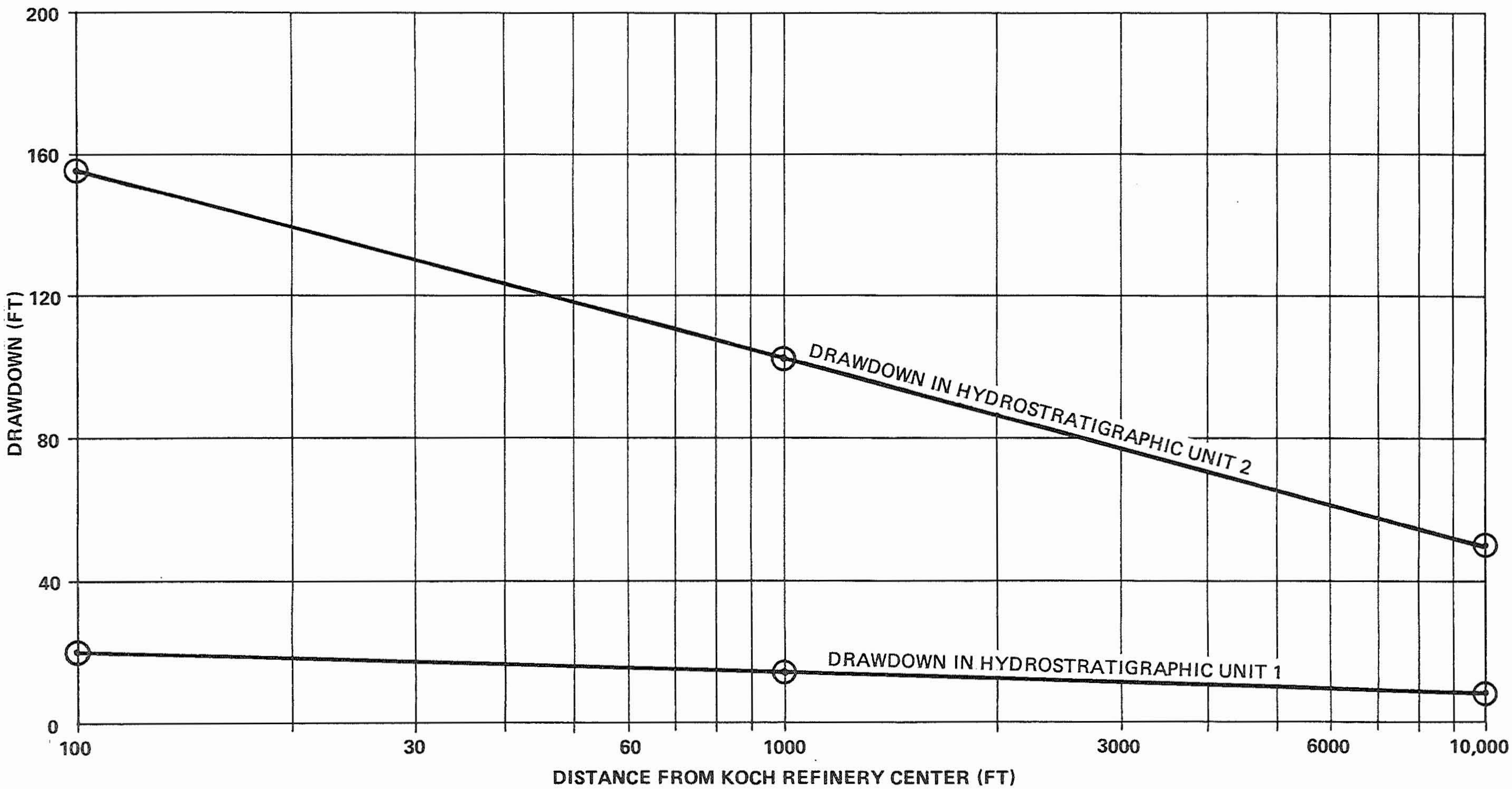
- o 771 gpm for Unit 1
- o 1,983 gpm for Unit 2

For the analysis, the seven-well network was assumed to be at one central location within the refinery. The wells are actually located in a circular pattern around the plant with approximately a 750-foot radius. Steady state drawdowns calculated in Units 1 and 2 due to pumping at the Koch refinery are shown in Figure 3-12. (Drawdowns were calculated using the Theis equation with large time values [t=1000 days.]) The average drawdown at any distance from the central location of the refinery can be read from this figure.

The analysis indicates that water levels at a distance of 4,000 feet from the refinery pumping center are lowered by about 10 feet in Unit 1 and about 70 feet in Unit 2 assuming 1982-83 average pumping at the refinery. Actual drawdowns in the area are expected to be greater because of the combined effects of pumping by other nearby water users. For example, the St. Paul Ammonia Products wells, completed in Unit 1, pumped an average of 660 gpm in 1982-83. This pumpage is expected to lower water levels at Koch refinery wells and other industrial and residential wells.

3.6.2 IMPACTS

The projected groundwater pumpage after expansion will be approximately 3,410 gpm, representing an increase of approximately 656 gpm over the 1982-83 total refinery pumping rate



Note: The Hydraulic properties used in this analysis are as follows;

UNIT 1: Transmissivity (T)= 9000ft^2 / d
Storage Coefficient (S)= 4.7 x 10^{-4}

UNIT 2: T= 2620ft^2 / d
S= 8 x 10^{-4}

These values are based on the limited amount of data collected near the project site reported in Norvitch et al.

FIGURE 3-12

DRAWDOWN AS A FUNCTION OF DISTANCE FOR HYDROSTRATIGRAPHIC UNITS 1&2, USING AVERAGE 1982-1983 PUMPING RATES of 2,754 gpm. The additional pumpage requirements could be accomplished several ways, each producing different effects on surrounding groundwater aquifer water levels. Three pumpage cases were considered for this analysis.

- Case A: All the additional pumpage occurs in the wells completed in Unit 1.
- Case B: All the additional pumpage occurs in the wells completed in Unit 2.
- Case C: The additional pumpage is distributed between Units 1 and 2 based on the average of the observed 1982-83 pumping distribution.

The pumpage distribution for Cases A, B, and C and the observed 1982-83 pumpage distribution are summarized in Table 3-52 below.

Table 3-52
PUMPAGE ALTERNATIVE

Alternative	Additional Koch Pumpage (gpm)		Total Koch Pumpage (gpm)	
	Unit 1	Unit 2	Unit 1	Unit 2
1982-83 Average	-	-	771	1,983
Case A	656	0	1,427	1,983
Case B	0	656	771	2,639
Case C	184	472	955	2,455

The anticipated drawdowns, as a function of distance from the hypothetical pumping center, resulting from each of these three pumpage alternatives are presented in Figures 3-13 and 3-14. Under Case A, the pumpage from Unit 1 was increased from 771 gpm to 1,427 gpm. The additional drawdowns at a distance of 4,000 feet from the refinery pumping center would be about 9 feet in wells completed in Unit 1 (the Prairie du Chien-Jordan aquifer). Under Case B, the pumpage from Unit 2 was increased from 1,983 gpm to 2,639 gpm. The additional drawdown at 4,000 feet would be about 24 feet for wells completed in Unit 2. Under Case C, where the additional groundwater pumpage is distributed between Units 1 and 2 in a manner that is consistent with past water use patterns at the refinery, the pumping rate is increased from 771 gpm to 955 gpm in Unit 1 and from 1,983 gpm to 2,455 gpm in Unit 2. The computed additional drawdowns at a distance of 4,000 feet from the Koch refinery center are 2.5 feet in Unit 1 and 17 feet in Unit 2.

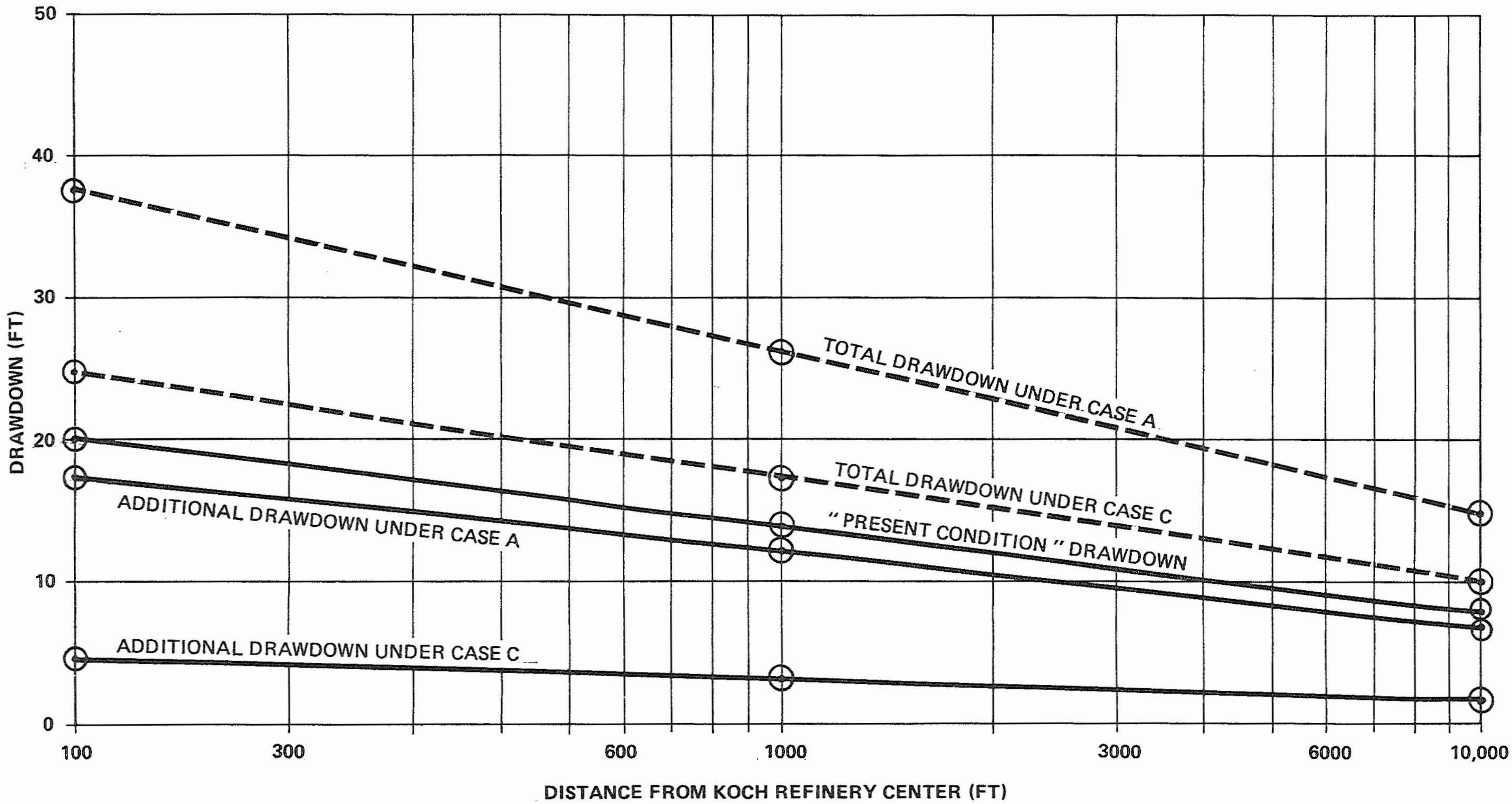


FIGURE 3-13

DRAWDOWN AS A FUNCTION OF DISTANCE FOR HYDROSTRATIGRAPHIC UNIT 1—UNDER CASE A AND CASE C PUMPING SCENARIOS

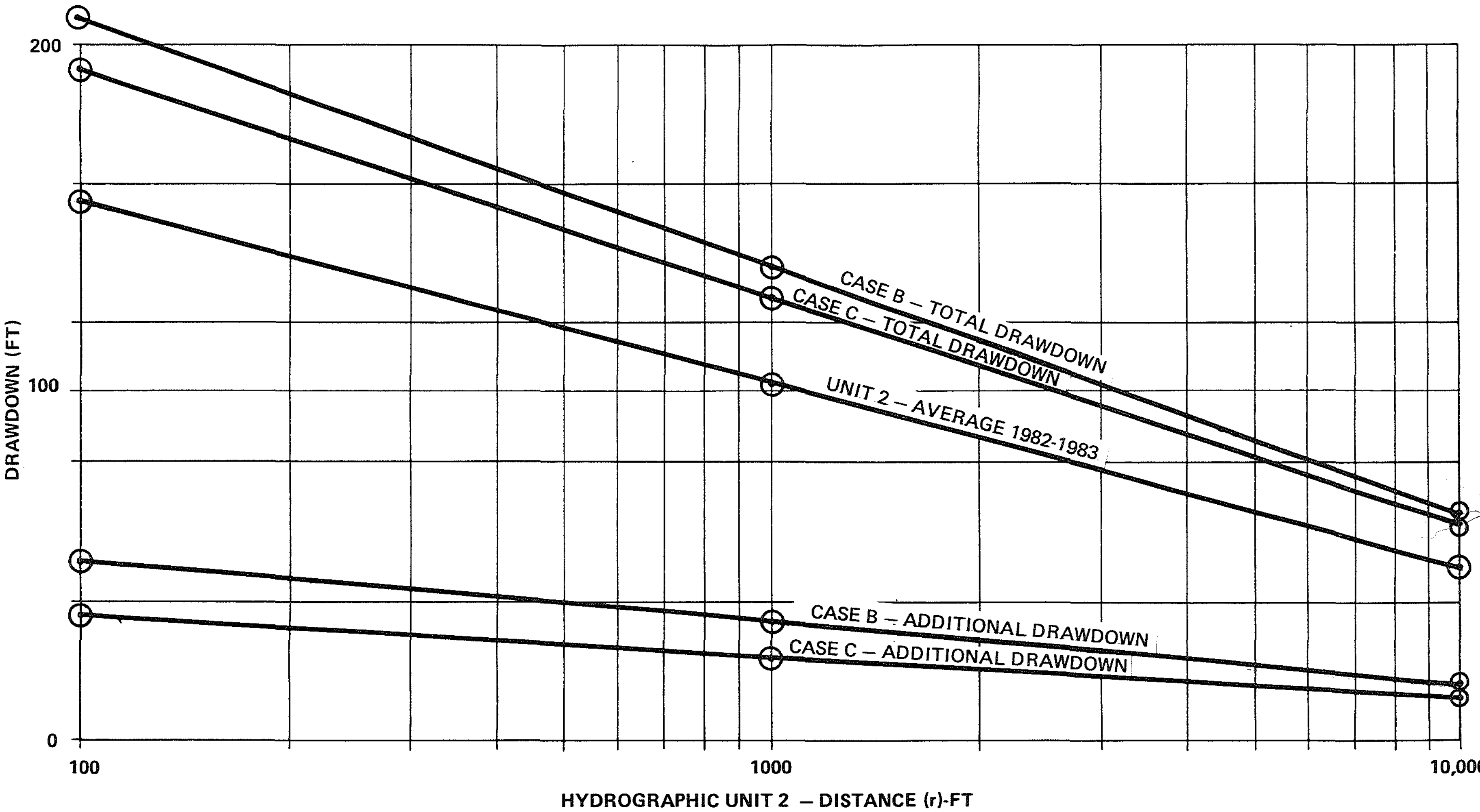


FIGURE 3-14

DRAWDOWN AS A FUNCTION OF DISTANCE FOR HYDROSTRATIGRAPHIC UNIT 2- UNDER CASE B AND CASE C PUMPING SCENARIOS

An effort was made to identify the major effects associated with additional drawdown caused by an increase in groundwater use at the refinery. Attention was focused on additional drawdown, only, because area water users have adjusted to current water levels associated with existing pumping patterns.

Since the water level elevations at the refinery are approximately 750 feet mean sea level (msl) in Unit 1 and 725 feet msl in Unit 2 and the land surface elevation is approximately 920 feet msl, wells pumping from either of the two units must provide enough energy to overcome the 170- to 195-foot elevation difference or lift. Minor changes in water levels (10 to 20 feet) induced by additional refinery pumpage will most probably not affect local water users that have high capacity wells. These water users have water supply systems that are capable of handling large flows and variable head changes of this order-of-magnitude. Since these high capacity systems are designed for specific flow, head, and efficiency conditions, the increase in head (lift) may be accompanied by a minor (10 to 12 percent) decrease in flow, a decrease in efficiency and a 5- to 10-hp increase in pump motor size. The effects of the additional drawdown anticipated if Case A or C (or perhaps even Case B) pumpage is implemented, will be minor.

Smaller water users, such as those identified to the northwest of the Koch site, may not be equally unaffected. Although most of these users have wells completed in Unit 1, some have wells completed in the overlying unconsolidated deposits and the effect of drawdown in Unit 1 on water levels in the overburden has not been assessed. Data on low capacity well pumping systems or local overburden hydrogeology are not available at present. For this reason, the impact of additional Koch Refinery pumpage cannot be fully evaluated for these smaller water users.

3.6.3 MITIGATION

There is some concern over the efficiency of implementing Case B (all additional pumpage from Unit 2). Unit 2 does not receive as much recharge as Unit 1, and pumpage to maintain a given flow rate results in greater drawdown in Unit 2 than in Unit 1. Increased use of the Mt. Simon-Hinckley aquifer (the lower portion of Unit 2) in the Twin Cities area has led to significant lowering of the water levels in wells completed in this aquifer (Schoenberg, 1984). Minor effects of Mt. Simon-Hinckley water use in the Twin Cities area extend into this study area. Future increased use of this aquifer will probably lead to larger declines in Unit 2 water levels.

In light of these trends and the more limited yields associated with Unit 2, Koch Refining Company should satisfy most of its increased water demand with water taken from Unit 1, pursuing Case A, Case C, or more probably some alternative between the two. This suggestion is based on hydraulic factors only and, as such, does not take water quality considerations into account. Water quality issues are discussed in Section 3.8.

Suggested Study

The groundwater analyses have been based on limited data. Some questions cannot be completely answered given the existing data for the region. These questions include:

- The actual shape of the potentiometric surface and total drawdown at selected wells caused by the combined effect of pumpage at all of the wells identified in Figure 3-10

- The effect of increased pumpage on the volume of groundwater available for use without depleting groundwater storage ("mining" groundwater in the area)

- The effect of drawdown in Unit 1 on water levels in the overlying Quaternary aquifer tapped by wells northwest and west of the refinery

These issues can be addressed only after the collection and evaluation of additional site data. Suggested study tasks are as follows:

- Gather water levels and associated pumping data throughout the area. These should be taken over several seasons. This task may require that the available wells be surveyed.

- Perform at least two pumping tests onsite to assess hydraulic characteristics of the hydrostratigraphic units.

- Perform slug tests within the glacial material to determine/confirm reported hydraulic properties in the general region.

- Gather additional information on the areal extent of the glacial deposits which act as local aquifer(s).

- Determine basin characteristics including basin boundaries, groundwater recharge, runoff, and evapotranspiration.

- Construct a numerical model to analyze the interactions of all water users in the area and the potential for groundwater "mining" in the basin.

3.7 SOLID AND HAZARDOUS WASTES

Most of the solid and hazardous wastes that are generated from Koch's refinery operations are disposed of onsite by landfarming. This section contains a discussion about the wastes landfarmed from the existing refinery, and from the proposed refinery expansion, and an evaluation of the landfarm's ability to treat these wastes.

3.7.1 EXISTING CONDITIONS

Landfarm Regulatory History

The landfarm began operation in 1978 after an upgrading of the wastewater treatment plant at the refinery. As such, the landfarm was operating before the first state hazardous waste rules were adopted in 1979. Koch submitted a permit application to obtain a state hazardous waste permit required by these rules in 1979.

In 1980, the U.S. EPA promulgated hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA). The federal regulations required that any state wishing to operate a state hazardous waste program in lieu of the federal program would have to adopt a program consistent with or more stringent than the federal one.

Since the state hazardous waste rules were significantly different than the federal rules the state hazardous waste rules were revised. Although state permitting activities were suspended during this period, the Koch landfarm was not unregulated; the landfarm was regulated by the federal program. The federal program included provisions allowing hazardous waste facilities existing prior to enactment of the federal regulations to continue operation under interim status standards (ISS) until a final permitting decision was made. Koch applied for and was granted interim status for the entire 31-acre landfarm. Koch currently operates the landfarm under the federal ISS.

In 1982, Koch was found to be in noncompliance with groundwater and soil-pore water monitoring requirements of the federal ISS. Koch had both systems in place, but the groundwater monitoring system did not meet federal requirements and the lysimeters used for unsaturated zone monitoring encountered operational problems and had not been replaced. The U.S. EPA issued a compliance order for Koch and an agreement on the order was reached in August 1984. Under this order, new monitoring wells and lysimeters have recently been installed. Koch has generally been in compliance with the ISS except for the abovementioned noncompliance issues.

In July 1984, Koch submitted a hazardous waste permit application to the U.S. EPA as was requested by EPA in January 1984. About the same time the federal permit application was received, the revised state hazardous waste rules were adopted. Koch thus became regulated under state interim status standards as well as the federal standards. Since the federal and state requirements were similar, Koch elected to use the federal permit application for the state application.

The permit application has been under review since that time. In addition to the submitted application, Koch is required to perform a treatment demonstration for the landfarm in order to receive a final permit. It is estimated that the treatment demonstration and final permit process will take 5 years to complete. Koch will continue to operate under the interim status standards during this time period.

Landfarmed Wastes

Existing Conditions (1984 Estimate). It is estimated that 24,000 tons of solid and hazardous wastes will be landfarmed at the Koch refinery in 1984. These wastes and their characteristics are summarized in Table 3-53.

The historical yearly average of landfarmed wastes at the refinery is approximately 10,000 tons (Table 2-4). Landfarmed waste tonnage for the year 1982 compares fairly well with the historical average. A summary of landfarmed wastes and their characteristics for the year 1982 is provided in Table 3-54.

Comparison of the 1982 and 1984 tables shows that the major sources of waste increase in 1984 were DAF float and digester sludge resulting from the wastewater treatment plant. The total tonnage of other landfarmed waste has also increased. The characteristics of the 1984 wastes are expected to be similar to those of the 1982 wastes. However, due to an increase in water content, the quantity of oil, water, and metals to be disposed of at the landfarm in 1984 is greater than in 1982.

Koch has attributed these increases in the amount of water and waste to be landfarmed to two factors. First, operational changes in the DAF system have resulted in a higher percentage of water in the waste. Second, more raw sludge is produced in the activated sludge basins and the digested sludge has a very high water content (95.5 percent). Therefore, large amounts of water are conveyed to the landfarm with the sludge.

Hazardous Constituents. There are two categories of hazardous constituents to be considered in refinery wastes: metals and organic compounds. Available metals data are summarized on

Table 3-53
KOCH REFINING COMPANY
WASTE TO LANDFARM 1984

Waste Name	HW-Non-HW[a]	Tn.	Tn. Oil	Tn. Water	Tn. Solid	Lbs Pb	Lbs Cr	Lbs Zn	Lbs Fe	Lbs Cd	Lbs Ni
DAF Float	HW	5,486	362	4,800	324	395	351	384	2,765	66	395
Slop Oil Emulsion	HW	2,980	954	539	1,487	542	501	1,073	10,728	95	596
HT Ex Bndle Sludge	HW	120	13	64	43	19	29	22	2,400	4	23
Api Sep Sludge	HW	450	104	239	108	81	108	83	2,340	14	85
Tank & Flare Sludges	HW	226	68	90	68	36	45	41	149,160	2	136
Oil Spil Cleanups	HW	4	1	0	3	0	0	0	0	0	0
Alky Acid Sludge	HW	0	0	0	0	0	0	0	0	0	0
Poly Catalyst	HW	20	0	0	20	0	0	0	0	0	0
Neutralizer Sludge	Non-HW	200	0	156	44	0	0	0	0	0	0
WWTP Digester Sludge	Non-HW	12,663	0	12,600	63	0	0	0	25	0	0
Equal Basin Sludge	Non-HW	1,937	118	1,507	312	349	465	356	10,072	62	364
WWTP Act. Slude Bsn	Non-HW	0	0	0	0	0	0	0	0	0	0
Total Annual Rate		24,086 tons	1,620 tons	19,995 tons	2,472 tons	1,422 lbs	1,499 lbs	1,959 lbs	177,491 lbs	243 lbs	1,598 lbs

[a]HW - Hazardous Wastes
Non-HW - Nonhazardous Wastes

GLT509/3

Table 3-54
KOCH REFINING COMPANY
WASTE TO LANDFARM 1982

Waste Name	HW-Non-HW[a]	Tn.	Tn. Oil	Tn. Water	Tn. Solid	Lbs Pb	Lbs Cr	Lbs Zn	Lbs Fe	Lbs Cd	Lbs Ni
DAF Float	HW	185	24	136	25	38	48	31	222	6	31
Slop Oil Emulsion	HW	1,644	526	298	820	197	220	335	5,918	53	329
HT Ex Bndle Sludge	HW	46	5	24	17	7	30	28	928	1	9
Api Sep Sludge	HW	66	15	35	16	8	26	25	343	2	12
Tank & Flare Sludges	HW	194	58	78	58	31	128	117	128,040	2	116
Oil Spil Cleanups	HW	0	0	0	0	0	0	0	0	0	0
Alky Acid Sludge	HW	0	0	0	0	0	0	0	0	0	0
Poly Catalyst	HW	56	0	0	56	0	0	0	0	0	0
Neutralizer Sludge	Non-HW	518	0	484	114	0	0	0	0	0	0
WWTP Digester Sludge	Non-HW	3,135	0	3,119	16	0	0	0	6	0	0
Equal Basin Sludge	Non-HW	2,532	154	1,970	488	456	608	466	13,166	81	476
WWTP Act. Slude Bsn	Non-HW	581	0	523	58	0	0	0	0	0	0
Total Annual Rate		8,957 tons	783 tons	6,586 tons	1,588 tons	719 lbs	1,853 lbs	1,003 lbs	148,617 lbs	145 lbs	973 lbs

[a]HW - Hazardous Wastes
Non-HW - Nonhazardous Wastes

GLT509/4

following pages as well as in Groundwater Quality - Section 3.8.

At this time, data on organic compounds that are landfarmed are extremely limited. The presence of organic compounds in the waste is attributed to their presence in crude oil. In the discussions, it is assumed that the oil fraction contains several organic constituents of concern.

There are several limitations involved in using oil as an indicator of organic hazardous constituents. Some of these are:

- Oil analysis results may be affected by the presence of certain other materials that would be measured as oil.
- Volatile compounds are lost in the oil analysis and so are not monitored.
- The analysis technique for oil is not sensitive enough to detect organic compounds at low levels.
- The analysis technique may not be able to detect several types of organic hazardous constituents in addition to volatiles.

We are limited to using oil data because they are the only data readily available to judge the presence of organic hazardous constituents.

Existing Landfarm Operational Practices

The Koch Refining Company has operated a land treatment facility (landfarm) since 1978 to dispose of petroleum refinery wastes generated at the Pine Bend complex. The 31-acre landfarm is used only for the treatment and disposal of Koch refinery wastes. Wastes from other sites have not and will not be managed at this facility.

Use of the land treatment system for disposal and degradation of petroleum refinery wastes is well recognized, but uniform standards are difficult to define since each system requires site-specific study. The landfarming concept developed at Koch is generally consistent with American Petroleum Institute (API) methods and other literature documenting this waste management technique. An innovative feature of the Koch landfarming method is the use of intensive landfarming. Standard industry practices of landfarming involve treatment of waste in the top 6 to 8 inches of soil whereas the Koch intensive landfarming technique involves treatment of waste in the top 25 inches of soil with up to 45 inches of the soil in windrows involved in treatment. This is made possible by using an auger to aerate and windrow landfarm soils. Application rates for standard landfarming practices are generally on the order of 2 to 4 $lbs/ft^2/yr$. Koch's intensive landfarming technique involves application rates at approximately 6 $lbs/ft^2/yr$. It should be noted that Koch does not and will not be growing food chain crops on this land.

In land treatment systems, a treatment zone within the soil is defined. All hazardous constituents of the applied wastes must be degraded or retained within this treatment zone. Koch has claimed that the treatment zone consists of the top 60 inches of soil. A variety of factors must be properly evaluated and managed to ensure that wastes are adequately treated in this zone. Factors that are crucial to the proper treatment of wastes include the following:

- Proper waste application
- Maintenance of optimum soil pH
- Maintenance of adequate nutrient levels in the soil
- Maintenance of active microbial populations
- Adequate soil aeration
- Adequate soil moisture content
- Proper temperature

Koch's management of each of these factors is discussed in the following paragraphs.

Waste Application Rates and Methods. Pumpable waste sludges are applied to the landfarm by spray bar and/or movable drain pipes on a transport vacuum truck. Trucks distribute waste onto treatment cells from roadways located on intercell berms which divide the treatment cells. The cells have an average size of 1 acre, but range in size from 0.7 acres to 1.6 acres per cell. There are currently 16 cells in use totaling about 16 acres. Application has been designed to evenly distribute the total oil loading in each of the treatment cells. The total mass of waste applied to the landfarm over the first 5.25 years (1978 to 1983) averaged 9,347 tons per year (49,071 tons in total). Of this total mass, 72 percent of the waste is water, 12 percent is total solids, and 15 percent are hydrocarbons. Koch considers hydrocarbon (oil) loading to be the primary factor that limits the rate of application. Koch does not allow the oil content in the top 25 inches to increase above 10 percent. In general, when the oil content drops to 3 percent, more waste is applied. Based on the limiting factors, the average current rate of waste application is 5.7 $lbs/ft^2/yr$ for the active land area.

Control of Soil pH. Maintenance of proper pH is essential in the landfarm, as this is a crucial factor in both biodegradation of hydrocarbons and the retention of heavy metals within the treatment zone. Slight to moderately alkaline conditions allow for the encouragement of both processes. Koch maintains the pH of landfarm soils within the range of 7 to 9 standard pH units through the addition of liming agents. Agricultural lime available in Minnesota (Dolomitic limestone) is used in conjunction with byproduct lime (neutralizer sludge containing $CaCO_3/MgCO_3$ and other spent caustics generated by Koch. Lime is typically added to the landfarm at a rate of 2 to 5 tons/acre depending upon soil pH.

Fertilization. Degradation of the hydrocarbons is primarily a biological activity. Therefore, adequate nutrient levels must be present in the landfarm. Since the waste added to the landfarm has a high carbon to nitrogen ratio, it is necessary to add an outside nitrogen source. Soil testing lab recommendations for nitrogen, phosphorus, and potassium additions are based upon a 200-bu/acre corn crop equivalent. This level represents a high nutrient demand. An additional factor used to determine landfarm nutrient requirements is the ratio of BOD-nitrogen-P205. Generally, soil lab recommendations and WWTP guidelines corroborate when nutrient additions are required.

Enhancement of Microbial Activity. Partially aerobically digested activated sludge from Koch's WWTP system is applied to the landfarm to enhance microbial populations. Because bacteria present in the WWTP sludge are acclimated to the hydrocarbon constituents in Koch's wastes, they are presumed adaptable to conditions in the landfarm.

Mechanical Aeration. Oxygen supply to the biomass in the landfarm is a critical factor in decomposition of hydrocarbons. Koch creates and aerates windrows in the landfarm to encourage higher oxygen concentrations in the soil. During the landfarm's active decomposition period, approximately May 1 to November 15, the waste/soil mixture in the treatment cells is auger-aerated and placed in windrows at least once per month. This averages out to mechanical aeration 6 to 7 times per season depending upon weather conditions.

Following a 1- to 3-week period of treatment in the windrows, a dozer flattens out the windrows. The soil is evenly distributed within the cells prior to the next application of waste.

The windrowing process is estimated by Koch to increase surface area by 71 percent. Based on observations of the windrows at the site, 31 percent appears to be a reasonable estimate. The estimate of surface area and available oxygen will affect estimates of the rate of waste degradation in the landfarm soils.

Surface Water Control and Moisture Management. Soil moisture control is another important factor in proper landfarm management. If the soil becames water-saturated, oxygen concentrations are greatly decreased. In this situation, aerobic degration processes are hampered, oxidation states of metals are reduced, and the downward leaching of waste constituents is increased. A minimum moisture content is required for a microbiological population to degrade the waste. Surface water drainage and collection is also required because of the potential for the water to transport waste constituents to groundwater through infiltration or to surface waters via runoff.

Koch has constructed a system of roadways on berms which surround each treatment cell. The exterior berms prevent precipitation run-on from outside the landfarm and prevent runoff from leaving the landfarm.

The management of surface water within the landfarm is dependent on the volume of water present. During periods of excessive water accumulation, primarily in the spring, temporary drainage ditches are excavated through the interior landfarm berms to allow drainage to the lowest lying cells. These cells act as temporary holding areas from which the water is pumped to a stormwater basin. After the drainage of excessive water, the ditches are filled and berms replaced.

At other times, during periods of heavy precipitation, the surface water drains to the low point within each cell. From there it is pumped off by vacuum truck and emptied into the stormwater basin.

Standing water in depressions and furrows within each treatment cell is also of concern because it can present treatment difficulties. Koch's management plan for this concern involves removal of the excess water by vacuum truck and augering to increase evaporation.

Temperature. The temperature at which wastes are degraded affects the activity of the microbiological community and therefore the ability of microbes to degrade hydrocarbons. Minimal microbial activity occurs during the winter months.

Koch does not actively operate the landfarm during the winter months and the spring snowmelt. However, wastes are continually applied during this period.

Landfarm Water Balance/Surface Water Removal Rates

Water balance information is used to define infiltration levels for the landfarm and to make estimates of the amount of surface water requiring removal. These data are required to evaluate the effectiveness of surface water removal systems and to evaluate the potential for contaminant transport in the landfarm area.

An attempt was made to define a range of possible infiltration volumes for the landfarm. The upper bound was calculated using a water balance that assumed all water was lost through infiltration and evaporation, without considering surface water removal. In calculating the lower bound, a ponded water condition on the landfarm was assumed with rapid removal of the water. Seepage from the pond was calculated and this volume represented infiltration. Details of the analysis are presented in Appendix C. The two water balance calculations performed yield infiltration values ranging from 0.85 to 3.1 million gallons per year for the existing landfarm. Actual volumes of infiltration probably lie somewhere between these two extremes.

Records have not been maintained of precipitation or the amount of surface water removed at the landfarm. Koch has estimated the volume of surface water removed at 7 million gallons annually. In calculating the lower infiltration bound, estimates made of surface water removal indicate the value may approach 8.9 million gallons per year as an uppermost limit, under the assumed conditions.

Estimates of spring snowmelt have been made in the water balance calculations. The precipitation and wastewater inputs for December through March were summed and used as the total water input for the spring snowmelt. The runoff was calculated to be approximately 1.9 million gallons using an active landfarm are of 11.51 acres, which was the area in use at the time of the calculations.

Koch employs a 150 gpm pump and 6-inch-diameter aluminum piping to remove spring runoff to the stormwater retention basin 1,000 yards to the north of the landfarm.

It is unknown how long it takes to remove excess water from the landfarm following precipitation events. Standing water has been noted within the cells for up to a week following the precipitation event.

Existing Landfarm Performance

The following performance evaluations are based on very limited data gathered during interim status monitoring. Considerably more data are required to conduct an accurate evaluation of landfarm performance. Therefore, the analyses presented are of limited value and the conclusions drawn must reflect this.

A treatment demonstration is required for Koch to receive a final hazardous waste permit for the landfarm. The purpose of the treatment demonstration is to assure that for each waste applied to the landfarm, the hazardous constituents in the waste can be completely degraded, transformed, or tied up within the treatment zone. As an initial step for development of the treatment demonstration, it will be necessary to conduct a detailed investigation of the existing landfarm. The investigation is expected to begin in 1985.

Hydrocarbons. Soil core samples taken from below the landfarm indicate that migration of oil from the treatment zone into the soil below is occurring. Koch has reported oil concentrations ranging from 860 to 7,220 ppm in the soil at between 25 and 45 inches of depth. At the 60-inch depth Koch has reported oil concentrations ranging from <63 ppm to 10,000 ppm. The majority of these values are considerably above the background values for oil. The presence of such high oil concentrations in the lower treatment zone and below is probably the result of two factors: First, incorporation methods are most likely resulting in the incorporation of wastes to a greater depth than intended. Second, the high values may indicate that wastes are not totally degraded in the treatment zone and are migrating downward through the soils.

Oil concentrations were measured in background monitoring plots for the two soil types located at the landfarm. For one soil type, the background oil concentrations at the 60-inch depth were all less than 56 ppm. For the other soil type the background oil concentration ranged from 84 ppm to 310 ppm. Since the material monitored in both cases should be a clean outwash sand, there is some question as the whether the second background plot truly represents ambient conditions.

Travel times required for oil to reach varying depths below the landfarm were computed using equations in the U.S. EPA document entitled "Waste Oil Storage," WH-565. The equations assume the case of an oil spill where all the oil applied to the landfarm will seep into the soil, and part of the oil will migrate downward, with the remainder being adsorbed by soil particles.

Assuming only vertical (downward) migration, a worst-case number for penetration was calculated to be 1.56 ft/yr for the existing landfarm. If the conditions stated are representative of the landfarm situation, the depth of penetration would be less than 10 feet considering the landfarm has been operating for 6 years.

It is important to note that this transport analysis is not truly representative of conditions at the landfarm. Biodegradation of the oil, which would retard penetration, is not factored into the transport calculations. Nor is it considered that the oil is part of a heterogenous waste rather than pure oil. Another important factor is that many organic constituents may not move at the same rate as oil. Some may be soluble and migrate much more rapidly while others may be completely immobile. However, the analysis does provide an

Table 3-55
KOCH REFINING COMPANY
HEAVY METALS COMPARATIVE DATA (lbs)

	Pb	Cr	Zn	Cd	Ni	Source
Landfarm Content						
Upper Treatment	3,864	11,674	8,483	455	4,237	Table D-25.1
Lower Treatment	708	669	1,343	31	890	Table D-25.2
Totals	4,572	12,343	10,826	486	5,127	
Landfarm Inputs						
Background	2,210	1,658	4,052	295	2,210	Table D-30
Wastes	3,192	8,269	6,562	837	3,482	Table D-3
Totals	5,402	9,927	10,614	1,132	5,692	
% Contents to Inputs	85	124	102	43	90	

Although unlikely under the worst-case assumptions, it could be assumed that cadmium is not being retained in the treatment zone and is moving with the pore water phase. Travel times for cadmium were computed under this worst-case assumption. A discussion of the travel time analysis is presented in Appendix C. The results indicate that cadmium would reach the soil-pore water monitoring devices anywhere between 2.4 months and 45 months after waste application. To reach groundwater, it would take between 4.1 years and 93 years. This is provided, of course, that worst-case assumptions hold true.

3.7.2 IMPACTS

Following refinery expansion, Koch intends to develop the landfarm as at present. Koch has been expanding the active area of the landfarm as its waste disposal needs warrant by the addition of new treatment cells. Landfarm operational practices are also anticipated to remain the same as during prerefinery expansion. Therefore, the concerns about performance of the existing landfarm would also apply following refinery expansion.

Koch has provided an estimate of the volumes and characteristics of wastes to be landfarmed at the proposed refinery

Organic material in the waste and the soil can also combine with heavy metals as chelates. Chelates may act as soluble agents that move easily through the soil. Other organics may hold the metals in suspension within the treatment zone.

The microbial mass is also capable of immobilizing small amounts of metals. However, certain metals may also present a toxic threat to microbial populations. The effect of metal on the activity of the microbial mass existing in the landfarm needs to be addressed in detail.

Under Koch's landfarm operational practices, precipitation of metals, is probably the main mechanism for the retention of metal in the treatment zone. Although cation exchange capacity, organo-metallic complexes, and immobilization will affect the activity of metals, they are not primary factors.

Metals Balance And Cadmium Transport Analysis. Koch has provided data that compare the estimated amount of heavy metals disposed of in the waste since the landfarm has been in operation to the amount of heavy metals in the treatment zone. The data are presented in Table 3-55. Considerable error is possible in this type of analysis. Given the insensitivity of this technique, it appears that the metals balance closes for all metals except cadmium. The cadmium content of the soil is less than 50 percent of the expected value. The insensitivity of the technique is probably the cause of this discrepancy for the following reasons:

- The cadmium concentrations are low enough that a slight deviation in analytical data would be magnified to an apparently large discrepancy.

- The soil sampling technique and the samples analyzed may not be representative of the landfarm as a whole.

- The estimated volume of metals disposed of may be in error because data for the initial years of landfarm operation were not collected but rather synthesized from data of later years.

- A higher concentration of cadmium would be expected in the lower treatment zone if leaching were occurring. However, less than 7 percent of soil cadmium was detected in the lower part of the treatment zone with the remaining 93 percent in the upper treatment zone.

Table 3-56
KOCH REFINING COMPANY
WASTE TO LANDFARM 1988

Waste Name	HW-Non-HW[a]	Tn.	Tn. Oil	Tn. Water	Tn. Solid	Lbs Pb	Lbs Cr	Lbs Zn	Lbs Fe	Lbs Cd	Lbs Ni
DAF Float	HW	416	27	364	25	30	27	29	210	5	38
Slop Oil Emulsion	HW	3,022	242	151	2,629	955	882	1,892	18,736	169	1,052
HT Ex Bndle Sludge	HW	200	22	106	72	32	48	37	4,000	6	38
Api Sep Sludge	HW	200	46	106	48	36	48	37	1,048	6	38
Tank & Flare Sludges	HW	200	68	80	68	32	48	36	132,000	2	120
Oil Spil Cleanups	HW	20	6	0	14	0	0	0	0	0	0
Alky Acid Sludge	HW	20	8	8	4	0	0	0	0	0	0
Poly Catalyst	HW	40	0	0	40	0	0	0	0	0	0
Neutralizer Sludge	Non-HW	200	0	156	44	0	0	0	0	0	0
WWTP Digester Sludge	Non-HW	8,000	0	7,960	40	0	0	0	16	0	0
Equal Basin Sludge	Non-HW	1,435	88	1,116	231	258	344	264	7,462	46	270
WWTP Act. Slude Bsn	Non-HW	200	0	0	0	0	0	0	0	0	0
Total Annual Rate		13,953 tons	499 tons	10,247 tons	3,207 tons	1,343 lbs	1,389 lbs	2,295 lbs	163,464 lbs	235 lbs	1,547 lbs

[a]HW - Hazardous Wastes
Non-HW - Nonhazardous Wastes

GLT509/5

expansion capacity. These are presented in Table 3-56. Generally, it is assumed that waste volumes will increase in proportion to crude production and that waste characteristics will remain constant. The predictions are useful for comparative purposes only. More information is necessary to predict accurate waste volumes and characteristics for the expansion.

The predictions also factor in two practices to reduce the amount of waste to be disposed of from expanded operations.

- Expansion of coker No. 3 and coker No. 4 will allow for approximately 96 percent use of DAF float as feed stock to the cokers compared to 75 percent under current operations.

- Addition of a centrifuge for phase separation of oil, water, and solids from the slop oil emulsion.

These practices are expected to reduce the yearly tonnage of oil disposed of in the landfarm. Use of the DAF float as feed stock will aid in reducing the yearly volume of metals to be landfarmed.

Waste reduction practices will also reduce the amount of water in the waste. Koch is also proposing to add sludge dewatering facilities to the WWTP to reduce the volume of water in the WWTP digester sludge. This reduction in water content is not reflected in Table 3-56. This measure would significantly reduce the volume of water requiring disposal at the landfarm.

The closure plan for the landfarm calls for continued operation (i.e., aeration, nutrient additional, pH control, etc.) following final waste application until hydrocarbon degradation is complete. Once degradation is complete, the landfarm is to be capped and vegetated. The cap will minimize infiltration and prevent wildlife or human exposure to the remaining constituents. No food chain crops are to be grown over this cap.

Landfarm life is dependent upon a number of factors such as:

- Whether food chain crops will be grown in the treatment zone

- Toxicity limits of constituents that accumulate in the treatment zone

- The ability of the treatment zone to retain waste constituents that accumulate

- Operation and closure plans for the landfarm

In Koch's case, the lifetime will be dependent upon such factors as the ability of the microorganisms to actively

Land treatment of wastes is very minimal during winter months. Koch should provide appropriate waste storage facilities for wastes during the winter months.

decompose wastes and the ability of the soils to retain high metals concentrations. Since the facility will not be used to grow food crops and will be capped, plant toxicity and metals buildup in plant tissue are not concerns.

Under the current landfarm practices at Koch, increased metal loading combined with increased landfarm area should not immediately affect the operational performance of the landfarm. Koch has estimated the landfarm lifetime to be 52 years at current refinery capacity, and at expanded capacity a reduced lifetime to 42 years is anticipated. These lifetime values cannot be verified without further investigation.

There is the unlikely possibility under worst-case assumptions, that cadmium is not being retained. If this worst case holds true, measures will have to be taken to prevent the release of cadmium into the environment or those areas of the landfarm where cadmium overloading has occurred will have to be closed.

3.7.3 MITIGATION

To fully evaluate the adequacy of Koch's landfarm operation, more data are required. These will be gathered as part of the final permitting process for the landfarm. As part of the process, a treatment demonstration will be required to assure the adequacy of treatment and other related concerns.

Additional assessment of the existing land treatment system is necessary. Information will be obtained through more extensive soil testing and soil-pore water monitoring at the landfarm site. More detailed evaluations of the landfarm management practices are also necessary. This work will be initiated in 1985 by the MPCA staff.

Data indicate oil is migrating out of the existing treatment system. Loading rates for oil should be reduced until the treatment demonstration verifies acceptable loading rates for the system. This can be accomplished through improved oil recovery practices, as proposed in the expansion project, and through use of additional land area presently designated for landfarming.

Migration of waste constituents is directly affected by infiltration. The sludge dewatering associated with the proposed project will help this situation. Koch's program for water removal from the landfarm cells should be reviewed to develop methods for increasing the rate of surface water removal. In addition, Koch should continue practices to optimize landfarm performance and prevent surface water run-on to the treatment system.

3.8 GROUNDWATER QUALITY

This section contains an evaluation of the impact of the existing and expanded refinery on the quality of area groundwater resources. Information for this evaluation has been acquired from published sources, permit applications, and a site visit in October 1984.

3.8.1 EXISTING CONDITIONS

Geology and Groundwater

The Koch refinery is located in the southeastern quadrant of a geologic basin known as the Twin Cities basin. This is a relatively stable, circular geologic basin that has been without major tectonic movement for several million years, although minor isostatic rebound from the retreat of the last glaciation is still occurring.

The area is underlain by a sequence of sandstones, shales and limestones of the Paleozoic age overlain by recent deposits of sands and gravels from the last glaciation. The major water-bearing units within this geologic sequence are the sandy limestones and dolomites from the Prairie du Chien group and the overlying glacial and postglacial deposits (Figure 3-9, Groundwater Availability - Section 3.6). Wells penetrating the glacial deposits support generally low to moderate yields except along rivers or in ancient buried river valleys, where the thickness of sands and gravels may exceed 300 feet. There are major buried valleys 6 miles southeast of the site and possibly near the northeastern corner of the refinery site. Yields from wells in the Prairie du Chien group vary depending on whether they intercept major fracture zones or solution channels in the limestone. In general, yields are very good from both a quality and quantity standpoint.

The average thickness of the glacial drift below the refinery site is approximately 50 feet; the drift is underlain by a thin (0 to 7 feet) layer of St. Peter sandstone, which lies over the Prairie du Chien group. The Shakopee and Oneota dolomites are the uppermost layers of the Prairie du Chien group and are approximately 100 to 175 feet thick below the site. The general direction of groundwater flow is toward the Mississippi River to the northeast, but varies locally depending on wells, springs, and regional discharge points. Velocities of groundwater flow also vary widely, but range from 2,000 to 4,000 feet/year in the glacial deposits, and from 1,000 to 5,000 feet/year in the upper Prairie du Chien aquifer. For a further discussion of the hydrogeologic aspects of the site, the reader is directed to Section 3.6, Groundwater Availability.

monitoring wells at the landfill revealed that the groundwater was contaminated by a variety of volatile organic hydrocarbons. As part of an expanded sampling program in the Pine Bend area, the Minnesota Department of Health (MDPH) subsequently sampled several residential wells downgradient (northeast, toward the Mississippi River) of the University of Minnesota Rosemount Research Center (see Figure 3-15). This sampling revealed the presence of a number of volatile organic hydrocarbons in the groundwater, with the probable source being the research center. It should be noted that the research center, located upgradient from Koch Refining and the Pine Bend area, must be taken into consideration in any groundwater contamination investigations in this area.

Groundwater testing by the MPCA and MDH staff in 1972 confirmed that the groundwater downgradient of the Pine Bend industrial area is contaminated with nitrates. More recent sampling of wells in the Coates area by private parties or by MPCA staff through the ambient groundwater monitoring program has shown nitrate concentrations in some private wells to be above drinking water standards. These wells, however, are located to the south of the Pine Bend industrial area and are not believed to be affected by that area. At this point, it is uncertain whether there is a specific source of the nitrates in the area, or whether the problem is from long-term agricultural practices (i.e., fertilization of fields or feedlots) or from poorly designed and constructed individual sewer systems. Sampling by the MPCA staff is being undertaken to begin to determine if the nitrates are coming from a specific source or if they are ubiquitous to the groundwater in the area.

As a result of these findings, the MPCA staff has submitted these three areas (the Pine Bend Industrial Area, Pine Bend Sanitary Landfill, and the University of Minnesota Rosemount Research Center) for inclusion on the National Priorities List (NPL) for investigation and possible cleanup under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA or the Superfund Act).

Groundwater Quality Effects of the Existing Refinery

A discussion of refinery operation is provided in the project description chapter. Past waste disposal practices at the refinery have affected the groundwater quality beneath and downgradient of the site and affected several private residential wells downgradient (east-northeast) of the site. Koch has been supplying bottled water to three downgradient residences since the early 1970's. There are also indications that present waste management practices may be affecting water quality beneath the site. The first set of monitoring results from the expanded monitoring system at the landfarm indicate that several monitoring wells located downgradient

Existing Groundwater Quality

Groundwater quality in the Pine Bend area and in the vicinity of the refinery has been affected by the general land use practices and industrial development in the region. Groundwater quality problems in the Pine Bend area first came to the attention of the MPCA in the fall of 1971. The Minnesota Department of Health, acting at the request of the Agency, then sampled a number of residential and industrial wells in the area. The sampling revealed degradation of some of the well water supplies in the Pine Bend industrial complex and surrounding areas. A subsequent study of area groundwater quality in 1974 by the United States Geological Survey (USGS) revealed an area of degraded water quality, as measured by specific conductance, of about 2.0 square miles surrounding the industrial complex.

In 1972, the MPCA conducted field investigations at St. Paul Ammonia Products, Koch Refining Company, and North Star Chemicals. St. Paul Ammonia Products was found to be discharging water high in ammonia, nitrates, and chromium to a stormwater basin that was discharging to groundwater. The main sources of potential groundwater contamination identified at Koch Refining Company were several surface impoundments which received effluent from the wastewater treatment plant (WWTP). This effluent was often of poor quality because of operational problems with the treatment plant, and often contained elevated levels of phenols, ammonia, and oil. Substantial quantities of this effluent apparently reached the groundwater table since the lagoons rarely discharged to the river, despite a daily average flow to the lagoons of approximately 2 million gallons per day (gpd). North Star Chemicals was found to be generating about 100,000 gpd of low pH, high dissolved and suspended solids wastewater which also contained lead and arsenic. This waste was discharged to a two-cell seepage basin, which over-flowed to a cornfield owned by the company. The MPCA developed stipulation agreements with the three companies that required corrective action be taken to abate potential sources of groundwater contamination. The above-mentioned concerns were corrected by 1) construction of a new WWTP at Koch, 2) draining the pond at St. Paul Ammonia Products (now the N-Ren Corp.), 3) providing wastewater treatment at North Star (now the Koch Sulfuric Acid Unit), and 4) controlling discharges under NPDES permit and other stipulated programs.

More recently, groundwater investigations in the Pine Bend area have revealed several other potential sources of groundwater pollution. Several years ago, MPCA staff sampled monitoring wells at several Minnesota sanitary landfills for volatile organic hydrocarbon contamination. The Pine Bend sanitary landfill was among those sampled. The results of the initial sampling and testing of the groundwater from

from the landfarm show elevated levels of mercury and nitrates compared to monitoring wells located upgradient from the landfarm (Table 3-57). No previous monitoring results have shown the presence of mercury. It should be pointed out that these data are of a preliminary nature, since this is the first sampling from these wells, and more samples are necessary throughout the year to reliably establish whether the landfarm is indeed affecting area groundwater. Previous data from monitoring well Nos. 1, 2, and 3, although gathered from a monitoring system which was later deemed inadequate, indicated no statistically significant difference between upgradient and downgradient water quality. Recent sampling of production wells on Koch property by MPCA staff has also revealed very low levels of several chlorinated hydrocarbons and napthalene. These results are from one sampling event and must be confirmed by further testing.

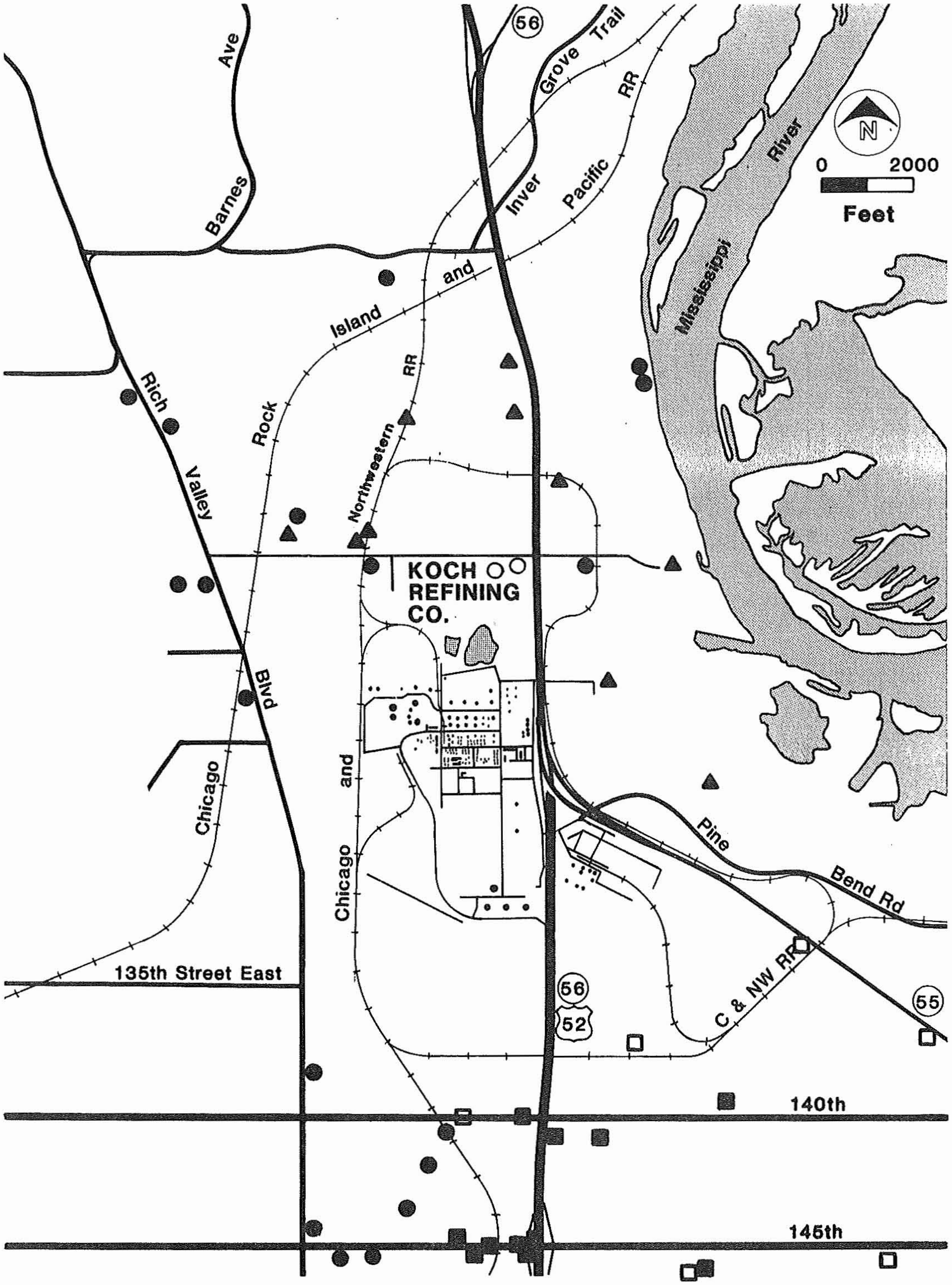
There may also be complicating factors because of the possible influence of upgradient sources of contamination mentioned previously. Because of these complications, it is not possible with the present level of data to accurately define the relative contributions of any one source of groundwater pollution to the overall problem in the Pine Bend area. The investigations to be conducted under CERCLA are intended to clarify this. Given the available data, the approach taken in this report is to identify potential impacts of sources at the existing refinery on the groundwater quality, to evaluate these potential impacts, and then to conduct similar analyses for the expansion of the refinery.

Potential Contamination Sources at the Koch Oil Refinery

Figure 3-16 shows the location of potential contamination sources on the refinery property. The landfarm in the southwest corner of the site is included among the potential contamination sources.

Before the wastewater treatment plant (WWTP) was upgraded in 1977, two lagoons, the "Upper Middle Lagoon" and "Upper East Lagoon," located in the north-central site area, were used to treat oily wastewater. To the north of these lagoons is the old treated water settling basin.

Before 1980, leaded tank bottoms resulting from the cleaning of lead gasoline storage tanks were treated onsite. Treatment of these tank bottoms consisted of exposing them to the atmosphere, resulting in the transformation of organic lead to inorganic lead compounds. Several areas in the past were designated for leaded tank bottom treatment. The area used most recently is south of the Upper East Lagoon. At present, leaded tank bottoms are placed in drums, temporarily stored at the refinery, and shipped offsite for disposal. Residues from the past treatment of leaded tank bottoms have been



LEGEND

● UNCONTAMINATED

▲ ■ CONTAMINATED

□ CONTAMINATED BELOW CRITERIA

FIGURE 3-15

WELL SAMPLING
PINE BEND AREA

Table 3-57 (page 2 of 2)

Analysis	Well No. 4	Well No. 5	Well No. 6	Well No. 7
Total organic carbon, mg/L as TOC	17	16	17	11
Total organic Halide, ug/L	7	37	10	6
Radium 226, picocuries/L	<0.6	.9+/-.7	1.3-.9	<0.6
Radium 228, picocuries/L	<1	<1	<1	<1

[a]Equals of exceeds the drinking water standard for mercury of 2.0 µg/L.
[b]Equals or exceeds the drinking water standard for nitrate-nitroga of 10 µg/L.

GLT263/108-2

Table 3-57 (page 1 of 2)
CHEMICAL ANALYSIS FOR MONITORING WELL NOS. 4, 5, 6, AND 7

Analysis	Well No. 4	Well No. 5	Well No. 6	Well No. 7
Mercury, (filtered), ug/L as Hg	2.2[a]	2.0[a]	2.6[a]	0.5
Fluoride, ug/L as F	0.13	≦0.04	0.17	≦0.04
Nitrates, ug/L as H	1.6	12[b]	4.1	2.8
Endrin, ug/L	<0.1	<0.1	<0.1	<0.1
Lindane, ug/L	<0.1	<0.1	<0.1	<0.1
Methorchlor, ug/L	<0.1	<0.1	<0.1	<0.1
Toxaphene, ug/L	<1.0	<1.0	<1.0	<1.0
2.4 D, ug/L	5.5	2.3	5.7	<0.2
2 4.5 TP (Silver) ug/L	<0.1	<0.1	<0.1	<0.1
Total Coliform Bacteria, nc./ 100 mL (Membrane Filter)	TNTC	TNTC	TNTC	TNTC
Chloride, mg/L as Cl	20	15	15	15
Phenol, mg/L	<0.002	<0.002	<0.002	0.011
Sulfate, mg/L as SO_4	90	53	90	24
Gross Alpha, picocuries/L	4+/-3	8+/-6	4+/-3	3+/-2
Gross Beta, picocuries/L	9+/-3	17+/-6	5+/-2	7+/-3
Silver, (filtered), ug/L as Ag	<0.04	<0.04	3	<1
Arsenic (filtered), ug/L as As	<1	2		
Barium, (filtered), mg/L as Ba	<0.25	<0.25	<0.25	<0.25
Cadmium (filtered), ug/L as Cd	0.04	0.04	0.28	0.04
Total Chromium (filtered, ug/L as Cr	14	1.2	14	1.4
Total Iron, (filtered), mg/L as Fe	<0.05	<0.05	1.9	<0.05
Manganese, (filtered), mg/L as Mn	<0.03	0.03	0.48	0.03
Sodium, (filtered), mg/L as Ma	13	8.6	7.2	3.6
Lead (filtered), ug/L as Pb	<1	1	3	<1
Selenium, (filtered) ug/L as Se	<1	3	4	1
pH	3.3	7.2	7.2	6.8
Depth, feet	43.90	45.37	56.94	52.45
Specific Conductance, umbo's at 25°C	344	511	242	391

GLT263/108-1

put in containers and shipped to a secure landfill out-of-state for proper disposal.

Sludge from the old WWTP lagoons was treated by chemical fixation (Chemfix) in 1975, 1976, and 1981. The Upper East and Upper Middle Lagoons have been closed and the remaining waste and contaminated soil removed and disposed of in the landfarm.

There are numerous crude oil and refined product pipelines that cross the refinery property. According to Koch personnel, the lines are buried at a 6-foot depth. As with any pipeline, there is a potential for leakage. Koch employs pressure monitoring of the pipelines to detect leakage. Most leaks, however, would be promptly detected by plant personnel should breakage occur.

Stormwater runoff from the landfarm and process area is transferred to the stormwater basin located in the west-central part of the site (Figure 3-16), and is eventually transferred to the wastewater treatment plant. Since this liquid is in contact with hazardous waste in the landfarm area, it could contain untreated inorganics or organic constituents. The basin is asphalt-lined and inspected regularly by Koch personnel; however, as with any surface impoundment, there is a potential for seepage from this lagoon. Freeze-thaw events and waste-asphalt reactions may have the potential to increase the permeability of the stormwater basin bottom.

General refinery operations involve the handling and storage of large quantities of crude and refined products. There is potential for leakage from product storage, refining processes, and handling. Because the refinery is continuously staffed, major problems should be detected quickly if they develop. Additionally, Koch has a Spill Control and Countermeasure (SPCC) plan for handling spill situations and a contingency plan in case an emergency arises in its hazardous waste operations.

Review of the Landfarm Interim Status Monitoring Well Network

Groundwater quality monitoring has been conducted under the Resource Conservation and Recovery Act (RCRA) Interim Status Standards (ISS) monitoring requirements at the land treatment facility since December 1980. Two downgradient wells and one upgradient well (monitoring wells 1, 2, 3, Figure 3-17) made up the original network.

Following an inspection of the site and monitoring data, U.S. EPA officials recommended that the original network be modified. The following reasons were cited: 1) some of the wells were located too far downgradient from the waste

LEGEND

- LANDFARM
- FINAL LAGOON
- CHEMFIX STORAGE
- OLD TREATED WATER SETTLING BASIN
- OILY WASTE WATER PONDS (UPPER MIDDLE & UPPER EAST)
- STORM WATER POND

FIGURE 3-16

POTENTIAL CONTAMINATION SOURCES

management area, and 2) some of the wells were periodically dry, indicating an improper depth of screening.

Koch submitted a new groundwater monitoring plan in response to the EPA's recommendations in May 1984. The new groundwater monitoring network was based on several considerations including:

- o Obtaining representative groundwater samples in downgradient locations that would most likely be contaminated

- o Placing wells to provide equal coverage along the most probable pathways of contaminant migration, i.e., at the downgradient boundary of the facility for detection of localized contamination

- o Locating downgradient wells immediately adjacent to the waste treatment facility boundary, i.e., at the compliance point, in accord with regulatory requirements

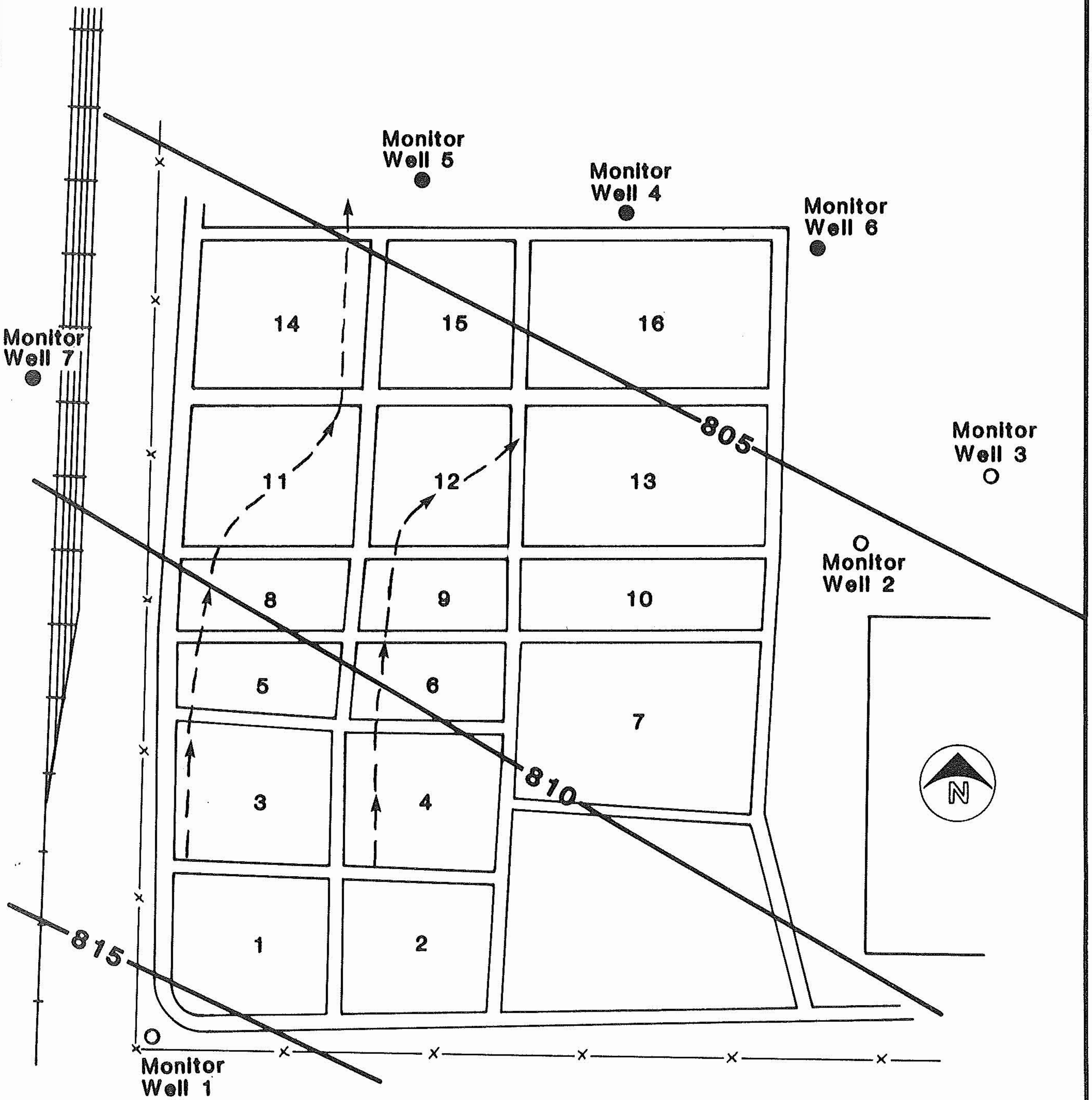
Wells were installed at location Nos. 4, 5, 6, and 7 (background), as shown in Figure 3-17. Only one well (No. 6) was located along the eastern boundary of the landfarm

The depths of the wells in the revised network range from 55 to 65 feet. Except for well No. 4, which extends into the Prairie du Chien group, all wells are completed in the unconsolidated glacial sand and gravel deposits.

Monitoring Well Design and Construction. Monitoring wells No. 5 and 7 were drilled with mud, and well No. 4 was drilled with a combination of mud and air rotary techniques. A 4-inch-diameter steel casing was set into the borehole. The screened interval consisted of 4-inch-diameter, 20-slot stainless steel screen. A clean sand or pea gravel pack was installed around the screened interval. Cement grout was placed from the top of the gravel pack to the surface. Locking caps were placed at the top of the boreholes to prevent precipitation from entering the borehole, and protective posts were installed around the top of the wells to minimize damage from facility vehicles and vandalism.

Generally, the construction, design, and development methods for the monitoring wells are adequate.

Monitoring Parameters and Sampling Procedures. Groundwater samples will be collected quarterly, in January, April, July, and October. Four samples will be taken at each well every quarter. A fifth sample will be collected during the first and third quarters. Each of the samples will be analyzed for the 16 parameters listed in Table 3-58. The procedures



LEGEND

—805— GROUNDWATER CONTOUR LINES

— — → FLOW

○ ORIGINAL MONITORING WELLS

● NEW MONITORING WELLS

FIGURE 3-17

LANDFARM SURFACE WATER DRAINAGE AND MONITORING WELL INSTALLATIONS for sample collection are described in Appendix C. Groundwater sampling conducted by Koch appears to reflect accepted standards for RCRA monitoring programs.

Unsaturated Zone Monitoring. The monitoring program for the unsaturated zone consists of soil-pore water measurements (through the use of suction lysimeters) and soil core measurements (through a program of periodic random core sampling). The sampling methods conform with the range of soil and drainage conditions.

Groundwater Quality Effects from the Existing Landfarm

Available data on landfarm performance indicate that contaminants may be migrating out of the treatment zone. Specifically, oil has been detected at 60 inches below the surface of the landfarm and because of a lack of sufficient available data, a worst-case assumption was made for cadmium retention within the land treatment system.

Preliminary monitoring data from Koch's expanded groundwater monitoring system show elevated levels of nitrate when comparing downgradient wells to upgradient wells. No indication of significantly elevated hydrocarbons or cadmium is noted. Monitoring data obtained from the wells in place before expansion of the monitoring system indicated no statistically significant difference between upgradient and downgradient wells. It should be noted the expanded monitoring system was installed because the prior monitoring system was insufficient. However, the data from the previous monitoring system are considered valid.

Lysimeters initially installed to satisfy ISS requirements for the land treatment facility encountered operational problems common to lysimeters. The lysimeters were unable to sample sufficient liquid (in some cases, none at all) to permit analysis of all parameters. A revised lysimeter network and soil sampling plan was developed and submitted to the EPA to address these problems. The plan was submitted in June 1984 as part of a compliance program. Permanent lysimeters have recently been installed at the land treatment facility.

Summary of the Existing Facility Groundwater Conditions

Groundwater in the Pine Bend area has been affected by industrial and land use practices in the area. Past waste management practices at Koch's refinery may have affected groundwater quality beneath and downgradient of the facility. Potential sources of contaminantion at the Koch refinery include the landfarm area, surface water storage areas, buried pipelines, former leaded tank bottom treatment areas, and the intraplant

Table 3-58
PRINCIPAL GROUNDWATER MONITORING PARAMETERS

Monitoring Parameter	Selection Criteria
Chromium[a]	EPA listed Hazardous Constituent
Lead[a]	EPA listed Hazardous Constituent
Nickel[a]	Priority Pollutant in Waste
Zinc	Priority Pollutant in Waste
Cadmium[a]	Trace Priority Pollutant in Waste
Arsenic[a]	Trace Priority Pollutant in Waste
Oil and Grease	Major Constituents in Waste Indicator of Waste Migration
Total Organic Carbon	Indicator of Leachate Presence
Total Organic Halogen	Indicator of Leachate Presence
Specific Conductance	Indicator of Leachate Presence
pH	Indicator of Leachate Presence
Total Dissolved Solids	Indicator of Leachate Presence
Chloride[b]	Mobile Waste Constituent
Sulfate[b]	Mobile Waste Constituent
Sodium[b]	Mobile Waste Constituent
Nitrates[a]	Mobile Constituent Added to the Waste

GLT263/109

contamination noted in groundwater below the Koch refinery. CERCLA activities are intended to clarify these questions. Additionally, although the monitoring well configuration in place at the landfarm is adequate for interim status monitoring purposes, consideration should be given to the installation of additional monitoring wells at the landfarm. This issue will be examined during the ongoing RCRA Part B application process.

Based on limited data on the transport of contaminants through the soil, the amount of waste applied per unit area in the existing landfarm area may be too high. Enlargement of the active portion of the landfarm and increased efficiencies in the refinery process as a result of the expansion will result in a lower waste per unit area application rate. The enlargement of the landfarm area will also result in an increase in total infiltration from the landfarm. A reanalysis of landfarm loading criteria using site-specific data is necessary to define appropriate loading rates. These activities are being carried out as a part of the requirements for the RCRA Part B application for the facility to determine ideal operating procedures.

More data from unsaturated zone monitoring are also necessary to allow reliable conclusions to be reached on the treatment efficiency of the landfarm. An expanded lysimeter network and soil coring program are in place below the landfarm, and regular monitoring of the network will be carried out in compliance with the interim status standards.

Surface water volumes to be removed from the landfarm area will increase as a result of facility expansion. This means that the potential for seepage from surface water storage areas will also increase. An examination of the characteristics of the contents of the surface water storage basins should be carried out to determine whether hazardous constituents are present and groundwater monitoring for the basins is required.

The potential for leakage and spillage of raw and refined petroleum products will naturally increase with expanded refinery capacity. Koch already has procedures in place for dealing with such emergencies. Additionally, new storage tanks will have containment facilities. Liquid storage permits must be obtained.

GLT509/7

transfer and storage of finished, intermediate, and raw products.

Very limited data from the landfarm monitoring system and sampling from onsite production wells indicate that contaminants in the form of oil, nitrates, metals, and volatile organic compounds exist in the groundwater beneath the refinery. Because of the limitations of available data and the presence of offsite contamination sources which could contribute to this contamination, it is not possible to define the origin or source(s) of these contaminants. Expanded groundwater investigations to be conducted under CERCLA and further monitoring to be conducted as part of the RCRA Part B application for the landfarm are intended to clarify these issues.

3.8.2 IMPACTS

Potential sources of groundwater contamination at the Koch refinery after expansion will remain essentially the same as the preexpansion facility. The volume of products and raw materials stored and moved within the refinery will increase with the expansion of the refinery. Consequently, the potential for spillage and leakage of products will naturally increase with an expanded facility. Koch plans to employ the same in-place procedures used for detection and cleanup of leaks and spillage at the existing refinery for the expanded refinery.

Expansion of the landfarm disposal facility will result in greater volumes of infiltration coming into contact with the waste. This creates the potential for increased movement of contaminants if the land treatment system is not performing properly. Control of surface water at the landfarm will be an increasingly important factor with the expansion to minimize infiltration.

Available data indicate the landfarm may not be performing adequately. Expansion of the landfarm and increased efficiencies in refinery processes as a result of the expansion will, however, also act to lower the waste application rate per area. This will have the effect of improving landfarm performance and of decreasing the potential for contaminant movement from the landfarm.

Surface water volumes to be removed from the landfarm area and runoff from expanded refinery operations will increase as a result of facility expansion. The potential for seepage from surface water storage areas will also increase.

3.8.3 MITIGATION

The available groundwater monitoring data are insufficient to positively determine the extent and origin of

CHAPTER 4

EVALUATION OF ALTERNATIVES

Chapter 4.0
EVALUATION OF ALTERNATIVES

The Koch Refining Company's Crude Expansion Project is compared to other alternative actions in this chapter. The information in this chapter is presented in two parts: a description of the alternatives, and an evaluation that quantitatively compares the proposed project and the alternatives in terms of their relative environmental, economic, and social effects.

4.1 DESCRIPTION OF ALTERNATIVES

The alternatives presented here were identified during the DEIS scoping process in March 1984. The suggested alternatives were evaluated by an MPCA staff, which concluded that four alternatives warranted consideration in this document. Among them is the No Action Alternative, which is required by the Minnesota Environmental Quality Board rules. During the review process, alternatives that would use renewable resources to meet general energy needs of the region were eliminated from further consideration. These alternatives were judged by the staff to be outside the range of reasonable alternatives. They represent options (i.e., solar energy, hydroelectric, etc.) for which the proposer has no expertise; which may require further technological development and acceptance, economic incentives or modification in personal preference; or which may not satisfy near-term needs because of long-lead times required for development. Thus, the staff determined these alternatives to be "unreasonable" or "not comparable" to the proposed action. The alternatives to be evaluated are:

- No Action
- Limited Expansion
- Change In Crude Oil Supply
- Change In Product Mix

4.1.1 ALTERNATIVE 1 - NO ACTION ALTERNATIVE

Essentially, two No Action Alternatives are possible. First, a refinery could be built by another company in the Upper Midwest to provide additional refining capacity. This option may have lesser or greater environmental impacts; however, this cannot be determined with the present information.

Secondly, the Koch Refinery could remain static at the current capacity of 137,000 B/D. Refinery processes and air and water pollution control systems would remain the same with routine operational and maintenance improvements. The

diesel fuel, and jet fuel), 11 percent residual fuels and asphalt, and 8 percent petroleum coke and other products. Alternative 4 changes the distribution of products from lighter end products to heavier end products. For example, Alternative 4 would produce a much larger percentage of asphalt and residual fuels than the present distribution of products, and assumes that market demand exists for these products.

Alternative 4 achieves the proposed change in product mix by eliminating facilities that would maximize light end product yields.

Alternative 4 would require the Phase 1 facilities, described for the proposed project expansion, to be constructed with the exception of the No. 3 Coker. Most Phase 2 activities would be eliminated. The approximate cost of this alternative would be $100 million.

4.2 ALTERNATIVE EVALUATION

The proposed project and the alternatives are evaluated in this section to define in relative terms their individual environmental, economic, and social effects. The comparative evaluation analyzes the proposed action, the "build" alternatives (Alternatives 2, 3, and 4), and the No Action Alternative (Alternative 1). The analysis uses a set of criteria to measure the environmental effects of each alternative. The criteria established for this evaluation cover a wide range of topics that were developed with the input from a variety of sources including:

- The issues and concerns identified through public involvement
- Input from agency resource managers and staff
- Various laws and regulations

With these sources serving as the basis, the criteria were developed. The criteria represent those issues considered most significant from an assessment of public issues and input from resource agencies. Other criteria were considered but eliminated because they would not produce any relative difference in the analysis of alternatives.

The criteria shown in Table 4-1 are grouped into seven categories, i.e., transportation, socioeconomics, water quality, air quality, etc. Criteria were then developed (shown in the left column) that aligned with each topical category.

The analysis of alternatives presented here uses a numerical evaluation system. Numerical weights are assigned to each of the criteria so that their total equals 1,000. Each of facility's compliance status with applicable environmental regulations would remain the same.

4.1.2 ALTERNATIVE 2 - LIMITED EXPANSION

Alternative 2 would increase total refinery capacity to 175,000 B/D or a net increase of 38,000 B/D. The limited expansion alternative would be accomplished by implementing Phase 1 of the proposed project (see Chapter 2, Project Description). Phase 2 process units would be eliminated. The approximate cost for Alternative 2 is about $100 million.

4.1.3 ALTERNATIVE 3 - CHANGE CRUDE OIL SUPPLY

The configuration of Alternative 3 would include operating the existing refinery capacity with sour crude (as designed), and adding 70,000 B/D of light sweet crude refining capacity. Koch's existing 137,000 B/D capacity is designed for refining heavy crude oils, primarily Canadian heavy sour crude. Unlike refineries whose crude oil feedstocks are lighter crudes, the refinery has additional refining process units required to derive lighter products (gasolines and fuel oils) from its crude oil feedstock with a high residuum and sulfur content. The existing refinery, as designed and built, would require extensive modification to process light crude. Therefore, sweet crude production in the existing complex is rendered impractical. The additional 70,000 B/D of light crude oil capacity would be accomplished with the addition and modification of facilities generally listed in the Phase 1 expansion for the proposed project. The change in crude oil type, however, requires that the capacity of the various facilities be redesigned. Phase 2 facilities would not be required. Lighter sweet crudes contain less residues; therefore, less heavy end products like asphalt and petroleum coke are produced. Expanded cracking facilities, which are now used to maximize the production of products by thermal processing of the heavy ends resulting from the vacuum and atmospheric distillation step, would not be needed. Additionally, it is assumed that expanded sulfur recovery and hydrogen plant capacity would not be required because of the low sulfur content of lighter crudes.

The approximate construction cost of Alternative 3 would be over $100 million.

4.1.4 ALTERNATIVE 4 - CHANGE IN PRODUCT MIX

Alternative 4 would consist of a refinery with a capacity of 207,000 B/D and an anticipated product mix of 48 percent gasoline, 24 percent middle distillates, 22 percent asphalt and residual fuels, and 6 percent petroleum coke and other products. This compares to a present product mix of 54 percent gasoline, 27 percent middle distillates (fuel oils,

Table 4-1
ALTERNATIVE EVALUATION

Criteria	Weight	Proposed Project Rating	Proposed Project Total	Limited Expansion Rating	Limited Expansion Total	Crude Oil Supply Rating	Crude Oil Supply Total	Product Mix Rating	Product Mix Total	No Action Rating	No Action Total
Air Quality	250										
o SO_2		2.0		2.5		3.0		3.0		2.5	
o TSP		2.0		2.2		2.4		2.4		2.2	
o NO_2		2.0		2.0		2.0		2.0		1.8	
o NmHC		2.0		3.0		2.0		2.0		2.5	
o Toxics		2.5		3.0		2.5		2.5		2.0	
o Odors		2.0		2.8		2.0		2.0		2.4	
o Visible Emissions		2.0		2.2		2.0		2.0		2.5	
o Malfunctions		3.0		2.5		2.8		2.8		2.0	
		2.19	547.5	2.53	632.5	2.34	585	2.34	585	2.24	560
Surface Water Quality	110										
o Conventional Pollutants		3.5		3.0		3.0		3.5		2.0	
o Toxics		2.0		2.0		2.0		2.0		2.5	
		2.75	302.5	2.5	275	2.5	275	2.75	302.5	2.25	247.50
Solid and Hazardous Wastes	125										
o Waste Generation		3.0		2.5		3.0		3.0		3.5	
o Land Application		3.0		2.5		3.0		3.0		3.5	
o Offsite Shipments		3.5		3.0		3.0		3.5		2.5	
		3.16	395	2.67	333.8	3.0	375	3.16	395	3.16	395
Groundwater Quality/Availability	180										
o Subsurface Quality		2.30		2.15		2.30		2.30		2.0	
o Downgradient Quality Impact		2.2		2.1		2.2		2.2		2.0	
o Consumption Impact		2.25		2.1		2.25		2.25		2.0	
		2.25	405	2.12	381.6	2.25	405	2.25	405	2.0	360
Transportation	55										
o Effects on Existing Transporation Network		2.0	110	1.5	82.5	2.0	110	2.0	110	1.0	55
Noise	55										
o Impacts to Sensitive Receptors		2.4	132	2.2	121	2.4	132	2.4	132	2.0	110
Socioeconomics	225										
o Continuing Availability of Competitively Priced Petroleum Products		2.4		2.8		2.5		2.6		3.0	
o Effects on Labor Force		2.0		2.7		2.4		2.4		3.0	
o Tax Revenues		2.0		2.4		2.4		2.4		3.0	
o Public Health Impact		3.5		4.0		3.5		3.5		3.0	
o Economic Spin-off Effects		2.0		2.7		2.4		2.4		3.0	
o Raw Material Availability		2.0		2.0		3.0		2.0		2.0	
		2.32	552	2.77	623.25	2.70	607.5	2.55	573.8	2.83	636.8
TOTAL			2414.0		2449.7		2489.5		2503.3		2364.3

GLT495/12

the alternatives are then rated on a scale of 1 to 5 (1 is best and 5 is worst) for each of the criteria. This rating is a measure of how well each alternative satisfies the criteria. The relative weights are then multiplied by the rating (or average rating in the case of several subcriteria) to give a column of abstract numbers for each alternative. Each column is totaled, giving a comparison of environmental impacts. The lower numbers are an indication of greater environmental acceptability.

4.2.1 THE ANALYSIS

The evaluation of the proposed project and alternatives is presented in Table 4-1. The total scores show the order of environmental acceptability to be as follows:

- No action
- Proposed project
- The limited expansion
- A change in crude oil supply
- A change in project mix

The analysis was an attempt to order the acceptability of the alternatives using a systematic approach. The approach, although subject to individual judgement, is sufficiently objective, that even though the rank order of the top three alternatives may change depending on the evaluators, their relative difference would most probably be small. The scores shown in Table 4-1 strongly suggest that the proposed expansion could be accomplished with minimal overall impact to the environment, when compared to the No Action Alternative. The following discussion of key evaluation criteria (air quality, water quality, solid and hazardous wastes, and socioeconomics) is used to further document the judgment used in rating the various alternatives.

Air Quality

Air emissions for the proposed project and the alternatives are shown in Table 4-2. As indicated in Table 4-2, the Proposed Expansion will result in a net decrease in total air emissions. When Phase 2 equipment is installed and operational, total air emissions will be about 14,600 tons per year. Current air emissions are about 18,200 tons per year. Reduction in total air emissions will result primarily from Koch's expanded ability to recover gases derived from thermal and catalytic cracking processes. These fuel gases are then used in lieu of fuel oils to meet process energy needs. Estimates of air emissions presented in Table 4-2 are based largely upon reduced emissions resulting from the use of the increased amounts of fuel gases for process boilers made available by refining processes rather than fuel oils. Table 4-2 also incorporates slight increases in air emissions resulting from a new sulfur recovery unit.

The first alternative is the No Action Alternative. Refinery operations will remain at the current capacity of 137,000 barrels per day (B/D). Air pollution emissions and control systems would remain at existing conditions. Compared to the proposed project, the No Action Alternative would produce higher particulate, SO_2 emissions, hydrocarbon and odor emissions, and slightly lower NO_x and CO emissions.

Refinery capacity is proposed to increase by 38,000 B/D to about 175,000 B/D in the Limited Expansion Alternative. Only the first phase of expansion would be completed. The expanded fuel gas generating process associated with the second phase would not be constructed. Process energy needs would increase with limited expansion. The increased energy need would primarily be met by increased use of fuel oils. Fuel oil combustion produces more SO_2 and particulate emissions than fuel gas, therefore more SO_2 and particulates would be emitted from this alternative than the proposed project. Hydrocarbon, odors, and most toxic pollutant emissions will be higher than existing, but lower than the proposed project. NO_x and CO emissions will remain about the same as the proposed full expansion.

The third alternative is defined as the Change In Crude Alternative. Total refinery capacity would be expanded to 207,000 B/D by adding 70,000 B/D of light sweet crude capacity. The first phase of expansion facilities would be redesigned to handle light crudes and the second phase facilities would not be required. More process energy derived from fuel oil combustion would be required to replace the energy from lost fuel gas generation capability. The new sulfur recovery plant would not be constructed, resulting in higher SO_2 emissions than with the more efficiently controlled proposed expansion. In general, particulates and SO_2 emissions would increase and NO_x, CO, hydrocarbon, toxic pollutant, and odor emissions would remain about the same relative to the proposed expansion.

The Change Product Mix Alternative would involve eliminating expansion of coking facilities intended to maximize light end product yields. Most of the first phase expansion activities would be completed and most of the second phase activities would be eliminated. Total refinery capacity would be 207,000 B/D. Air pollution emissions would be about the same as under the Change In Crude Alternative.

There is no one alternative that is best in terms of all air quality impacts. The proposed project is estimated to emit the least amount of SO_2, particulates, hydrocarbons, and odors. However, the No Action Alternative should emit the least amount of NO_x, CO, benzene, and toluene.

Table 4-2
AIR EMISSIONS TONS/YEAR

Parameters	Proposed Project	No Action (Existing Conditions)	Limited Expansion	Crude Oil	Product Mix
SO_2	7,234	10,048	9,980	10,640	10,640
Particulates	1,141	1,465	1,470	1,490	1,490
NO_x	3,177	3,090	3,140	3,205	3,205
CO	251	237	251	245	245
HC	2,800	3,344	3,965	2,800	2,800
TOTAL	14,603	18,184	18,806	18,380	18,380

GLT495/10

Table 4-3
PROJECTED WASTEWATER DISCHARGE TONS/YEAR

Parameters	Proposed Expansion	No Action	Limited Expansion	Crude Oil	Product Mix
BOD	198	86	160	198	198
COD	825	484	697	668	825
O&G	27	12	22	27	27
TSS	178	82	150	178	178
NH_3-N	50	101	42	41	50
Phenol	1	1	1	1	1
Sulfite	1	0	1	1	1
Total Cr.	1	1	1	1	1
TOTAL	1,281	767	1,074	1,115	1,281

GLT495/8

Water Quality

Projected wastewater discharges are presented in Table 4-3 for the proposed project and each of the alternatives. Their relative effects are described below.

Increased generation of process wastewater resulting from the Proposed Expansion will necessitate expanding wastewater treatment capacity. The expanded wastewater treatment capacity, like existing capacity, would meet EPA's Best Available Technology standards as well as the MPCA's discharge standards. This increase in total wastewater flow, despite the fact that the concentration of pollutants from an expanded facility would be at or below existing levels, would result in a new increase in the total pollutant load discharged to the Mississippi River. The overall impact, however, on water quality from the proposed expansion would be minimal.

Under the No Action Alternative, treatment wastewater discharge levels will remain at present day levels.

The relationship of total wastewater discharge and refinery size is determined by the EPA "Complexity Factor." This complexity factor is based upon the number of process units required to refine a crude oil. Because Koch refines heavy crude oil, its complexity factor is greater than for a refinery utilizing light crude. Total wastewater discharge is based upon the complexity factor, the allowable rate of waste generation, and the total refining capacity. As seen in Table 4-3, there is a roughly linear increase in the wastewater discharge under the Limited Expansion Alternative approximately proportional to the increase in refining capacity. The complexity factor and allowable pounds/barrel/day will remain constant while the overall refining capacity will increase to 175,000 B/D. Like the proposed expansion, the overall effect of the limited expansion alternative on water quality is not significant.

The Change In Crude Alternative will generate a lower level of wastewater discharge than a 70,000 B/D heavy crude expansion because of the reduction in the refinery's complexity factor. Like the proposed expansion, the projected increase in total discharge will not have a significant impact on water quality.

The impact of the Change in Product Mix Alternative would be the same as the proposed expansion.

Solid and Hazardous Wastes

Solid and hazardous wastes generated from the proposed project and the alternatives are presented in Table 4-4. With the Proposed Expansion, the amount of hazardous waste to be landfarmed will be less than current waste generation, but more than 1982 historical conditions. As shown in Table 4-4, this will amount to a very substantial reduction, if water content is factored into the calculation. The reduction in hazardous waste amounts (excluding water content) will be the result of expanded recycling capacity. Proportionally, greater volumes of hazardous waste from both the existing and expanded facilities (wastes that are now being landfarmed) will be recycled with the expansion of the No. 3 Coker and the addition of the No. 4 Coker. Total hazardous waste generation will also be reduced through enhancements in the slop oil recovery system.

Reduction in the water content of the waste is another aspect of the proposed expansion. With the installation of sludge dewatering equipment, Koch will be able to significantly reduce the amount of water in the waste sent to the landfarm for treatment thus improving landfarm performance.

Similarly, solid wastes from the expanded refinery would be less than current conditions (Table 4-4). With the addition of sludge dewatering equipment, the water volume in the solid wastes would be reduced significantly.

The No Action Alternative poses some operational drawbacks, primarily because of the large volumes of water that must be managed at the landfarm. Continued management of excess surface water by pumping from the landfarm to the wastewater treatment plant is a drawback that affects landfarm performance and should be avoided.

The impact of Limited Expansion on waste reduction is roughly the same as for the proposed expansion. As shown in Table 4-4, the net reduction in the amount of hazardous waste now being landfarmed would be realized from the expansion of the No. 3 Coker and the installation of waste dewatering systems.

The Change in Crude and the Change in Product Mix Alternatives would generate the same waste volumes as the proposed expansion.

Economics

The Proposed Expansion will create new jobs including additional refinery positions, new turnaround jobs, and new construction jobs. Over the next 3 years, Koch expects to create 500 full-time equivalent construction jobs, 150 full-time equivalent turnaround jobs, and 300 additional refinery personnel.

The proposed expansion will positively affect the local employment base because Koch will maintain full-time equivalent construction jobs at the high levels that occurred between 1981 and 1983, and it will create new turn-around jobs and new refinery jobs. The net increase in Koch employment resulting from the proposed expansion will be particularly important

Table 4-4
PROJECTED SOLID AND HAZARDOUS WASTE VOLUMES LANDFARMED
(tons/yr)

	Hazardous Wastes		
	Solids and Oil	Water	Total
Proposed Expansion	3,311	807	4,118
No Action (existing conditions, 1984 estimate)	3,554	5,732	9,286
Limited Expansion	2,791	691	3,482
Change in Crude Supply	3,311	807	4,118
Change Product Mix	3,311	807	4,118
Historical Conditions (conditions from 1982)	2,191	628	2,819

	Solid Wastes		
	Solids and Oil	Water[a]	Total
Proposed Expansion	403	9,432	9,835
No Action (existing conditions, 1984 estimate)	537	14,263	14,800
Limited Expansion	340	7,974	8,314
Change in Crude Supply	403	9,432	9,835
Change Product Mix	403	9,432	9,835
Historcial Condition (conditions from 1982)	750	6,016	6,766

[a]Does not consider dewatering facilities to be installed.

GLT495/11

REFERENCES

in light of the recent announcement by Brockway Glass that it will close its Rosemount facility.

Under the No Action Alternative, Koch would maintain its current complement of refinery jobs (about 600) and turnaround jobs (125). Most of the 500 full-time equivalent constructions jobs would be unneeded. Remaining construction jobs would involve relatively minor projects such as equipment replacement and retrofits, minor process modifications, and other similar projects required to maintain acceptable performance of existing refinery systems.

The net effect of the No Action Alternative would be the unreplaced loss of jobs in the area. This combines the employment impact caused by the closing of Brockway Glass and the lack of replacement jobs offered by the proposed expansion. A loss of employment of this nature could significantly affect local services and retail trade.

Under the Limited Expansion Alternative, Koch would generate about half the number of jobs as it would under the proposed 70,000 barrel per day expansion. This would include about 150 refinery personnel, approximately 250 full-time equivalent construction jobs over 3 years, and about 130 full-time equivalent turnaround jobs in future years.

The additional employment offered by the Limited Expansion Alternative may slightly offset the loss of 450 jobs at Brockway Glass. However, under the Limited Expansion Alternative, the local employment base would realize a net loss of jobs.

The $100 million Change In Crude Alternative would involve fewer additional refinery positions, turnaround jobs, and construction jobs than the proposed expansion. The process of refining a sweet crude oil is less involved and does not require the same type or number of different process units. Therefore, the total additional employment is expected to be 100 to 125 refinery positions, 250 construction jobs, and 110 future turnaround jobs. This alternative will have generally the same level of beneficial impact on local employment as the limited expansion.

The Change In Mix Alternative will involve about $100 million, therefore, its effect on employment would be the same as the Change In Crude Alternative.

GLT499/37

REFERENCES

"Annual Refining Report," <u>Oil and Gas Journal</u>. March 26, 1984.

<u>Annual Report 1983 Energy</u>, Iowa Energy Policy Council.

Barcelona, Michael, James Gibb, and Robin Miller. A Guide to the Selection of Materials for Monitoring Well Construction and Groundwater Supply, U.S. EPA Robert S. Kerr Environmental Research Laboratory and Environmental Monitoring Systems Laboratory. 1983.

Barr Engineering. Ground Monitoring Plan at the Koch Refining Co. Land Farm. 1984.

__________. Unsaturated Zone Monitoring Plan at the Koch Refining Co. Land Farm. 1984.

__________. Vertical Groundwater Hydrology in the Pine Bend Area. 1975.

Benson, D., Minnesota Pollution Control Agency, personal communications, October 8, 1984, and December 19, 1984.

Berglund, B., "Quantitative and Qualitative Analysis of Industrial Odors with Human Observers," Annals of the New York Academy of Sciences, Volume 237. 1974.

Charles-Shannon, V., Minnesota Pollution Control Agency, personal communications, October 15, 1984, November 9, 1984, and December 20, 1984.

City of Inver Grove Heights, <u>Comprehensive Guide Plan</u>. 1980.

City of Rosemount, <u>Comprehensive Guide Plan</u>. Adopted November 17, 1981.

<u>Code of Federal Regulations, Title 40 Protection of Environment (Part 419)</u>, EPA. 47 FR 46434. 1982.

<u>Code of Federal Regulations, Title 40 Protection of Environment (Part 419)</u>, EPA, 49 FR 34152. 1984.

<u>Costs of Reducing Lead in Gasoline</u>, Turner Mason and Associates Consulting Engineers. July 13, 1984.

Crocket, E., American Petroleum Institute, personal communications. October 10, 1984, and November 1984.

Minnesota Code of Agency Rules, Title 6, Environment, Part 4, Pollution Control Agency--Air Pollution Control Regulations and Air Quality Standards.

Minnesota Rules, Water Quality Division, Chapter 7050, Classification and Standards for State Water, Minnesota Pollution Control Agency. 1983.

MPCA Procedures on Setting Water Quality Based Effluent Limitations for Discharge of Toxic Substances, Minnesota Pollution Control Agency (undated).

Penkala, S., "Sensation and Description of Odor," Proceedings: State-of-the-Art of Odor Control Technology Specialty Conference, Western Pennsylvania Section, APCA, March 1974.

Perry, Robert H. and Cecil H. Chilton, editors, Chemical Engineers' Handbook, Fifth Edition, McGraw-Hill Book Company, St. Louis. 1973.

Popadopolos, I., S. and H. Cooper. Drawdown in a Well of Large Diameter, Water Resources Research, Vol 3 No. 1. 1967.

Reeder, Harold, and Ralph Norvitch. Pollution in the Pine Bend Area, Dakota County, Minnesota, USGS Open File Report. 1974.

"Refining the Cruder Crude," Compressed Air Magazine. October 1984.

Report of Physical Development Committee, Referral No. 82-46, Metropolitan Council. August 27, 1982.

Scalf, Marion, James McNabb, William Dunlap, Roger Cosby, John Fryberger. Manual of Ground-Water Quality Sampling Procedures, Robert S. Kerr Environmental Research Laboratory Report. 1981.

Segar, Tom. personal communication. 1984.

Seltz, J., Minnesota Pollution Control Agency, personal communication. October 8, 1984.

Spring Lake Park Reserve Master Plan, Dakota County, Minnesota. August 1983.

State Energy Data Report, Consumption Estimates 1960-1982, Energy Information Administration/Department of Energy. 1984.

Development Document for the Petroleum Refining Point Source Category, U.S. EPA, EPA-440/1-74-014-a. 1974.

Durham, J., Environmental Protection Agency, Emissions and Engineering Section, personal communication. October 12, 1984.

Economic Study: Long Range Planning Program, Dakota County, Minnesota, Report Number 5. December 1978.

Energy Policy and Conservation Biennial Report, Minnesota Department of Energy and Economic Development. 1982.

Energy Policy and Conservation Biennial Report, Draft, Minnesota Department of Energy and Economic Development. 1984.

Fenn, D.G., Hanley, K.J. and T.V. DeGeare. Use of the Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites. U.S. EPA report SW-168. 1975.

Fetter, C.W., Applied Hydrogeology. Charles E. Merrill Publishing Co. Columbus, Ohio. 1980. pp. 406-438.

"Higher Prices, Rising Exports Spark Canada's Heavy Oil Areas," Oil and Gas Journal. October 15, 1984.

ICF, Inc., Liner Location Risk Analysis Model Appendix F: Waste and Consitutent Characteristics, Draft Report to U.S. EPA Office of Solids Waste. 1984.

Johnson, J.W., and L.A. Poth, Regional Impact via Multiplier Analysis of Primary Industries; A Case Study (Homestake Mining Co., Lead, South Dakota), University of South Dakota, Business Research Bureau, Bulletin 109, 1974.

Kellermeyer, D., and S. Ziemer, "Risk Assessment for Trace Element and Organic Emissions," Henningson, Durham & Richardson, Inc., Santa Barbara, California. revised June 4, 1984.

Koch Refinery. RCRA Part B Application. 1984.

McWhorter, D.B., and J.D. Nelson. Unsaturated Flow Beneath Tailings Impoundments, Journal Geotech Eng. Div. ASCE GT 11. 1979. pp. 1317-1334.

Metzler, Suzanne, Nicholas Artz, Jacob Beachly, and Robert Hunt-Franklin Associates, Ltd., and Pedco Environmental, Inc. Waste Oil Storage Final Draft Report. U.S. EPA Office of Solid Waste WH-565. 1984.

U.S. Refining Capacity, National Petroleum Refiners Association. July 13, 1984.

Weast, Robert C., Melvin J. Astle, and William H. Beyer, editors, _CRC Handbook of Chemistry and Physics, 64th Edition_, CRC Press, Inc., Boca Raton, 1983. pp. B-219 and D-151.

Wetherold, R.G., and P.D. Rosebrook, "Assessment of Atmospheric Emissions from Petroleum Refining: Volumes 1 and 2," Radian Corporation, EPA-600/2-80-075. April 1980.

Wisconsin Energy Statistics, Wisconsin Division of State Energy. 1984.

Wurzel, K., G. Avery and D. Brandt, "Technical Methods for Determining if the Emission of a Non-Criteria Pollutant May Cause Injurious Effect to Human Health or Safety," Michigan Department of Natural Resources. January 1984.

Zoning and Subdivision Ordinances, Village of Rosemount, Minnesota.

GLT505/7

State of Minnesota Commissioner of Revenue, 1981 Minnesota Sales and Use Tax, Bulletin No. 27. 1983.

__________. 1981 Property Tax Relief for Minnesotans, Bulletin No. 14. 1983.

State of Minnesota Department of Revenue, 1981 Minnesota State Individual Income Tax, Bulletin No. 58. 1983.

Sunde, G.M., Summary of Activities, Task 1: Existing Data Collection and Evaluation, Pine Bend Sanitary Landfill, Report to Pine Bend, Inc. 1984.

Survey of Current Business, Tax Foundation Inc., State and Local Sales Taxes. Res. Publication No. 23 (new series) 1970.

Turner, B., "Workbook of Atmospheric Dispersion Estimates," Environmental Protection Agency, AP-26. Revised January 1974.

Two Energy Futures: A National Choice for the 80's, American Petroleum Institute. 1982.

U.S. Department of Agriculture, National Atmospheric Deposition Program.

U.S. Environmental Protection Agency. "Volatile Organic Compound (VOC) Species Data Manual," Research Triangle Park, N.C., EPA 450/4-80-015. July 1980.

__________. "Compilation of Air Pollutant Emission Factors," Research Triangle Park, N.C., AP-42.

__________. Hazardous Waste Land Treatment Municipal Environmental Research Laboratory Solid and Hazardous Waste Research Division SW-874. 1983.

__________. Hazardous Waste Management System Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, and EPA Administered Permit Program, Federal Register 47, No. 143, July 26, 1982, S264.253. 1982. p. 32360.

__________. Hazardous Waste Management Systems: Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Federal Register 45, No. 98, May 19, 1980. SS265.71-.73. 1980. pp. 33238-33239.

__________. Unsaturated Zone Monitoring for Hazardous Waste Land Treatment Units, Draft Permit Guidance Manual, Environmental Monitoring Systems Laboratory and Office of Solid Waste and Emergency Response. 1984.

APPENDICES

Appendix A
LIST OF PREPARERS

The following individuals were directly involved in the preparation of the Draft Environmental Impact Statement. Their responsibilities included collecting and analyzing the data, evaluating impacts, identifying mitigations, and writing or reviewing specific sections of the environmental impact statement.

MINNESOTA POLLUTION CONTROL AGENCY

Deborah Pile: Director, Office of Planning and Review

Marlene Voita: Senior Planner, Office of Planning and Review, EIS Project Manager

Louis Chamberlain: Professional Engineer, Division of Air Quality, Air Quality New Source Review

John Seltz: Research Scientist, Division of Air Quality, Air Quality Monitoring/Toxics

Velma Charles-Shannon: Toxicologist, Office of Planning and Review

Gary Kimball: Senior Biologist, Division of Water Quality, Permits

Mike Wiltfang: Hydrologist, Solid and Hazardous Waste Division, RCRA/Regulatory Compliance

Don Kriens: Staff Engineer, Division of Water Quality Enforcement

George Pruchnofski: Professional Engineer, Solid and Hazardous Waste Division, RCRA/Regulatory Compliance

Judy Slater: Engineer, Division of Air Quality

KOCH REFINING COMPANY

Thomas Segar: Koch Refining Company's Project Manager

Jack Kennedy: Air Quality Modeling

CH2M HILL (EIS CONTRACTOR)

Larry Martin: Title: Manager of Planning
DEIS Responsibility: Project Manager
Years Experience: 15

	Education: M.S., Civil Engineering
Pixie Newman:	Title: Hydrogeologist DEIS Responsibility: Hydrogeology/ Groundwater Availability Years Experience: 2 Education: M.S., Civil and Environmental Engineering
Brian Brown:	Title: Mechanical Engineer DEIS Responsibility: Mechanical Engineer/ Noise Years Experience: 7 Education: B.S., Mechanical Engineering

POPE-REID ASSOCIATES (EIS SUBCONTRACTOR)

David Gurney:	Title: Senior Civil Engineer/Project Manager DEIS Responsibility: Solid and Hazardous Wastes Years Experience: 11 Education: B.S., Civil Engineering
William Rohrer:	Title: Senior Environmental Scientist DEIS Responsibility: Hydrogeologist/ Groundwater Quality Years Experience: 13 Education: Ph.D., Geology
Sheila Zimmerer:	Title: Hydrogeologic Research Assistant DEIS Responsibility: Hydrogeologist/ Groundwater Quality Years Experience: 1 Education: M.S., Hydrogeology/Civil Engineering, Program - Present
Richard Lovett:	Title: Senior Policy Analyst DEIS Responsibility: Socioeconomics Years Experience: 10 Education: Ph.D., Economics

INTERPOLL, INC. (ODOR SUBCONTRACTOR)

K.C. Moon: 612/786-6020	Title: Senior Research Engineer DEIS Responsibility: Odor Sampling Years Experience: 3 Education: Ph.D., Mechanical Engineer

GLT499/1

Education: B.A., Urban Planning; Interdisciplinary Engineering Studies

Rick Kester:	Title: Industrial Air Quality Manager DEIS Responsibility: Air Quality Task Leader Years Experience: 16.5 Education: Ph.D., Civil Engineer
Candice Hatch:	Title: Environmental Engineer DEIS Responsibility: Regulatory Compliance/ Toxic Emissions Years Experience: 8 Education: B.S., Environmental Engineer
Doug Ober:	Title: Air Quality Specialist DEIS Responsibility: Air Quality Modeling Years Experience: 7.5 Education: B.S., Applied Science
George Marquardt:	Title: Environmental Scientist DEIS Responsibility: Ambient Air Monitoring Years Experience: 10 Education: B.S., Biology
Don Caniparoli:	Title: Environmental Scientist/ Meteorologist DEIS Responsibility: Meteorologist Years Experience: 8 Education: M.S., Civil Engineering, Air Resources
Dennis Totzke:	Title: Industrial Processes Manager DEIS Responsibility: Wastewater Engineering Task Leader Years Experience: 14 Education: M.S., Civil Engineering
Rich Onderko:	Title: Chemical Process Engineer DEIS Responsibility: Wastewater Engineering/ Water Quality Years Experience: 3 Education: M.S., Civil Engineering
Roberta Perry:	Title: Civil Engineer DEIS Responsibility: Wastewater Engineering/ Regulatory Compliance Years Experience: 2.5 Education: M.S., Civil Engineering
Thomas Ragland:	Title: Transportation Engineer DEIS Responsibility: Transportation Years Experience: 10

Appendix B
MONETARY RATE OF WITHDRAWALS

Calculation of spinoff benefits requires knowledge of the monetary rate of withdrawals from the local economy. This information follows.

Table B-1 examines withdrawals from the Minnesota spending cycle, which fall into three categories:

- Taxes
- Savings
- Out-of-state purchases

Table B-1 shows the effects of various taxes. For most income brackets, federal income taxes dominate, followed by state income taxes, social security payments, sales and use taxes, and property taxes. Savings and out-of-state purchases, however, also represent important withdrawals.

The data in Table B-1 come from several sources. Most of them are compiled from various Minnesota Department of Revenue publications. The necessary sales tax data, however, are unavailable from the state.[1] The U.S. Internal Revenue Service (IRS) has compiled such data for people who itemize their deductions, but these tables omit taxes on automobiles and other durables. Because the IRS statistics are seriously incomplete, as well as potentially distorted, it was necessary to seek data from other sources. Compilations were available for a number of states, and the State of Washington was ultimately chosen, primarily for reasons of data availability but also because of similarities in tax structure.[2]

In Table B-2, these data are presented and adjusted to account for inflationary changes in income brackets and differences in the two states' tax rates.

Data were also unavailable for the pattern of withdrawals from savings and out-of-state expenditures by Minnesota residents. Instead, it was necessary to use data from a 1974 study of the effects of the Homestake Mine on the South Dakota economy. Since both the Homestake Mine and Koch Refining are

---

[1] The Department of Revenue records and publishes many sales tax data, but they are concerned with the effect on businesses, not on consumers.

[2] Source: Tax Foundation, Inc. (see Table B-3).

Table B-1 (page 2 of 2)

[e] Source: Calculation based on 1984 employee contributions rates (6.7 percent on first $37,800). Employer contributions do not figure in employee incomes and are, therefore, omitted.

[f] Source: Interpolation from Table B-2. Values for incomes less than $8,000 are probably lower bounds.

[g] Source: Interpolation from Table B-3. Values for incomes less than $14,000 are probably overstated, and the value for incomes over 100,000 is probably too low.

[h] This figure includes an additional 1.0 percent for state corporation and bank income taxes.

[i] Source: 1984 Survey of Current Business. Wage and salary income was $1,659 billion of a total of $2,744 billion of personal income. All wage and salary income was assumed to be subject to Social Security tax. Employer contributions were included.

[j] Source: Figures compiled in State of Minnesota, Commissioner of Revenue, "1981 Minnesota Sales and Use Tax" Bulletin No. 27 (1983), and "1981 Minnesota State Individual Income Tax," supra, note 1. The 1981 figure was increased by a factor of 1.33 to account for subsequent tax rate increases.

GLT263/94

Table B-1 (page 1 of 2)
WITHDRAWALS FROM THE MINNESOTA SPENDING CYCLE

Income Category[a]	Federal Income Taxes (%)[b]	State Income Taxes (%)[c]	Net Property Taxes (%)[d]	Social Security Payments (%)[e]	Sales and Use Taxes[f]	Total Taxes (%)	Savings and Out of State Purchases (%)[g]	Total Withdrawals (%)
5,000-5,999	4.7	1.0	1.9	6.7	3.4	17.7	12.3	30.0
6,000-6,999	5.6	1.4	1.9	6.7	3.4	19.0	12.3	31.3
7,000-7,999	6.3	1.9	1.9	6.7	3.4	20.2	12.3	32.5
8,000-8,999	7.1	2.3	1.9	6.7	3.4	21.4	12.3	33.7
9,000-9,999	7.8	2.7	1.9	6.7	3.4	22.5	12.3	34.8
10,000-10,999	8.5	3.0	2.0	6.7	3.4	23.6	12.3	35.9
11,000-11,999	9.2	3.4	2.1	6.7	3.3	24.7	12.3	37.0
12,000-12,999	9.7	3.6	2.1	6.7	3.3	25.4	12.3	37.7
13,000-13,999	10.2	3.8	2.1	6.7	3.2	26.0	12.3	38.3
14,000-14,999	10.6	3.9	2.1	6.7	3.2	26.5	12.3	38.8
15,000-19,999	11.5	4.3	2.1	6.7	3.2	27.8	11.5	39.3
20,000-29,999	13.0	4.9	2.6	6.7	3.2	30.4	13.0	43.4
30,000-39,000	15.2	5.4	3.1	6.6	3.2	33.5	16.3	49.8
40,000-49,000	17.7	5.7	3.5	5.2	3.2	35.3	18.6	53.9
50,000-99,999	22.0	6.2	4.1	3.1	3.0	38.4	24.9	63.3
Over 99,999	31.2	6.7	8.2	2.0	2.7	46.7	24.9	71.6
All Taxpayers	14.8	5.8[h]	2.4	8.2[i]	3.2[j]	34.4	13.0	47.4

[a] Brackets are set according to Minnesota gross income, as reported on state tax returns. Income categories 0-4,999 have been omitted from the table. These low income groups are likely to be strongly influenced by retirees, students, and other groups with access to untaxed sources of income. For these groups, Minnesota gross income is a serious under representation of actual spending power, and apparent tax rates are, therefore, distorted. These groups have been included in the "all taxpayer" figures reported at the bottom of the table.

[b] Source: Federal income tax deductions from 1981 Minnesota Individual Tax Returns. Obtained from State of Minnesota, Department of Revenue, "1981 Minnesota State Individual Income Tax," Bulletin No. 58 (1983).

[c] Ibid.

[d] Source: State of Minnesota, Commissioner of Revenue, "1981 Property Tax Relief for Minnesotans," Bulletin No. 14 (1983). Note that the values listed are those applying after the Minnesota "Circuit Breaker," or property tax refund. Raw property tax values are considerably higher and considerably less progressive.

Table B-3
NONTAX WITHDRAWALS

Values for Homestake Mine (1974)[a]		Predicted Values for Koch	
Income Group	Savings Plus[b] Out-of-State Spending	Comparable[c] Income Group	Predicted Nontax Withdrawals
0 - 7,999	12.3	15,800	12.3
8 - 8,999	10.8	17,800	10.8
9 - 9,999	11,3	19,800	11.3
10 - 10,999	11.3	21,800	11.3
11 - 11,999	14.2	23,800	14.2
12 - 12,999	12.2	25,800	12.2
13 - 13,000	11.7	27,700	11.7
14 - 14,999	15.6	29,700	15.6
15 - 19,999	16.9	39,600	16.9
20 - 24,999	20.3	49,500	20.3
25 and over	24.9	50 and over	24.9
Average	13.0		13.0

[a] Source: J.W. Johnson and L.A. Poth, "Regional Impact via Multiplier Analysis of Primary Industries: A Case of Study (Homestake Mining Company, Lead, South Dakota), University of South Dakota, Business Research Bureau, Bulletin No. 109 (1974).

[b] Johnson and Poth calculated multipliers for various income categories. Their data, however, failed to take taxes into account, thereby considering only withdrawals due to savings and out-of-state spending. These values can, therefore, be obtained by using their multiplier values to solve the multiplier equation for w, the rate of withdrawals.

[c] Obtained by using a price index of 198. This was obtained from the Survey of Current Business. The third quarter 1984 price index is 222.31, using 1972 dollars as base. Implicit price deflators for 1974 and 1972 are 163.61 and 145.88, respectively (using 1958 dollars as base). A 1966 to 1984 price index is, therefore:

$$22.31 \times \frac{163.61}{145.88} = 198$$

Table B-2
COMPUTATION OF SALES TAX INCIDENCE

Values for Washington (1966)[a]		Predicted Values for Minnesota (1984)	
Income Group (AGI)	Effective Tax Rate[b]	Comparable Income Group[c]	Effective Tax Rate[d]
$ 3,000	2.2%	$ 8,550	3.4
5,000	2.1	14,250	3.2
7,000	2.1	19.950	3.2
9,000	2.1	25,650	3.2
12,000	2.1	34,200	3.2
17,000	2.1	48,450	3.2
30,000	2.0	85,500	3.0
50,000	1.8	142,500	2.7

[a] Source: Tax Foundation, Inc., "State and Local Sales Taxes," Research Publication No. 23 (New Series) (1970).

[b] Based on a 5 percent tax rate with exemptions for food and drugs. Actual Washington sales tax data were used, then modified to account for the fact that in 1966, Washington had a 4.2 percent tax rate without exemptions for food and drugs.

[c] Calculated using a price index of 385. This was obtained from Survey of Current Business Data. The third quarter 1984 price index is 222.31, using 1972 dollars as base. Implicit price deflators for 1972 and 1966 are 145.88 and 113.90, respectively (using 1958 dollars as base). A 1966 to 1984 price index is, therefore:

$$222.31 \times \frac{145.88}{113.90} = 285$$

[d] Calculated by noting that Minnesota sales and use tax revenues in 1981 averaged 2.4 percent of income. (Source: Table B-1). In 1983, taxes were increased to 6 percent. Since Washington tax revenues averaged 2.1 percent, a conversion factor of:

$$\frac{2.4}{2.1} \times \frac{6}{4.5} = 1.52$$

was used for this analysis.

GLT263/95

new payroll multiplier of 2.06. Each dollar of Koch's payroll, therefore, produces $1 in direct benefits and $1.06 in spinoff benefits.

GLT263/93

heavy industries in regions with few nearby out-of-state shopping districts, their effects should be similar. This analysis will incorporate the South Dakota Homestake data with no adjustments other than for inflation (see Table B-3).

Table B-1 has two parts: income bracketed amounts and statewide averages.

The income bracketed data will be used to determine the spending and tax paying patterns of Koch's labor force, and the statewide averages will be used to calculate subsequent cycles of the multiplier effect.

There is an apparent contradiction in Table B-1 between the income bracketed and average values for Social Security taxes because of a difference in the treatment of employer contributions to Social Security. Since these amounts are not included in Koch's payroll, they need not be considered in determining employee spending patterns. For businesses receiving spinoff income from Koch's employees, however, these withdrawals must be considered. Hence, Table B-2 includes employer contributions in the statewide average, but not the income bracketed withdrawals. Another difference between these two computations is that Koch's payroll is entirely composed of wage income, most of which is subject to Social Security tax. For the economy as a whole, however, only 60 percent of total income is subject to Social Security taxation. Thus, most of Koch's employees face Social Security withdrawals of 6.7 percent, while the economy as a whole experiences Social Security withdrawals of 8.2 percent. A similar apparent inconsistency results from the inclusion of corporate income taxes in the average value for Minnesota income taxes, but not in the income bracketed amounts.

In 1983, Koch's employees earned an average of $32,400 per year. Ignoring the unknown effects of other sources of income, Table B-2 indicates that these employees spend 50.2 percent of their income within the State of Minnesota.

A Koch payroll multiplier can, therefore, be calculated for the Minnesota economy. In the first round, each dollar of the payroll is income to the Koch employees. They spend 50.2 percent of this income locally, giving a second round effect of 50.2 cents. This second round income will be received by people in a large number of income categories. Subsequent rounds of the spending cycle will, therefore, involve the average withdrawal rate of 47.4 percent. These numbers can be combined to produce a single multiplier. A withdrawal rate of 47.4 percent corresponds to a multiplier of 2.11. Since the statewide economy is fueled by only 50.2 percent of Koch's payroll, the spinoff benefit multiplier is 50.2 percent of 2.11, or 1.06. Adding 1.00 to account for the benefits to Koch's own employees produces a

Appendix C
GROUNDWATER QUALITY

SAMPLING PROCEDURES

Before sampling the monitoring wells, approximately five casing volumes of water (or pumping to dryness, if the wells are tight), will be removed with a submersible pump. In general, pumping five casing volumes before sampling will ensure that stagnant water is removed from the well and formation water is being sampled.

The monitoring plan should also specify at what depth in the wells the evacuation pump is to be placed, and the total well depth should be measured before each round of sampling to check for silting.

Periodic testing of field blanks that have been run through the evacuation pump is advisable to check for cross contamination from the collection procedures and for absorption/desorption of organics by the pump material.

After purging with the pump, samples will be collected by dedicated combination stainless steel-Teflon bailers lowered into the wells with a stainless steel wire. The bailers will be cleaned with soap and water, followed by a tap water and distilled water rinse, and oven baking.

Samples will be filtered with a millipore, a septic filtration apparatus, and collected in a plastic or glass bottle, preserved, and placed in an ice chest. Volatile organics will be collected in VOA vials that are carefully and completely filled to avoid aeration of the sample and an airspace. Chain-of-custody forms will be completed after the sampling. Temperature, specific conductance, and pH measurements will be made on a separate sample in the field. Analytical methods to be used to process the samples are the Standard EPA-approved test methods (Table C-1). Sample preparation, analytical methods and sample bottle specifications appear to conform to accepted standards.

SOIL-PORE WATER SAMPLING IN THE UNSATURATED ZONE

According to EPA ISS Standards (U.S. EPA, 1983), soil-pore water sampling is to be conducted about 30 cm (1 foot) below the treatment zone and at a maximum depth of about 1.67 m (66 inches) below the surface. The depth of the treatment zone at the land treatment ranges from 15 to 45 inches based upon operating procedures for the soil auger (used to incorporate the waste into the soils), and visual inspection of the vertical extent of altered soils at the landfarm treatment facility.

TABLE C-1

SAMPLE PRESERVATION AND ANALYTICAL METHODS FOR GROUNDWATER SAMPLES

PARAMETER	CONTAINER	PRESERVATIVE	HOLDING TIME	ANALYTICAL METHOD	DETECTION LIMIT (ug/L)
Arsenic	P,G	HNO_3 to pH<2	6 months	EPA 7060[1]	1
Barium	P,G	HNO_3 to pH<2	6 months	EPA 7080[1]	100
Cadmium	P,G	HNO_3 to pH<2	6 months	EPA 7131[1]	0.1
Chromium	P,G	HNO_3 to pH<2	6 months	EPA 7191[1]	1
Fluoride	P	None Required	28 days	Std Meth 334[2]	100
Lead	P,G	HNO_3 to pH<2	6 months	EPA 7421[1]	1
Mercury	P,G	HNO_3 to pH<2, 0.05% $K_2Cr_2O_7$	6 months	EPA 7470[1]	.2
Nitrate	P,G	Cool, 4°C	48 hours	EPA 353.2[3]	100
Selenium	P,G	HNO_3 to pH<2	6 months	EPA 7740[1]	2
Silver	P,G	HNO_3 to pH<2	6 months	EPA 7761[1]	0.2
Endrin	G, teflon lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)	EPA 8080[1]	0.006
Lindane	G, teflon lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)	EPA 8080[1]	0.004
Methoxychlor	G, teflon lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)	EPA 8080[1]	0.176
Toxaphene	G, teflon lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)	EPA 8080[1]	--
2,4-D	G, teflon lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)	EPA 8150[1]	1
2,4,5-TP Silvex	G, teflon lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)	EPA 8150[1]	0.1
Radium	P,G	HNO_3 to pH<2	6 months	EPA 903.0[3]	1 pCi/L
Gross Alpha	P,G	HNO_3 to pH<2	6 months	EPA 900.0[3]	1 pCi/L
Gross Beta	P,G	HNO_3 to pH<2	6 months	EPA 900.0[3]	1 pCi/L
Coliform Bacteria	P,G	Cool, 4°C	6 hours	Std Meth 806[2]	--
Nickel	P,G	HNO_3 to pH<2	6 months	EPA 7521[1]	1
Zinc	P,G	HNO_3 to pH<2	6 months	EPA 289.1[3]	5
Chloride	P,G	None Required	28 days	EPA 325.2[3]	1000
Iron	P,G	HNO_3 to pH<2	6 months	EPA 236.1[3]	50
Manganese	P,G	HNO_3 to pH<2	6 months	EPA 243.1[3]	40
Phenols	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days	EPA 8040[1]	--
Sodium	P,G	HNO_3 to pH<2	6 months	EPA 273.1[3]	100
Sulfate	P,G	Cool, 4°C	28 days	EPA 375.2[3]	3000
Oil and Grease	G	H_2SO_4 to pH<2 Cool, 4°C	28 days	EPA 413.2[3]	--
pH	P,G	Determine on Site	2 hours	Std Meth 402[2]	--
Specific Conductance	P,G	Cool, 4°C	28 days	EPA 120.1[3]	1 umho/cm
Total Organic Carbon	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days	EPA 415.1[3]	1000
Total Organic Halogen	G, teflon lined cap	Cool, 4°C	7 days	EPA 450.1[4]	1

G = Amber glass, with non-metallic teflon-lined cap.

P = Plastic.

[1] U.S. Environmental Protection Agency. Test Methods for Evaluating Solid Waste. EPA SW-846. July 1982.

[2] APAA AWWA-WPLF. Standard Methods for the Examination of Water and Waste Water, 15th Ed. Amer. Pub. Health Assoc., Washington, D.C.

[3] U.S. Environmental Protection Agency. Methods for Chemical Analysis of Water and Wastes. EPA-60014-79-020. March 1979.

[4] U.S. EPA 60014/84-008 Appendix D.

Constituents, particularly heavy metals, may travel at a small fraction of the velocity of groundwater in which they are carried. Consequently, a distance of 15 to 25 inches may be traversed in a matter of an hour to a day by a leachate front, but the dissolved constituents in it may take much longer, due to sorption or precipitation mechanisms. It is recommended then that the unsaturated zone monitoring (lysimeters and soil-core sampling) be conducted as close to the bottom of the treatment zone (45 inches) as possible, preferably within 1 foot of the bottom. This suggests a maximum depth of placement of monitoring devices at 57 inches.

SOIL-PORE WATER SAMPLING

Soil-pore water will be sampled at the landfarm through the use of a network of 19 vacuum-pressure lysimeters. The lysimeters will be installed at selected locations within the uniform soil areas (Figure C-1). Two lysimeters will be placed in each of the two background monitoring plots. The samples will be collected four times a year, annually, from the lysimeters in the active landfarm area and four times every 5th year, in the background plots. Samples will be taken around the first part of the months of May, June, October, and November within 24 hours of a significant rainfall event. Samples will be collected, composited, stored, and recorded according to EPA guidelines, with the exception of depth of sampling. The concerns noted previously in regard to maintaining a maximum distance of 1 foot between the bottom of the treatment zone and the sampling depth are applicable to the lysimeter installation as well.

Sample parameters and analytical methods are the same as those for quarterly sampling of the groundwater monitoring network.

Recent work conducted by the U.S. EPA Environmental Monitoring Systems Laboratory (EPA, 1984) involves the use of pan lysimeters to augment or replace vacuum lysimeters in sites where macropore flow is of concern. This would involve flow through cracks or large pores in permeable soils (such as might be found at the treatment facility). Because lysimeters have already been installed at the site and agency draft guidance is subject to change, it is not warranted to install pan lysimeters at this time. If, however, problems involving insufficient sample volume develop in the lysimeter network, installing pan lysimeters should be considered.

SOIL CORE SAMPLING

Soil core samples are to be taken at selected points within uniform soil areas. The latter are defined on the basis of predominant soil type and moisture conditions within the land treatment facility. Four uniform areas within the active land treatment area and two background areas from outside the treatment boundary have been identified (Figure C-2). For each soil-core sampling event, samples from below the treatment zone will be obtained and composited to provide a sample coverage of approximately one sample per acre. New locations for the soil area will be selected for each sampling event. Sampling parameters to be analyzed from the soil cores (and soil-pore water lysimeters) are the same as those included in the quarterly sampling program for the groundwater monitoring wells.

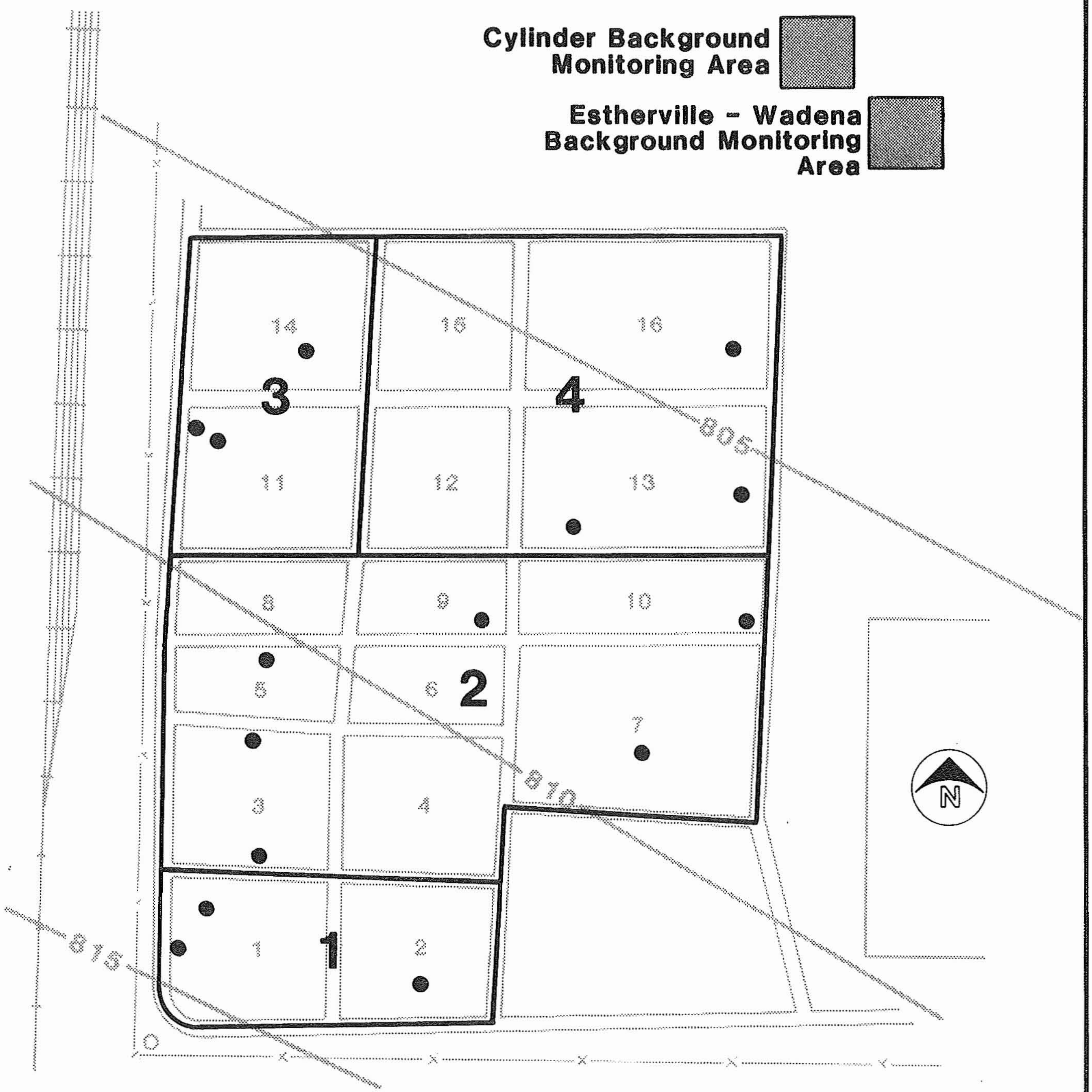
Sample collection will be conducted with a 4-inch, stainless steel barrel auger. Sampling techniques including sample preservation, sample storage, and chain-of-custody procedures appear to adhere to accepted EPA sampling protocol. Cleaning techniques, on the other hand, may not be sufficient to prevent cross contamination between sampling areas. It is recommended that sample collection equipment be cleaned with tap water, checked for adhered macroorganics, solvent rinsed for residual organics if present, double rinsed with deionized distilled water, and finally air dried. These methods are directed toward preventing cross contamination and minimizing the frequency of having to resample apparently contaminated areas.

Extreme care during the excavation and sample removal procedures must be exercised to avoid unintentionally contaminating the subsurface soils and introducing bias to the sampling program. Each sample point must be backfilled with clean soil or bentonite.

METHOD OF CALCULATING LOW AND HIGH INFILTRATION RATES

Water balances for both the preexpansion and postexpansion landfarm were performed using the method outlined in Fenn (1975) (Tables C-2 and C-3). Tables C-4 and C-5 list parameters and assumptions used in the water balances. This yields a liberal estimate of both evaporation and infiltration. For the preexpansion facility, the calculated evaporation is 22.21 inches or 6.8×10^5 gallons/year. Potential evaporation is calculated based on Thornthwaite's method, which expresses evapotranspiration as a function of mean monthly air temperature. The values calculated for evaporation using this method may be somewhat high, as no transpiration occurs on the landfarm (i.e., there is no vegetation). However, this effect may be compensated for by the existence of ponded water on the landfarm during the spring after snowmelt has occurred, and after periods of heavy rainfall. Infiltration for the preexpansion facility was found to be 9.93 inches, or 3.1 million gallons/year.

Postexpansion evaporation calculated using the same method (Fenn, 1975) for the entire landfarm was found to be 18 million



LEGEND

1 PREDOMINANTLY WADENA LOAM

2 PREDOMINANTLY ESTHERVILLE SANDY LOAM (DRY)

3 PREDOMINANTLY ESTHERVILLE SANDY LOAM (WET)

4 PREDOMINANTLY CYLINDER LOAM

● LYSIMETER LOCATION

FIGURE C-1

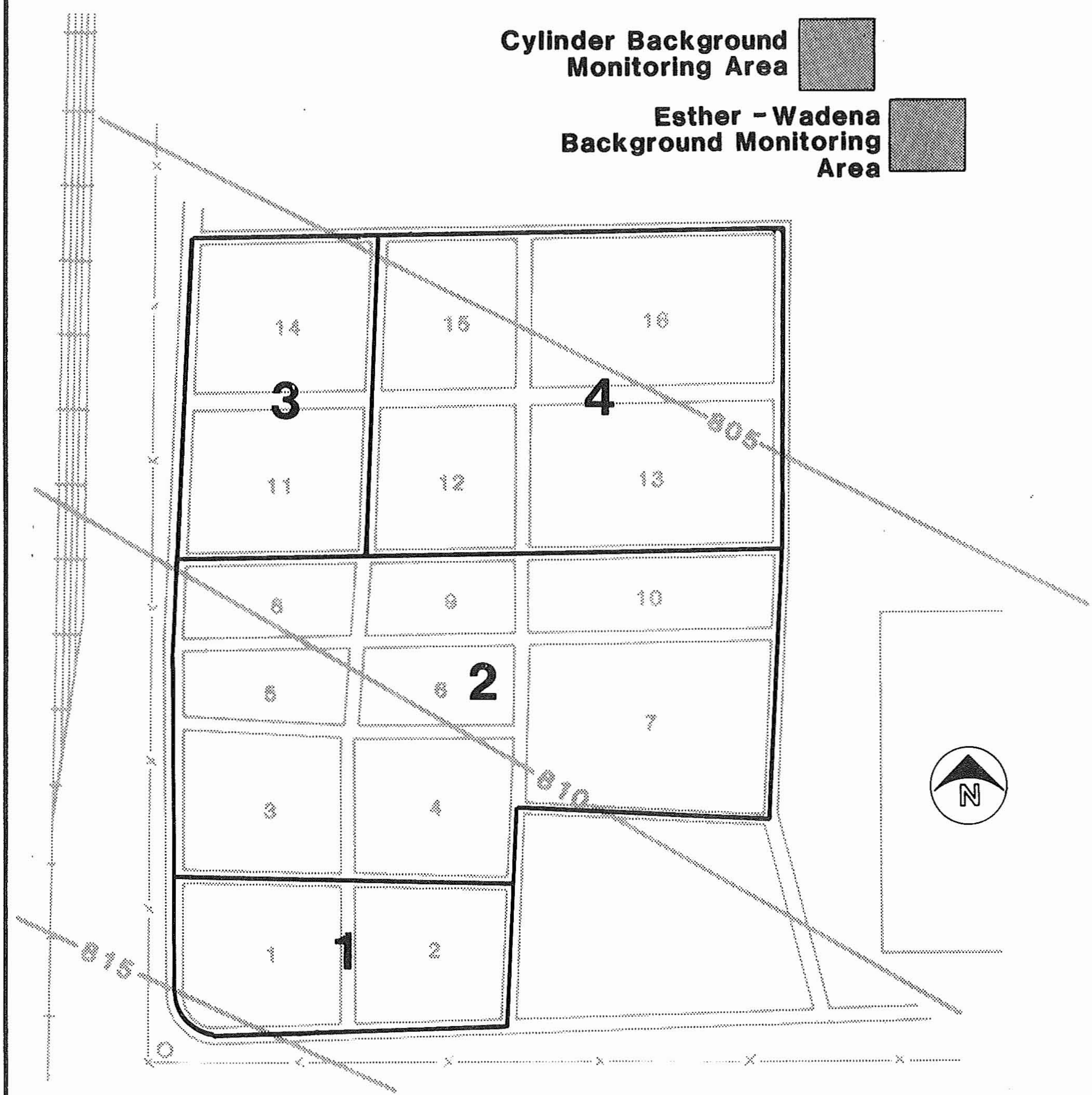
PROPOSED LOCATIONS OF SOIL-PORE WATER SAMPLES IN EACH UNIFORM MONITORING AREA

Table C-2
PREEXPANSION WATER BALANCE

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
PE[a]	-	-	-	1.54	2.83	3.93	4.41	4.25	3.11	2.05	0.15	-	22.27
P	0.73	0.84	1.68	2.04	3.37	3.94	3.69	3.05	2.73	1.78	1.20	0.89	25.94
WW[b]	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	5.76
(DEC-MAR)			6.06										
I	-	-	6.06	2.52	3.85	4.42	4.17	3.53	3.21	2.26	1.68	-	3.170
I-PE	-	-	+6.06	+0.98	+1.02	+0.49	-0.24	-0.72	+0.10	+0.21	+1.53	-	
ΣNEG(I-PE)							-0.24	-0.96					
ST[c]	5.5	5.5	5.5	5.5	5.5	5.5	5.27	4.61	4.71	4.92	5.5	55.5	
ΔST	0	0	0	0	0	0	-0.23	-0.67	+0.10	+0.21	+1.58	0	
AE	-	-	-	1.54	2.83	3.93	4.40	4.20	3.11	2.05	0.15	-	22.21
PERC.	-	-	6.06	0.62	1.02	0.49	0	0	0	0.21	1.53	-	9.93

Note: All values in inches.
[a]Calculated using Thornthwaite's method based on energy available for evaporation.
[b]Water from waste = initial water in waste plus water produced during waste decomposition.
[c]Values obtained from Thornthwaite soil moisture retention table (EPA/530/SW-168).

GLT499/16



LEGEND

1 PREDOMINANTLY WADENA LOAM

2 PREDOMINANTLY ESTHERVILLE SANDY LOAM (DRY)

3 PREDOMINANTLY ESTHERVILLE SANDY LOAM (WET)

4 PREDOMINANTLY CYLINDER LOAM

FIGURE C-2

UNIFORM UNSATURATED ZONE MONITORING AREAS

Table C-4
PARAMETERS IN WATER BALANCE

PE:	Potential Evaporation (Thornthwaite in Dunn and Leopold, 1978)
P:	Precipitation (From Minneapolis-St. Paul 30-Year Averages)
WW:	Water from Waste
I:	Infiltration (P & WW)
NEG(I-PE):	Months of Soil Moisture Depletion
ST:	Soil Moisture Storage (Calculated from Tables in Fenn, 1975)
AE:	Actual Evaporation
PERC:	Percolation

Calculation of Thornthwaite PE

$$E_t = 1.6 \; \frac{10T_a}{I}^{a}$$

where E_t = Evapotranspiration (PE)
T_a = Mean Monthly Air Temperature (°C)
I = Annual Heat Index

I (MPLS/SP) = 35
$a = 0.49 + 0.0179\,(I) + 0.0000771(E^2) + 0.000000675\,(I^3)$
$= 1.05$

GLT499/19

Table C-3
POSTEXPANSION WATER BALANCE

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
PE[a]	-	-	-	1.54	2.83	3.93	4.41	4.25	3.11	2.05	0.15	-	22.27
P	0.73	0.84	1.68	2.04	3.37	3.94	3.69	3.05	2.73	1.78	1.20	0.89	25.94
WW[b]	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	3.36
(DEC-MAR)			5.26										
I	-	-	5.26	2.32	3.65	4.22	3.97	3.33	3.01	2.06	1.48	-	29.3
I-PE	-	-	+5.26	+0.78	+0.82	+0.29	-0.44	-0.92	-0.10	+0.01	+1.33	-	
ΣNEG(I-PE)							-0.44	-1.36	-1.46				
ST[c]	5.5	5.5	5.5	5.5	5.5	5.5	5.1	4.3	4.2	4.21	5.5	5.5	
ΔST	0	0	0	0	0	0	-0.4	-0.8	-0.1	+0.01	+1.29	0	
AE	-	-	-	1.54	2.83	3.93	4.37	4.13	3.11	2.05	0.15	-	2.11
PERC.	-	-	5.26	0.78	0.82	0.29	0	0	0	0	0.04	-	7.19

Note: All values in inches.
[a]Calculated using Thornthwaite's method based on energy available for evaporation.
[b]Water from waste = initial water in waste plus water produced during waste decomposition.
[c]Values obtained from Thornthwaite soil moisture retention table (EPA/530/SW-168).

GLT499/10

gallons. Infiltration over the entire landfarm is estimated to be 5.9 million gallons/year. Evaporation and infiltration combined account for all of the water input to the landfarm (approximately 10 million gallons per year) in the method presented by Fenn (1975). Since these numbers depend on the amount of surface water removed from the landfarm, the assumption of no surface water removal yields liberal (i.e., high) values for both evaporation and infiltration.

It is necessary to make a conservative estimate of infiltration to define a range of possible values for this parameter. A water balance for both the preexpansion and postexpansion landfarm was calculated using Darcy's Law and making some basic assumptions (Tables C-6 through C-9). In this case, surface water removal was calculated, and evaporation was neglected. This procedure yields conservative estimates of infiltration through the landfarm soils.

Total precipitation plus wastewater input for the months of April through November was summed and divided by eight to yield an average value of hydraulic loading per month. This input was assumed to occur in one precipitation event each month. Surface water removal was assumed to take 7 days. A value of 10^{-6} cm/s was assumed for the landfarm soil. This value is based on the presence of standing water on the landfarm observed during a site visit 1 week after a rainfall; if the soil permeability were higher by one order-of-magnitude, all of the standing water would have infiltrated within a week.

Based on the assumptions listed, a flow rate (Q) was calculated for the standard monthly precipitation event. This value, in units of cm/s over a unit surface area, was converted to a flow volume over the 7-day period, and multiplied by eight (the number of precipitation events per year) to obtain a total flow per year (cm^3/year) caused by rainfall and wastewater inputs for the months in which infiltration occurs.

The precipitation and wastewater inputs for December through March were summed and used as the total water input for the spring snowmelt event. Surface water removal after snowmelt was assumed to require 12 days. Values of infiltration volume for the 12-day period following snowmelt were then calculated using Darcy's Law.

In both the infiltration calculations (for rainfall events and for spring snowmelt), the value of hydraulic head was assumed to remain constant. Values of infiltration over the 7- and 12-day periods are low enough to be neglected in considering hydraulic head flux.

Table C-5
ASSUMPTIONS IN WATER BALANCE

1. From Barr Engineering Report for Koch;
   Available water capacity = 0.22 inch/inch
   Available water at field capacity = (0.22) (25) = 5.5 inch where 25 inch = average depth of treatment zone

2. No surface water removal; this assumption will yield liberal values for evaporation and infiltration.

3. No evaporation from December through March.

4. No infiltration from December through February.

5. Runoff from landfarm equals zero.

6. Preexpansion:

   Water in waste is 72% of 9,347 tons/yr = 6,729 tons/yr
   = 1.6 million gallons/yr

   Postexpansion:

   Water in waste is 1.5 (6,730 tons/yr) = 10,100 tons/yr
   = 2.4 million gallons/yr

7. Preexpansion

   $$\text{Water from decomposition} = \frac{9}{13}\ (1{,}435 \text{ tons}) = 993 \text{ tons/yr} = 0.2 \text{ million gallons/yr}$$

   Postexapnsion:

   $$\text{Water from decomposition} = \frac{9}{13}\ (1.5 \times 1{,}435^{*} \text{ tons}) = 1{,}490 \text{ tons/yr} = 0.36 \text{ million gallons/yr}$$

   *Amount of hydrocarbons in waste

   $$CnHn + \frac{5}{4}\, nO_2 \text{ --- } nCO_2 + \frac{n}{2}\, H_2O$$

   $$MW(13n) + (40n) \text{ --- } (44n) + (9n)$$

Table C-7

CALCULATION OF INFILTRATION AND SURFACE WATER REMOVAL FOR PREEXPANSION FACILITY SPRING RUNOFF

Runoff

Total Precipitation (December-March)	=	4.14 inches
Total Wastewater Input (December-March)	=	1.92 inches
Total Spring Runoff (December-March)	=	6.06 inches

Assumptions:

1. No evaportranspiration or infiltration occurs during the months of December-March; total precipitation and wastewater input for the months of December-March effectively loaded to the landfarm during spring snowmelt.

2. Twelve days required for surface water removal after spring snowmelt.

3. Evapotranspiration is negligible over 12-day surface water removal period.

4. Hydraulic head (dh/dl) = 31/25 = 1.24 inches/inch.

5. Permeability of landfarm soils = 10^{-6} cm/s (based on observation of standing water 7 days after precipitation event).

6. Area = 1 cm^2

Darcy's Law:
$$Q = kA(dh/dl)$$
$$= (10^{-6})(1)(1.24)$$
$$= 1.24 \times 10^{-6} \text{ cm/s}$$
= 0.042 inches/day
= 0.504 inches/12 days

Total Infiltration:
$$Q = (1.14 \times 10^{3} \text{ gallons/day/acre}) (12 \text{ days}) (11.51 \text{ acres})$$
$$= 1.58 \times 10^{5} \text{ gallons}$$

Infiltration (12 days): Q = 0.504 inches
Removal: R = 6.06 - 0.504 = 5.56 inches
Total Removal: R = (5.56 inches) (1 ft/12 inches) (43,560 ft^2/acre) (11.51 acres) (7.48 gallons/ft^3)
= 1.7 million gallons

GLT499/18

Table C-6

CALCULATION OF INFILTRATION AND SURFACE WATER REMOVAL FOR PREEXPANSION FACILITY

Facility Refining Capacity: 137,000 barrels crude oil/day
Landfarm Area: 11.51 acres

"Rainfall" Events

Total Precipitation (April-November)	=	21.8 inches
Total Wastewater Input (April-November)	=	3.84 inches
Total Water Input (April-November)	=	25.64 inches

Assumptions:

1. One "rainfall"/month = 3.2 inches/month maximuim hydraulic loading to landfarm.

2. Seven days required for surface water removal.

3. Evapotranspiration is negligible.

4. Hydraulic head (dh/dl) = 28.2/25
   = 1.13 inches/inch

5. Permeability of landfarm soils = 10^{-6} cm/s (based on observation of standing water 7 days after precipitation event).

6. Area = 1 cm^2.

Darcy's Law: Q = kA (dh/dl)
= $(10^{-6})(1)(1.13)$
= 1.13×10^{-6} $cm^3/s/cm^2$
= 0.0384 inches/day
= 0.269 inches/7 days

Over 11.51 acres: Q = (1.04×10^3 gallons/day/acre)(7 days) (11.51 acres)
= 8.4×10^4 gallons/event

Total (April-November): Q = (8.4×10^4 gallons/event) (8 events)
= 6.7×10^5 gallons

Infiltraton (7 days): Q = 0.269 inches
Removal: R = 3.2 - 0.269 = 2.931 inches
Over 11.51 acres: R = (2.931 inches)(1 ft/12 inches)(43,560 ft^2/acre)
(11.51 acres)(7.48 gallons/ft^3)
= 0.9 million gallons/event

Total (April-November): R = (0.9 million gallons/event)(8 events)
= 7.2 million gallons

Table C-9
CALCULATION OF INFILTRATION AND SURFACE WATER REMOVAL FOR
POSTEXPANSION FACILITY SPRING RUNOFF

Runoff

Total Precipitation (December-March)	=	4.14 inches
Total Wastewater Input (December-March)	=	1.12 inches
Total Spring Runoff (December-March)	=	5.26 inches

Assumptions:

1. No evaportranspiration or infiltration occurs during the months of December-March; total precipitation and wastewater input for the months of December-March effectively loaded to the landfarm during spring snowmelt.

2. Twelve days required for surface water removal after spring snowmelt.

3. Evapotranspiration is negligible over 12-day surface water removal period.

4. Hydraulic head (dh/dl) = 30.25/25 = 1.21 inches/inch.

5. Permeability of landfarm soils = 10^{-6} cm/s (based on observation of standing water 7 days after precipitation event).

6. Area = 1 cm^2

Darcy's Law:
$Q = kA(dh/dl)$
$= (10^{-6})(1)(1.21)$
$= 1.21 \times 10^{-6}$ cm/s
= 0.04 inches/day
= 0.49 inches/12 days

Total Infiltration:
Q = $(1.1 \times 10^{3}$ gallons/day/acre) (12 days) (30 acres)
= 3.98×10^{5} gallons

Infiltration (12 days): Q = 0.49 inches
Removal: R = 5.26 - 0.49 = 4.77 inches
Total Removal: R = (4.77 inches) (1 ft/12 inches) (43,560 ft^2/acre) (30 acres) (7.48 gallons/ft^3)
= 3.9 million gallons

GLT499/12

Table C-8

CALCULATION OF INFILTRATION AND SURFACE WATER REMOVAL FOR POSTEXPANSION FACILITY

Facility Refining Capacity: 207,000 barrels crude oil/day
Landfarm Area: 30 acres

"Rainfall" Events

Total Precipitation (April-November)	=	21.8 inches
Total Wastewater Input (April-November)	=	2.24 inches
Total Water Input (April-November)	=	24.04 inches

Assumptions:

1. One "rainfall"/month = 3.0 inches/month maximuim hydraulic loading to landfarm.

2. Seven days required for surface water removal.

3. Evapotranspiration is negligible.

4. Hydraulic head (dh/dl) = 28/25
   = 1.12 inches/inch

5. Permeability of landfarm soils = 10^{-6} cm/s (based on observation of standing water 7 days after precipitation event).

6. Area = 1 cm^2.

Darcy's Law: Q = kA(dh/dl)
= $(10^{-6})(1)(1.21)$
= 1.21×10^{-6} cm/s
= 0.04 inches/day
= 0.49 inches/12 days

Over 30 acres: Q = (1.03×10^3 gallons/day/acre) (7 days) (30 acres)
= 2.16×10^5 gallons/event

Total (April-November): Q = (2.15×10^5 gallons/event) (8 events)
= 1.7 million gallons

Infiltration (7 days): Q = 0.267 inches
Removal: R = 3.0 - 0.267 = 2.733 inches
Total Removal: R = (2.733 inches) (1 ft/12 inches) (43,560 ft^2/acre) (30 acres) (7.48 gallons/ft^3)
= 2.2 million gallons

Total (April-November) Q = (2.2 million gallons/event) (8 events)
= 17.6 million gallons

GLT499/13

Table C-10

RESULTS OF WATER BALANCE CALCULATIONS PERFORMED USING DARCY'S LAW

	Q/Rainfall Event	R/Rainfall Event	Q/8 Events	R/8 Events	Q/Spring Snowmelt	R/Spring Snowmelt	Total Q/yr	Total R/yr
Preexpansion								
(11.51 acres + current refining capacity)	8.4×10^4	9.0×10^5	6.7×10^5	7.2×10^6	1.84×10^6	1.7×10^6	8.5×10^5	8.9×10^6
Postexpansion								
(30 acres + 50% increase in refining capacity)	2.2×10^5	2.2×10^6	1.7×10^6	17.6×10^6	4×10^5	3.9×10^6	2.1×10^6	2.12×10^7

GLT499/15

Surface water removal was calculated by taking the difference between total input for each event and total infiltration for the same event.

Table C-10 summarizes the results of the water balance calculations performed using Darcy's Law. For the preexpansion facility, total infiltration is approximately 8.5×10^5 gallons/year, and roughly 8.9 million gallons must be mechanically removed. Infiltration and removal for the postexpansion facility were found to be approximately 2.1 million gallons and 21.2 millions gallons, respectively.

For the postexpansion facility, infiltration values range from 2.1 to 5.9 million gallons/year. Surface water removal was estimated to be 21.2 million gallons/year using Darcy's Law in the second water balance. This value indicates that surface water removal will be a significant problem if the facility is expanded to the proposed 207,000 barrel per day capacity.

UNSATURATED ZONE TRANSPORT

The transport of leachate and constituents in the unsaturated zone is controlled by:

- o Infiltration rates
- o Subsurface permeability
- o Capillary forces
- o Adsorption/desorption/precipitation reactions

Several expressions have been developed for estimating the transport time from a leakage source to the groundwater table (zone of saturation). One developed by McWhorter and Nelson (1979) is based upon Darcy's law and the continuity equation. The expression for the travel time, t, of a leachate front traversing a vertical distance, L, is given by the following:

$$t = [(L/q)(n-\Theta_i)(q/K)]^{\lambda/(2 + 3\lambda)}\cdot$$

where q is the infiltration rate, n the porosity, Θ_i the initial moisture content, K is the hydraulic conductivity, and λ the pore size index. The latter varies from 1 to 4 in natural soils.

Because of a variety of phenomena, including adsorption and desorption, cation exchange, and precipitation reactions, the transport of dissolved constituents may be slowed relative to the velocity of the leachate front. This apparent transport velocity is retardation factor, equal to the average linear velocity divided by the (vi), (Rd), and varies according to soil type, pH and Eh conditions, and constituent type. Values for retardation factors vary from less than one (for certain organic constituents) to several thousands in the case of of a single invariant value for Rd (even for a single site) is questionable, we have chosen to present a range of Rd values. This may make interpretation of the results of the constituent transport calculations more difficult, but we do not believe that selection of a single Rd value (and prediction of a single travel time) is justified. Estimates of travel time using a value of 32, however, are probably more realistic than those based on a lower Rd value.

The results of the unsaturated zone transport time calculations are shown in Table C-11.

Table C-11
COMPUTED LEACHATE TRAVEL TIME IN UNSATURATED ZONE
(Time in Years)

	No Expansion of Capacity		Expansion of Capacity	
	Low Rd	High Rd	Low Rd	High Rd
12-inch depth	0.08	1.87	0.08	1.9
24-inch depth	0.2	3.74	0.2	3.9
50 feet	4.1	93.44	4.3	97.3

Travel times are given for depths corresponding to: (1) the recommended depth for lysimeters below the treatment zone, (2) the acutal depth of lysimeters, and (3) the groundwater table. These values are again valid for a single constituent; different constituents would travel faster or slower, depending upon their Rd values.

The computed travel times compare favorably with soil core data that show elevated levels of inorganics in the lower portions of the treatment zone after a period of operation of only a few years. Data from the Koch RCRA Part B application show that cadmium concentrations at a 50-inch depth in cell 12 exceed background levels by a factor of 3 (5.1 ppm/ 1.6 ppm) after a period of operation of 2.75 years. According to the leachate travel time calculations, cadmium should reach this depth between 0.03 and 0.8 years, which is well within the observed travel time. The data also suggest that travel times to the groundwater table may vary from 4.1 to 93.44 years for the no-expansion alternative. Values for the expansion alternative are essentially the same as for no-expansion since although waste loading increases, treatment area increases as well.

According to the data in Table C-11, the difference between travel times to the 12-inch and 24-inch depths ranges from less than 1 year to 2 years, assuming small and large Rd values, respectively. This may support the contention that the deeper lysimeter installations will not adversely increase the time to detection of leached constituents. However, this does not remove the concern about the possible incorporation of waste below the 1.5m maximum depth, as addressed in the RCRA regulations.

GLT499/2