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FINAL

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 2

2A

MINNESOTA PORTION OF A CRUDE OIL PIPELINE FROM WOOD RIVER, ILLINOIS TO PINE BEND, MINNESOTA

3 1978?

4 228 p. in v.p. maps

PERPARED BY

[DE]PARTMENT OF NATURAL RESOURCES

[environ]mental impact statement
[...] resources

Appendix I

Northern Pipeline
Addendum to EIS
Need Issues

Prepared by Minnesota Energy Agency

I. BACKGROUND

A. Large Energy Facilities and Public Processes. For most construction projects in Minnesota involving large energy facilities, the state has two processes that allow public participation in decision-making: the Minnesota Energy Agency's (MEA) Certificate of Need and the Environmental Quality Board's (EQB) Environmental Impact Statement (EIS) process. If the facility is a large electric generating plant or a large high-voltage transmission line, the public may participate in a third process--siting the facility.

No large energy facility may be built in Minnesota unless the director of the MEA certifies the need for it. Authority to grant or deny a certificate of need is given exclusively to the MEA director by the state legislature. His decision is binding on other state agencies and units of local government, except that the EQB may act within 10 days of the decision to suspend and subsequently modify it.

Projects that have a major effect on the environment require EQB acceptance of an EIS. The EIS describes the proposed action--its purpose, scope, alternatives, irreversible impacts on the environment--as well as mitigating actions and irretrievable commitment of resources. It assists decision-makers in reaching environmentally acceptable decisions.

After acquiring a certificate of need, and after obtaining EQB acceptance of an EIS, a company proposing to build a large crude oil pipeline in Minnesota still must acquire other state and local permits.

As a large energy facility with a major effect on the environment, the Northern crude oil pipeline required a certificate of need and an EIS. The EIS process is also taking on some routing aspects in the absence of a state siting procedure for pipelines.

Minnesota Pipe Line Company (MPL) applied for a certificate of need on November 29, 1976. Almost concurrently, it retained a consultant to gather information for the EIS. Public hearings on the need application were held in St. Paul and in five outstate locations in February and March, 1977.

On July 13, 1977, the MEA director granted a certificate of need to MPL. State law requires the need decision to be made within six months of the application, but Koch Refining Co., MPL's parent company, agreed to waive the time limitation when it moved to substitute another subsidiary as the applicant.

Although the MEA director has determined that the Northern pipeline is needed, those who perceive themselves to be adversely affected by that decision continue to question the need for the pipeline. This portion of the EIS addresses the need questions raised by the public during the EIS process.

B. <u>Forecasting</u>. It is important to realize that public debate on the need question is largely due to different perceptions of the future, and that such perceptions depend upon the assumptions one makes.

Mathematical or statistical methods are inappropriate for projecting Minnesota's petroleum supply. At best, one can only make an educated guess. Like forecasts based on mathematical formulas, educated guesses could miss wide just because of one unforeseen event.

Who in the oil-importing countries could have predicted the successful four-fold increase in the price of crude imposed by the oil cartel in 1973? Previous attempts of the oil-exporting countries to form a cartel to keep oil prices artificially high had failed. Even if a cartel were formed, so it was thought, the very low production cost of less than $.20 per barrel in some countries would drive them to aim for a larger market share by individually shaving prices. In doing so, they would weaken the cartel. This theory has not been completely discredited, but in more current plans a continuing high price for oil (indeed, for all types of energy) is assumed.

This digression into history serves two purposes. First, it illustrates pitfalls forecasters must keep in mind. Second, it shows that predicting the trend is difficult. Predicting the timing of an event or what will happen at a given time is even more difficult. For instance, one may be reasonably certain that oil prices will rise. Having chosen a year, say 1985, one can only estimate what the oil price might be by then.

Having picked a price, say $20 a barrel, one can only estimate when that level might be reached.

C. Opposing Positions. Those who assert that the pipeline is not needed have a scenario for Minnesota's petroleum future different from the MEA's. Reroute Crude Oil (RCO) Association is the most articulate exponent of this view. Having made a thorough analysis of the state's petroleum situation, it presents well-reasoned arguments on why the Northern pipeline is not needed. The arguments advanced by some who are not formally affiliated with RCO are similar to RCO's. Hence, it is sufficient to compare the RCO and the MEA positions.

Part of the divergence between the two positions can be explained by the different orientations of the two groups. The MEA is charged with planning Minnesota's energy future. One of MEA's greatest risks lies in being too optimistic on future supply, since it would have to direct state efforts to cope with energy shortages should they develop. RCO is more interested in avoiding the disruption of agricultural land in southern Minnesota and Iowa. Thus it believes that existing facilities can guarantee an adequate petroleum supply, until the alternative that it prefers is built.

D. Certificate of Need Criteria. In determining that the Northern pipeline is needed, the MEA director used four criteria in evaluating the record of the certificate of need proceeding on the Northern pipeline. RCO applied the same criteria to the public record and arrived at a different conclusion. However, it has not shown that grounds exist for reopening the certificate of need process.

A certificate of need is granted if the MEA director determines that: (1) there is a demand for the energy that would be supplied by the facility, (2) meeting the demand is in the public interest, (3) there is no better means of meeting the demand, and (4) the proposed facility is legal and consistent with public policy.

In the next sections the MEA and RCO positions on need will be examined in detail. Here their major arguments on the four criteria will be summarized.

	MEA	RCO
1. Energy demand	Because of the rapid curtailment of crude oil imports from Canada, the Minnesota area refineries must have access to other sources.	Significant amounts of heavy crude will continue to be available from Canada beyond 1981.
2. Public interest	If the C/N would have been denied, Minnesota-area refineries would probably shut down, or less desirable modes	The project has adverse impacts on neighboring states and refineries in Wrenshall and

	of transporting crude oil would have to be built. Because the C/N was granted, landowners may experience adverse impacts. The MEA has mitigated those impacts by attaching conditions to the C/N to protect landowner rights.	Superior.
3. Alternatives	Other fuel types or electricity either are not available or else are less preferable. Other modes of transportation are not as cheap, efficient, safe, or suitable. The Williams system imposes more stringent viscosity and sulfur limitations. Other pipelines could not be	The proposed Northern Tier pipeline is a viable and preferable alternative.

	built in time to bridge the crude supply gap.	
4. Public policy	There has been no evidence that the Northern pipeline would violate government regulations or public policy.	The federal government is neutral on Northern, which relies on foreign oil, hence it contravenes President Carter's policy of reducing oil imports.

II. SCENARIOS

A. Minnesota's Current Petroleum Situation. The MEA assessment of the state's petroleum supply and demand during the first quarter of 1978 is shown in Table 1. If the contribution of Amoco to both supply and demand is removed, the state's reliance on inventory during the winter becomes evident. The adjustment, shown in the second column, is necessary because throughput on the proprietary Amoco product pipelines into Minnesota is limited by capacity restrictions on the Amoco refineries at Mandan, North Dakota and Whiting, Indiana. MEA weekly surveys of primary inventories of middle distillates during the winter months confirm the supply drawdown (Fig. 1).

The adjustment to the state's petroleum supply and demand due to practical limitations on the Amoco pipelines into

Minnesota also shows that one must be careful in using pipeline capacity and throughput interchangeably. Yet this is the trap that RCO falls into when it decries the tripling of crude capacity to the Twin Cities refineries. Its concern is based on the following numbers:

Minnesota Pipe Line	175,000 B/D
Williams	130,000
Northern	246,700
	551,700

Interestingly enough, RCO's own projection (Table 3) shows less than 87,000 B/D through Minnesota pipeline in 1980, since some of the supplies through Portal pipeline and from Canada presumably would go to the refineries in Wrenshall and Superior (Fig. 2).

The MEA's assessment of the Minnesota-area refineries' crude supply for the first quarter of 1978 is shown in Table 2A. The average throughput on the Williams line for the quarter as a whole was higher than 51,000 barrels per day (B/D), but the increase on the Williams line was offset by the decrease in Ashland's reliance on inventory.

The four refineries ran at a combined level of approximately 226,000 B/D, rather than the lower figure used by RCO. RCO's 198,000 B/D run level (see #42-12) corresponds to the crude requirements of the three refineries in Minnesota. Of the 226,000 B/D crude supply, approximately 144,000 B/D came from Canada, which must eventually be replaced by other sources.

The area refineries' crude supply for the second quarter of 1978 are shown on Tables 2B and 2C. There is some surplus supply capacity to the Twin Cities refineries during the second quarter, which could be used to build inventory for succeeding periods. The two tables, along with Table 2A, show Murphy's increased inability to obtain adequate crude supplies. Of the four refineries, its run levels as a fraction of capacity have been the lowest.

Allowing for energy conservation, declining natural gas supplies, and economic growth, the MEA estimates that petroleum demand will grow at 3.6 percent a year. If the area refineries obtain sufficient supplies to enable them to maintain their market shares, combined refinery runs will be 242,000 B/D in 1980.

RCO does not question the MEA estimate of total petroleum demand in the state but it does not agree with MEA estimates of the contributions from each source to the area refineries' crude supply.

B. Short-term Crude Supply Projections. The MEA does not believe that Minnesota would have a pipeline connection to the west coast before early 1983. By then, Canada's crude oil exports to the Minnesota area refineries are expected to be negligible. This is very likely, with the recent passage of Canadian legislation to give tax credits to companies that upgrade heavy Canadian crude so it can be used in Canadian refineries.

MEA and RCO estimates of the refineries' 1980 winter crude supply without the Northern pipeline are shown on Table 3. The MEA estimate shows a deficit of up to 86,425 B/D. RCO estimates a supply that is higher than current run levels, but less than the current total capacity of the area refineries.

In projecting crude oil supplies, RCO makes several assumptions. First, it assumes that the 18-inch Williams pipeline will have a capacity of 130,000 B/D devoted to crude transportation. Crude throughput on the Williams line is limited at present by the amount of breakout tankage at the connection between the Williams and Osage pipelines. (Crudes that differ greatly in properties such as sulfur content and viscosity must be segregated from each other.) Williams and Osage are scheduled for expansion late in 1978, increasing the crude oil capacity of the Williams system to 120,000 B/D. A further increase in the capacity of Williams would require the construction of a pipeline from Mason City, Iowa back to Oklahoma and more pumping stations on the 18-inch Williams pipeline from Mason City to the Twin Cities. This expansion is unlikely, unless no other pipeline is built to serve the Minnesota-area refineries.

Second, RCO incorporated several assumptions originally made by the Federal Energy Administration (FEA) when it estimated the refineries' 1980 allocation. The FEA assumed that: (1) Koch and Ashland would be made priority II refiners, (2) the FEA would allocate light and heavy crude separately but would make no further changes in the allocation procedures, and (3) the level of allocable exports would be 89,000 B/D, of which 88,000 B/D would be heavy crude.

The FEA estimate must be revised in light of recent developments. Koch and Ashland are still priority I refiners, but the Department of Energy (DOE) has put them on notice that their priority status may be downgraded. The basis for the proposed DOE action is the availability of barging to the two refineries during the shipping season. DOE assumes that barging and the Williams pipeline would supply Koch and Ashland with at least 75 percent of their base period runs to stills, disqualifying them from priority I status. It should be noted that Koch's and Ashland's base period volumes have already been reduced by 30,000 B/D each, to take into account shipments through the Williams pipeline. However, the DOE thus far has not used the adjusted base period volumes in allocating heavy crude.

Koch's and Ashland's 1980 Canadian allocation may also be less than the FEA projection due to a change in the allocation procedure. Beginning with the second quarter of 1978, first priority refiners may nominate for heavy crude for exchange purposes. Koch's particular advantage of having a large base period volume for heavy crude would be nullified if it loses its priority I status and remaining priority I refiners maximize their heavy crude nominations.

The third FEA assumption should be updated in light of a September 1978 report by the Canadian National Energy Board (NEB) on Canada's oil supply and demand. A conclusion of this report is that light crude oil exports to the U.S. can be maintained at a level of 55,000 B/D until 1981, but it must be completely curtailed thereafter. The volume of heavy crude licensed for export would continue to be restricted to those quantities remaining after meeting the needs of Canadian refineries.

Finally, RCO assumes that either Canadian exchanges will continue at current levels, or the combination of barging and inventory drawdowns during the winter will make up for any deficiencies in the crude supply.

The Canadian government has agreed to exchanges as a stop-gap measure. Because it is faced with growing reliance on oil imports, Canada intends to eventually cut off oil supplies to the U.S. Thus it is prudent to not count on exchanges as part of the supply picture in the years to come.

Storage facilities are expensive, more so if they are used on a seasonal basis. But even if heavy reliance on inventory were economic, barges would still be subject to more uncertainties than pipelines. Lack of dredging, lock delays, low water, and fleeting space all interact to reduce the predictability of barge shipments. Thus, more storage capacity would be required to even out barge shipments compared to pipeline shipments.

The MEA projection in Table 3 assumes: (1) no Northern pipeline, (2) priority II designations for Koch and Ashland, (3) Canadian allocations of 55,000 B/D light and 100,000 B/D heavy, (4) no changes in DOE's allocation process for heavy crude, and (5) maximized nominations for heavy crude by remaining priority I refiners.

Although the Osage and Williams systems are scheduled for expansion to give the new Williams line a 120,000 B/D capacity, MEA believes that scheduling and other operational problems would limit the reliable throughput to 114,000 B/D.

The MEA projection of crude supplies labelled Portal includes Montana crude shipped to Minnesota by way of Canada, through the Lakehead-Interprovincial pipeline. The figure of 20,000 B/D is an upper limit. As the Canadian curtailment grows, so will pressure on DOE to relax its regulations and permit crude produced in Montana and North Dakota to remain in those states regardless of historical use patterns.

The third MEA assumption makes no allowance for heavy crude oil upgrading plants in Canada. This is a reasonable assumption, since the NEB report estimates that no upgrading plant would come on stream until 1983. Once an upgrading plant comes on stream, exports of heavy Canadian crude to the U.S. could cease.

Unlike RCO, MEA incorporates the current DOE process of allocating heavy crude. The priority I refiners in Montana and in Wrenshall-Superior have a combined base period volume of 101,617 B/D. At an export level of 155,000 B/D and assuming that these refiners maximize their nominations for heavy crude, Conoco in Wrenshall would get rights to 20,651 B/D while Murphy in Superior would get 25,625 B/D. Both refiners would have to arrange trades to exchange for light crude any heavy crude they would not be able to process. Koch and Ashland would be allocated heavy crude at levels of 25,908 and 999 B/D, respectively.

Refineries normally use crude storage to segregate different types of crude, and to provide a buffer in case supplying pipelines are shut down or shipments do not arrive as scheduled. The combination of barging during the shipping season and reliance on crude inventory during winter is an expensive proposition. Refineries use this only to augment supplies, not as a major supply mechanism. In the MEA column in Table 3, the amount available for inventory drawdown is zero, because any crude barged during the 1979 shipping season would have been needed then also to keep Koch and Ashland running at their desired run levels.

The MEA would like to see the Northern pipeline in service by the 1979-80 winter season to avert market disruption in the regions served by the area refineries. This conclusion is based on estimates of the reliable volumes that existing supply systems can deliver, shown on Table 3.

At present, Minnesota-area refineries supply approximately 60 percent of the state's petroleum requirements; product pipelines supply the other 40 percent. If the area refineries are forced to cut back, product pipelines could pick up some of the difference. For instance, the new Williams line would have a capacity of 170,000 B/D instead of 120,000 B/D if it were used exclusively for refined products. However, viscous products such as asphalt and #6 fuel oil cannot be transported by pipelines. Moreover, refining capacity in the U.S. is already inadequate to meet domestic demand so reducing crude oil supplies to Minnesota area refineries would mean that more refined products would have to be imported. Thus, it is in Minnesota's interest and that of the nation to keep the refineries running close to capacity.

If the Northern pipeline were built, the area refineries would adjust their use of the different supply routes depending upon economic factors. Among the more important are supply availability, type of crude the refinery can process, and cost of the crude as delivered to the refinery.

The Northern pipeline is designed primarily to transport heavy and high-sulfur crude, such as Venezuelan and Alaskan crude. Not all refineries can process this type of crude, which makes it relatively cheaper and more available.

The new 18-inch diameter Williams pipeline is currently used to transport light, low-sulfur crude. As part of a product pipeline system, it can easily be converted to product service. Williams currently batches crude with refined products.

Assuming that supplies from the south are available, and considering the varying ability of the area refineries to process heavy and high sulfur crude, the area refineries could be adequately supplied by Northern and Williams. Crude pipeline capacity from the Twin Cities to Wrenshall-Superior would have to be increased to keep the northern refineries running at current levels. This can be accomplished either by reversing the Minnesota pipeline, or by expanding the Williams pipeline between the Twin Cities and Duluth-Superior (Fig. 2).

C. Long-term Crude Supply Projections. A pipeline connection to the west coast could be part of the MEA's long-term crude supply scenario. The Northern pipeline would not make Minnesota's west coast connection unnecessary, but would reduce the urgency of having it. The MEA's second biennial report does not show crude supplies from the Pacific northwest, because of the uncertainties surrounding the three competing proposals.

The northern tier states, the federal government, and petroleum companies have wrestled with the Canadian crude curtailment problem for several years. Neither declining Canadian supplies nor the growing surplus of Alaskan crude on the west coast has caused opinion to embrace a single solution. Hopefully, a solution will emerge soon.

There is no question that the northern tier states and the midwest region of the U.S. require additional crude transportation capacity. Ideally, the additional capacity would provide economic access to Alaskan and foreign crude oil, because Alaskan crude alone will not permit a drastic cut in U.S. dependence on foreign oil. To reduce the volume of imported oil from the current level of more than 8 million barrels daily would require additional domestic supplies or curtailment of demand.

There are three competing proposals to supply crude to the refineries in the northern tier and midwest U.S. regions. All face problems, some of which may be insurmountable.

The original proposal for reversal of the Transmountain pipeline between the refineries on the Puget Sound and Edmonton, Alberta was effectively killed by the passage of the 1977 amendment to the Marine Mammals Protection Act. The amendment prohibits the construction of oil ports on inner Puget Sound. A modified Transmountain proposal is a possibility if the port were built at or west of Port Angeles, but even this would have problems. Public opposition to oil ports in Washington is strong, particularly if the port serves only as a transshipment facility. Washington state refiners most likely would not support a proposal that requires the closing of their own docks.

The Kitimat proposal which the MEA supported for a long time was dealt a fatal blow by the Canadian government. In February 1978, Prime Minister Trudeau's cabinet declared a policy of not supporting the construction of an oil port on the Canadian west coast. Kitimat Pipe Line Ltd. still has a pipeline application pending before the Canadian National Energy Board (CNEB), but even if the CNEB approved the pipeline project, the federal government's opposition to an oil port on Canada's west coast still would have to be overcome.

At this point, the Northern Tier proposal is the only viable alternative for moving Alaskan crude east from the northern Pacific coast. Project proponents have applied for a certificate of need but the MEA director's decision is still pending, so it would be inappropriate to state conclusions about the merits of the proposal. However, it is not out of line to point out the problems facing the project. Northern Tier does not have the announced support of the refiners it would serve, and its low tariff estimates depend upon a large volume being delivered to Clearbrook, Minnesota. Moreover, it requires an oil port in Washington state, and oil port siting is a controversial issue there.

The timetable for the Northern Tier pipeline or the other two alternatives (should they be resurrected), provides further support for the MEA position. The Northern project, 500 miles long, traversing three states, crossing no reservation land, and originating with a barge terminal in Illinois at least has two major permits after two years. in the permitting process. The Northern Tier proponents initiated permit applications in Washington state in July 1976 and have just started some more of the many required processes. To this day they do not have a major permit. Northern Tier would be 1500 miles long, traverse five states, cross federal and reservation land, and originate with a deepwater port in Washington state.

Given these problems, RCO is still convinced that the Northern Tier proposal offers the best solution to Minnesota's crude oil supply problems. Its uncritical acceptance of claims made by Northern Tier proponents contrasts sharply with its microscopic examination of Northern's analysis.

III. OTHER NEED ISSUES

A. Economic Considerations. The government's regulatory posture for regulated monopolies is different than for competitive companies, a difference that is not ignored by the MEA in its certificate of need proceedings. All four criteria used in determining whether to grant the certificate include economic factors. However, the level of detail appropriate for MEA consideration in determining the need for the Northern pipeline is less than that required by the company management or federal agencies. The former has the burden of having an economically viable project, a viability which the MEA cannot guarantee.

The federal government, with more authority over petroleum companies and more resources than the MEA, has studied the northern tier petroleum situation for several years. It started with the Bonner-Moore study, completed in 1976, which concluded that market forces should determine the solution to the crude supply problem because no alternative was clearly superior on economic and environmental grounds. Several other studies or hearings on the short-term petroleum situation have been conducted by the Federal Energy Administration or its successor, the DOE. These resulted in changes to the Canadian allocation program, but no concerted effort to push for the construction of new pipelines.

The DOE has just started a major study to evaluate the transportation alternatives that could resolve the problems of surplus Alaskan crude on the west coast and the projected supply deficiencies in northern tier states. The Williams, Northern, and Northern Tier pipelines are included in the alternatives to be evaluated. The study is being conducted in anticipation of the enactment of a bill introduced by Montana Senator Melcher, which would mandate a federal decision on the selection of a transportation alternative, cutting red tape and expediting its construction. The study would be wide-ranging in scope, considering alternatives from existing pipelines to iceberg tankers and addressing a range of factors such as economic, environmental, and international relations.

B. Federal Government Position. The DOE deputy secretary, John O'Leary, submitted a Statement of Policy to the Illinois and Iowa Commerce Commission in connection with Northern's application for a certificate of public convenience and necessity. His statement expressed support for any economic and environmentally sound pipeline proposal that would serve the northern tier states. It also expressed an opinion that the Northern pipeline appears to be a reasonable proposal. However, while recognizing the two problems mentioned in the preceding paragraph, the DOE does not want to impose a solution that ignores state and environmental interests.

C. Foreign Oil. For security of supply and balance of payments reasons, the MEA agrees with RCO that the Minnesota-area refineries should turn to Alaskan crude as their Canadian supplies are curtailed. However, Alaskan crude is by no means cheaper than foreign crude of similar quality and it cannot completely replace the Canadian crude now used by the area refineries. They would have to continue to rely on imports for their light crude requirements, unless DOE rules which limit old domestic crude to historic users are changed. In addition, security of supply requires a variety of sources.

The problem of burgeoning oil imports is a national one. As a state with no oil resources of its own, Minnesota must pursue aggressive conservation and alternative energy development policies although such policies by themselves will not eliminate the need for oil imports for the foreseeable future.

D. Line Size and Energy Efficiency. Ideally, market forces allocate scarce resources in the most efficient manner such that the best line size in terms of energy efficiency for a given volume or throughput would also entail the least cost over the life of the project. The problem of finding the best line size gets more complicated if the volume does not remain constant during the project's life.

The MEA considered the appropriateness of the proposed line size. Since the best line size depends upon the estimated volumes, the MEA concentrated on determining the new or additional capacity that can be justified by the record. The MEA director determined that up to 210,000 B/D had been justified. For this volume, and depending upon other parameters, the best line size is 24 inches. This size allows for future expansion of up more than 200,000 B/D. However, the Kitimat option was still alive when the certificate of need for the Northern project was granted. Consequently, the 20-

inch alternative was kept open in case required volumes remained in the 100,000 B/D range for several years.

E. Alternative Energy Sources. The MEA is committed to the development of alternative energy sources. However, they will not make a significant contribution until the 1990's. Until then the state will have to rely upon traditional fuels for most of its energy.

IV. CONCLUSION

It is apparent that the difference in the MEA and RCO positions arises from their different perspectives and assumptions. RCO assumes that significant amounts of heavy crude will be available from Canada well beyond 1981, and that this buys enough time for the state to pursue the Northern Tier solution. However, Minnesota would face a significant risk if it relied on a convergence of favorable circumstances, most of which are beyond the control of the state. The MEA has chosen to pursue a reasonable solution which minimizes the risk of major petroleum shortages in Minnesota and neighboring states.

TABLE 1

MINNESOTA PETROLEUM PRODUCT SUPPLY/DEMAND

1977-78 Winter
(Barrels Per Day)

	WITH AMOCO	WITHOUT AMOCO
Crude runs-Actual January 1978	226,000	226,000
Refinery yield	214,700	214,700
Pipeline inshipment	220,000	130,000
Williams - 130,000*		
Amoco - 90,000		
Net truck & railroad	20,000	20,000
TOTAL SUPPLY	454,700	364,700
Murphy production consumed in Wisconsin and Upper Michigan	20,000	20,000
Exports by pipeline to Wisconsin, North & South Dakota	77,000	77,000
Net Supply	357,700	267,700
Average Demand	305,000	253,600
Winter Demand	349,200	290,400
Winter Shortfall	0	22,700**

*Hydraulic capacity is rated at 150,000 BPD, but during the winter the line must be derated because of the high proportion of distillate shipped.

**Reliance on inventory = 22,700 BPD X 70 days
= 1,589,000 BBL

TABLE 2 A

ESTIMATES OF MINNESOTA-AREA REFINERIES' CRUDE SUPPLY

FIRST QUARTER, 1978
BPD

	ASHLAND	CONOCO WRENSHALL	MURPHY	KOCH	TOTAL
Desired runs	62,000	20,000	34,000-35,000	110,000-115,000	
Inventory drawdown	7,000	Some	2,000	some	9,000+
Canadian light	6,000	2,000	9,000	-	17,000
Canadian heavy	13,000	0	8,000	74,000	95,000
Exchange	3,000	18,000	11,000	-	32,000
Domestic	7,000	0	4,500	10,000	21,500
New Williams Line - Actual Experience	26,000	0[2]	0	25,000	51,000
Actual Runs Jan. 1978	62,000[1]	20,000	34,000-35,000	110,000-115,000	225,500+

The data indicates the continued heavy reliance on Canadian crude oil, especially at the Koch Refinery. More pipeline capacity is needed to replace the quantities currently received from Canada.

[1]This level reached by heavy drawdown of crude inventory.

[2]None in January; approximately 2,300 in February.

TABLE 2B

MINNESOTA-AREA REFINERIES' CRUDE SUPPLY
APRIL 1978
B/D

	ASHLAND[1]	CONOCO WRENSHALL	MURPHY	KOCH[1]	TOTAL
Desired runs	62,000	21,000	34,000-35,000	110,000-115,000	
Canadian light	5,215	5,500[2]	8,046	-	18,761
Canadian heavy	34,000	-	8,000	74,383	116,383
Exchange	3,000	15,500	11,000	-	29,500
Domestic	6,500	-	3,500-4,000	10,498	20,498-20,998
New Williams line	33,000	-	-	20,051	53,051
Actual runs	62,000	21,000	30,000-31,000	98,786[3]	211,000+

1 The heavy Canadian allocation includes volumes for Ashland's Priority II refineries in Ohio and New York.

2 Allocation is 8,204 B/D, which includes condensate. Some of Conoco's allocation for its Wrenshall refinery is used in its Billings refinery.

3 Low run level due to refinery "turnaround."

TABLE 2C

MINNESOTA-AREA REFINERIES' CRUDE SUPPLY
MAY-JUNE 1978
B/D

	ASHLAND	CONOCO WRENSHALL	MURPHY	KOCH	TOTAL
Desired runs	62,000	21,000	34,000-35,000	110,000-115,000	
Barging	15,000	-	-	25,000-30,000[2]	
Canadian light	5,215	5,500[1]	8,046	-	
Canadian heavy	19,460	-	8,000	71,097	
Exchange	3,000	15,500	11,000	-	29,500
Domestic	6,500	-	3,500-4,000	9,500-10,000	19,500-20,500
New Williams line	33,000	-	-	33,000[3]	66,000
Estimated runs	62,000	21,000	30,000-31,000	113,000	226,000+
Surplus (Deficit) compared with desired run level	20,175	0	(2,954-4,454)	23,597-34,097	

1 Allocation is 9,323 B/D, which includes condensate. Some of Conoco's allocation for its Wrenshall refinery is used in its Billings refinery.

2 Koch estimates 22,000 B/D on the average.

3 Koch estimates 8,500 B/D in May, 0 in June.

TABLE 3

PROJECTION OF CRUDE OIL SUPPLY
TO MINNESOTA AREA REFINERIES
FIRST QUARTER 1980
B/D

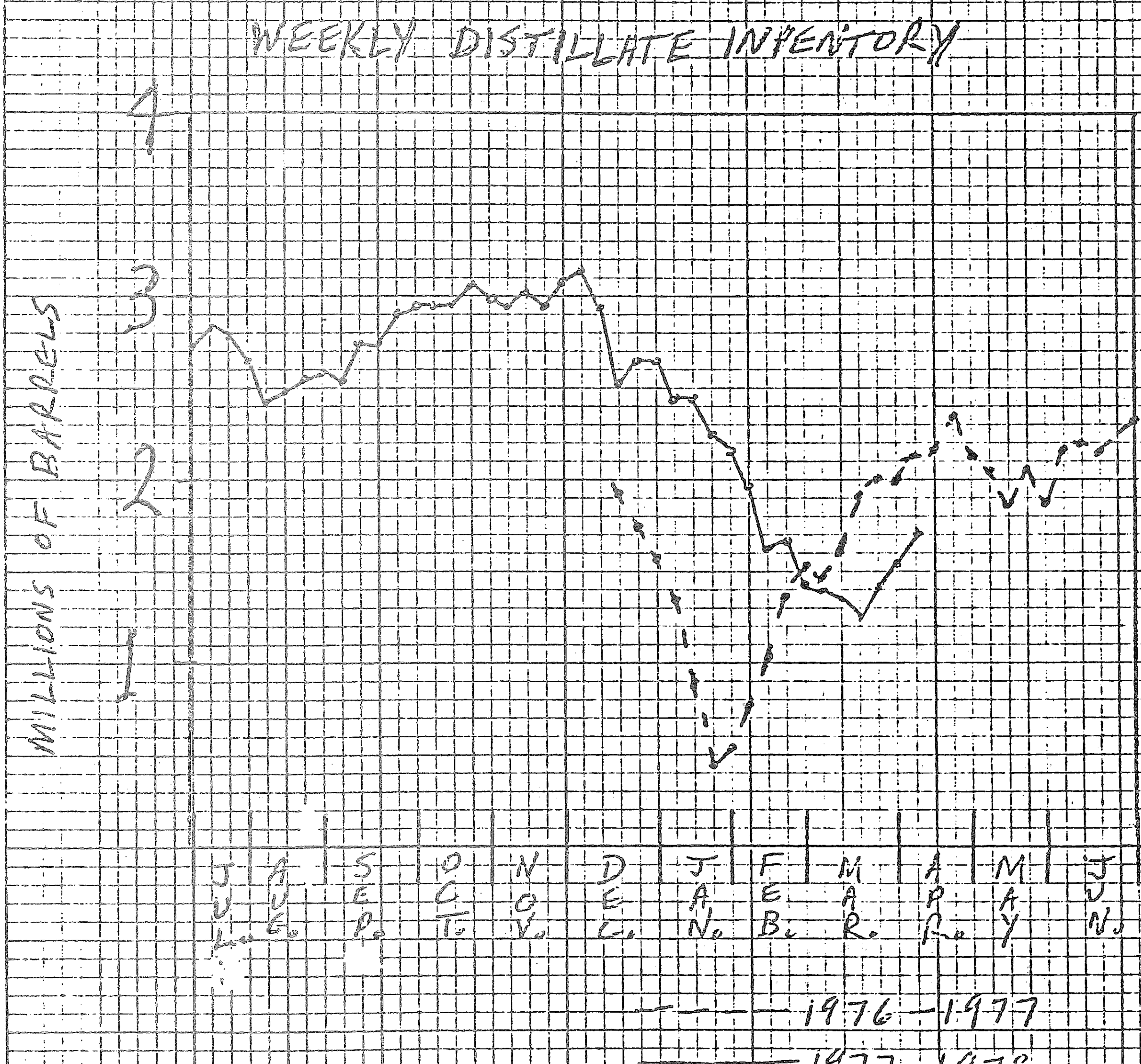
Without Northern Pipeline

	MEA	RCO
Williams Pipeline	114,000	130,000
Portal Pipeline	20,000	22,000
Canadian Allocation	72,283	65,000*
Barging	0	0
Inventory Drawdown	0	7,000**
Canadian Exchanges	0	20,000
	206,283	244,000
Refinery Requirements	233,000 to 257,000	
Refinery Shortfall	(up to 50,717)	(up to 13,000)

* Based on an early FEA estimate; RCO figure adjusted to include FEA estimate of Murphy's Canadian allocation.

** The tight supply picture and the heavy reliance on barging will make it very difficult to build inventory, so reliance on inventory is risky.

FIG. 1



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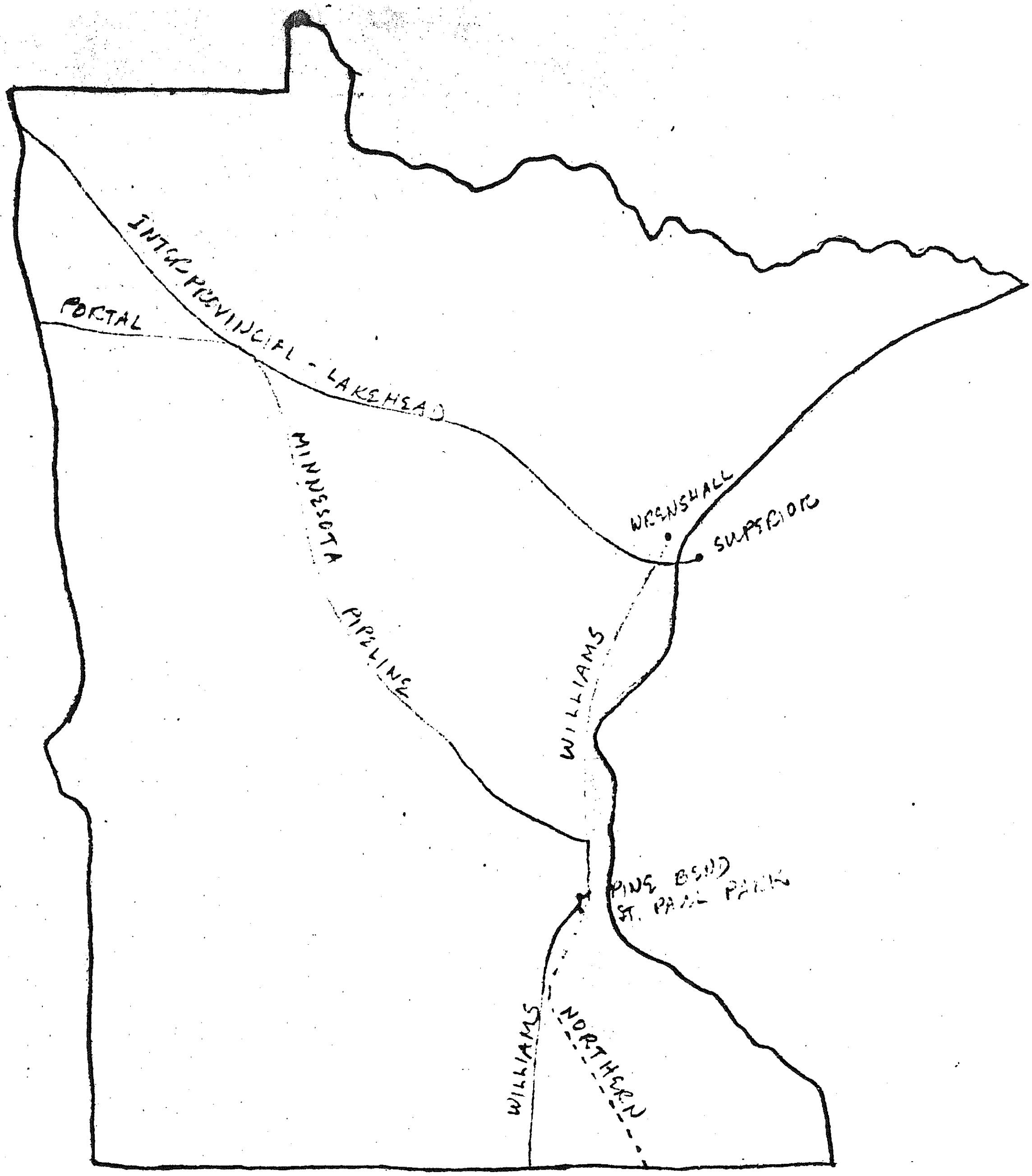


FIG. 2
CRUDE OIL PIPELINES
MINNESOTA

Appendix II

Spill/Pollution Concerns

Based on Information Provided by
by Minnesota Pollution Control Agency

I. Surface Water Pollution From a Spill

A. Surface water pollution in general - risk, clean-up

The risk of a pipeline spill polluting surface water is estimated at 10%. Historically (1967 to the present), nine out of the 81 pipeline spills in Minnesota have polluted surface waters (three marches, two lakes, two streams, two flowing drainage ditches). Of the nine spills, four were ruptures, two were operator errors, two were line hits (machinery) and one was corrosion. Due to improved materials and operating and construction practices, spills from ruptures and corrosion should be less than in the past.

Clean-up of spills to the ground or to surface waters should be in accordance with procedures written by the Company, reviewed, and found acceptable to the Minnesota Pollution Control Agency. The Company has spill procedures which were written in 1974. They should be revised to include methods of cleaning up spills which enter ground water. Contractor lists, names of people to contact and lists of clean-up materials should be updated if necessary.

Extra safeguards are utilized at stream crossings and special safeguards are being required for the section of line which traverses bedrock less than 50 feet deep east of Northfield and near LeRoy.

B. There have been two documented cases of oil entering tile lines in Minnesota since 1967. One occurred during hydrostatic tests with an estimated 500 gallons of fuel oil and 4,500 gallons of water being discharged. The oil and water drained to a road ditch approximately ½ mile from the line rupture. The other occurred when a line rupture discharged 42,000 gallons of fuel oil. The oil drained into a county drainage ditch where it was contained and recovered. The ditch was several hundred feet from the rupture. Effects of crude oil on a tile system are unknown. The viscosity of the oil may plug or clog the tile rendering it nearly useless. Cleaning of such a damaged tile line would probably be impossible. A new tile line would have to be installed and the old one removed.

II. Ground Water Contamination

A. General concern over pollution of aquifers, wells, water supply; especially shallow wells.

The Minnesota Pollution Control Agency's first concern with the Northern pipeline route was with potential pollution of bedrock aquifers, especially the carbonate formations in southeastern Minnesota. Establishment of the requirement to maintain a minimum of 50 feet of till between the line and bedrock was for the purpose of minimizing the probability of damage to the bedrock aquifers if a spill occurred. The original route traversed areas where the water table is nothing less than a carbonate aquifer. Also, the carbonate bedrock is at or near the surface where numerous sinkholes and other karst features exist imparting a high degree of secondary permeability to the surface sediments. Thus we have no surficial aquifer (either in till or perched above an aquiclude) which would hold spilled oil above the deeper bedrock aquifers along with easy access to many localized pathways through the bedrock. These were totally unacceptable conditions and the line was subsequently re-routed.

Another concern is with shallow aquifers and local water supplies (including private wells). Establishing a route over glacial till will minimize potential pollution of shallow aquifers. Till is not generally a good source of water. Shallow aquifers used as water supplies are, almost exclusively, located in well sorted medium to coarse grained deposits (valley train sand and gravel, glacial outwash sand and gravel, and other deposits of fluvial, glaciofluvial or other alluvial origin). There will no doubt be some areas where the pipeline will cross such aquifers. It is virtually impossible to route a pipeline to avoid all of them. Maintaining the 50' till thickness will minimize the hazard. Also, maintaining a minimum distance between the line and wells in use will lessen the chance of contamination of wells.

B. The probability of well contamination or of pollution of an aquifer or water supply is impossible to determine. There are no known cases of well contamination in Minnesota as a result of a pipeline leak or spill. Ground water has been polluted by pipeline spills on numerous occasions but in only one case has it been determined that a private well was threatened. The well has not been contaminate and a study of the problem by a private consultant projects that the well will not be contaminated.

C. The risks of polluting aquifers, water supplies and wells has been taken under consideration and the following mitigating measures have been taken:

1) Re-route pipeline ;
2) Require 50 feet of till between the pipeline and bedrock;
3) Require special construction and operation practices for the area east of Northfield and near LeRoy;
4) Recommend location and proper abandonment of abandon wells;
5) Recommend maintenance of minimum distance between line and active wells;
6) Recommend revision and updating of spill procedures.

D. Are the geologic conditions on the present route still a problem, especially sinkholes?

The geologic conditions on this route present problems in two areas. The first area is in southeastern Mower County near LeRoy where an apparent error was made in determining the 50 foot till thickness isopach. A recent inspection of the area by the Minnesota Geological Survey has resulted in a new map of till thickness.

The second area of concern is east of Northfield where the line traverses eight miles of bedrock which is covered by less than 50 feet of till. This route was selected over a western route for several reasons, including population density, topography, location of "sensitive" areas and cost.

Due to the lack of sufficient till, construction and operation of the line through these areas must meet special requirements. 100 percent x-raying of girth welds, thicker walled pipe, and additional valves will be required in these areas. These requirements were included to minimize the potential for pollution of ground water.

E. What clean-up procedures would be employed in the event of ground water pollution?

Several methods may be used to clean up oil which has reached ground water. They include the following:

1) Modified "Venturi vacuum" system;
2) Pumping directly from the oil lense;
3) Dewatering;
4) Trench or sump excavation along with pumping and sorbing of oil;
5) Addition of nutrients, oxygen and possibly special strains of oil "eating" bacteria.

The vacuum system is limited to recovery at depths of approximately 30 feet or less. Also, very viscous crude oil may not be totally recoverable by this method, although a certain fraction (the more volatile parts) probably would be. The heaviest oil recovered by this method to date was a blend of number 2 and number 5 fuel oils.

Dewatering and pumping directly from the oil lense would probably be used in combination. Wells installed through the oil lense could be used to dewater the aquifer locally. This would create a "sink" below the oil lense which would act like a bowl, retaining the oil in one area. Pumping could then proceed directly from the thickened oil lense.

Where ground water is especially shallow (15 feet or less) sumps and ditches could be excavated to below the water table. Impermeable curtains would be placed on the downstream side of the trenches and recovery would be done by pumping and with sorbent materials.

When physical recovery cannot be done and when there are still residual oils in the ground water a means of accelerating breakdown of the oils is by injection of nutrients, oxygen and sometimes bacteria. This will increase the rate of oxidation of the oil, a natural but slow process.

F. The Cannon River does not present any greater potential for ground water pollution than other stream crossings. The segments of line east of Northfield and near LeRoy does cross bedrock which is less than the desired 50 feet deep. Thus, the potential for bedrock aquifer pollution is greater across these areas then elsewhere. For this reason special safeguards during construction and operation of the line are called for.

G. Abandoned wells do present a potential ground water pollution problem. Spilled oil flowing over land could enter abandoned wells, flow down the well and enter an aquifer. The route should be carefully inspected to determine locations of abandoned wells within one mile on each side of the line. All improperly abandoned wells should be abandoned in accordance with the Water Well Regulations.

III. Miscellaneous

A. Hydrostatic test water, whether used prior to operating the line or after the line has been operating, cannot be discharged in Minnesota without an National Pollutant Discharge Elimination System Permit. This requires prior application and public notice. These permits set forth discharge standards which must be adhered to by the permittee.

B. All pipeline spills contaminate soils. Most refined products are fairly easily removed from soils in a short period of time (mostly by aeration). Due to its wide range of constituent compounds crude oil may remain in soils for a long period of time (several years).

C. Clean-up procedures, other than those used for surface or ground water clean-up, include physical removal of as much liquid product as possible by pumping and sorbing, burning residuals on the ground, aeration of soils by plowing and discing and adding nutrients to accelerate biodegradation of the oil.

Polluted debris generally includes trees and brush plus sorbents. These can usually be burned. Other solid debris such as oil coated boulders or very coarse gravel can usually be removed to an acceptable site for storage or final disposal. This may include idle sections of permitted sanitary landfills.

D. Removal of contaminated soils is not recommended unless they threaten to contaminate surface or ground water. Restoration of contaminated soils in place is the best solution to this problem. Such restoration is accomplished by a systematic and regular program of nutrient application, plowing and discing. Even though this approach substantially speeds up soil restoration it is not an immediate process. Several years are required before the soil approaches its former condition. In the interim, reduced crop production and initial damages have historically been compensated for by the pipeline company.

E. Spilled oil which contaminates crop land will initially destroy that land for agricultural purposes. Reduced crop production will continue for several years even if the soil restoration program has been started. Eventually, when the soil has been restored to its former condition, the affected soil will probably be somewhat more fertile for a while than it was before the spill. This is due to the formation of organic soil acids and other biodegradation end products.

The effect of oil on livestock is more difficult to assess. Pasturage and land used to grow feed grain and hay could be impacted. Potential effects on livestock due to ingestion of contaminated water are not known. It is doubtful that livestock will drink highly contaminated water. The long term effect of ingesting water with low level oil contamination (1 part per million or less) is not known due to a lack of research.

(DNR Note: Dr. Dennis Cortese stated at the public meeting in Dodge Center that 1 part per million of phenols in water would be toxic; however, water would become unpalatable at levels much lower than that.)

Appendix III

OIL SPILL HISTORY 1972-77

Minnesota has about 3000 miles of liquid petroleum pipelines (see attached map) about 1400 miles of which transport primarily crude oil. The remainder of the lines carry a variety of refined petroleum products. There are two pipelines in southeastern Minnesota, the Williams line to Rochester and the Amaco line through Fillmore, Olmsted and Goodhue Counties.

In the six year period from 1972 to 1977, inclusive, a total of 72 pipeline spills were reported to the Pollution Control Agency, an average of 12 per year. More than 3.5 million gallons of petroleum were involved. (see Table 1).

TABLE 1
PIPELINE SPILLS IN MINNESOTA
(SOURCE: PCA)

	number of spills	gallons spilled	causes*			
			a	b	c	d
1972	12	897,310	3	3	2	4
1973	14	1,962,584	3	3	5	3
1974	13	294,858	2		10	1
1975	13	134,411	3	5	4	1
1976	6	50,254	1	3	2	
1977	14	237,968	1	3	10	
(72-77)	72	3,577,385	13 (18%)	17 (24%)	33 (46%)	9 (12%)

* a hit by machinery
b corrosion
c equipment failure (seam ruptures, seals, gaskets, valves)
d operator error (over pressures, overfills, other damage)

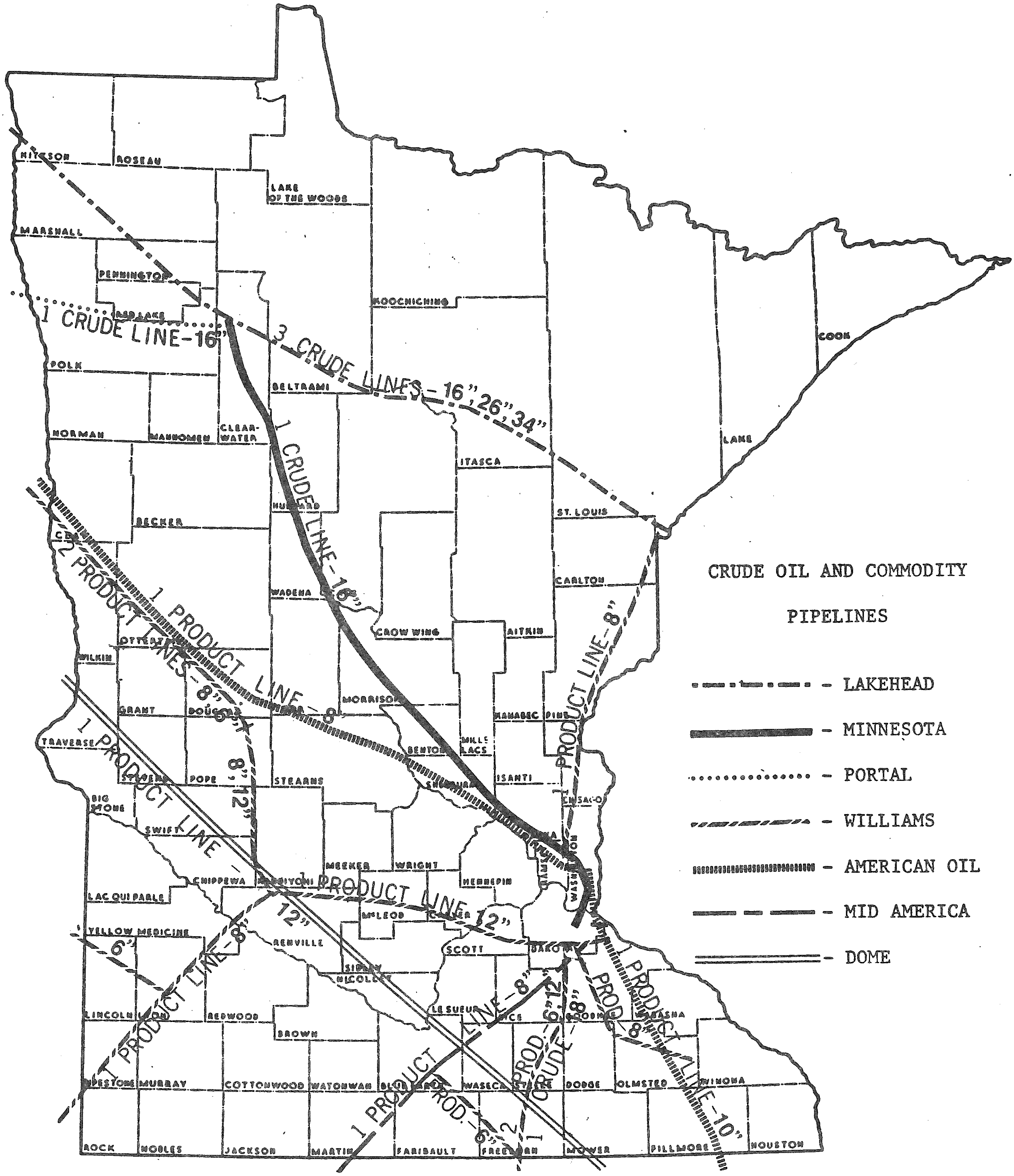
Relating the number of spills to the total pipeline milage in the state, there were 2.4 spills per 100 miles of pipeline in the six year period, or an average of 0.4 spills per 100 miles per year.

Of 54 spills where the quantity of product lost was reported, almost one-third (31.5%) involved 10 barrels (420 gallons) or less of product, and a total of 63% involved 100 barrels (4200 gallons) or less. Three very large spills involved more than 10,000 barrels. (see Table 2).

TABLE 2
NUMBER OF SPILLS BY QUANTITY OF PRODUCT LOST

Size of Spill	Number of Spills	%	Cumulative %
10 barrels or less	17	31.5	31.5
11 to 100 barrels	17	31.5	63.0
101 to 1000 barrels	10	18.5	81.5
1001 to 10,000 barrels	7	13.0	94.5
Over 10,000 barrels	3	5.5	100.0
Total	54	100.0	

It should be noted that most of the existing pipelines were installed in the 1950's or before, and there are important differences in construction standards between the pipes installed 20 to 30 years ago or more and the ones installed today. These changes include better quality pipe, improved methods of manufacturing (mainly the method of factory welding), Federal requirements regarding cathodic protection, leak monitoring systems, and the type of crude being transported. Thus, for the newer lines being installed spills caused by corrosion and equipment failure should be significantly reduced, even after the pipes are in for many years. Spills caused by operator error and by second parties hitting the pipe may increase because of the increase in pipeline mileage


CRUDE OIL AND COMMODITY
PIPELINES
- LAKEHEAD
- MINNESOTA
- PORTAL
- WILLIAMS
- AMERICAN OIL
- MID AMERICA
- DOME
1 CRUDE LINE-16"
3 CRUDE LINES-16",26",34"
1 CRUDE LINE-16"
1 PRODUCT LINE-8"
2 PRODUCT LINES-8",6"
8",12"
1 PRODUCT LINE
1 PRODUCT LINE 12"
12"
1 PRODUCT LINE-8"
6"
1 PRODUCT LINE-8"
1 PRODUCT LINE
PROD.-6",12"
CRUDE-8"
PROD-8"
PRODUCT LINE-10"
KITTSON
ROSEAU
LAKE OF THE WOODS
MARSHALL
PENNINGTON
RED LAKE
KOOCHICHING
COOK
POLK
BELTRAMI
NORMAN
MAHNOMEN
CLEARWATER
LAKE
ITASCA
HUBBARD
BECKER
ST. LOUIS
CARLTON
WADENA
CROW WING
AITKIN
OTTERTAIL
WILKIN
GRANT
DOUGLAS
MORRISON
KANABEC
PINE
TRAVERSE
BENTON
MILLE LACS
STEVENS
POPE
STEARNS
ISANTI
BIG STONE
CHISAGO
SWIFT
MEEKER
WRIGHT
CHIPPEWA
KANDIYOHI
HENNEPIN
LAC QUI PARLE
McLEOD
WASHINGTON
YELLOW MEDICINE
RENVILLE
SCOTT
DAKOTA
SIBLEY
NICOLLET
LE SUEUR
GOODHUE
WABASHA
LINCOLN
REDWOOD
BROWN
PIPESTONE
MURRAY
COTTONWOOD
WATONWAN
WASECA
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON

Appendix IV

RAILROAD ALTERNATIVE

Part 1, Discussion and Comparisons

The Draft Addendum briefly discussed the alternative of routing the proposed pipeline along the Chicago - Northwestern Railroad (pp. 102-103). Since the release of the Addendum, a great deal of interest has been expressed in such a route. Therefore, the following additional analysis is provided.

OPTIONS CONSIDERED

Two basic options were considered to take advantage of the railroad corridor. They are:

A. Locate the pipeline within the railroad right-of-way to the extent possible.

B. Locate the pipeline outside but immediately adjacent to the railroad right-of-way to the extent possible.

In addition, several options were considered as to the length of railroad right-of-way which could be utilized. These include:

1. LeRoy to the point where the company's proposed route crosses the railroad, about three miles north of Hayfield;

2. LeRoy to a point south of Dodge Center where a by-pass of Dodge Center would have to begin.

3. LeRoy to Kenyon.

A. LOCATING THE PIPELINE WITHIN THE RIGHT-OF-WAY

1. ADVANTAGES

Factors which have been cited as advantages to locating the pipeline within the railroad right-of-way include:

a. Substantially fewer crossings of drain tiles would be involved, resulting in savings in tile repair costs and fewer landowner concerns and complaints regarding the adequacy of tile repairs. It is estimated that 704 tile lines would be crossed by the proposed route from LeRoy to west of Kenyon.

b. There would be reduced potential of oil entering tile lines in the event of a spill.

c. Pipeline burial depth could be reduced by not having to pass beneath tile lines.

d. Top-soil separation ("double-ditching") would not be necessary on the railroad right-of-way.

e. Landowner access problems and interference with field operations would be substantially reduced.

f. Crop damage payments would be reduced.

g. Restoration of the right-of-way would be simplified (for example, subsoiling should not be necessary on the right-of-way.)

h. Access to the pipeline for maintenance would not result in crop damages where the pipeline is located on railroad right-of-way.

2. <u>DISADVANTAGES</u>

a. The railroad right-of-way is for the majority of the route 100 feet in width (50 feet each side of center of track). Examination of right-of-way maps provided by the Chicago and Northwestern Railroad indicates that of the 64.5 miles of right-of-way between the Iowa border and the town of Nerstrand (north of Kenyon) 46.9 miles (73 percent) is no more than 100 feet wide. The tracks, ballast, and roadbed occupy a minimum of fifteen to twenty-five feet on each side of centerline. In addition, drainage ditches paralleling the tracks at the toe of roadbed are common, and could not be blocked during construction. Culverts under the roadbed often take up a considerable part of the right-of-way. Between Taopi and Dodge Center there are eight culverts 60 feet or more in length, four which are 40 to 59 feet, 19 which are 20 to 39 feet, and two less than 20 feet in length. The culverts range in size from small (i.e. 24") corrugated iron pipes to large (i.e. 4' X 6', 6' X 6') stone arches. Therefore, physically, there is not available within the railroad right-of-way the 50 foot width on one side of the track which is needed for pipeline construction.

For the remaining distance (18.5 miles or 27 percent of the distance between the Iowa border and Nerstrand) the railroad right-of-way is 60 to 100 feet or more wide on one or both sides of centerline. The additional right-of-way was acquired in most cases to accommodate construction of the railroad and is nearly always occupied by higher roadbed fills, cut-slopes, borrow areas, spoil areas, spur tracks or passing sidings, bridges or culverts, ditches, or other similar facilities.

b. There is a potential for damage to the pipeline in the event of a train derailment.

c. The right-of-way is wet in many locations due to the fact that drainage ditches are common paralleling the track, or because borrow areas created during construction have become ponds or marshes. These areas would make construction more difficult and costly.

d. Because there is not generally available within the railroad right-of-way the clear 50 foot width necessary for pipeline construction, the pipeline right-of-way would overlap onto the adjacent private property if the railroad right-of-way is to be utilized at all. This would require removal and replacement of those facilities which are frequently found along the property line between the railroad right-of-way and the abutting private land such as fences and telephone lines which parallel the railroad, berms of spoil material deposited during construction of the railroad, and utility poles on telephone and electric lines which cross the railroad. There are approximately 23 miles of telephone lines along the east side of the railroad and 31 miles along the west side, in the area between Taopi and Kenyon. The right-of-way is fenced on both sides for approximately 54 miles between the same towns. Because utility lines crossing the railroad generally must have high clearance there are usually poles located on the property lines on both sides of the railroad. There are approximately 11 telephone lines and power lines crossing the railroad between Taopi and Kenyon.

e. Road crossings of the railroad which are at less than 90 degree angles also present a problem. The pipeline must usually cross major Interstate, state and county state-aid roads at a 90 degree angle (+ or - 5 degrees). Where smaller-angle crossings are encountered, the pipeline route would have to be diverted outside the railroad right-of-way to make the "jog" necessary to accomplish the proper crossing. Between Taopi and Dodge Center there are ten State Trunk Highways (including Interstate 90) and County State-aid Highways which do not cross the railroad at 90 degree angles (+ or - 5 degrees). There are another 19 county and township roads which do not cross at 90 degree angles (+ or - 5 degrees); it is not known on which, if any, of these roads the local authorities would require 90 degree crossings by the pipeline.

3. RAILROAD ABANDONMENT

The Chicago and Northwestern Railroad has, as of April 1, 1978, put the railroad from the Iowa border to Randolph in Category I status for abandonment (subject to abandonment within three years).

Abandonment would make the use of the railroad right-of-way substantially more attractive by reducing or eliminating many of the disadvantages cited above, the most significant being that there would be 100 feet. or more of right-of-way available for construction, thus eliminating much of the need for acquiring additional right-of-way overlapping onto private land.

There are several unanswered questions at this point regarding the abandonment of the railroad and its use for a pipeline:

a. When would abandonment occur.

b. When would the right-of-way actually become available for pipeline use (that is, how soon after abandonment would removal of tracks, bridges, signals, communications facilities, etc. be completed, and the right-of-way be made available for purchase).

c. Ownership after abandonment.

d. Maintenance and policing responsibilities on the right-of-way following pipeline construction.

SUMMARY OF OBSTRUCTIONS TO ROUTING WITHIN
RAILROAD RIGHT-OF-WAY COMPARED TO
PROPOSED ROUTE
TAOPI TO KENYON

	Proposed Route	Within Railroad Right-of-way
Tile Crossings	704 (Est.)	Approx. 9 (mains)
Major Road Crossings not at 90°, + or - 5°	18	12
Culverts	see footnote 1	50
Fences parallel	see footnote 1	54 miles
Telephone lines parallel	see footnote 1	54 miles
Power lines parallel	see footnote 1	10 miles
Utility lines crossing	see footnote 1	11

1 These features either are not present on the proposed route or can be avoided in locating the centerline, with little other consequence. Avoiding them on the railroad right-of-way would result in routing on the adjacent private land.

B. LOCATING THE PIPELINE OUTSIDE OF, BUT ADJACENT TO THE RAILROAD RIGHT-OF-WAY.

1. ADVANTAGES

a. The major advantage of locating the pipeline adjacent to the railroad right-of-way would be to increase opportunities for following field boundaries and a substantial reduction in the number of tile line crossings, as compared to the proposed route. It is estimated that the number of tile crossings could be reduced by approximately 500 by routing adjacent to the railroad.

b. Pipeline construction adjacent to field boundaries will cause less interruption of agricultural pursuits than the proposed diagonal route. Field crop management procedures will be enhanced and farmers could employ more practical measure to restore the soil productivity.

c. Since railroad right-of-way was acquired before the installation of underground drain tile, most systems were designed with no construction within approximately 50 feet of said right-of-way. The same criteria has been followed for individual farm units. Due to economic and easement requirements, property boundary (railroad or private) crossings have been restricted to those essential for obtaining drainage outlets for particular tracts of land.

d. Crossings will be at approximately 90^{o} angle and, except for tile mains through railroad property, all lines would be intercepted near the outlet or upper terminus. Therefore, restoration of existing systems should be less expensive than repair of skewed crossings.

e. Future drainage needs including replacement systems, will generally follow the course of existing systems or will be typical of inplace design and construction.

f. Depending on railroad company permission, approximately a 10 foot wide strip of land at the outer right-of-way boundary could possibly be used for access during pipeline construction.

g. There would be reduced potential of oil entering tile lines in the event of a spill.

h. Although no calculations have been made, lands adjacent to railroads may not be cropped as extensively as lands coursed by the diagonal route.

i. It appears that less bends will have to be made for highway crossings.

2. DISADVANTAGES

a. It is estimated that a route parallel to the railroad would be 8 miles longer than the proposed route, and would affect 25 more tracts of land than the proposed route.

b. Northern Pipeline Company has estimated that a route parallel to the railroad would cost $2,075,000 more than the proposed route.

c. Bypassing of cities and several building sites or other obstructions may result in a less flexible construction alignment selection.

d. Railroad companies may object to the close proximity of the pipeline. However, none of the rail lines appear to be heavily traveled.

ERRATA SHEET

The following information should be added to the Route Comparison chart in Appendix IV, Part I, following page 6.

	Railroad Alternative Route	Corresponding Portion of Proposed Route
Route paralleling property lines	21¼ miles	7¼ miles
Route paralleling railroad	34 3/4 miles	4¼ miles

ROUTE COMPARISON

From West of LeRoy to West of Epsom

(Points of Divergance and Convergance)

	Railroad Alternative Route	Corresponding Portion of Proposed Route
Land Use		
Overall Length	67.2 miles	59.8 miles
Cultivated	62.9 miles	57.2 miles
Pasture	2.7 miles	1.0 mile
Forest	0.1 mile	0.4 mile
Other	1.5 miles	1.2 miles
Drain Tile	207	704
Surface Waters	10 stream and river crossings	6 stream and river crossings
Soils	62.9 miles of cultivated soil	57.2 miles of cultivated soil
Geology	Approximately 4.6 miles of shallow bedrock	Approximately 2.4 miles of shallow bedrock
Groundwater	Approximately 4.6 miles of shallow bedrock	Approximately 2.4 miles of shallow bedrock
Biology	0.1 mile of forest, no significant differences between routes	0.4 mile of forest, no significant differences between routes
Socio-Economics		
Number of incorporated towns within 3 miles	10	8
Population of incorporated towns within 3 miles	6,424	4,462
Number of landowners	179	154
No. of railroad crossings	7	4
No. of pipeline crossings	3	4
No. of transmission line crossings	2	5
No. of major road crossings	34	33

APPENDIX IV

PART 2

RAILROAD ALTERNATIVE ROUTE

ENVIRONMENTAL ASSESSMENT

Prepared Under the Direction of

The Department of Natural Resources

by

National Biocentric, Inc.
2233 Hamline Avenue North
St. Paul, Minnesota 55113

TABLE OF CONTENTS

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INTRODUCTION

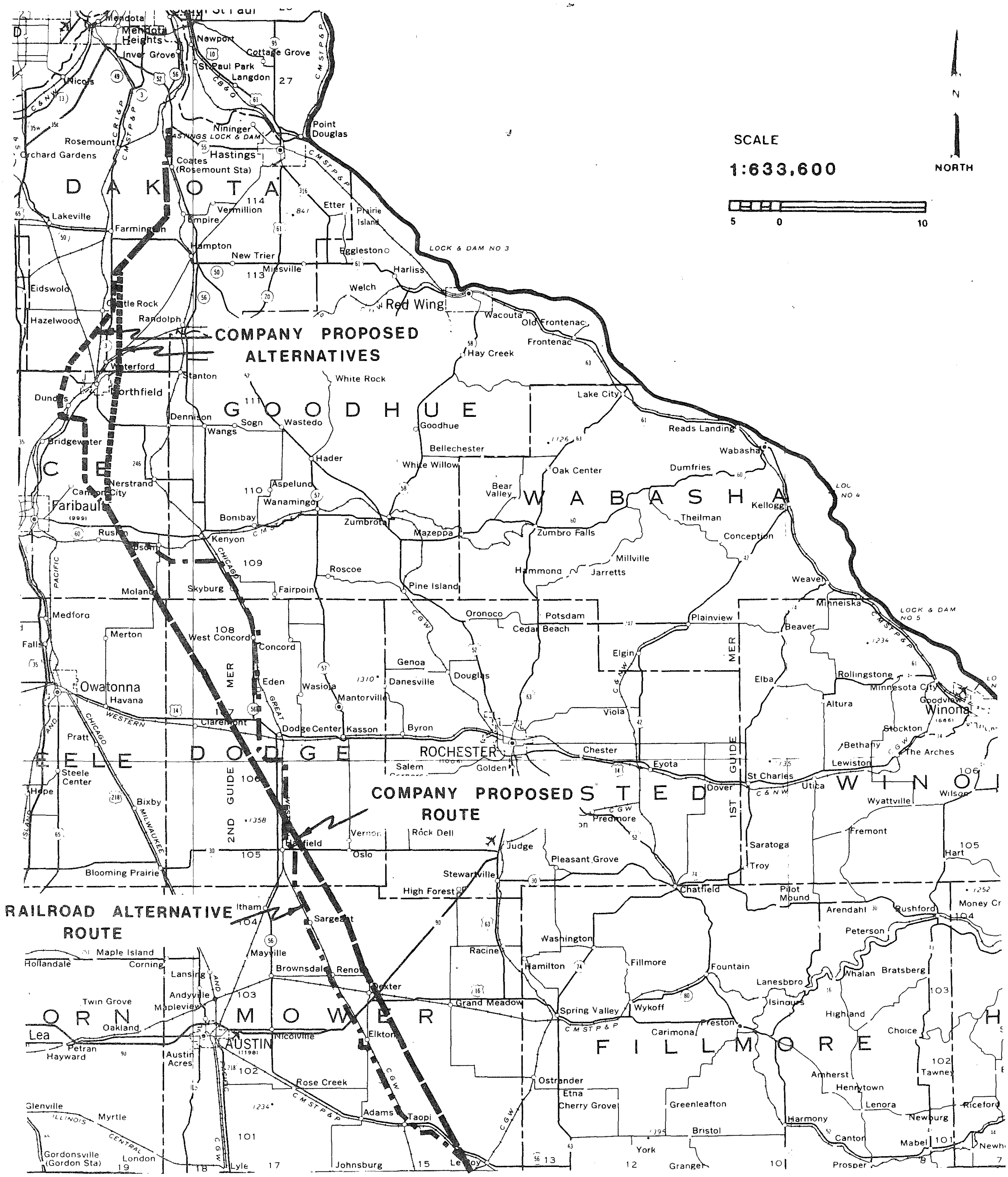
This assessment of the proposed railroad alternative route was prepared to provide information similar to that contained in the Draft EIS and Draft Addendum on the route proposed by Northern Pipeline Company.

This alternative would parallel the Chicago-Northwestern Railroad (and a short section of the Milwaukee Railroad) from just west of LeRoy to a point south of Kenyon, where it turns west to rejoin the company's proposed route west of Epsom, a distance of about 67 miles.

This Assessment covers only that part of the route described above; the reader is referred to the Draft EIS and the Draft Addendum for information on the remainder of the route, and for other information not repeated in this Assessment which applies equally to both routes.

FIGURE 1

PROJECT LOCATION



NORTHERN PIPE LINE CO.

OF DELAWARE INC.

1. PROJECT DESCRIPTION

1.3.2 Pipeline Crossings

County	Pipeline	Location
Goodhue	Northern Natural Gas	T.109N R.18W. Sec. 16
Dodge	Northern Natural Gas	T.107N R.17W. Sec. 29
Mower	Northern Natural Gas	T.104N R.17W. Sec. 1

1.4 LAND REQUIREMENTS

1.4.1 Right-Of-Way

The proposed right-of-way width for this project is 50 feet, or approximately 6 acres per mile of pipeline. The entire right-of-way acreage along the Railroad Alternative Route (from west of LeRoy to west of Epsom, where junctions are found with the Company-proposed route) would be about 412 acres.

2. DESCRIPTION OF THE EXISTING ENVIRONMENT

2.1 LAND USE

2.1.1 General

The crude oil pipeline proposed for construction from the Pine Bend Terminal in Rosemount, Minnesota, to the Minnesota-Iowa border would traverse portion of the following Minnesota counties: Dakota, Rice, Goodhue, Dodge, and Mower.

In this report, "Railroad Alternative" refers to the alternative pipeline route which leaves the Company-proposed route near LeRoy and returns to the proposed route just west of Epsom (see Figure 1 and Appendix G).

The land use along the proposed Railroad Alternative Route is predominantly agricultural, with approximately 93.6 percent in cropland, and another 4.2 percent in pasture or agriculture/open land. Less than 1 percent is forested and the remainder consists of either public or private rights-of-way for roads, highways, railroads, transmission lines, or other pipelines.

The total route-miles by land use and the total acreages for the proposed 50-foot right-of-way and the 3-foot wide trench are presented in Table 1. Land use per township for the respective route alternatives is presented in Table 2.

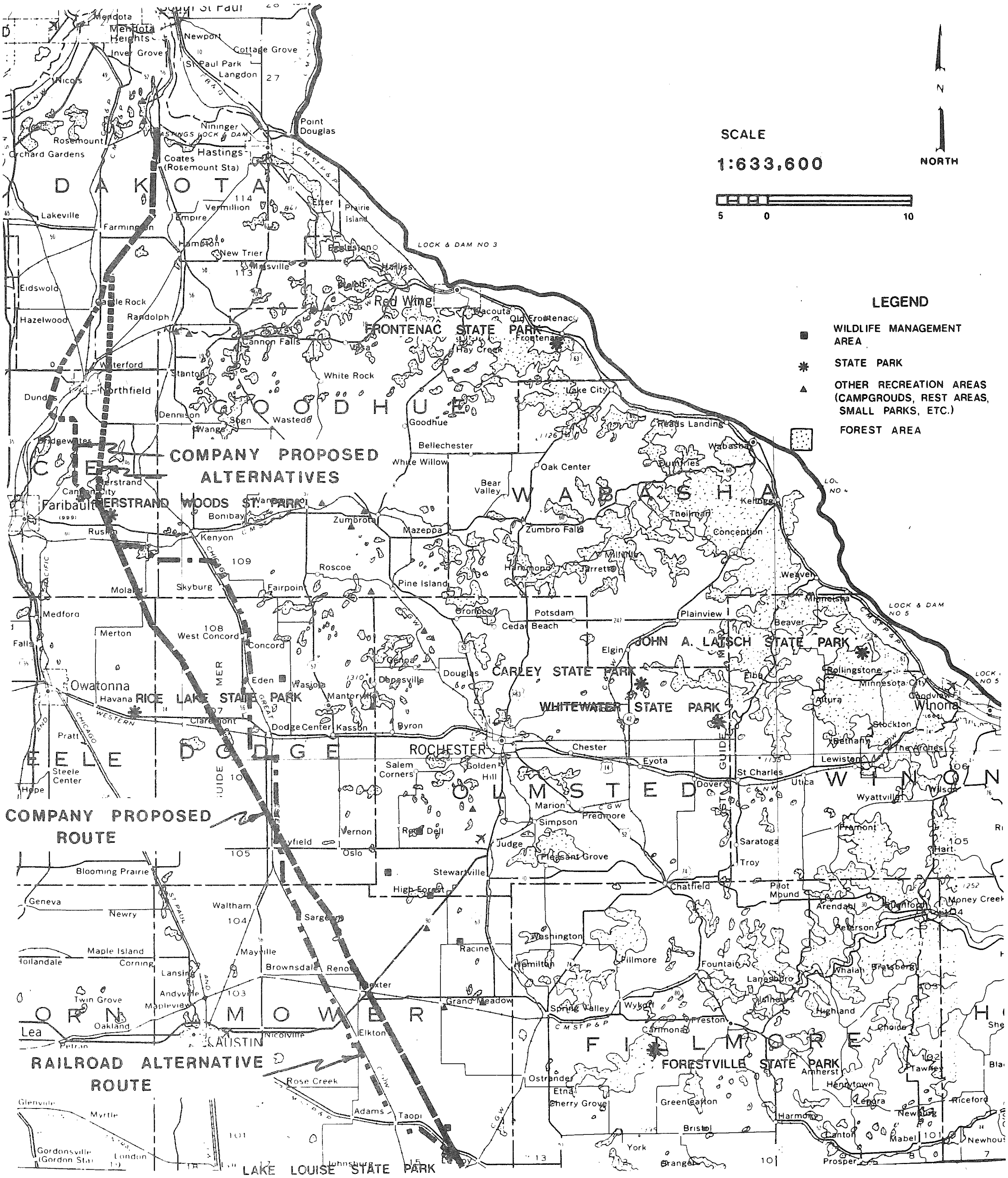
Table 1
LAND USE ALONG PROPOSED RAILROAD ALTERNATIVE
RIGHT OF WAY: From West of LeRoy to West of Epsom

		Acreage	
	Miles	50' ROW	3' Trench
Cultivated	62.9	381.2	22.9
Pasture and Open	2.7	16.4	1.0
Forest	0.1	0.6	*
Other**	1.5	9.0	0.5
TOTAL	67.2	407.2	22.4

*Not applicable.
**Includes right-of-way of all public roads, transmission lines, pipeline, and railroad tracks.

FIGURE 2

LAND USE



NORTHERN PIPE LINE CO.

OF DELAWARE INC.

Table 2

MILES OF LAND USE ALONG RAILROAD ALTERNATIVE ROUTE:
From West of LeRoy to West of Epsom

County/Township	Miles				
	Cultivated	Pasture & Open	Forest	ROW*	Total
Rice County					
Richland	4.2	0.1	0	0.1	4.4
Goodhue County					
Kenyon	7.4	0.2	0	0.2	7.8
Dodge County					
Concord	6.3	0.2	0	0.1	6.6
Wasioja	5.2	0.9	0.1	0.1	6.3
Ashland	7.6	0.6	0	0.1	8.3
Hayfield	6.3	0.1	0	0.1	6.5
Mower County					
Waltham	3.4	0.1	0	0.1	3.6
Sargeant	3.3	0	0	0.1	3.4
Dexter	6.8	0	0	0.2	7.0
Marshall	3.4	0	0	0.1	3.5
Clayton	3.3	0.1	0	0.1	3.5
Lodi	5.6	0.4	0	0.2	6.2
LeRoy	0.1**	0.1	0	0	0.1**
TOTAL	62.9	2.7	0.1	1.5	67.2

*ROW (Right-Of-Way) includes that of all public roads, transmission lines, pipelines, and railroad tracks.

**Railroad Alternative Route would extend less than 200 feet (0.03 mile) into LeRoy Township. This distance has been rounded off to the nearest whole tenth-of-a-mile.

With the exception of approximately 1.1 miles of public right-of-way along roads and highways, the route passes through land which is privately-owned.

2.1.2 Communities and Residential Areas

The proposed Railroad Alternative Route traverses the incorporated communities of West Concord and Elkton in Dodge and Mower Counties, respectively. In both instances, the pipeline has been routed through undeveloped portions of the communities. In addition to the above communities, the pipeline will be routed proximal to several other communities. A list of incorporated communities, and their population, which would be traversed by or within three miles of the Railroad Alternative Route is given below:

County	Community	Population
Goodhue	Kenyon	1,575
Dodge	West Concord	718
	Dodge Center	1,603
	Hayfield	939
Mower	Sargeant	85
	Dexter	252
	Elkton	134
	Taopi	59
	LeRoy	870

In addition to traversing portions of West Concord and Elkton, the Railroad Alternative Route would pass within a few hundred feet of the corporate boundaries of Hayfield and Sargeant, and within approximately 1,300 feet of Taopi. All other communities and residential areas are located at least one mile from the route.

2.1.3 Agriculture

The dominant land use of southeastern Minnesota is agriculture. Along the approximately 67-mile alternative route, from west of LeRoy to west of Epsom, about 93.6 percent of the land is cultivated. Table 3 shows the farm versus the non-farm use of the land on a township basis.

Table 4 indicates the acreage of various crops harvested in 1976 by township. Corn is the most important crop by acreage followed by soy beans, hay, and oats, respectively.

2.1.4 Forest Use

The only segment of forested land (0.1 mile) along this route is located at the Dodge Center Creek crossing in Wasioja Township in Dodge County; however, tree lines along fence rows are not uncommon. The closest major forested area to the route is the Lake Louise State Park, located approximately 1.4 miles east of the route in LeRoy Township of Mower County.

2.1.5 Other Land Uses

The Railroad Alternative pipeline will intersect 9 railroads, 4 electrical transmission corridors, 3 pipelines, and 69 roads and highways, of which 75 percent are graveled.

2.1.6 Other Significant Resources

The land along the Railroad Alternative pipeline route has been subjected to intensive cultivation and other forms of development. As a result, there are few natural, undisturbed areas remaining. The proposed route does not come within one mile of any wildlife management area. With the exception of the Dodge Center Creek crossing, the floodplains of most of the creeks or streams are pastures and cultivated fields, which come right to the banks.

Table 3

LAND USE BY TOWNSHIP: RAILROAD ALTERNATIVE ROUTE

County/Township	Farm Acreage			Percent of Township Land in Farms		
	Total Farm Acres	Number of Farms	Average Acres per Farm	Harvested Percent	Total Percent	Non-Farm Percent
Rice County						
Richland	16,709	76	220	59	73	27
Goodhue County						
Kenyon	17,741	75	237	59	77	23
Dodge County						
Concord	20,604	96	215	63	85	15
Wasioja	19,757	100	198	67	87	13
Ashland	22,117	62	357	90	95	5
Hayfield	21,314	77	277	87	92	8
Vernon	18,789	88	214	58	81	19
Mower County						
Waltham	22,121	97	228	71	96	4
Sargeant	18,700	58	322	60	95	17
Dexter	19,347	68	285	73	84	16
Marshall	21,641	80	271	82	94	6
Clayton	15,654	48	326	56	68	32
Lodi	15,710	59	266	57	69	31
Le Roy	17,717	66	288	56	76	24

Source: Minnesota Crop and Livestock Reporting Service and Minnesota Analysis Planning System

Table 4

ACRES OF CROPS HARVESTED IN 1976
BY TOWNSHIP: RAILROAD ALTERNATIVE ROUTE

County/Township	Corn, Grain or Silage	Soy Beans	Oats	Barley	Wheat	Potatoes	Peas	Sweet Corn	Hay	Others	Total Acres Harvested
Rice County											
Richland	6,968	3,012	1,012	12	394	0	50	60	1,818	95	13,421
Goodhue County											
Kenyon	5,641	4,118	1,117	0	629	0	0	450	1,600	30	13,585
Dodge County											
Concord	6,172	3,727	1,835	11	280	0	34	205	3,049	0	15,313
Wasioja	7,397	3,725	1,372	40	92	0	35	82	2,414	0	15,157
Ashland	10,105	7,988	1,086	0	150	0	58	287	1,320	0	21,144
Hayfield	7,596	8,417	1,059	0	347	0	60	140	1,121	0	19,861
Mower County											
Waltham	6,320	6,772	1,707	0	5	0	50	157	1,232	205	16,448
Sargeant	6,355	5,120	505	0	25	35	168	490	873	0	13,571
Dexter	7,136	7,462	1,041	0	85	0	40	180	846	0	16,790
Marshall	8,139	7,526	1,775	0	102	0	165	77	1,153	0	18,937
Clayton	6,283	5,114	1,034	0	80	0	0	0	712	0	13,223
Lodi	6,124	3,783	1,507	0	0	0	0	0	1,589	0	13,003
Le Roy	5,682	4,020	1,311	0	0	0	0	0	1,818	0	12,831

Source: Minnesota Crop and Livestock Reporting Service

The Railroad Alternative Route passes 1.25 miles to the east of the Claremont Game Refuge in Claremont Township of Dodge County, and, as noted previously, within approximately 1.4 miles of Lake Louise State Park at the southern end of the route in Mower County.

2.1.7 Land Use of Possible Pump Station Site

A pumping station is not planned for this segment of the pipeline at this time. However, if in the future, one is required, one 5-acre, non-forested site will be selected at some point along the proposed route for a pump station.

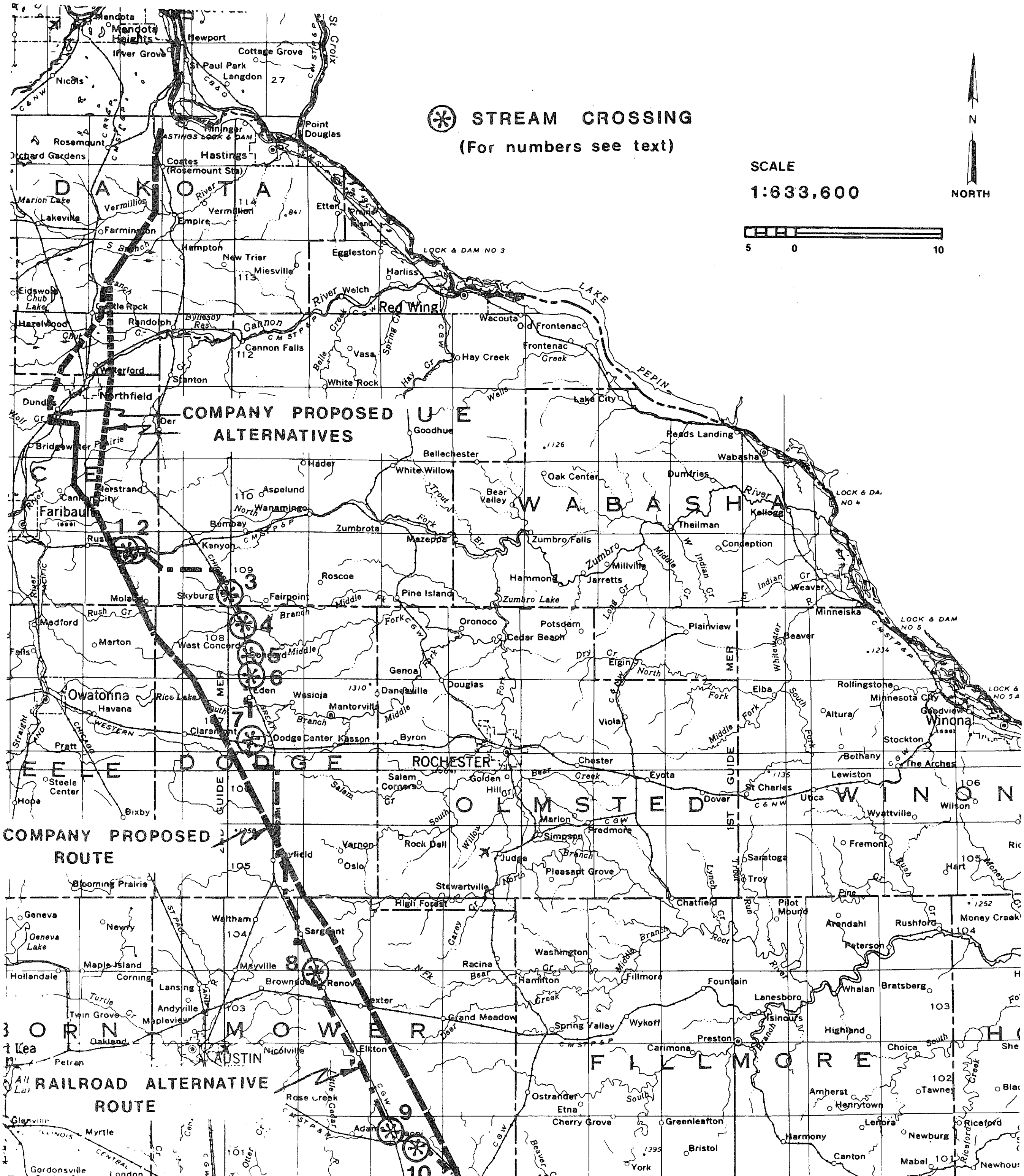
2.2 SURFACE WATERS

2.2.1 Location

Ten river/stream crossings are proposed on the Railroad Alternative Route (see Figure 3).

		Map Location Number
RICE COUNTY		
Ditch to North Branch Zumbro River	T.109N R.19W. Sec. 10	1
North Branch Zumbro River	T.109N R.19W. Sec. 10	2
GOODHUE COUNTY		
North Branch, Middle Fork Zumbro River	T.109N R.18W. Sec. 25	3
DODGE COUNTY		
Middle Fork Zumbro River	T.108N R.17W. Sec. 7	4
Milliken Creek	T.108N R.17W. Sec. 32	5
South Branch Middle Fork Zumbro River	T.107N R.17W. Sec. 17	6

FIGURE 3
SURFACE WATERS



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Dodge Center Creek	T.107N R.17W. Sec. 32	7
MOWER COUNTY		
North Branch Root River	T.104N R.16W. Sec. 5	8
North Branch Upper Iowa River	T.101N R.15W. Sec. 9	9
North Branch Upper Iowa River	T.101N R.15W. Sec. 14	10

2.2.2 Physical Description

The listed streams and rivers were examined in the field in August, 1978. The following descriptions pertain to conditions observed at that time. All measurements, including flows, are field estimates. "Floodplain" refers to the visually estimated 100 year floodplain. A summary of river characteristics is included in Table 6.

Ditch to North Branch Zumbro River

The stream is 8 feet wide and between 1/2 and 1 foot deep. This v-shaped ditch has banks of 45° slope which are 8 feet in height. Flow was visually estimated as 3 cfs. This ditch could contain minnows in the spring.

The floodplain is about 50 feet wide and has no notable forms of vegetation.

North Branch Zumbro River

At the proposed point of crossing the stream ranges between 3 and 10 feet in width and is less than 1 foot in depth. The flow was visually estimated to be less than 1 cfs. The bottom consists of gravel and silt deposits. The west bank is 3 feet high with a 60° slope. The adjacent pasture attains an additional 3 foot rise with a gentle slope. This pasture is about 25 feet wide at this point and is bounded by the

Table 5

ESTIMATED WATERSHED DISCHARGE DATA
(All Data Expressed as Cubic Feet/Second (cfs)

River Crossings	Period of Record	Extremes: Period of Record Max.	Extremes: Period of Record Min.	Extremes: 1976 Max.	Extremes: 1976 Min.	Means - 1976 June	Means - 1976 July	Means - 1976 Aug.	Means - 1976 Sept.
Milliken Creek	Not available, estimated to be 1 cfs August, 1978								
Middle Fork Zumbro River	*	1,700	3	1,900	12	25	23	17	14
North Branch, Middle Fork Zumbro River	*	1,100	0.5	300	2	4	3.5	2.5	2
Tributary to Upper Iowa River	Not available, estimated to be 0.5 cfs August, 1978								

*No data, discharges are estimated by proportional watershed areas.

NOTE: Other rivers are included in Table 5 of the Draft Addendum, Draft Environmental Impact Statement. Data are approximate and applicable to either crossing site.

Table 6

SELECTED DATA ON PROPOSED RIVER AND STREAM CROSSINGS
(Railroad Alternative Route)

Crossing	Location	August, 1978 Width (ft)	August, 1978 Depth (ft)	Discharge August, 1978 (cfs)	Gradient (ft/mi)	Bottom	Banks	Flood-plain* (ft)
Ditch to North Branch Zumbro River	T.109N, R.19W, Sec. 10	8	½-1	3	5.0	---	8 ft high, 45° slope	50
North Branch, Zumbro River	T.109N, R.19W, Sec. 10	3-10	<1	<1	8.0	Gravel w/silt deposits	West: 30 ft high, 60° slope; East: 8 ft high, 30° to vertical slope	100
North Branch, Middle Fork Zumbro River	T.109N, R.18W, Sec. 25	20	1-2	<½	6.1	Sand and silt	North: 3 ft high, 60° slope; South: 3 ft high, 45° slope	300-500
Middle Fork, Zumbro River	T.108N, R.17W, Sec. 7	15-20	½-1	5	7.0	Sandy-silty with a few large rocks	North: 4-5 ft high, 20° slope; South: 10-15 ft high, 45-60° slope	300-500
Milliken Creek	T.108N, R.17W, Sec. 32	3	½-1	1	5.7	Sandy with some gravel	3-5 ft high, 30-60° slope	100+
South Branch, Middle Fork Zumbro River	T.107N, R.17W, Sec. 17	8-10	½-1	5-10	7.1	Sand, gravel, cobbles	2 ft high	750
Dodge Center Creek	T.107N, R.17W, Sec. 32	30-30	½	5	3.9	Silt, sand, gravel, rocks	4 ft high, vertical	1,000+
North Branch, Root River	T.104N, R.16W, Sec. 5	Stagnant Pools		0	11.9	---	6 ft high	100-400

Table 6 (Continued)

SELECTED DATA ON PROPOSED RIVER AND STREAM CROSSINGS
(Railroad Alternative Route)

Crossing	Location	August, 1978 Width (ft)	August, 1978 Depth (ft)	Discharge August, 1978 (cfs)	Gradient (ft/mi)	Bottom	Banks	Floodplain* (ft)
North Branch, Upper Iowa River	T.101N, R.15W, Sec. 9	2	½	<½	13.1	Sandy	2 ft high, 60° to vertical	650
North Branch, Upper Iowa River	T.101N, R.15W, Sec. 14	3-5	½	<½	10.7	Sandy	3 ft high, vertical	300
Tributary to Upper Iowa River	T.101N, R.14W, Sec. 30	5	1	½	10.0	Sandy	3 ft high, vertical	100-200

*Approximate 100-year floodplain estimated visually in the field.

stream and an agricultural field. There are a few box elders and 1 large cottonwood in the vicinity of the proposed crossing. The east bank is about 8 feet high with a slope that varies from 30° to near vertical. There is a 30-foot wide strip of pasture adjacent to the stream, separating it from a 50 to 100-foot wide box elder woods.

The 100-year floodplain is estimated to be 100 feet wide. A long time local resident confirms that only minnows are found this far upstream.

North Branch, Middle Fork, Zumbro River

This stream is about 20 feet wide and ranges from 1 to 2 feet deep. The bottom material is sand and silt. It was almost stagnant at the time of observation, having a flow of less than 1/2 cfs. The north bank is about 3 feet high and sloped at 60°. The south bank is 3 feet high with a 45° slope.

Open mesic pasture borders the stream and is 150 feet wide on the north and 100 feet wide to the south. Cornfields add to the remainder of the floodplain which is between 300 and 500 feet wide. The soil appears to be a light clayey sand with some organic matter. There are no trees at this site.

Small minnows were observed and this stream may contain rough fish in the spring.

Middle Fork Zumbro River

The river is 15 to 20 feet wide and between 1/2 and 1 foot deep. The bottom is sandy-silty with a few large rocks. The water was fairly clean at the time of observation and flowing at approximately 5 cfs. There is no submerged vegetation at this site. The north bank is steep for 1 foot and then slopes at about 20°, with a total relief of 4 to 5 feet. The south bank is 10 to 15 feet high, with a 45° to 60° slope.

The north floodplain is visually estimated as 300 to 500 feet wide and consists of 300 feet of mesic pasture bordered by cornfield. The south floodplain is represented by the steep bank, only 30 feet in width, which is thinly vegetated with grasses, weeds, and a few white oaks. Agricultural fields extend to the banks.

Many small fish up to 8 inches in length were observed.

Milliken Creek

The banks of this creek are 3 to 5 feet high with slopes between 30° and 60°. The creek is about 3 feet wide and 1/2 to 1 foot deep. Flow was visually estimated at 1 cfs. The bottom is sandy with some small gravel. The water was observed to be fairly clean with quite a bit of submerged vegetation.

To the north of the creek is a grassy wasteland, 10 to 20 feet wide and bordered by a cornfield. The width of this treeless floodplain is indeterminate. To the south of the stream is a grassy pasture containing several well-spaced large willows and cottonwoods. An agricultural field lies about 300 feet back from the creek. The floodplain is estimated at 100 feet in width, on the south bank.

Small minnows were noted.

South Branch, Middle Fork, Zumbro River

At the proposed site of crossing this stream is 8 to 10 feet wide and 1/2 to 1 foot deep. The bottom is composed of a mixture of sand, gravel, and large cobbles. The flow was medium fast, estimated as between 5 and 10 cfs. The banks are about 2 feet high.

To the north is a 75 foot wide strip of overgrown moist-mesic pasture. A 250 foot wide pasture separates this strip from a cornfield. To the south is a 30 foot wide strip of weedy wasteland and agricultural fields.

The 100-year floodplain is estimated as being 750 feet wide.

Many small minnows were seen in the stream.

Dodge Center Creek

At this proposed crossing the streambed is 20 to 30 feet wide and is a mixture of silt, sand, gravel, and large rocks. At the time of inspection the water was low, with only about 6" of water and a flow of 5 cfs, and many temporary sand bars were exposed. The banks are 4 feet high and nearly vertical.

In general, the land along this stretch of Dodge Center Creek is characteristic mature bottomland woodlands which has been utilized as pasture. The bottomland is well-wooded with mature silver maples and basswood trees. A few white oaks are found on the higher, drier sites. Patches of hazel-nut and other brush and small trees are scattered to form the understory. There are several low depressions, possibly old creek channels, in the area. This area provides habitat for many wild animals, including deer. The creek was noted to contain minnows, some quite large, and many clams.

Next to the north bank is a 30 foot wide grassy floodplain which then slopes upward at 45° for an 8 foot rise to the fields above. There are a few large basswoods and some white oaks in this area. To the south of the creek the floodplain is quite wide, at least 1000 feet, and is wooded bottomland/pasture.

North Branch, Root River

At the time of observation this intermittent stream had no flow, but was just a series of small stagnating pools. At the proposed crossing this creek lies within a v-shaped channel that is 6 feet deep and 25 feet wide at the top. Agricultural fields border this narrow, grassy ditch.

The 100-year floodplain is indistinct but is estimated at between 100 and 400 feet in width. The area soils are sandy with some rocks.

North Branch, Upper Iowa River

This stream is very small at this point, about 2 feet wide and 6 inches deep. There was almost no flow (<1/2 cfs.) at the time of inspection. The banks are about 2 feet high and are vertical or have 60° slopes. The bottom of the stream is sandy.

The land surrounding this stream is very moist, low pasture. Vegetation is low and thick and is dominated by goldenrod, thistles, and sunflowers. Also present are day lilies, asters, ragweed, grasses, milkweed, blue vervain, wild cucumber, and a few small shrubby willows. To the east, about 150 feet of this pasture lie between the stream and a cornfield. About 500 feet of this overgrown pasture separate the west bank from the railroad tracks. Total floodplain is estimated at about 650 feet wide.

North Branch, Upper Iowa River

At the proposed point of crossing this stream is only 3 to 5 feet in width and about 6 inches deep. The flow was estimated as being about 1/2 cfs. or less. The water is fairly clean and the bottom is sandy. The banks are vertical and 3 feet high. The north bank is bordered by about 50 feet of sloping mesic pasture with agricultural fields beyond. There are a few white oaks in the vicinity. To the south is a mesic pasture 100 feet wide and then cornfield. There are several large white oaks in the vicinity, including a stand to the southwest on the south side, but these can be avoided.

The estimated floodplain is 300 feet wide. Small minnows are present in the stream. Vegetation includes arrowhead, water plantain, reeds, and various grasses.

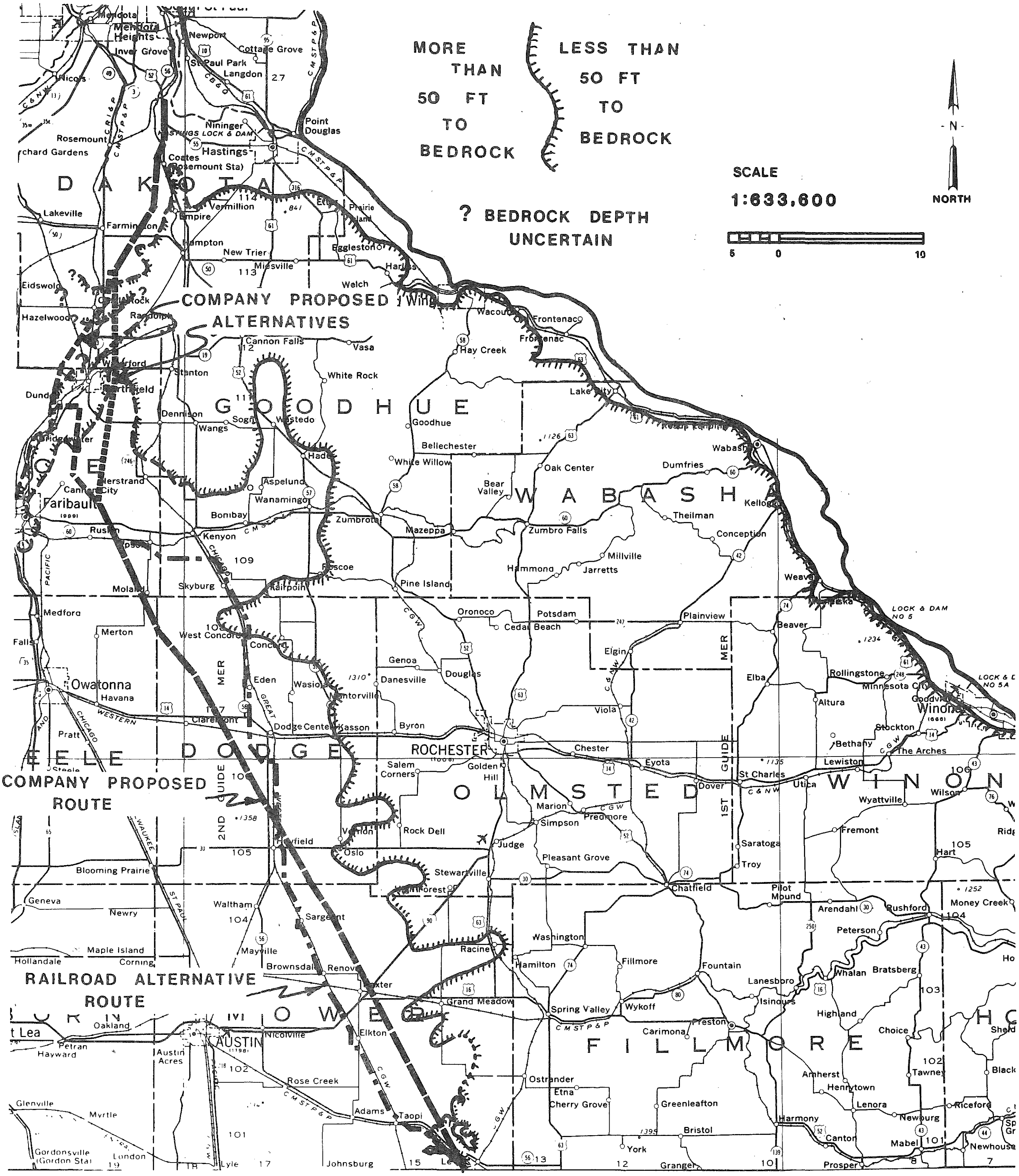
2.3 SOILS AND TOPOGRAPHY

2.3.1 General

All of the Railroad Alternative Route lies within the Kenyon-Taopi Plain (#38), as defined in the Minnesota Soil

FIGURE 6

DEPTH TO BEDROCK



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Atlas. This geomorphic feature is described on page 48 of the Draft Environmental Impact Statement.

2.3.2 Soil Surveys

Appendix C includes copies of the County Soil Surveys with the Railroad Alternative Route overlain.

2.5 BIOLOGICAL ENVIRONMENT

2.5.4 Rare, Unique or Endangered Species

No federally-designated rare, unique or endangered species are likely to be encountered along the Railroad Alternative Route. The bobwhite quail, which is classified as a protected species by the State of Minnesota, is at the northern limit of its range in southern Minnesota. The Minnesota Department of Natural Resources is considering the implementation of a game management program that will encourage the development of brush-type habitat in southeastern Minnesota that is favored by the bobwhite quail.

The wood turtle is a rare species, found in woodland habitat near water in southeastern Minnesota.

The Minnesota trout-lily is extremely rare and occurs nowhere else in the world than a few sites (moist soils in hardwood forests) in southeastern Minnesota. Professor Thomas Morley of the Department of Botany, University of Minnesota, has indicated that known occurrences of trout-lilies, west of Kenyon, are not near the proposed route.

2.6 SOCIO-ECONOMIC ENVIRONMENT

2.6.1 Population

Growth rates have varied and will continue to vary in the counties traversed by, and the communities within 3 miles of, the Railroad Alternative Route. Table 11, containing past, present, and projected population figures, documents the differing rates of growth. While Dodge and Mower Counties can expect stable population conditions, Rice and

Table 11

POPULATION OF COUNTIES AND COMMUNITIES
WITHIN THREE MILES OF RAILROAD ALTERNATIVE ROUTE
From West of LeRoy to West of Epsom

	1940	1950	1960	1970	1976	1980	1990	2000
Rice County	32,160	36,235	38,988	41,582	43,200	44,700	47,600	50,200
Goodhue County	31,564	32,118	33,035	34,763	36,800	38,400	43,600	48,600
Kenyon	1,530	1,651	1,624	1,575	NA	NA	NA	NA
Dodge County	12,931	12,624	13,259	13,037	13,700	13,200	13,600	13,400
West Concord	744	770	810	718	NA	NA	NA	NA
Dodge Center	1,029	1,151	1,441	1,603	NA	NA	NA	NA
Hayfield	742	805	889	939	NA	NA	NA	NA
Mower County	36,113	42,277	48,498	43,783	43,200	44,100	45,000	43,100
Waltham	172	212	207	189	NA	NA	NA	NA
Sargeant	138	121	113	85	NA	NA	NA	NA
Dexter	303	316	313	252	NA	NA	NA	NA
Elkton	117	141	147	134	NA	NA	NA	NA
Taopi	151	118	92	59	NA	NA	NA	NA
LeRoy	752	959	971	870	NA	NA	NA	NA

Sources: 1940-1970 - All areas, U.S. Census
1976-2000 - Rice, Dodge, and Mower Counties, Minnesota State Demographer

Goodhue Counties can expect continued modest population increases.

Table 12 shows the density of population in the unincorporated areas of the townships through which the proposed Railroad Alternative Route passes.

2.6.2 Economics

Income and economic base characteristics also vary among the counties traversed by the proposed pipeline. Tables 13 and 14 illustrate these variations. As indicated on the tables, Dodge County is the most dependent on agriculture (26.8%) and has the lowest median income and, as noted in Table 11, this county experienced a population decline between 1960 and 1970. The reverse is true in Rice County, which has less than 10 percent of its population employed in agriculture and the second highest median income of the counties along this segment of the route. In addition, it has a high growth rate.

2.6.3 Transportation

The Railroad Alternative pipeline route will cross portions of the rail, highway, pipeline, cable, and electrical transmission network. Appendix E lists all the designated federal, state, and county roads under which the pipe will be laid. The pipeline will also cross numerous non-designated township roads and a few municipal roads, as illustrated on the maps in Appendix G.

The following rail lines intersect the Railroad Alternative pipeline route:

County	Rail Line	Location
Goodhue	Chicago and Northwestern	T.109N R.18W, Sec. 23
Dodge	Chicago and Northwestern	T.108N R.17W, Sec. 29
	Chicago and Northwestern	T.107N R.17W, Sec. 32
	Chicago and Northwestern	T.106N R.17W, Sec. 10

Table 12

RURAL POPULATION DENSITIES ALONG RAILROAD ALTERNATIVE ROUTE, 1970:
From West of LeRoy to West of Epsom

County	Township	Population/Square Mile
Rice	Richland	15.6
Goodhue	Kenyon	14.5
Dodge	Concord	19.1
	Wasioja	23.6
	Ashland	11.3
	Hayfield	12.6
Mower	Waltham	20.6
	Sargeant	11.5
	Dexter	12.0
	Marshall	13.8
	Clayton	7.6
	Lodi	11.5
	LeRoy	12.5

Source: Extrapolated from 1970 U.S. Census.

Table 13

INDUSTRY OF EMPLOYED PERSONS, 16 YEARS OLD AND OVER, 1970

	Rice County		Goodhue County		Dodge County		Mower County		State of Minnesota	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture	1,487	9.6	1,911	14.3	1,331	26.8	1,607	9.9	111,030	7.6
Mining	12	-	20	0.2	5	0.1	10	0.1	14,008	0.9
Construction	902	5.8	770	5.8	289	5.8	657	4.1	82,759	5.7
Manufacturing	2,450	15.8	3,237	24.3	818	16.5	5,409	33.5	309,222	21.1
Trans/Comm/Util	543	3.5	774	5.8	161	3.2	597	3.7	96,004	6.6
Wholesale/Retail	2,821	18.2	2,613	19.6	870	17.5	3,065	18.9	322,579	22.0
F.I.R.E.	405	2.6	350	2.6	155	3.1	495	3.1	67,977	4.6
Service	5,501	35.4	2,374	17.8	897	18.1	2,889	17.9	309,870	21.2
Govt/Public	1,402	9.0	1,271	9.5	434	8.8	1,415	8.8	150,824	10.3
TOTAL	15,523	99.9	13,320	99.9	4,960	99.9	16,144	100.0	1,464,273	100.0

Source: 1970 U.S. Census

Table 14

INCOME CHARACTERISTICS BY COUNTY, 1970

	Rice County	Goodhue County	Dodge County	Mower County	State of Minnesota
Median Income	$9,486	$9,085	$8,146	$9,834	$9,931
Percentage of All Families Earning More Than $15,000	16.5%	14.0%	9.7%	17.7%	20.3%
Percentage of All Families with Incomes Below Poverty Level	7.4%	9.5%	11.8%	8.6%	8.2%

Source: 1970 U.S. Census

Mower	Chicago and Northwestern	T.104N R.17W, Sec. 2
	Chicago and Northwestern	T.104N R.16W, Sec. 32
	Chicago and Northwestern	T.103N R.16W, Sec. 35
	Chicago and Northwestern	T.101N R.15W, Sec. 5
	Chicago, Milwaukee, St. Paul and Pacific	T.101N R.15W, Sec. 15

As listed in the Project Description, the Railroad Alternative line will cross three existing gas or oil pipelines, all of which carry natural gas and are owned by the Northern Natural Gas Company.

2.6.4 Taxation

See pages 72 and 73 of the Draft Environmental Impact Statement.

The 1976 mill levies and the total assessed valuation of taxable properties in the study area counties are as follows:

County	Mill Levy	Total Assessed Value
Rice	27.19	$100,877,689
Goodhue	10.52	240,369,987
Dodge	25.93	46,628,397
Mower	25.70	138,438,210

Source: County Auditor's Offices

2.6.5 Services

See the general discussion on Services on page 73 of the Draft Environmental Statement.

1. Health Care - Table 15 inventories primary physicians* and general hospital beds in the study area counties. As noted in the Draft EIS, the maximum safe physician-to-population ratio, as recognized by the Minnesota Health Department, is 1:5,000. All of the study area counties are within this standard. (Refer to the discussion on

*General Practitioner, Internal Medicine, Pediatrics, Ob-Gyn.

Table 15

HEALTH CARE MANPOWER AND FACILITIES

County	Primary Physicians	Physicians/ Population Ratio	Hospitals	Beds	Beds/ Population
Rice	18	1:2,356	Northfield City Hospital, Northfield	46	1:290
			Rice County District Hospital, Faribault	103	
			Sub-Total	149	
Goodhue	15	1:2,453	Community Hospital, Cannon Falls	13	1:237
			St. John's Hospital, Red Wing	115	
			Zumbrota Hospital, Zumbrota	27	
			Sub-Total	155	
Dodge	3	1:4,387	None	0	0
Mower	22	1:2,000	St. Olaf Hospital, Austin	147	1:294
			Sub-Total	147	
			TOTAL	451	

Sources: Minnesota Department of Health and Region 10 Development Commission

Emergency Facilities found on page 75 of the Draft Environmental Impact Statement.)

2. Police Protection - The County Sheriff's Department in each of the study area counties provides law enforcement services to the unincorporated portions of their counties, as well as to those municipalities contracting for police protection. Municipalities not under contract with the Sheriff, generally maintain their own police departments; exceptions are the small communities of Waltham and Sargeant in Mower County.

3. Fire Protection - The unincorporated communities and rural areas along the proposed route maintain contractual agreements with townships and municipalities to provide fire protection. Waltham and Sargeant Townships in Mower County do not have fire departments, but are within the service area of neighboring Rural Fire Districts.

2.6.6 Archaeological/Historical Sites

The Minnesota Historical Society has been requested to prepare an evaluation of the proposed project.

3. ENVIRONMENTAL IMPACTS

3.1 CONSTRUCTION

3.1.1 Land Use

For the discussion of construction impacts along the 50-foot right-of-way, see page 79 of the Draft Addendum.

Proper drainage of fields having drain tiles will not be disturbed, since the drain tiles, when cut, will be repaired. The route along the 67-mile railroad right-of-way is estimated to intersect 207 drain tiles, and along the proposed route, it is estimated to intersect 704 drain tiles. There has been historical evidence that drain tiles intersected by a pipeline can and have been successfully repaired. A more detailed discussion of the techniques used is found in Section 3.1.3 of the Addendum to the Draft Environmental Impact Statement. It is estimated that drain tile repair will cost between $100 and $200 per tile. Drain tile repair along the railroad right-of-way would cost $100,000 less than the proposed route.

The proposed route does not go through any residential areas, nor does it pass within 250 feet of any residence.

3.1.2 Surface Waters

The Railroad Alternative Route will cross ten streams (four more streams than the proposed route).

3.1.3 Soils and Topography

The Railroad Alternative Route will cross 62.9 miles of cultivated agricultural land (5.7 more miles of cultivated agricultural land than the proposed route).

3.1.4 Geology/Groundwater

The Railroad Alternative Route will cross approximately 4.6 miles of shallow bedrock (2.2 miles more of shallow bedrock than the proposed route).

3.1.5 Biology

The Railroad Alternative Route crosses 0.1 mile of forested land (0.3 mile less forest than the proposed route).

3.1.6 Socio-Economic Environment

Population

The reader is referred to page 85 of the Draft Addendum for a description of number of workers, size of families, and length of stay in the counties. As it relates to the Railroad Alternative Route, extending from Section 9 in Richland Township, Rice County, to Section 19 in LeRoy Township, Mower County, the resulting population impacts would be the same; they would be short-term (two to three months) and of a small scale. The larger communities along and in proximity to the Railroad Alternative Route which would probably serve as short-term places of residence for the pipeline workers and any accompanying dependents are Kenyon, West Concord, Dodge Center, Kasson, Hayfield, Austin, and LeRoy.

Economics

It is estimated that the Railroad Alternative Route will cost $2,075,000 more than the proposed route. This is based on an estimated cost of $250,000 per mile of pipeline. The Railroad Alternative would increase the total cost of the pipeline in Minnesota by almost 9 percent.

For a discussion of the direct and indirect (secondary) economic impacts that may be associated with the Railroad Alternative route, the reader is referred to pages 86 through 88 of the Draft Addendum.

It is estimated by Northern Pipe Line Company that average wages could amount to approximately $4.80/foot of pipe, or $1,703,117 for the Railroad Alternative Route as compared to $1,498,084 for the proposed route.

Transportation

For a discussion of impacts associated with pipeline construction on highways and roads, the reader is referred to page 88 of the Draft Addendum.

A Pipeline Ordinance newly adopted (February, 1978) in Mower County, requires that all pipelines be bored and cored through both public and private roads unless otherwise approved by the appropriate road authorities.

Permits will be obtained from the rail companies and a rail company representative will be present for any rail line borings. The Railroad Alternative Route would cross the Chicago and Northwestern line eight times between Richland Township in Rice County and LeRoy Township in Mower County, and the Chicago, Milwaykee, St. Paul and Pacific line once. Although a tunneling technique will be used to cross the tracks, each pipeline crossing will constitute a slow zone for trains during the construction period. Because of the importance of exact time schedules in rail operations, the incidence of numerous slow zones could create operational hazards for the railroads.

The reader is referred to the discussion on pages 88 and 89 of the Draft Addendum relating to impacts on existing pipelines and transmission lines.

Taxation

The state directly benefits from taxes on wages earned by both resident and non-resident workers, and also from the 4 percent sales tax imposed on the cost of all materials used on the project, whether purchased in or out of Minnesota. Since the Railroad Alternative Route is longer, the total amount of wages and construction material required will be greater for this route, hence the state will receive more income tax and sales tax.

Services

The reader is referred to page 89 of the Draft Addendum.

Historical/Archaeological Sites

The reader is referred to page 89 of the Draft Addendum.

3.2 OPERATION AND MAINTENANCE

3.2.6 Socio-Economic Environment

Population

Population impacts as a result of operation of the line will be negligible, as Northern Pipe Line Company has, at this point, no plans for establishing new line maintenance centers along the proposed route, or hiring new employees to serve the new line.

Economics

No direct or indirect economic impacts are expected in the study area as a result of pipeline operation. However, as addressed earlier in this report, the pipeline will improve the petroleum supply situation in the Upper Midwest, and thereby assist in the stabilization of petroleum-related product prices.

Taxation

Much of the tax benefit would accrue to local taxing jurisdictions along the proposed route. There are approximately 54 jurisdictions along the four-county Railroad Alternative segment that are authorized to levy taxes. In addition to the four counties, there are several incorporated cities and numerous townships, school districts, rural fire districts, and special districts. Rather than apply the individual levies of each of the authorized taxing jurisdictions, the unit appraisal method has been used to indicate the amount of tax revenue that would be generated by the pipeline.

As an indicator of tax revenue generation, a unit appraisal of $25 of tax revenue per $1,000 of fair market value has been used. Fair market value is defined as the total cost of pipeline construction. Final construction cost estimates for the Railroad Alternative have not been determined as yet; however, based on such costs in similar areas, a cost of $260,400 per mile will be used to indicate fair market value for tax revenue generation purposes. Thus, application of the unit appraisal method ($25 of tax revenue per $1,000 of value) indicates each mile of the pipeline would generate $6,515 in tax revenues annually. The amount of tax revenues that would be generated annually in each of the counties along the Railroad Alternative from Section 9 in Richland Township to Section 19 in LeRoy Township is given below:

County	Miles of Pipeline	Annual Revenue
Rice	4.4	$ 28,666
Goodhue	7.8	51,078
Dodge	27.8	181,117
Mower	27.3	177,860
TOTAL	67.2	$438,721

However, it must be stressed that these revenue figures can only be used as indicators, in the absence of detailed information. The actual revenue generated will result from the application of mill levies by each jurisdiction to the assessed value of the pipeline based on 43 percent of its market value as determined annually by the Minnesota Department of Revenues.

Services

See page 96 of the Draft Addendum.

3.3 IMPACT SUMMARY AND COMPARISON

Table 16 compares the major impacts of the Railroad Alternative Route and the corresponding portion of the proposed route. The comparison includes the point in Richland Township, Rice County, where the two routes diverge, to the point near LeRoy where they converge.

The Railroad Alternative Route has 9 more total miles, crosses 4 more rivers or streams, crosses 2.2 more miles of shallow bedrock, crosses one-third of a mile less forest, crosses 497 less drain tiles, passes close to two more towns, contacts 25 more landowners, crosses 3 more railroads, crosses one less pipeline, crosses 3 less transmission lines, and one more major road than the proposed route.

Table 16

IMPACT COMPARISONS

	Railroad Alternative Route	Corresponding Portion of Proposed Route
Land Use		
Overall Length	67.2 miles	59.8 miles
Cultivated	62.9 miles	57.2 miles
Pasture	2.7 miles	1.0 mile
Forest	0.1 mile	0.4 mile
Other	1.5 miles	1.2 miles
Drain Tile	207	704
Surface Waters	10 stream and river crossings	6 stream and river crossings
Soils	62.9 miles of cultivated soil	57.2 miles of cultivated soil
Geology	Approximately 4.6 miles of shallow bedrock	Approximately 2.4 miles of shallow bedrock
Groundwater	Approximately 4.6 miles of shallow bedrock	Approximately 2.4 miles of shallow bedrock
Biology	0.1 mile of forest, no significant differences between routes	0.4 mile of forest, no significant differences between routes
Socio-Economics		
Number of incorporated towns within 3 miles	10	8
Population of incorporated towns within 3 miles	6,424	4,462
Number of landowners	179	154
No. of railroad crossings	7	4
No. of pipeline crossings	3	4
No. of transmission line crossings	2	5
No. of major road crossings	34	33

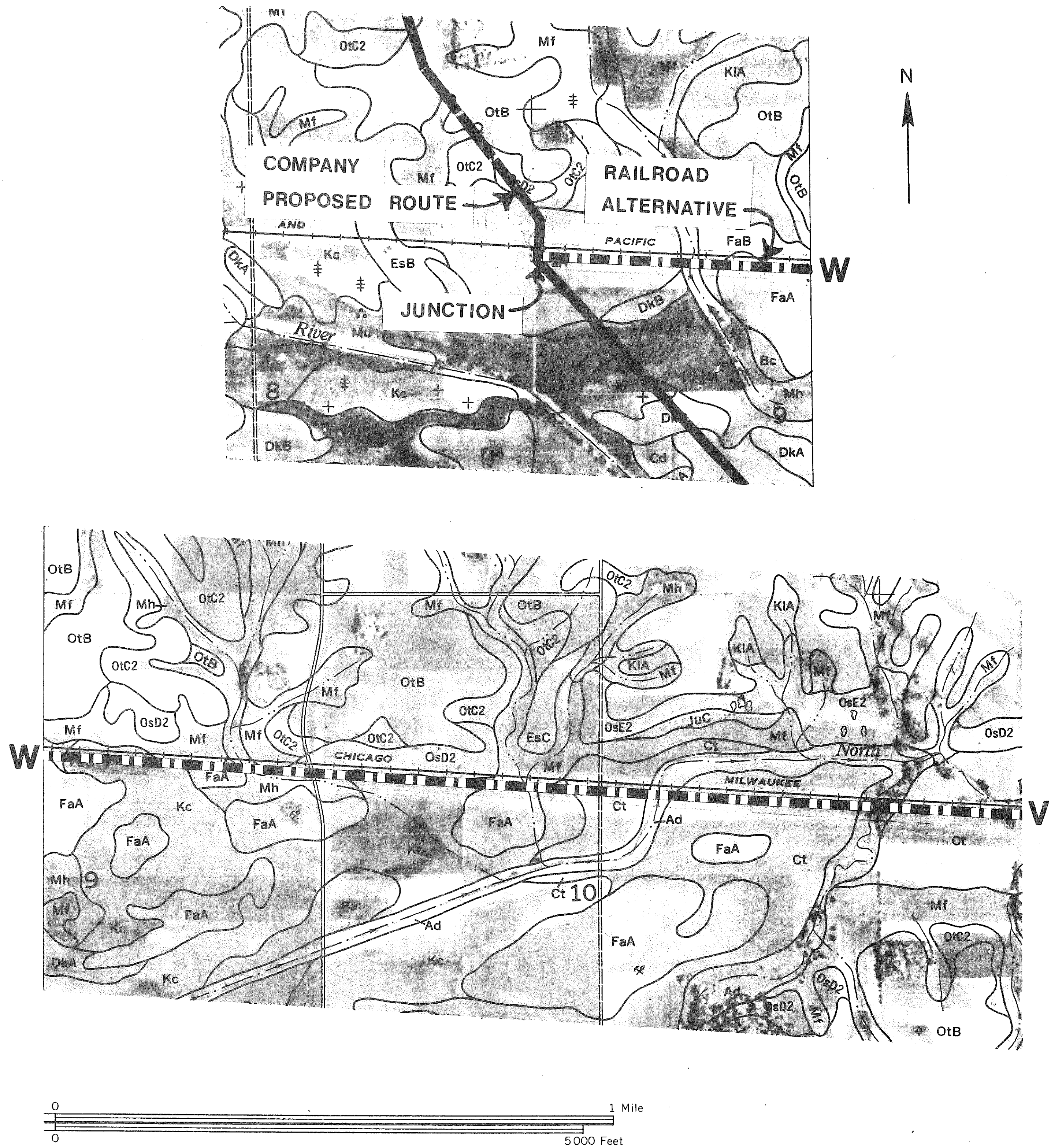
APPENDIX C

SOIL DATA

Map symbol	Mapping unit	Capability unit
Ad	Alluvial land	IIw-3
Af	Alluvial land, frequently flooded	VIw-1
Bc	Biscay loam	IIw-2
Bk	Biscay loam, seepy variant	VIw-2
BoC	Boone fine sand, 2 to 12 percent slopes	VIs-1
BoD	Boone fine sand, 12 to 25 percent slopes	VIIs-1
BoF	Boone fine sand, 25 to 40 percent slopes	VIIs-1
Ca	Canisteo clay loam	IIw-1
Cd	Canisteo clay loam, depressional	IIIw-1
Ck	Caron muck	IIIw-2
ClB	Clarion loam, 2 to 6 percent slopes	IIe-1
ClC	Clarion loam, 6 to 12 percent slopes	IIIe-1
CnC2	Clarion-Estherville-Storden complex, 4 to 12 percent slopes, eroded	IIIe-4
	Clarion and Storden	------
	Estherville	------
CsC	Clarion-Storden loams, 6 to 12 percent slopes	IIIe-1
CsD	Clarion-Storden loams, 12 to 18 percent slopes	IVe-1
CsE	Clarion-Storden loams, 18 to 25 percent slopes	VIe-1
Ct	Colo silty clay loam	IIw-1
CvA	Copaston sandy clay loam, 0 to 2 percent slopes	IIIs-1
Cy	Cordova clay loam	IIw-1
DcA	Dickman sandy loam, 0 to 2 percent slopes	IIIs-1
DcB	Dickman sandy loam, 2 to 6 percent slopes	IIIe-4
DoC	Dickman sandy loam, 6 to 12 percent slopes	IVe-4
DkA	Dickman sandy loam, benches, 0 to 2 percent slopes	IIIs-1
DkB	Dickman sandy loam, benches, 2 to 6 percent slopes	IIIe-4
DoB	Dodgeville silt loam, 2 to 6 percent slopes	IIIe-4
DoC	Dodgeville silt loam, 6 to 12 percent slopes	IVe-4
DoD	Dodgeville silt loam, 12 to 18 percent slopes	VIe-2
DoE	Dodgeville silt loam, 18 to 25 percent slopes	VIIe-1
Du	Dundas silt loam	IIIw-3
ErB	Erin silt loam, 2 to 6 percent slopes	IIe-3
ErC2	Erin silt loam, 6 to 12 percent slopes, eroded	IIIe-3
ErD2	Erin silt loam, 12 to 18 percent slopes, eroded	IVe-3
ErE	Erin silt loam, 18 to 30 percent slopes	VIe-1
EsA	Estherville sandy loam, 0 to 2 percent slopes	IIIs-1

Map symbol	Mapping unit	Capability unit
EsB	Estherville sandy loam, 2 to 6 percent slopes	IIIe-4
EsC	Estherville sandy loam, 6 to 12 percent slopes	IVe-4
EtB	Etter fine sandy loam, 2 to 6 percent slopes	IIIe-4
EtC	Etter fine sandy loam, 6 to 15 percent slopes	VIe-2
FaA	Fairhaven silt loam, 0 to 2 percent slopes	IIs-1
FaB	Fairhaven silt loam, 2 to 6 percent slopes	IIe-4
FlA	Fairhaven silt loam, loamy subsoil variant, 0 to 2 percent slopes	I-1
FlB	Fairhaven silt loam, loamy subsoil variant, 2 to 6 percent slopes	IIe-1
Fx	Faxon clay loam	VIw-2
Ga	Garwin silty clay loam	IIw-1
Gc	Glencoe clay loam	IIIw-1
HaB	Hayden loam, 2 to 6 percent slopes	IIe-2
HaC	Hayden loam, 6 to 12 percent slopes	IIIe-2
HaD	Hayden loam, 12 to 18 percent slopes	IVe-2
HaE	Hayden loam, 18 to 30 percent slopes	VIe-1
JuC	Judson silt loam, 4 to 12 percent slopes	IIIe-1
KaA	Kasson silt loam, 1 to 3 percent slopes	IIe-3
Kc	Kato silty clay loam	IIw-2
KkB	Kilkenny clay loam, 2 to 6 percent slopes	IIe-3
KkC2	Kilkenny clay loam, 6 to 12 percent slopes, eroded	IIIe-3
KkD2	Kilkenny clay loam, 12 to 18 percent slopes, eroded	IVe-3
KkE	Kilkenny clay loam, 18 to 25 percent slopes	VIe-1
KlA	Klinger silt loam, 1 to 3 percent slopes	I-1
La	Lake beaches	VIw-1
LbB	Lerdal silt loam, 1 to 6 percent slopes	IIe-3
LeC2	Lerdal clay loam, 6 to 12 percent slopes, eroded	IIIe-3
LeD2	Lerdal clay loam, 12 to 18 percent slopes, eroded	IVe-3
LlB	Lester loam, 2 to 6 percent slopes	IIe-1
LlC	Lester loam, 6 to 12 percent slopes	IIIe-1
LlC2	Lester loam, 6 to 12 percent slopes, eroded	IIIe-1
LlD2	Lester loam, 12 to 18 percent slopes, eroded	IVe-1
LlE	Lester loam, 18 to 25 percent slopes	VIe-1
LuA	Le Sueur clay loam, 1 to 3 percent slopes	I-1
Ma	Marsh	VIIIw-1
Mb	Maxcreek silty clay loam	IIw-1
Mc	Maxcreek silty clay loam, swales	IIIw-1
Mf	Maxfield silty clay loam	IIw-1
Mh	Maxfield silty clay loam, swales	IIIw-1
Mk	Mazaska silty clay loam	IIw-1
MnA	Merton silt loam, 1 to 3 percent slopes	I-1

Map symbol	Mapping unit	Capability unit
MoB	Moland silt loam, 2 to 6 percent slopes----------	IIe-1
MoC	Moland silt loam, 6 to 12 percent slopes---------	IIIe-1
MoD2	Moland silt loam, 12 to 18 percent slopes, eroded---	IVe-1
Mu	Muskego muck------------------------------------	IIIw-2
NcA	Nicollet clay loam, 1 to 3 percent slopes--------	I-1
OsD2	Ostrander loam, 12 to 18 percent slopes, eroded---	IVe-1
OsE2	Ostrander loam, 18 to 30 percent slopes, eroded---	VIe-1
OtB	Ostrander silt loam, 2 to 6 percent slopes-------	IIe-1
OtC2	Ostrander silt loam, 6 to 12 percent slopes, eroded---	IIIe-1
OuA	Ostrander silt loam, bedrock substratum, 0 to 2 percent slopes-------------------------	I-1
Pa	Palms muck--------------------------------------	IIIw-2
PbA	Port Byron silt loam, 0 to 2 percent slopes------	I-1
PbB	Port Byron silt loam, 2 to 6 percent slopes------	IIe-1
PbC	Port Byron silt loam, 6 to 12 percent slopes----	IIIe-1
PbD	Port Byron silt loam, 12 to 18 percent slopes---	IVe-1
PoC	Port Byron-Bold silt loams, 6 to 12 percent slopes---	IIIe-1
PoD	Port Byron-Bold silt loams, 12 to 18 percent slopes---	IVe-1
RnB	Renova silt loam, 2 to 6 percent slopes--------	IIe-2
RnC	Renova silt loam, 6 to 12 percent slopes-------	IIIe-2
RnD2	Renova silt loam, 12 to 18 percent slopes, eroded--	IVe-2
RnE	Renova silt loam, 18 to 30 percent slopes------	VIe-1
Ro	Rolfe silty clay loam--------------------------	IIIw-1
Ru	Rough broken land------------------------------	VIIe-1
SaC	Salida gravelly sandy loam, 4 to 12 percent slopes--	VIs-1
SaD	Salida gravelly sandy loam, 12 to 30 percent slopes--	VIIs-1
Sh	Shields silt loam------------------------------	IIIw-3
Sk	Skyberg silt loam------------------------------	IIIw-3
SoE	Sogn stony loam, 18 to 35 percent slopes--	VIIs-1
TeB	Terril loam, 1 to 6 percent slopes-------------	IIe-1
TeC	Terril loam, 6 to 12 percent slopes------------	IIIe-1
VlA	Vlasaty silt loam, 1 to 4 percent slopes-------	IIe-3
WaA	Waukegan silt loam, 0 to 2 percent slopes--	IIs-1
WaB	Waukegan silt loam, 2 to 6 percent slopes--	IIe-4
We	Webster clay loam------------------------------	IIw-1
Zu	Zumbro sandy loam------------------------------	IIw-3


COMPANY
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RICE COUNTY


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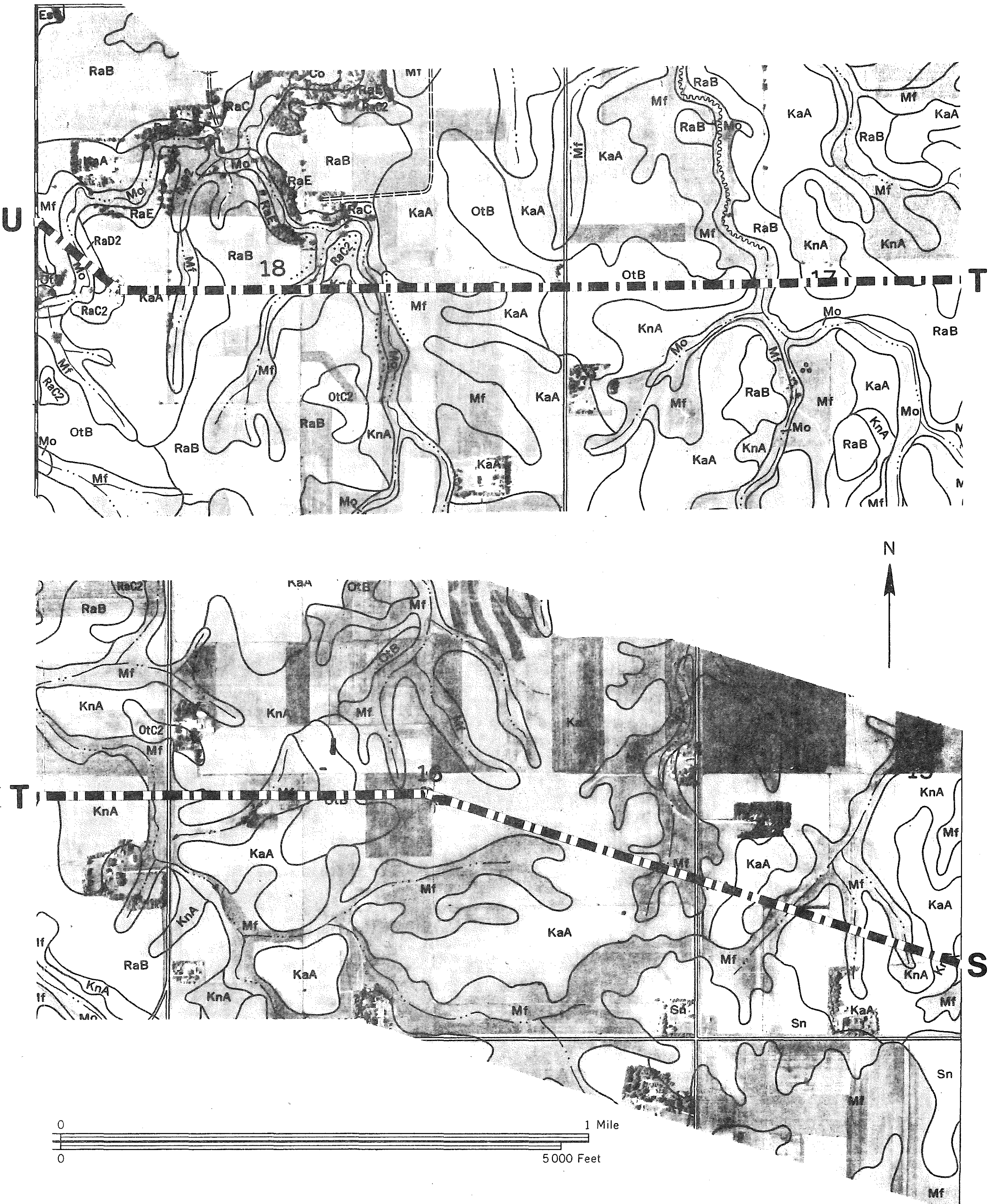
RICE COUNTY

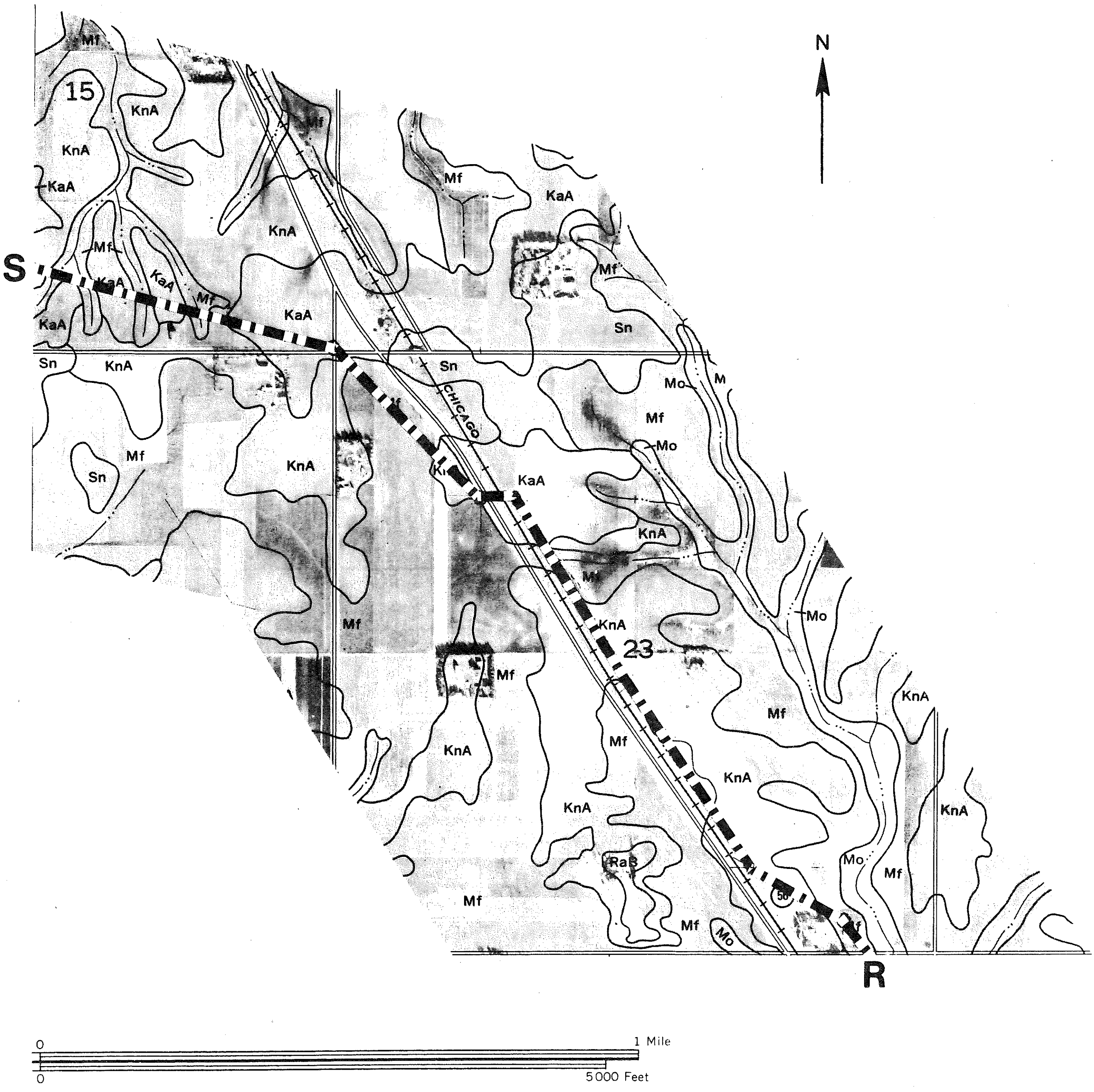
Map symbol	Mapping unit	Capability unit
Af	Alluvial land, frequently flooded	VIw-2
An	Alluvial land, sloping	VIw-3
AvA	Alvin fine sandy loam, 0 to 3 percent slopes	IIs-1
AxA	Ankeny sandy loam, 0 to 3 percent slopes	IIs-1
BaF	Bellechester sand, 25 to 45 percent slopes	VIIs-1
BbB	Billett sandy loam, 2 to 6 percent slopes	IIIe-4
BbC	Billett sandy loam, 6 to 12 percent slopes	IVe-4
Bc	Biscay loam	IIw-1
Bm	Bremer silty clay loam, wet	IIIw-3
BoE	Brodale-Sogn flaggy loams, steep	VIIs-2
BoF	Brodale-Sogn flaggy loams, very steep	VIIIs-1
BrA	Burkhardt loam, 0 to 3 percent slopes	IIIs-1
Ca	Canisteo silty clay loam	IIw-1
ChA	Chaseburg silt loam, 0 to 3 percent slopes	IIw-3
Co	Colo silty clay loam	IIIw-3
CvB	Copaston loam, 1 to 6 percent slopes	IIIe-3
CvC2	Copaston loam, 6 to 12 percent slopes, eroded	IVe-3
CwB	Copaston loam, moderately deep, 0 to 6 percent slopes	IIe-2
CwC2	Copaston loam, moderately deep, 6 to 12 percent slopes, eroded	IIIe-2
DaA	Dakota loam, 0 to 3 percent slopes	IIs-1
DeC2	Derinda silt loam, 5 to 12 percent slopes, eroded	IIIe-2
DeD2	Derinda silt loam, 12 to 25 percent slopes, eroded	IVe-2
DkA	Dickinson sandy loam, 0 to 2 percent slopes	IIIs-1
DkB	Dickinson sandy loam, 2 to 6 percent slopes	IIIe-4
DkC	Dickinson sandy loam, 6 to 12 percent slopes	IVe-4
DoB	Dodgeville silt loam, 1 to 6 percent slopes	IIe-2
DoC2	Dodgeville silt loam, 6 to 12 percent slopes, eroded	IIIe-2
DuB2	Dubuque silt loam, 2 to 6 percent slopes, eroded	IIe-2
DuC2	Dubuque silt loam, 6 to 12 percent slopes, eroded	IIIe-2
DuD2	Dubuque silt loam, 12 to 18 percent slopes, eroded	IVe-2
DuF	Dubuque silt loam, 18 to 35 percent slopes	VIIe-2

Map symbol	Mapping unit	Capability unit
EeB	Eleva sandy loam, 2 to 6 percent slopes	IIIe-4
EeD	Eleva sandy loam, 6 to 18 percent slopes	IVe-4
EsA	Estherville loam, 0 to 6 percent slopes	IIIs-1
EsC	Estherville soils, 6 to 18 percent slopes	IVe-4
FaA	Fairhaven silt loam, 0 to 3 percent slopes	IIs-1
FrE	Frontenac soils, steep	VIIe-2
FrF	Frontenac soils, very steep	VIIe-2
GaA	Gale silt loam, 0 to 3 percent slopes	IIs-1
Gm	Garwin silty clay loam	IIw-1
Gr	Garwin silty clay loam, swales	IIIw-1
GtB	Gotham fine sand, 2 to 12 percent slopes	IVs-1
GtD	Gotham fine sand, 12 to 35 percent slopes	VIIs-1
Ho	Houghton muck	VIw-1
Hs	Houghton muck, seepy	VIw-1
JoA	Joy silt loam, 0 to 3 percent slopes	I-2
KaA	Kasson silt loam, 1 to 3 percent slopes	IIs-2
KeA	Kegonsa silt loam, 0 to 3 percent slopes	IIs-1
KfD	Kegonsa and Fairhaven silt loams, 6 to 18 percent slopes	IIIe-2
KnA	Klinger silty clay loam, 1 to 3 percent slopes	I-2
La	Lawson silt loam	IIw-2
LlA	Lilah sandy loam, 0 to 6 percent slopes	IVs-1
LlD	Lilah sandy loam, 6 to 35 percent slopes	VIIs-1
LnB	Lindstrom silt loam, 2 to 6 percent slopes	IIe-1
LnC	Lindstrom silt loam, 6 to 12 percent slopes	IIIe-1
LnD	Lindstrom silt loam, 12 to 25 percent slopes	IVe-1
MaE	Marlean soils, steep	VIIs-2
MaF	Marlean soils, very steep	VIIs-2
Md	Marsh	VIIIw-1
Mf	Maxfield silty clay loam	IIw-1
Mo	Maxfield silty clay loam, swales	IIIw-1
Mp	McPaul silt loam	IIw-3
MrA	Mt. Carroll silt loam, 0 to 2 percent slopes	I-1
MrB	Mt. Carroll silt loam, 2 to 6 percent slopes	IIe-1
MrC2	Mt. Carroll silt loam, 6 to 12 percent slopes, eroded	IIIe-1
MxA	Mt. Carroll silt loam, benches, 0 to 3 percent slopes	I-1
Or	Orion silt loam, wet	IIIw-3
OtB	Ostrander silt loam, 1 to 6 percent slopes	IIe-1
OtC2	Ostrander silt loam, 6 to 12 percent slopes, eroded	IIIe-1
PaB	Plainfield loamy sand, 0 to 6 percent slopes	IVs-1
PaD	Plainfield loamy sand, 6 to 25 percent slopes	VIIs-1

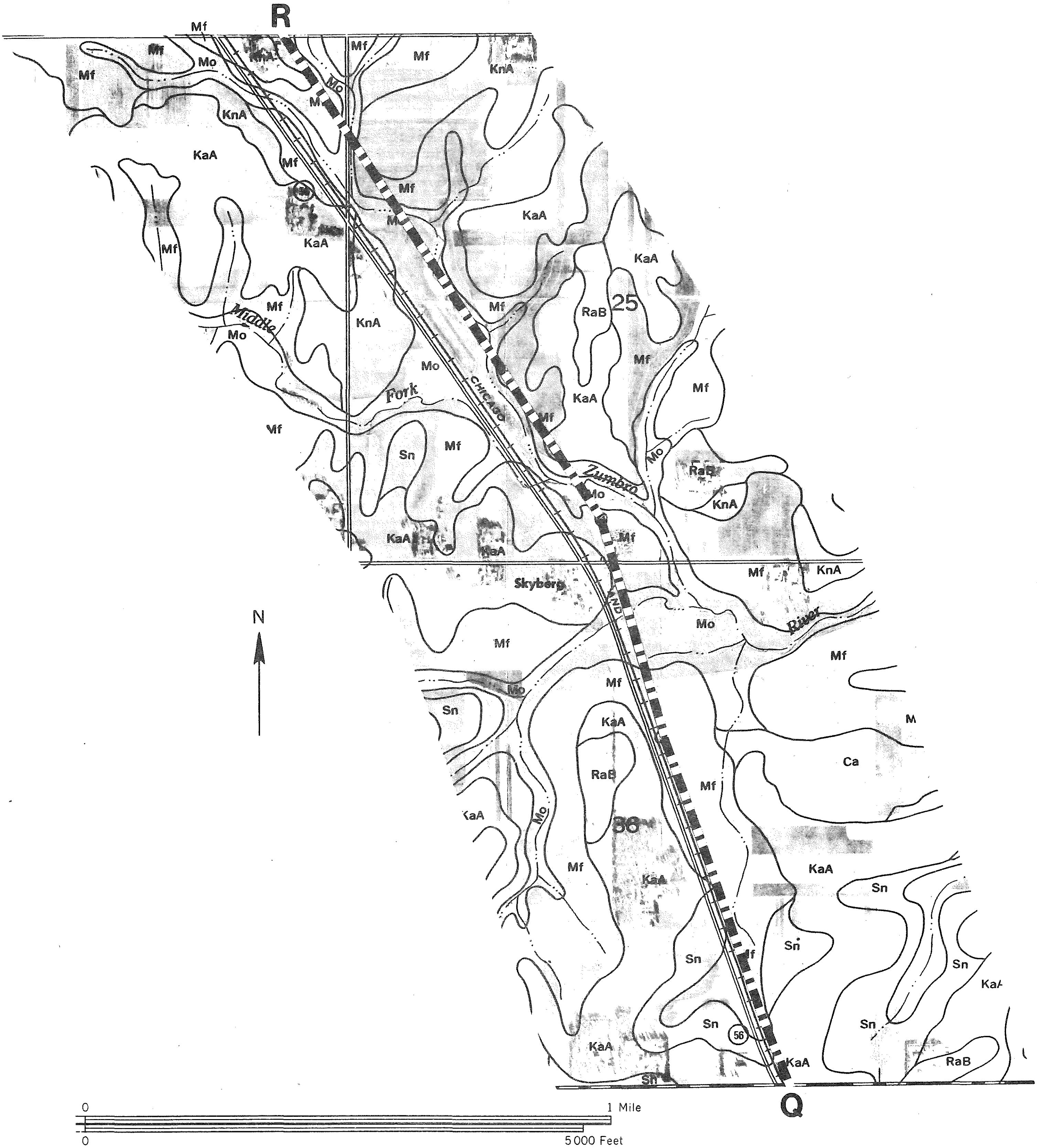
Map symbol	Mapping unit	Capability unit
PbA	Port Byron silt loam, 0 to 2 percent slopes	I-1
PbB	Port Byron silt loam, 2 to 6 percent slopes	IIe-1
PbC2	Port Byron silt loam, 6 to 12 percent slopes, eroded	IIIe-1
PoA	Port Byron silt loam, benches, 0 to 3 percent slopes	I-1
RaB	Racine silt loam, 1 to 6 percent slopes	IIe-1
RaC	Racine silt loam, 6 to 12 percent slopes	IIIe-1
RaC2	Racine silt loam, 6 to 12 percent slopes, eroded	IIIe-1
RaD2	Racine silt loam, 12 to 18 percent slopes, eroded	IVe-1
RaE	Racine soils, 18 to 35 percent slopes	VIIe-1
Rd	Radford silt loam	IIw-2
SaB	Salida gravelly coarse sand, 1 to 12 percent slopes	IVs-1
SaE	Salida gravelly coarse sand, 12 to 45 percent slopes	VIIs-1
ScC	Schapville silty clay loam, 2 to 12 percent slopes	IIIe-2
ScD	Schapville silty clay loam, 12 to 18 percent slopes	IVe-3
SdE	Schapville-Sogn complex, 18 to 35 percent slopes	VIIs-2
SfA	Seaton silt loam, 0 to 2 percent slopes	I-1
SfB	Seaton silt loam, 2 to 6 percent slopes	IIe-1
SfC2	Seaton silt loam, 6 to 12 percent slopes, eroded	IIIe-1
SfD2	Seaton silt loam, 12 to 18 percent slopes, eroded	IVe-1
SfE	Seaton silt loam, 18 to 25 percent slopes	VIe-1
ShC2	Seaton silt loam, valleys, 6 to 12 percent slopes, eroded	IIIe-1
ShD2	Seaton silt loam, valleys, 12 to 18 percent slopes, eroded	IVe-1
ShE	Seaton silt loam, valleys, 18 to 25 percent slopes	VIe-1
SkC2	Seaton complex, 6 to 12 percent slopes, eroded	IIIe-1
SkD2	Seaton complex, 12 to 25 percent slopes, eroded	IVe-1
SlE	Seaton, Timula, and Bold silt loams, steep	VIIe-1
SmC	Shullsburg silty clay loam, 2 to 14 percent slopes	IIIw-2
Sn	Skyberg silt loam	IIIw-2
SoD	Sogn and Copaston soils, 12 to 25 percent slopes	VIIs-2
SpA	Sparta loamy sand, 0 to 3 percent slopes	IVs-1
TeB	Terril sandy loam, 2 to 6 percent slopes	IIe-1
TeC	Terril sandy loam, 6 to 12 percent slopes	IIIe-1
TeD	Terril sandy loam, 12 to 25 percent slopes	IVe-1
TmB	Timula silt loam, 2 to 6 percent slopes	IIe-1
TmC	Timula silt loam, 6 to 12 percent slopes	IIIe-1
ToD	Timula-Bold silt loams, 12 to 25 percent slopes	VIe-1
VaA	Vasa silt loam, 0 to 3 percent slopes	I-2
WaA	Waukegan silt loam, 0 to 3 percent slopes	IIs-1
WhB	Whalan silt loam, 1 to 6 percent slopes	IIe-2
WhC2	Whalan silt loam, 6 to 12 percent slopes, eroded	IIIe-2
WsB	Whalan silt loam, moderately shallow, 1 to 6 percent slopes	IIIe-3
WsC2	Whalan silt loam, moderately shallow, 6 to 12 percent slopes, eroded	IVe-3
WsD2	Whalan silt loam, moderately shallow, 12 to 18 percent slopes, eroded	IVe-3
WsE	Whalan silt loam, moderately shallow, 18 to 35 percent slopes	VIIe-2
Zu	Zumbro loamy sand	IIIs-1



GOODHUE COUNTY



GOODHUE COUNTY



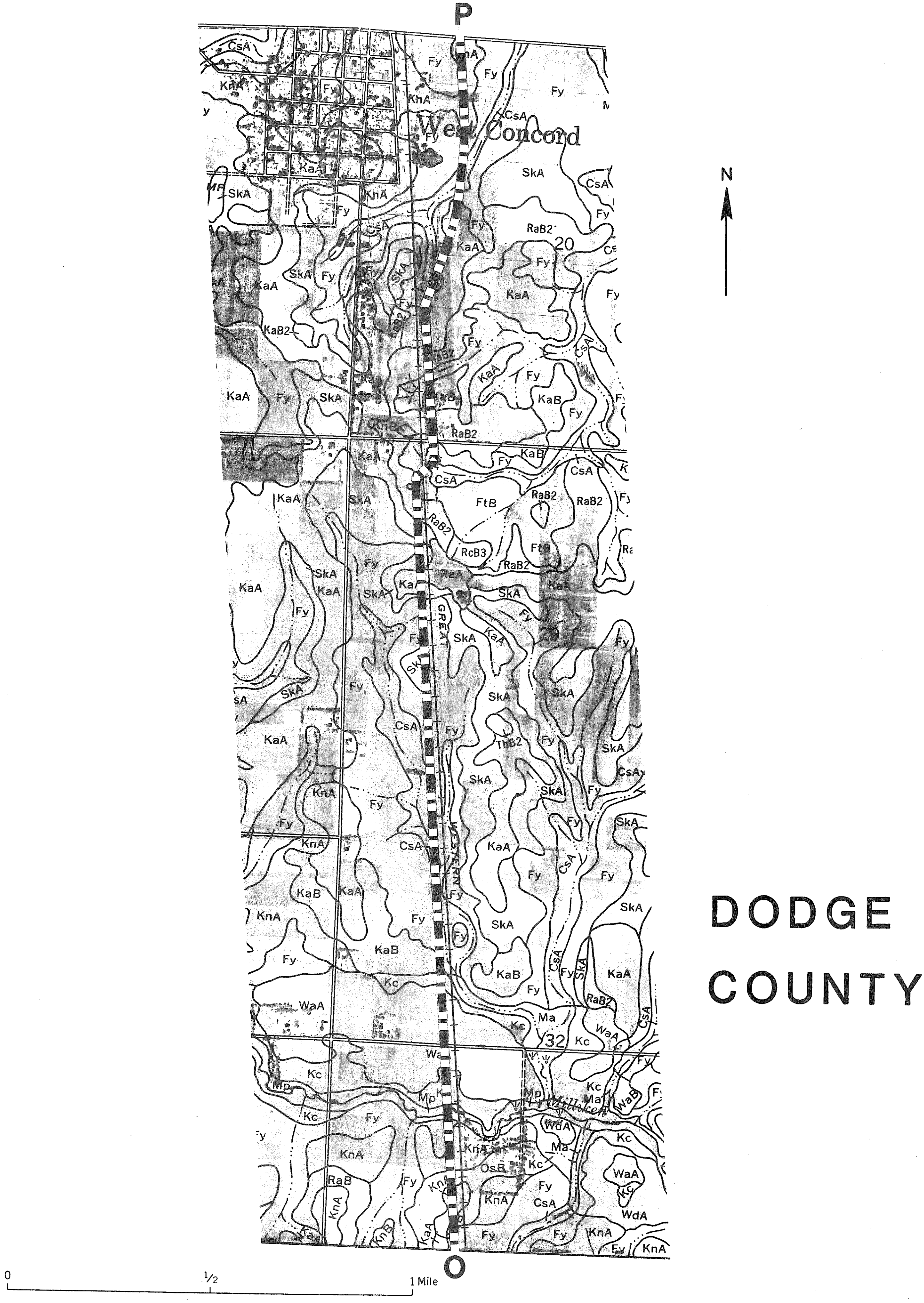
GOODHUE COUNTY

DODGE COUNTY

Map symbol	Mapping unit	Capability unit
Ad	Alluvial land	IIw–4
BbA	Bixby loam, 0 to 2 percent slopes	IIs–1
BbB2	Bixby loam, 2 to 6 percent slopes, eroded	IIe–3
BxA	Bixby loam, shallow, 0 to 2 percent slopes	IIIs–1
BxB2	Bixby loam, shallow, 2 to 6 percent slopes, eroded	IIIs–3
Ca	Canisteo silty clay loam	IIIw–4
Cb	Canisteo silty clay loam, coarse substratum	IIIw–5
ChA	Chaseburg silt loam, 0 to 2 percent slopes	IIw–4
ChB	Chaseburg silt loam, 2 to 6 percent slopes	IIw–5
CsA	Clyde silty clay loam, 0 to 2 percent slopes	IIIw–4
CsB	Clyde silty clay loam, 2 to 6 percent slopes	VIw–2
DaA	Dakota sandy loam, 0 to 2 percent slopes	IIIs–1
DaB2	Dakota sandy loam, 2 to 6 percent slopes, moderately eroded	IIIs–2
DaC2	Dakota sandy loam, 6 to 12 percent slopes, moderately eroded	IVs–1
DoA	Downs silt loam, 0 to 2 percent slopes	I–1
DoB	Downs silt loam, 2 to 6 percent slopes	IIe–1
DoB2	Downs silt loam, 2 to 6 percent slopes, moderately eroded	IIe–1
DoC2	Downs silt loam, 6 to 12 percent slopes, moderately eroded	IIIe–1
DoC3	Downs silt loam, 6 to 12 percent slopes, severely eroded	IIIe–1
DoD2	Downs silt loam, 12 to 25 percent slopes, moderately eroded	IVe–1
FaA	Fayette silt loam, 0 to 2 percent slopes	I–2
FaB	Fayette silt loam, 2 to 6 percent slopes	IIe–2
FaB2	Fayette silt loam, 2 to 6 percent slopes, moderately eroded	IIe–2
FaC	Fayette silt loam, 6 to 12 percent slopes	IIIe–1
FaC2	Fayette silt loam, 6 to 12 percent slopes, moderately eroded	IIIe–1
FaD	Fayette silt loam, 12 to 18 percent slopes	IVe–1
FaD2	Fayette silt loam, 12 to 18 percent slopes, moderately eroded	IVe–1
FaC3	Fayette silt loam, 6 to 12 percent slopes, severely eroded	IIIe–1
FaD3	Fayette silt loam, 12 to 18 percent slopes, severely eroded	IVe–1
FsE2	Fayette and Seaton silt loams, 18 to 25 percent slopes, eroded	VIe–1
FsF2	Fayette and Seaton silt loams, 25 to 35 percent slopes, moderately eroded	VIIe–1
FsE3	Fayette and Seaton silt loams, 18 to 25 percent slopes, severely eroded	VIe–1
FtB	Floyd silty clay loam, 2 to 6 percent slopes	IIw–2
Fy	Floyd and Clyde silty clay loams	IIw–1
HaA	Hayfield silt loam, 0 to 2 percent slopes	IIs–1
HaB	Hayfield silt loam, 2 to 6 percent slopes	IIe–3
JuA	Judson silt loam, 0 to 2 percent slopes	IIw–4
JuB	Judson silt loam, 2 to 6 percent slopes	IIw–5
KaA	Kasson silt loam, 0 to 2 percent slopes	IIs–1
KaB	Kasson silt loam, 2 to 6 percent slopes	IIe–2
KaB2	Kasson silt loam, 2 to 6 percent slopes, moderately eroded	IIe–2
Kc	Kato silty clay loam	IIw–3
KnA	Kenyon silt loam, 0 to 2 percent slopes	I–1
KnB	Kenyon silt loam, 2 to 6 percent slopes	IIe–1
KnB2	Kenyon silt loam, 2 to 6 percent slopes, moderately eroded	IIe–1
Lo	Lawson and Orion silt loams	IIw–4
Ma	Marshan silty clay loam	IIIw–5
Mp	Mixed alluvial land, poorly drained	VIw–1
Mx	Mixed alluvial land, moderately well drained	VIw–1
OsA	Ostrander silt loam, 0 to 2 percent slopes	I–1
OsB	Ostrander silt loam, 2 to 6 percent slopes	IIe–1
OsB2	Ostrander silt loam, 2 to 6 percent slopes, moderately eroded	IIe–1
OsC2	Ostrander silt loam, 6 to 12 percent slopes, moderately eroded	IIIe–1
PmA	Peat and Muck, coarse substrata, 0 to 2 percent slopes	IIIw–7
PtA	Peat and Muck, medium textured substrata, 0 to 2 percent slopes	IIIw–6
PtB	Peat and Muck, medium textured substrata, 2 to 6 percent slopes	VIw–2
RaA	Racine silt loam, 0 to 2 percent slopes	I–1
RaB	Racine silt loam, 2 to 6 percent slopes	IIe–1
RaB2	Racine silt loam, 2 to 6 percent slopes, moderately eroded	IIe–1
RaC	Racine silt loam, 6 to 12 percent slopes	IIIe–1
RaC2	Racine silt loam, 6 to 12 percent slopes, moderately eroded	IIIe–1
RcB3	Racine soils, 2 to 6 percent slopes, severely eroded	IIe–2
RcC3	Racine soils, 6 to 12 percent slopes, severely eroded	IIIe–1
ReA	Renova silt loam, 0 to 2 percent slopes	I–2
ReB	Renova silt loam, 2 to 6 percent slopes	IIe–2
ReB2	Renova silt loam, 2 to 6 percent slopes, moderately eroded	IIe–2
ReC	Renova silt loam, 6 to 12 percent slopes	IIIe–1
ReC2	Renova silt loam, 6 to 12 percent slopes, moderately eroded	IIIe–1
ReD	Renova silt loam, 12 to 18 percent slopes	IVe–1
ReD2	Renova silt loam, 12 to 18 percent slopes, moderately eroded	IVe–1
ReE	Renova silt loam, 18 to 25 percent slopes	VIe–1
ReE2	Renova silt loam, 18 to 25 percent slopes, moderately eroded	VIe–1
ReF2	Renova silt loam, 25 to 35 percent slopes, eroded	VIIe–1
RfB3	Renova soils, 2 to 6 percent slopes, severely eroded	IIe–2

Map symbol	Mapping unit	Capability unit
RfC3	Renova soils, 6 to 12 percent slopes, severely eroded	IIIe-1
RfD3	Renova soils, 12 to 18 percent slopes, severely eroded	IVe-1
RfE3	Renova soils, 18 to 25 percent slopes, severely eroded	VIe-1
RoB2	Rockton silt loam, 2 to 6 percent slopes, moderately eroded	IIIs-2
RoD	Rockton silt loam, 12 to 18 percent slopes	VIs-1
RoD2	Rockton silt loam, 12 to 18 percent slopes, moderately eroded	VIs-1
RpA	Rockton silt loam, moderately deep, 0 to 2 percent slopes	IIs-1
RpB	Rockton silt loam, moderately deep, 2 to 6 percent slopes	IIe-3
RpC	Rockton silt loam, moderately deep, 6 to 12 percent slopes	IIIe-2
RsC3	Rockton soils, 6 to 12 percent slopes, severely eroded	IVs-1
RsD3	Rockton soils, 12 to 18 percent slopes, severely eroded	VIs-1
Ru	Rough broken and stony land	VIIe-1
SaA	Sargeant silt loam, 0 to 2 percent slopes	IIIw-1
SeB	Seaton silt loam, 2 to 6 percent slopes	IIe-2
SeB2	Seaton silt loam, 2 to 6 percent slopes, moderately eroded	IIe-2
SeC	Seaton silt loam, 6 to 12 percent slopes	IIIe-1
SeC2	Seaton silt loam, 6 to 12 percent slopes, moderately eroded	IIIe-1
SeC3	Seaton silt loam, 6 to 12 percent slopes, severely eroded	IIIe-1
SeD	Seaton silt loam, 12 to 18 percent slopes	IVe-1
SeD2	Seaton silt loam, 12 to 18 percent slopes, moderately eroded	IVe-1
SeD3	Seaton silt loam, 12 to 18 percent slopes, severely eroded	IVe-1
SkA	Skyberg silt loam, 0 to 2 percent slopes	IIIw-1
SkB	Skyberg silt loam, 2 to 6 percent slopes	IIIw-3
TaA	Tama silt loam, 0 to 2 percent slopes	I-1
TaB	Tama silt loam, 2 to 6 percent slopes	IIe-1
TaB2	Tama silt loam, 2 to 6 percent slopes, moderately eroded	IIe-1
Te	Terrace escarpments	VIIe-1
ThB2	Thurston loam, 2 to 6 percent slopes, moderately eroded	IIe-3
ThB3	Thurston loam, 2 to 6 percent slopes, severely eroded	IIe-3
ThC	Thurston loam, 6 to 12 percent slopes	IIIe-3
ThC2	Thurston loam, 6 to 12 percent slopes, moderately eroded	IIIe-3
ThC3	Thurston loam, 6 to 12 percent slopes, severely eroded	IIIe-3
ThD3	Thurston loam, 12 to 18 percent slopes, severely eroded	VIs-1
TsB3	Thurston soils, 2 to 6 percent slopes, severely eroded	IIIs-3
TsC2	Thurston soils, 6 to 12 percent slopes, moderately eroded	IVs-1
TsC3	Thurston soils, 6 to 12 percent slopes, severely eroded	IVs-1
TtA	Thurston and Dickinson loams, 0 to 2 percent slopes	IIs-1
TtB	Thurston and Dickinson loams, 2 to 6 percent slopes	IIe-3
TuA	Thurston and Dickinson soils, 0 to 2 percent slopes	IIIs-1
TuB	Thurston and Dickinson soils, 2 to 6 percent slopes	IIIs-2
TuB2	Thurston and Dickinson soils, 2 to 6 percent slopes, moderately eroded	IIIs-2
Ud	Udolpho silt loam	IIIw-2
VaA	Vlasaty silt loam, 0 to 2 percent slopes	IIs-1
VaB	Vlasaty silt loam, 2 to 6 percent slopes	IIe-2
VaB2	Vlasaty silt loam, 2 to 6 percent slopes, moderately eroded	IIe-2
WaA	Waukegan silt loam, 0 to 2 percent slopes	IIs-1
WaB	Waukegan silt loam, 2 to 6 percent slopes	IIe-3
WaB2	Waukegan silt loam, 2 to 6 percent slopes, moderately eroded	IIe-3
WdA	Waukegan silt loam, deep, 0 to 2 percent slopes	I-1
WkA	Waukegan silt loam, thick surface variant, 0 to 2 percent slopes	I-1
WmC2	Waukegan-Bixby silt loams, 6 to 12 percent slopes, moderately eroded	IIIe-3
WnB	Whalan silt loam, 2 to 6 percent slopes	IIIs-3
WnB2	Whalan silt loam, 2 to 6 percent slopes, moderately eroded	IIIs-3
WnC	Whalan silt loam, 6 to 12 percent slopes	IVs-1
WnC2	Whalan silt loam, 6 to 12 percent slopes, moderately eroded	IVs-1
WnD	Whalan silt loam, 12 to 18 percent slopes	VIs-1
WnD2	Whalan silt loam, 12 to 18 percent slopes, moderately eroded	VIs-1
WoB	Whalan silt loam, moderately deep, 2 to 6 percent slopes	IIe-3
WoB2	Whalan silt loam, moderately deep, 2 to 6 percent slopes, moderately eroded	IIe-3
WoC	Whalan silt loam, moderately deep, 6 to 12 percent slopes	IIIe-2
WoC2	Whalan silt loam, moderately deep, 6 to 12 percent slopes, moderately eroded	IIIe-2
WoD	Whalan silt loam, moderately deep, 12 to 18 percent slopes	IVe-1
WoD2	Whalan silt loam, moderately deep, 12 to 18 percent slopes, moderately eroded	IVe-1
WoE	Whalan silt loam, moderately deep, 18 to 25 percent slopes	VIe-1
WoE2	Whalan silt loam, moderately deep, 18 to 25 percent slopes, moderately eroded	VIe-1
WpC3	Whalan soils, 6 to 12 percent slopes, severely eroded	IVs-1
WpD3	Whalan soils, 12 to 18 percent slopes, severely eroded	VIs-1
WsB3	Whalan soils, moderately deep, 2 to 6 percent slopes, severely eroded	IIe-3
WsC3	Whalan soils, moderately deep, 6 to 12 percent slopes, severely eroded	IIIe-2
WsD3	Whalan soils, moderately deep, 12 to 18 percent slopes, severely eroded	IVe-1
WuA	Wykoff loam, 0 to 2 percent slopes	IIs-1
WuB	Wykoff loam, 2 to 6 percent slopes	IIe-3
WuB2	Wykoff loam, 2 to 6 percent slopes, moderately eroded	IIe-3
WuC	Wykoff loam, 6 to 12 percent slopes	IIIe-3
WuC2	Wykoff loam, 6 to 12 percent slopes, moderately eroded	IIIe-3
WuC3	Wykoff loam, 6 to 12 percent slopes, severely eroded	IIIe-3
WuD2	Wykoff loam, 12 to 18 percent slopes, eroded	IVe-1
WuD3	Wykoff loam, 12 to 18 percent slopes, severely eroded	IVe-1
WyB	Wykoff soils, 2 to 6 percent slopes	IIIs-3
WyB2	Wykoff soils, 2 to 6 percent slopes, moderately eroded	IIIs-3
WyC2	Wykoff soils, 6 to 12 percent slopes, eroded	IVs-1
WyC3	Wykoff soils, 6 to 12 percent slopes, severely eroded	IVs-1
WzD2	Wykoff and Thurston soils, 12 to 18 percent slopes, eroded	VIs-1
WzD3	Wykoff and Thurston soils, 12 to 18 percent slopes, severely eroded	VIs-1

DODGE COUNTY


P
West Concord
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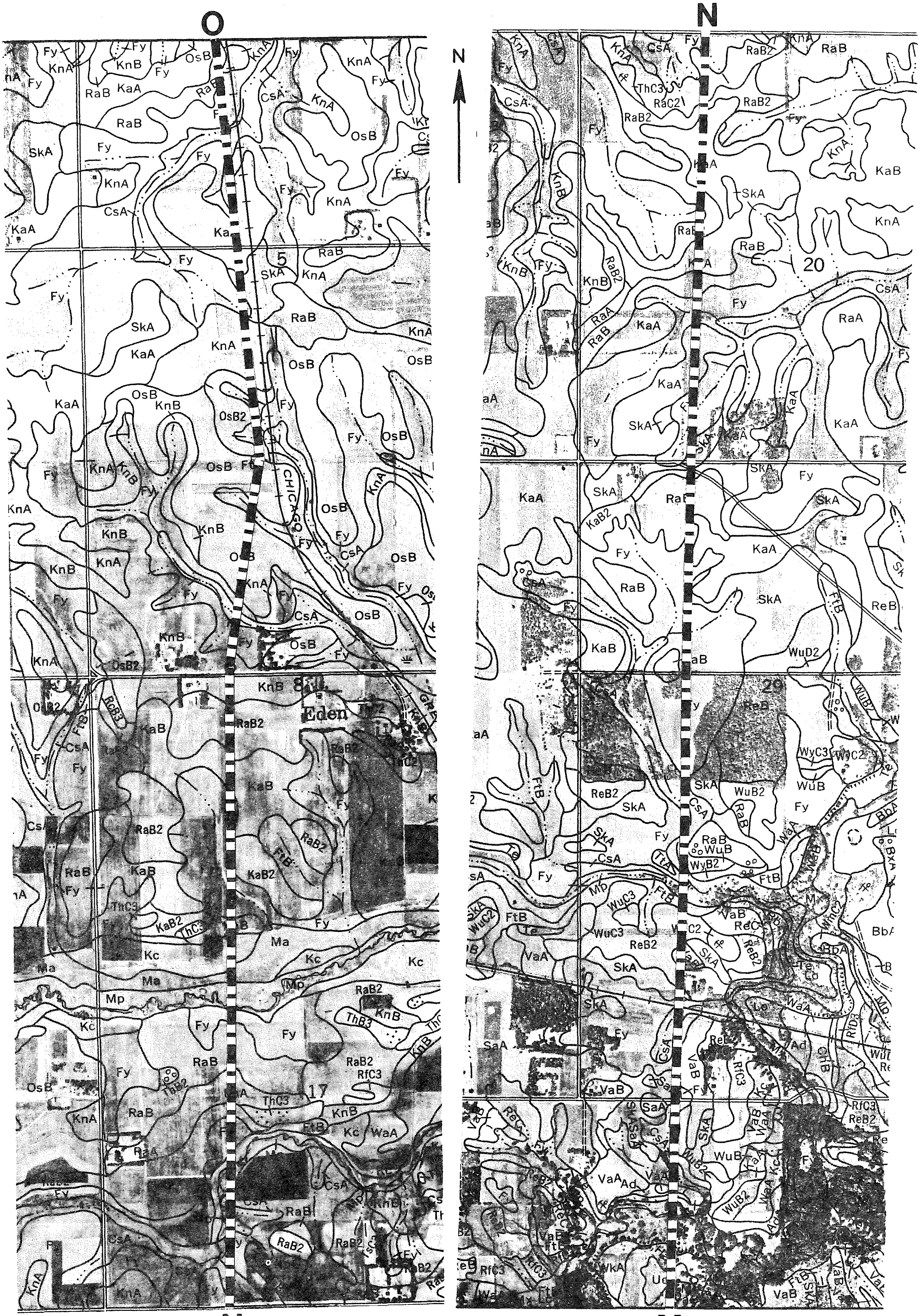
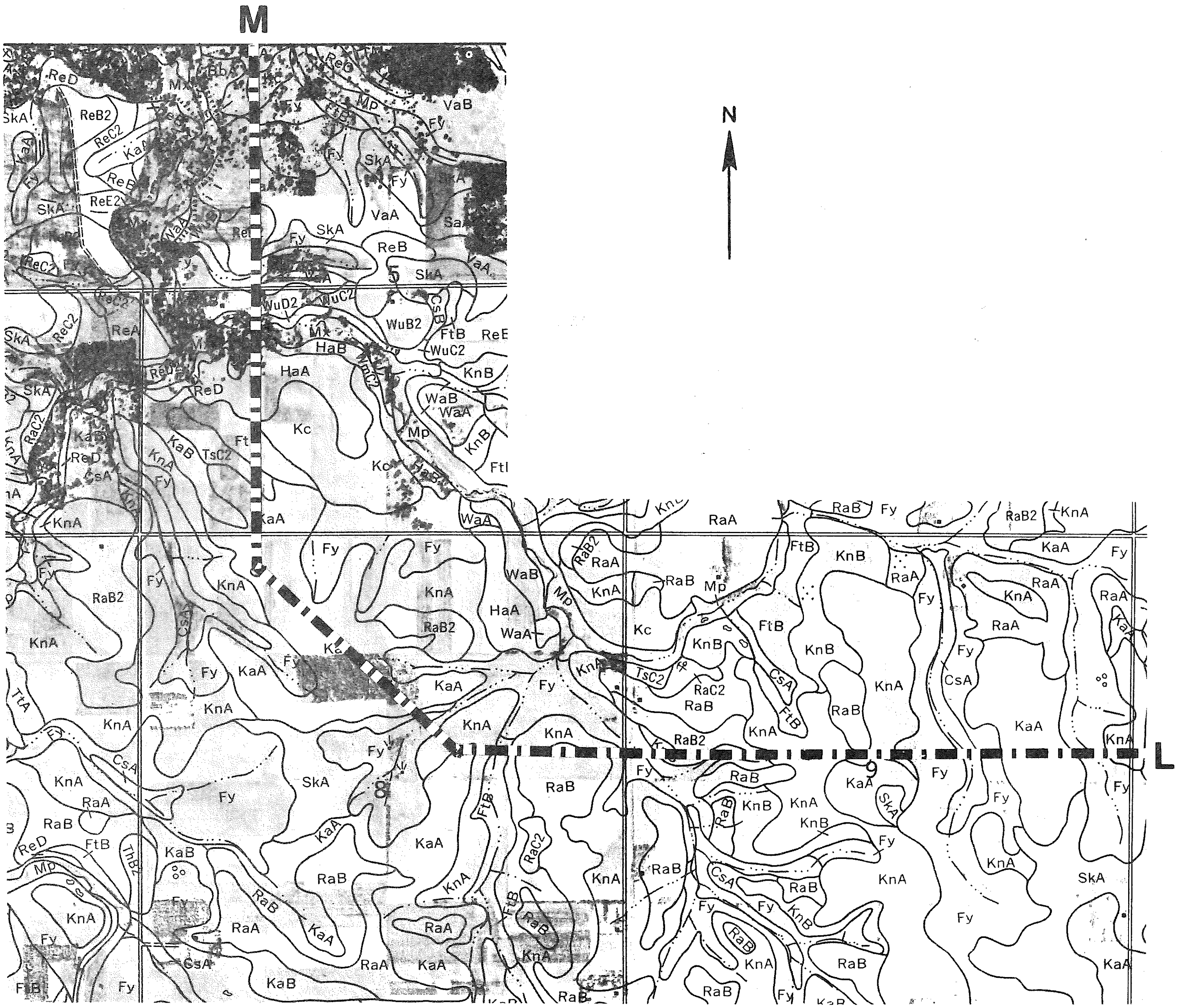
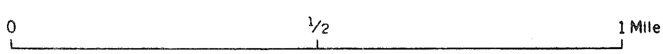


0 ½ 1 Mile

DODGE COUNTY





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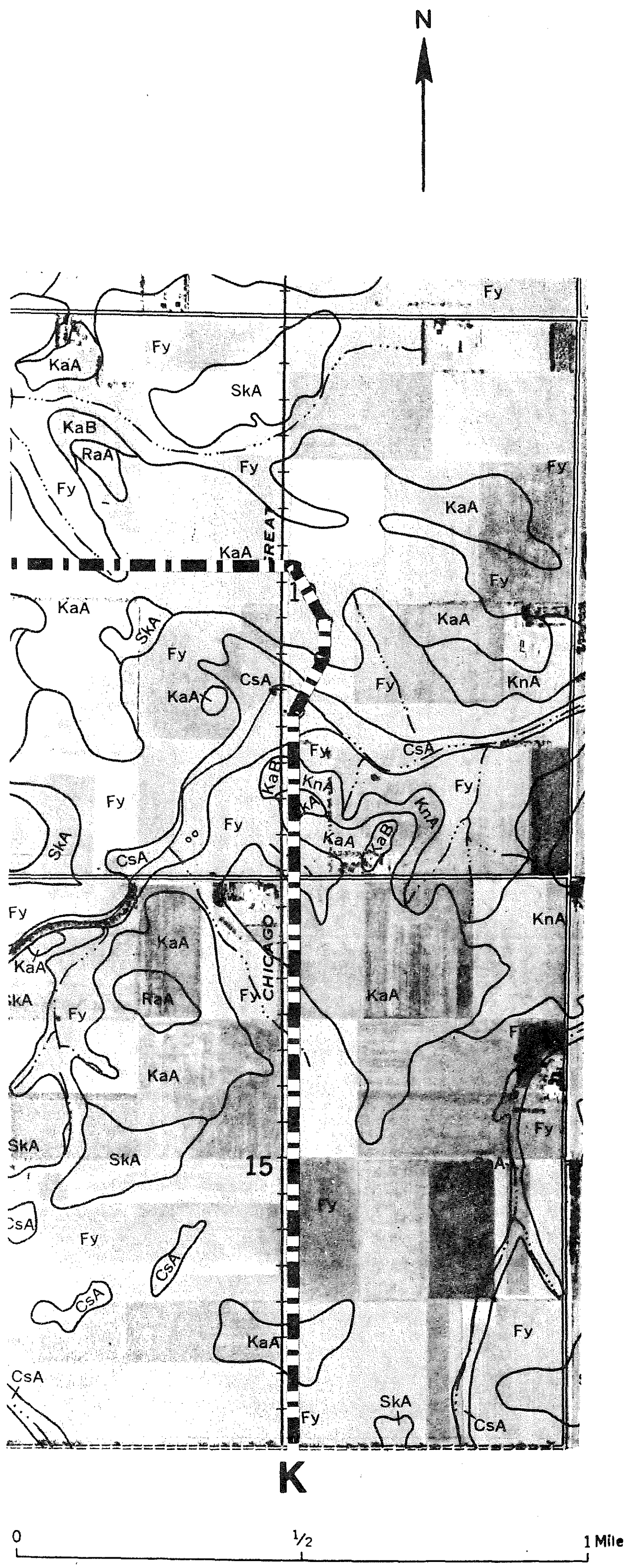

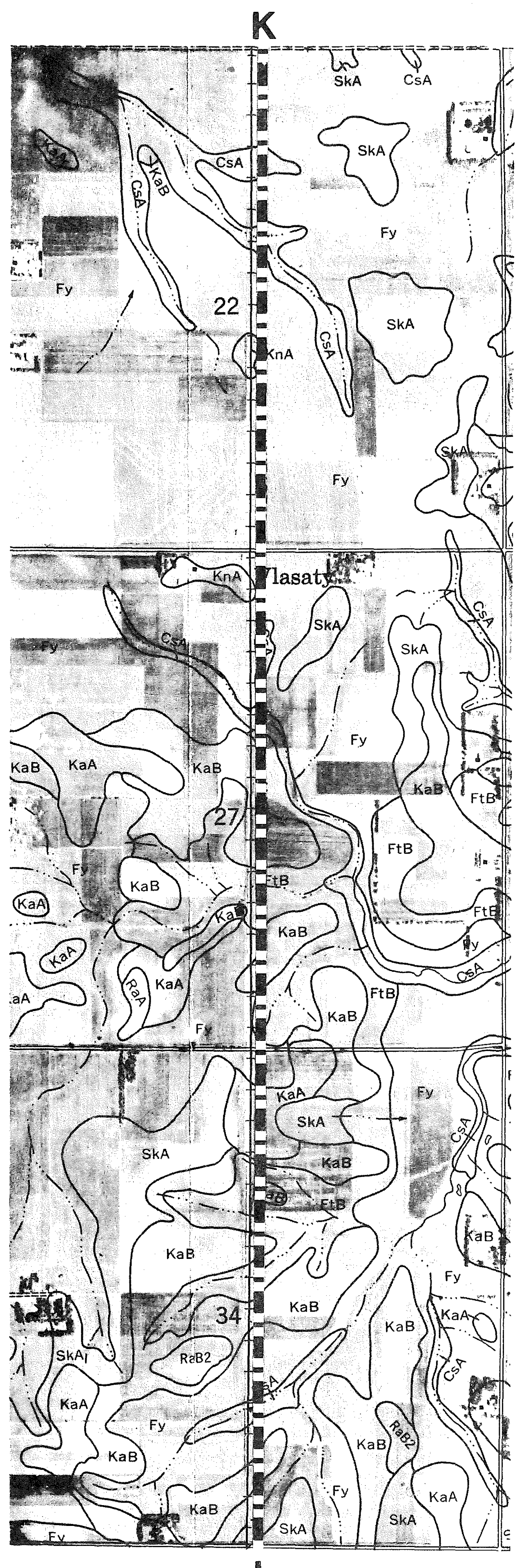

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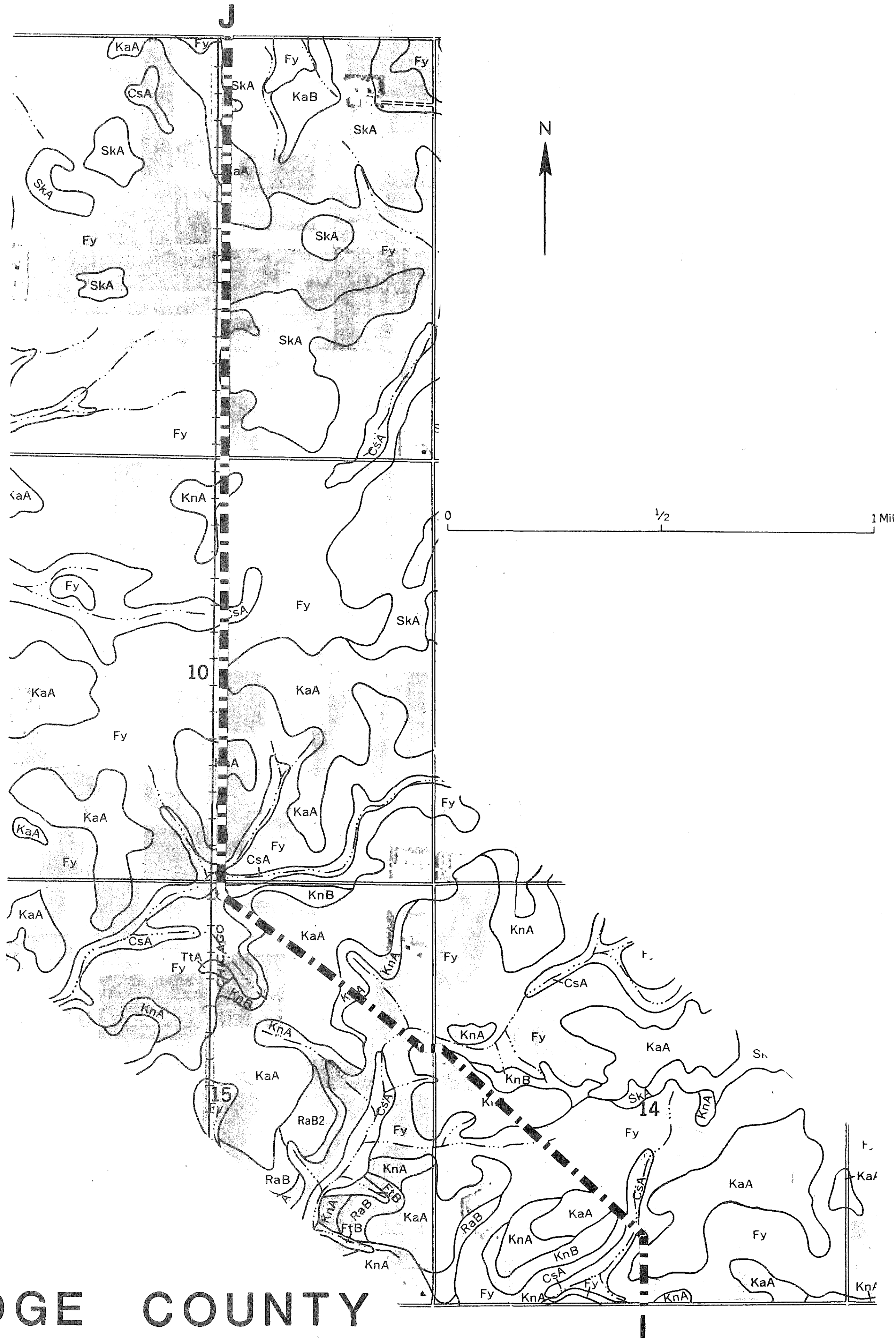

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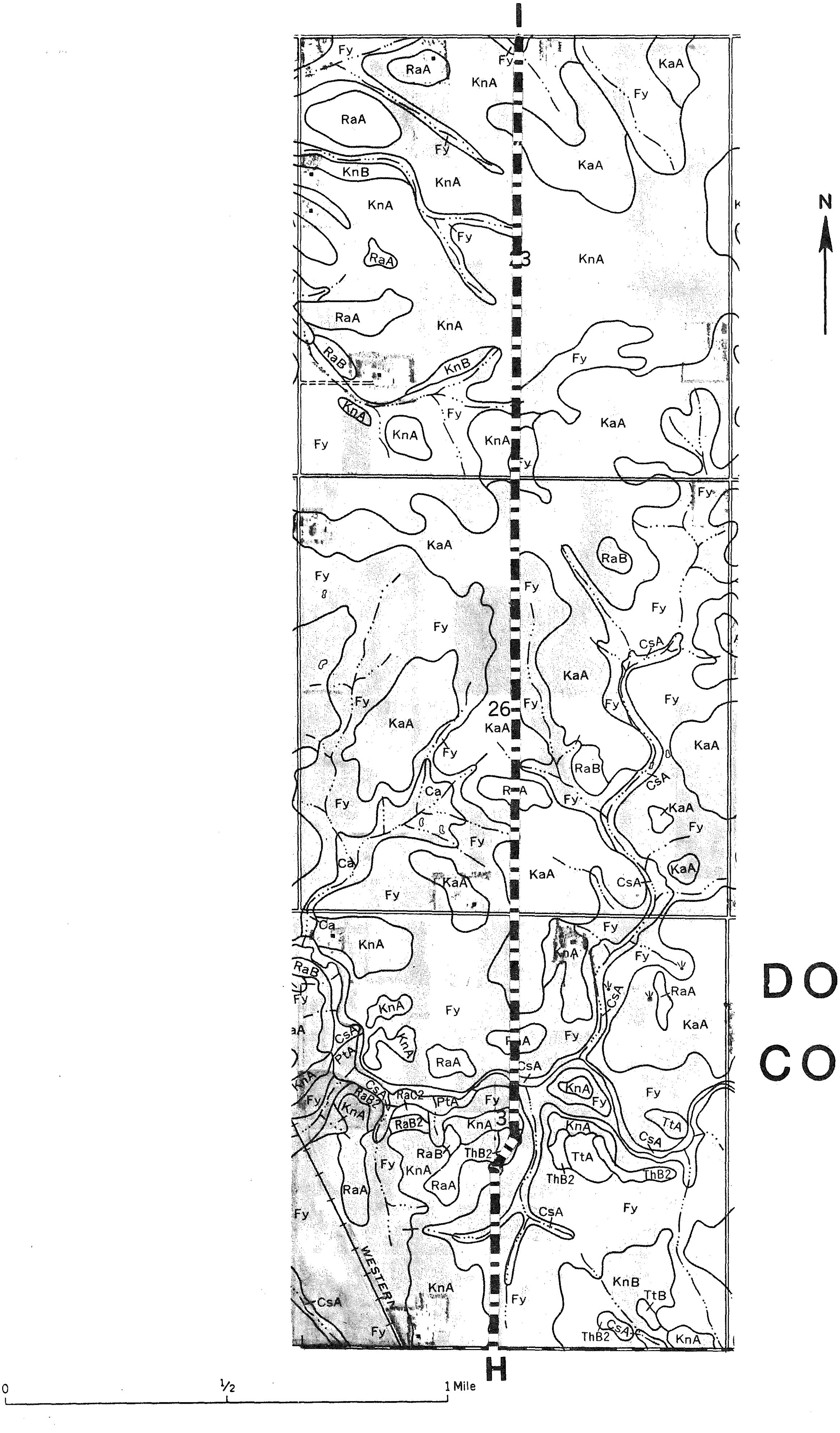


DODGE COUNTY

MOWER COUNTY

K Dark colored, fine textured, moderately well drained soils on gentle slopes (0 to 7 per cent)

- Granger silt loam, nearly level phase
- Granger silt loam, nearly level overwash phase ....
- Kenyon silt loam, nearly level phase......
- Kenyon silt loam, undulating phase.........
- Taopi-Kenyon silt loams, nearly level phase ....
- Taopi-Kenyon silt loams, undulating phase ....

C Dark colored, fine textured, well drained soils on gentle to moderate slopes (2 to 12 per cent)

- Ostrander silt loam, eroded gently rolling phase ....
- Rockton silt loam, eroded gently rolling phase ....
- Rockton silt loam, undulating phase......

R Moderately light colored, fine textured, well drained soils on gentle slopes (0 to 7 per cent)

- Racine silt loam, nearly level phase.........
- Racine silt loam, undulating phase...........
- Renova silt loam, nearly level phase .....
- Renova silt loam, undulating phase.........
- Whalen silt loam, undulating phase ....

W Moderately light colored, fine textured, well drained soils on moderate slopes (7 to 12 per cent)

- Racine silt loam, gently rolling phase......
- Renova silt loam, eroded gently rolling phase ....
- Whalen silt loam, eroded gently rolling phase ....

G Light colored, fine textured, poorly drained soils on nearly level to gentle slopes (0 to 7 per cent)

- Sargeant silt loam, nearly level phase
- Sargeant silt loam, undulating phase ....

B Soils of the bottoms and organic soils (0 to 2 per cent)

- Huntsville silty clay loam..........
- Lomax fine sandy loam ....
- Mixed alluvium ....
- Peat and muck..........

L Light colored silt loams, loams, and sandy loams on terraces and uplands, overlying sand and gravel, on gentle slopes (0 to 7 per cent)

- Bixby loam, nearly level phase..........
- Bixby loam, undulating phase..........
- Lamont fine sandy loam, nearly level phase ....
- Lamont fine sandy loam, undulating phase ....
- Tell silt loam, nearly level phase..........
- Tell silt loam, undulating phase ....
- Wykoff loams and sandy loams, nearly level phases ....
- Wykoff loams and sandy loams, undulating phases ....

T Dark and light colored silt loams, loams, and sandy loams, overlying sand, gravel, or bedrock, on moderate to strong slopes (7 to 18 per cent)

- Dickinson fine sandy loam, eroded gently rolling phase..........
- Lamont fine sandy loam, eroded gently rolling phase..........
- Sogn silt loam, eroded strongly sloping phase ....
- Terrace escarpment ....
- Thurston loams and sandy loams, eroded gently rolling phases..........
- Thurston loams and sandy loams, eroded rolling phases..........
- Wykoff loams and sandy loams, eroded gently rolling phases ....
- Wykoff loams and sandy loams, eroded rolling phases..........

F Dark colored, fine textured, imperfectly and poorly drained, nearly level to undulating soils (0 to 7 per cent)

- Clyde silty clay loam..........
- Floyd silty clay loam, nearly level phase ....
- Floyd silty clay loam, undulating phase
- Varco silt loam, nearly level phase.........
- Varco silt loam, undulating phase..........

Dark colored, imperfectly and poorly drained, fine textured, nearly level soils (0 to 2 per cent)

- Kato silty clay loam..........
- Kato silty clay loam, calcareous variant
- Marshan silty clay loam..........

D Dark colored, well drained loams, silt loams, and sandy loams on terraces and uplands, underlain by sand or gravel, on gentle slopes (0 to 7 per cent)

Dakota loam, nearly level phase..............

Dakota loams and sandy loams, undulating phases ....

Dakota sandy loam, nearly level phase

Dakota sandy loam, undulating phase

Dickinson fine sandy loam, nearly level phase ....

Dickinson fine sandy loam, undulating phase ....

Thurston loams and sandy loams, nearly level phase ....

Thurston loams and sandy loams, undulating phase ....

Waukegan silt loam, nearly level phase ....

Waukegan silt loam, undulating phase

N Light colored, imperfectly and poorly drained, fine textured, nearly level soil (0 to 2 per cent)

Udolpho silt loam, nearly level phase

S Moderately light colored, fine textured, moderately well and imperfectly drained soils on nearly level to gentle slopes (0 to 7 per cent)

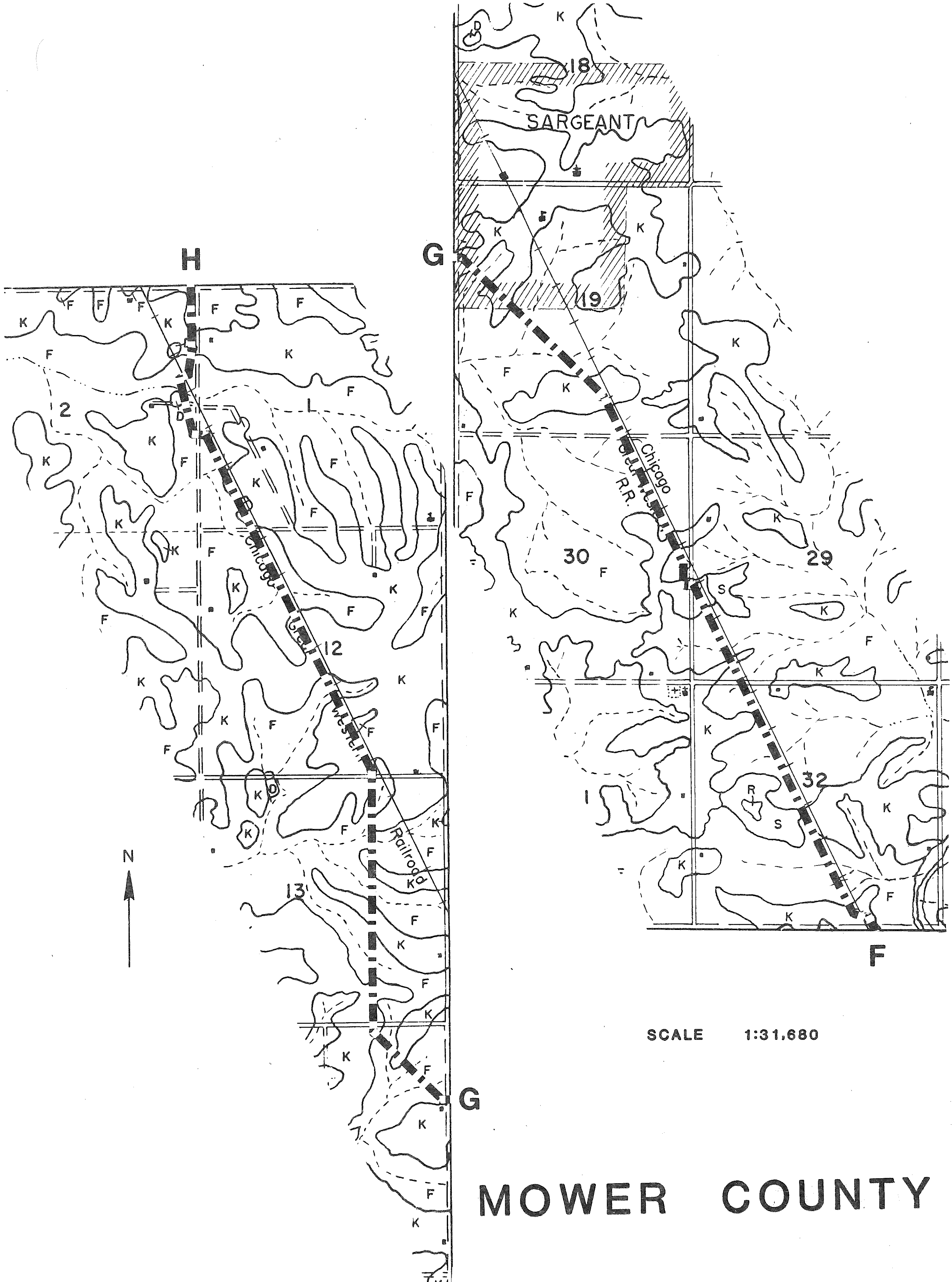
Kasson silt loam, nearly level phase......

Kasson silt loam, undulating phase ....

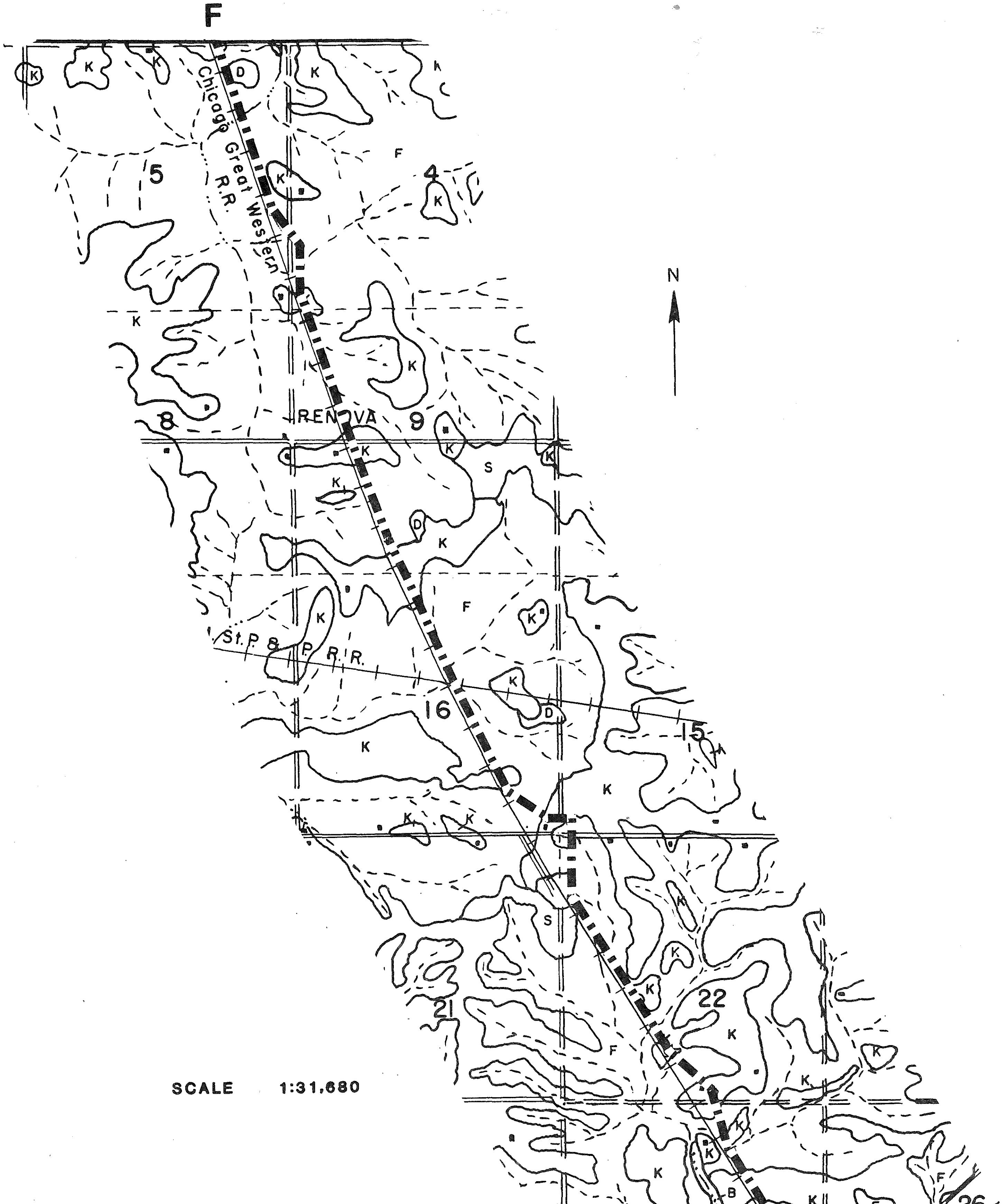
Roseville silt loam, nearly level phase

Skyberg silt loam, nearly level phase

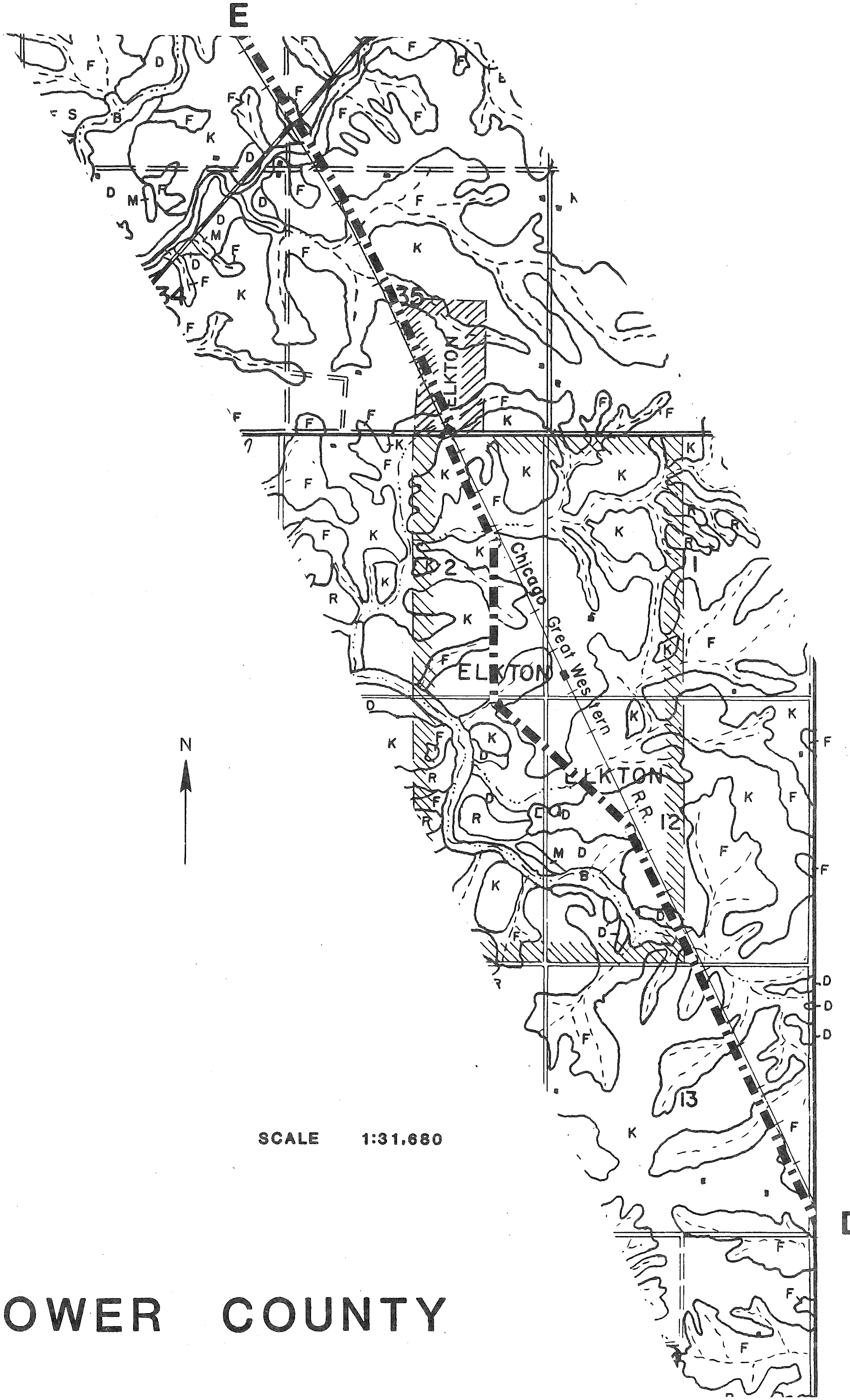
Skyberg silt loam, undulating phase .....



MOWER COUNTY



MOWER COUNTY



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MOWER COUNTY

MOWER COUNTY

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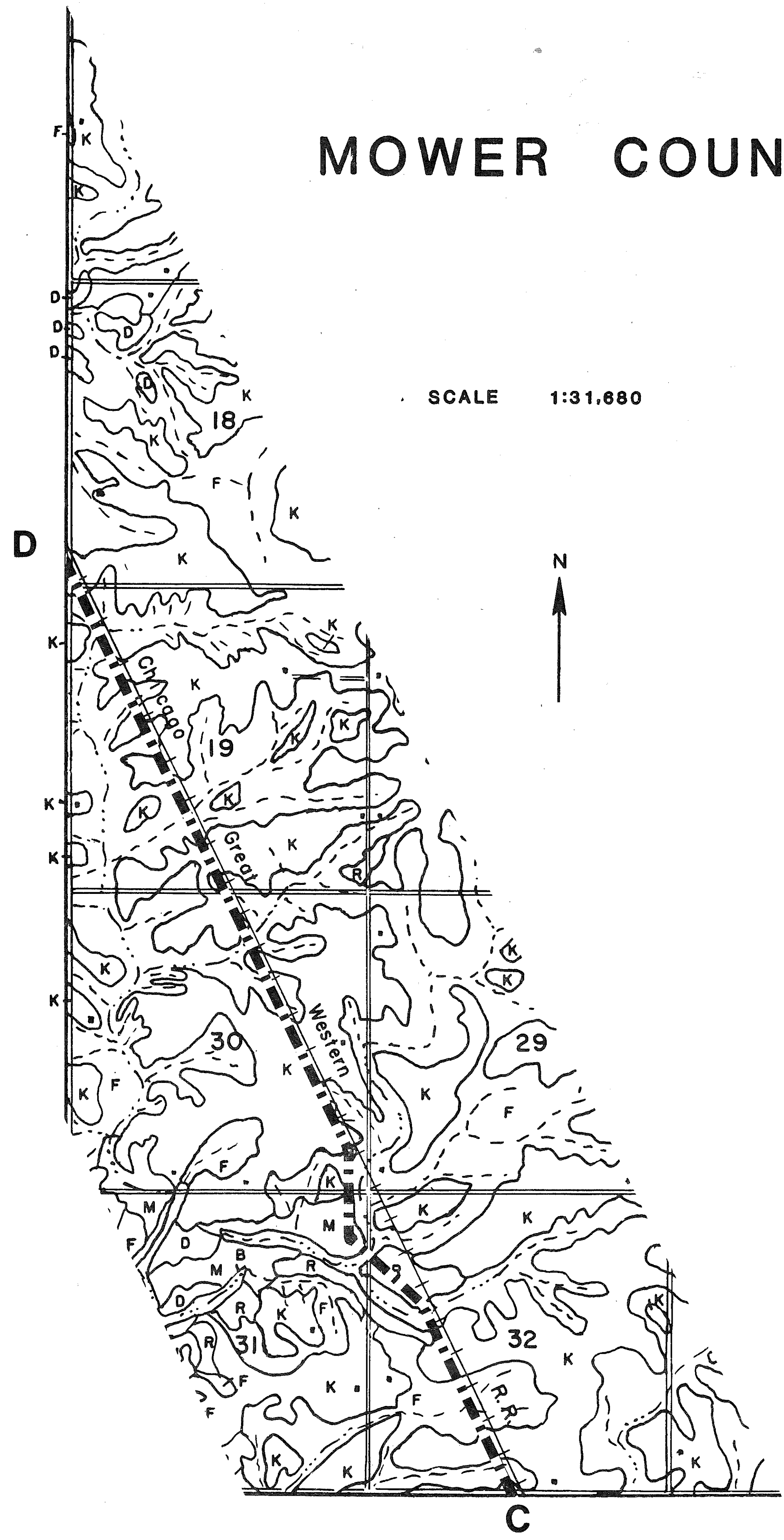

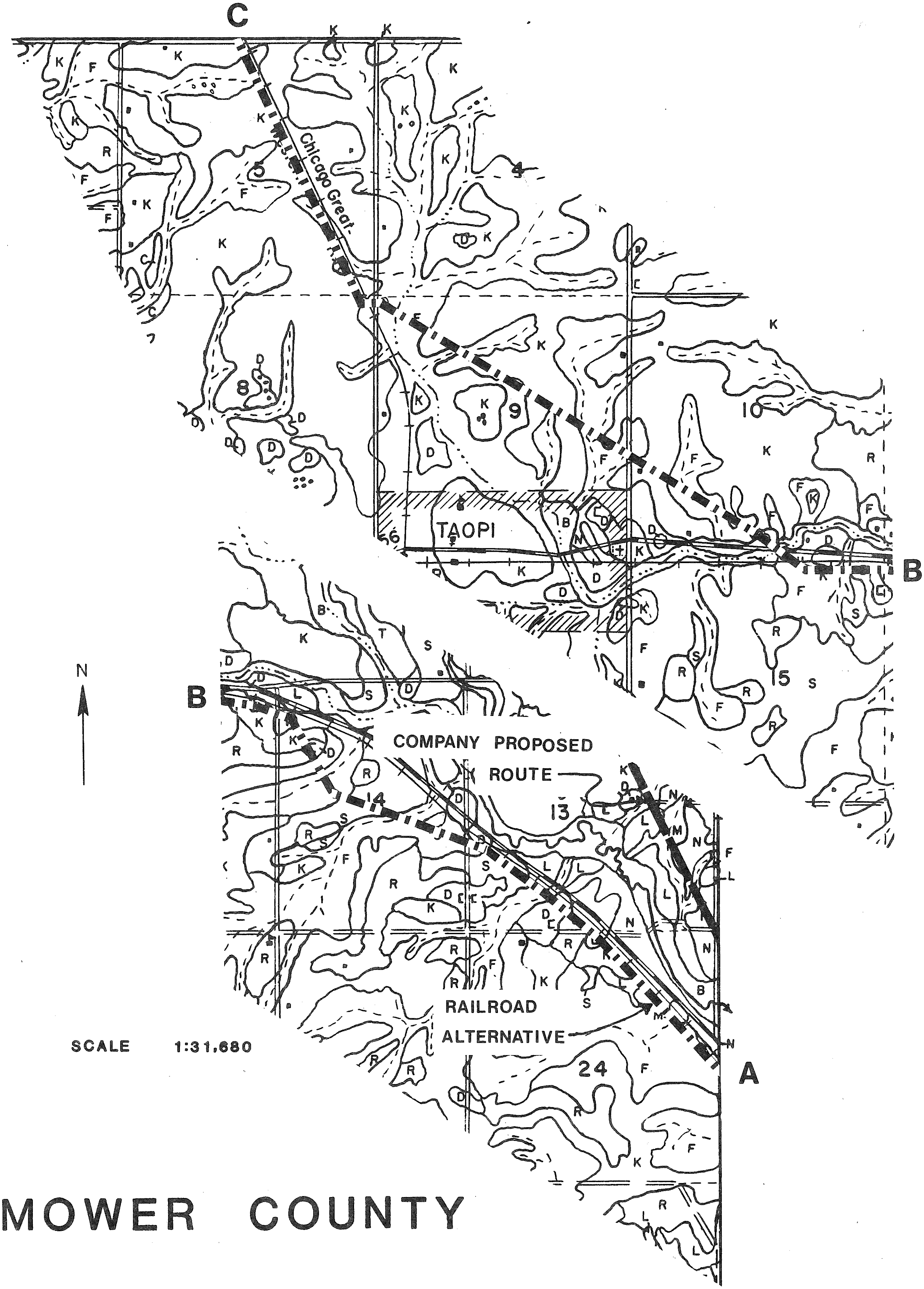

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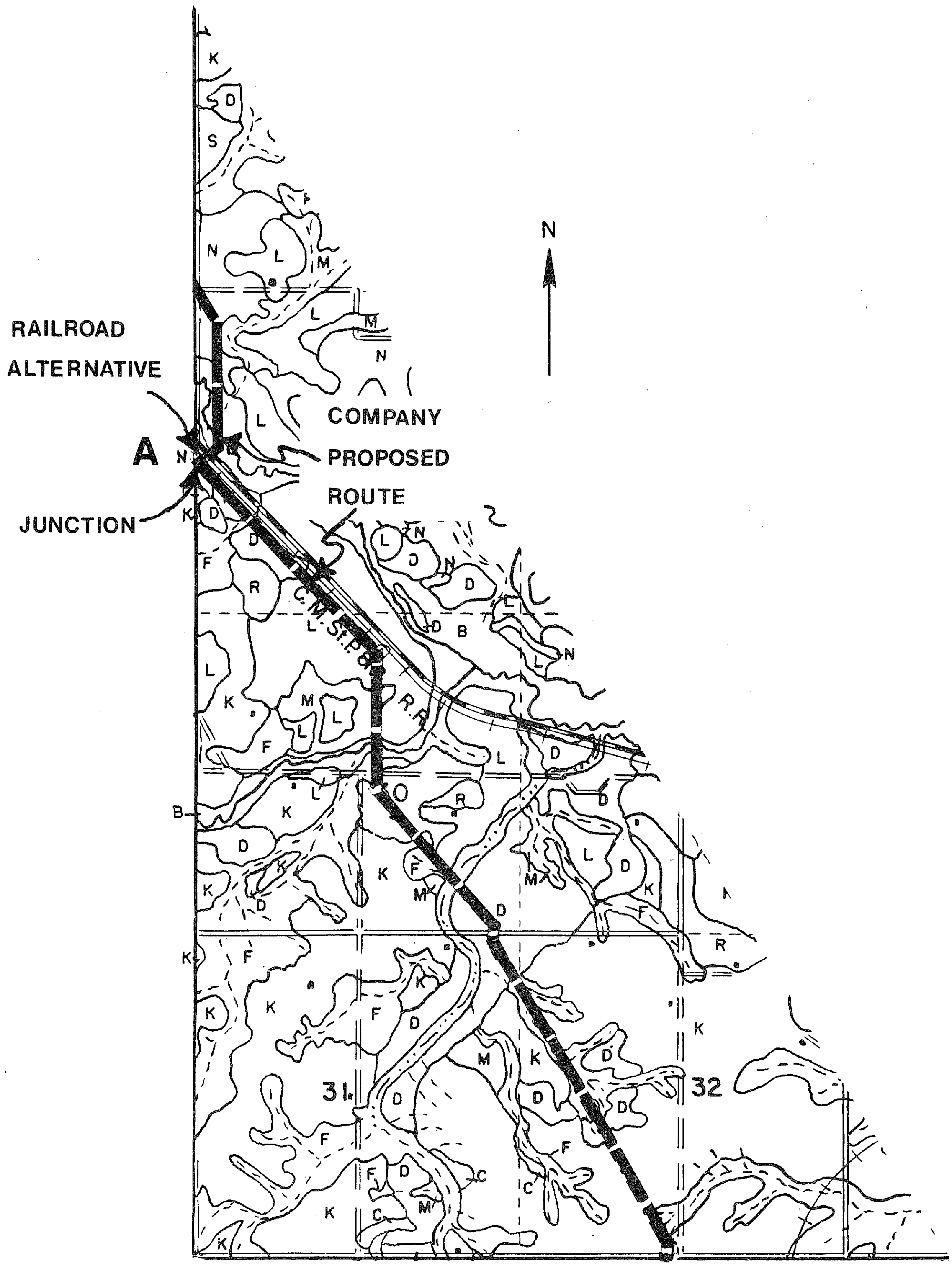
MOWER COUNTY



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MOWER COUNTY

APPENDIX E

DESIGNATED ROADWAY CROSSINGS

DESIGNATED ROADWAY CROSSINGS

Rice County	Surface
1. County Road 86	Gravel
2. CSAH* 26	Gravel

Goodhue County	
1. CSAH 15	Gravel
2. CSAH 12	Bituminous
3. CSAH 13	Bituminous
4. State Trunk Highway 56	Paved
5. CSAH 23	Gravel
6. CSAH 11	Gravel

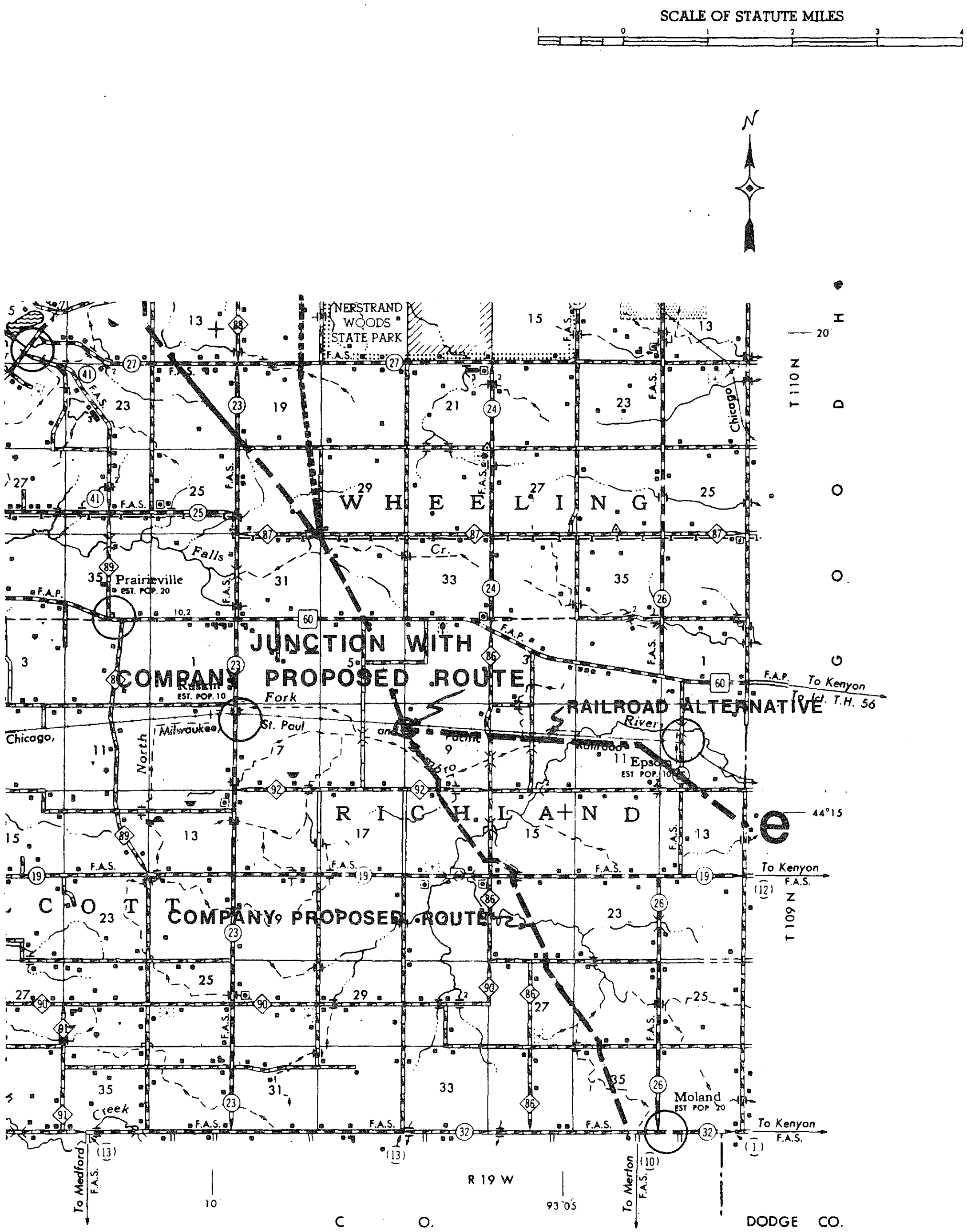
Dodge County	
1. County Road A	Gravel
2. County Road B	Gravel
3. CSAH 26	Gravel
4. CSAH 24	Gravel
5. CSAH 20	Gravel
6. CSAH 16	Bituminous
7. U.S. Trunk Highway 14	Paved
8. County Road H	Gravel
9. CSAH 10	Gravel
10. CSAH 6	Gravel
11. County Road K	Bituminous
12. CSAH 4	Gravel
13. County Road T	Gravel
14. State Trunk Highway 30	Paved
15. County Road M	Gravel

Mower County	
1. CSAH 1	Bituminous
2. CSAH 20	Bituminous
3. County Road 57	Gravel
4. CSAH 2	Bituminous
5. U.S. Interstate Highway 90	Paved
6. CSAH 13	Bituminous
7. CSAH 7	Bituminous
8. CSAH 3	Bituminous
9. CSAH 4	Bituminous
10. CSAH 9	Gravel
11. CSAH 11	Bituminous
12. State Trunk Highway 56	Bituminous

* CSAH = County State Aid Highway

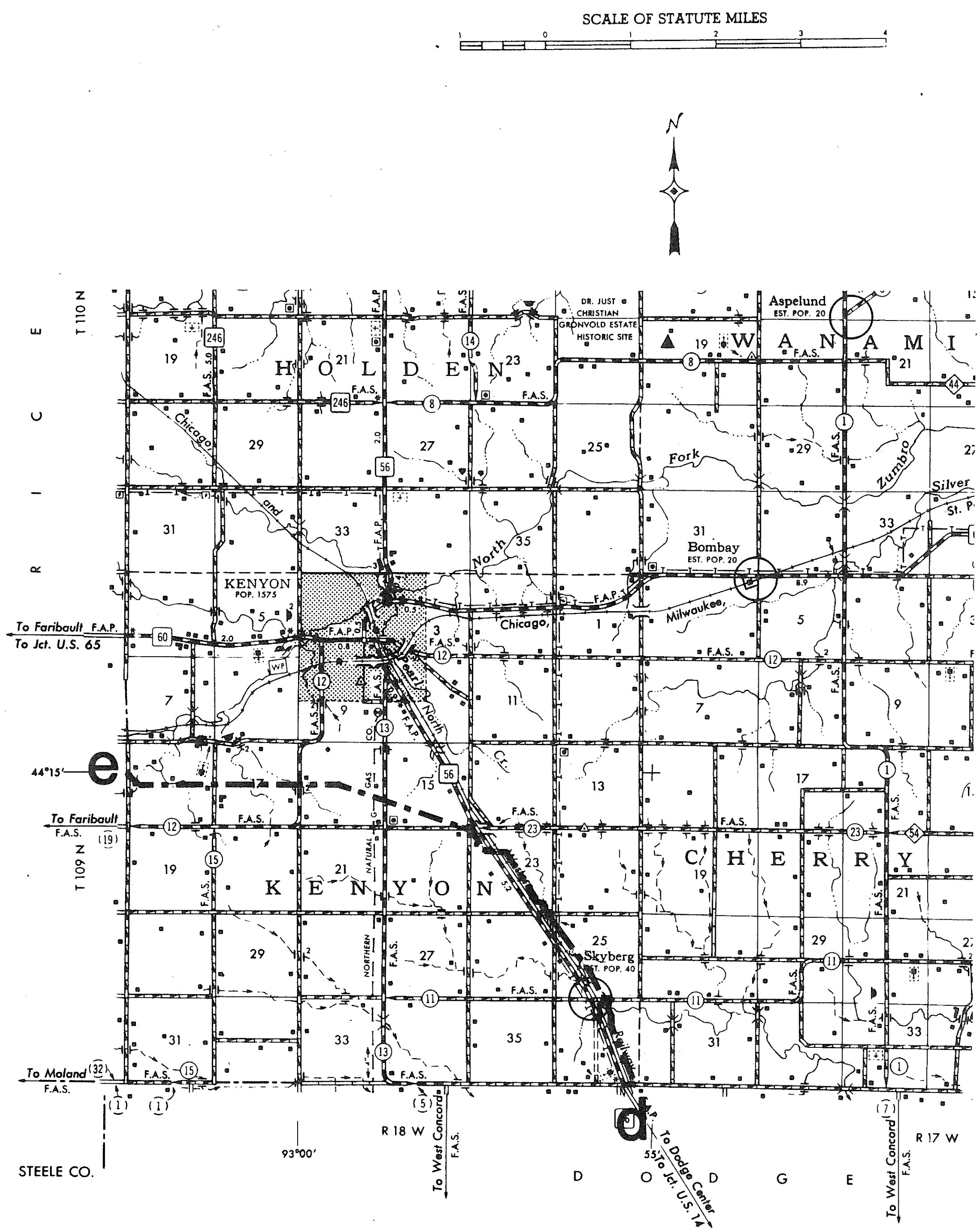
APPENDIX G

ROUTE MAPS

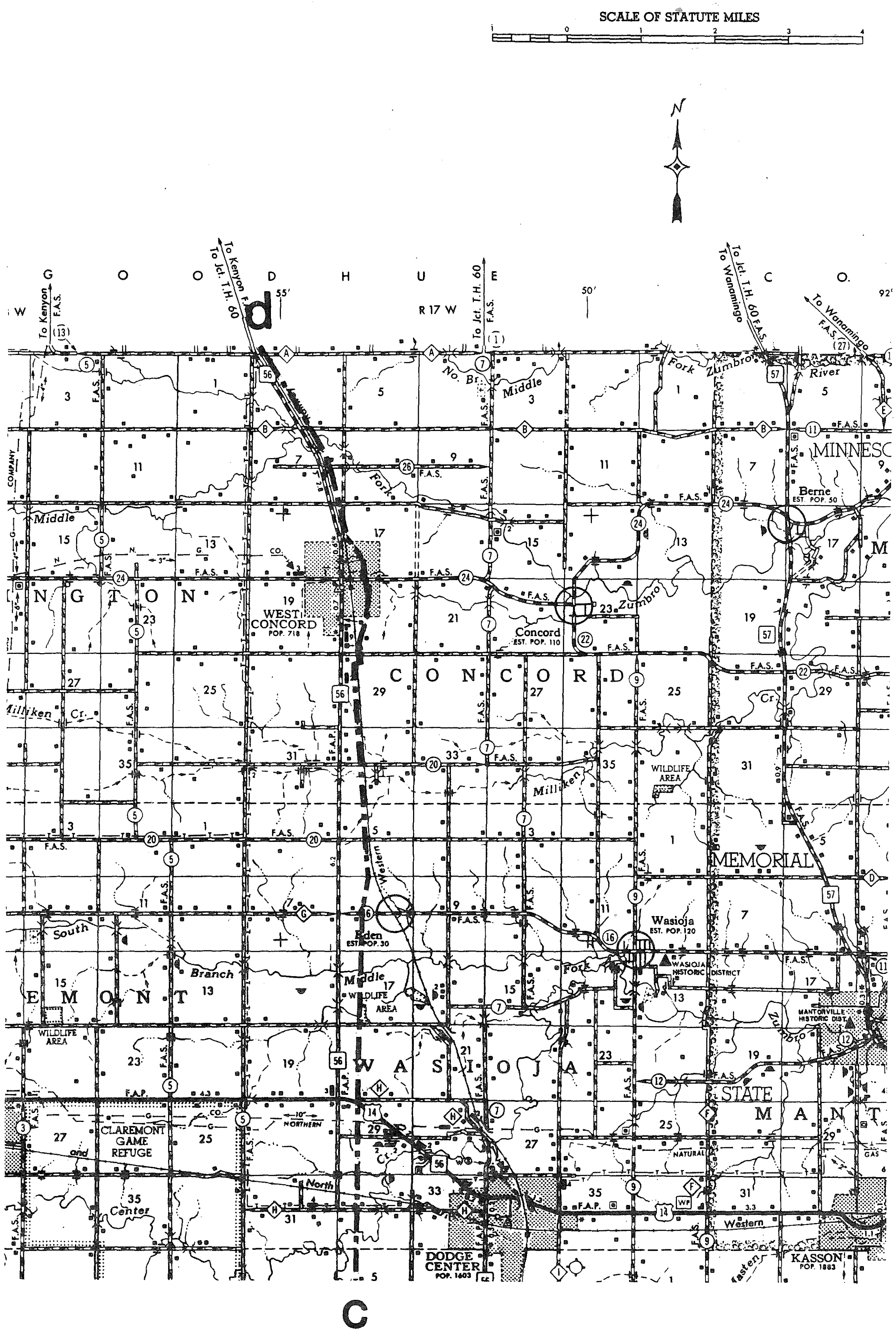


SCALE OF STATUTE MILES
N
NERSTRAND WOODS STATE PARK
W H E E L I N G
JUNCTION WITH COMPANY PROPOSED ROUTE
RAILROAD ALTERNATIVE
Prairieville EST. POP. 20
Epsom
R I C H L A N D
COMPANY PROPOSED ROUTE
Moland EST POP 20
Falls Cr.
North Fork
Chicago, Milwaukee, St. Paul and Pacific Railroad
To Kenyon
To Medford
To Merton
T 110 N
T 109 N
R 19 W
G O O D H U E
DODGE CO.

RICE COUNTY

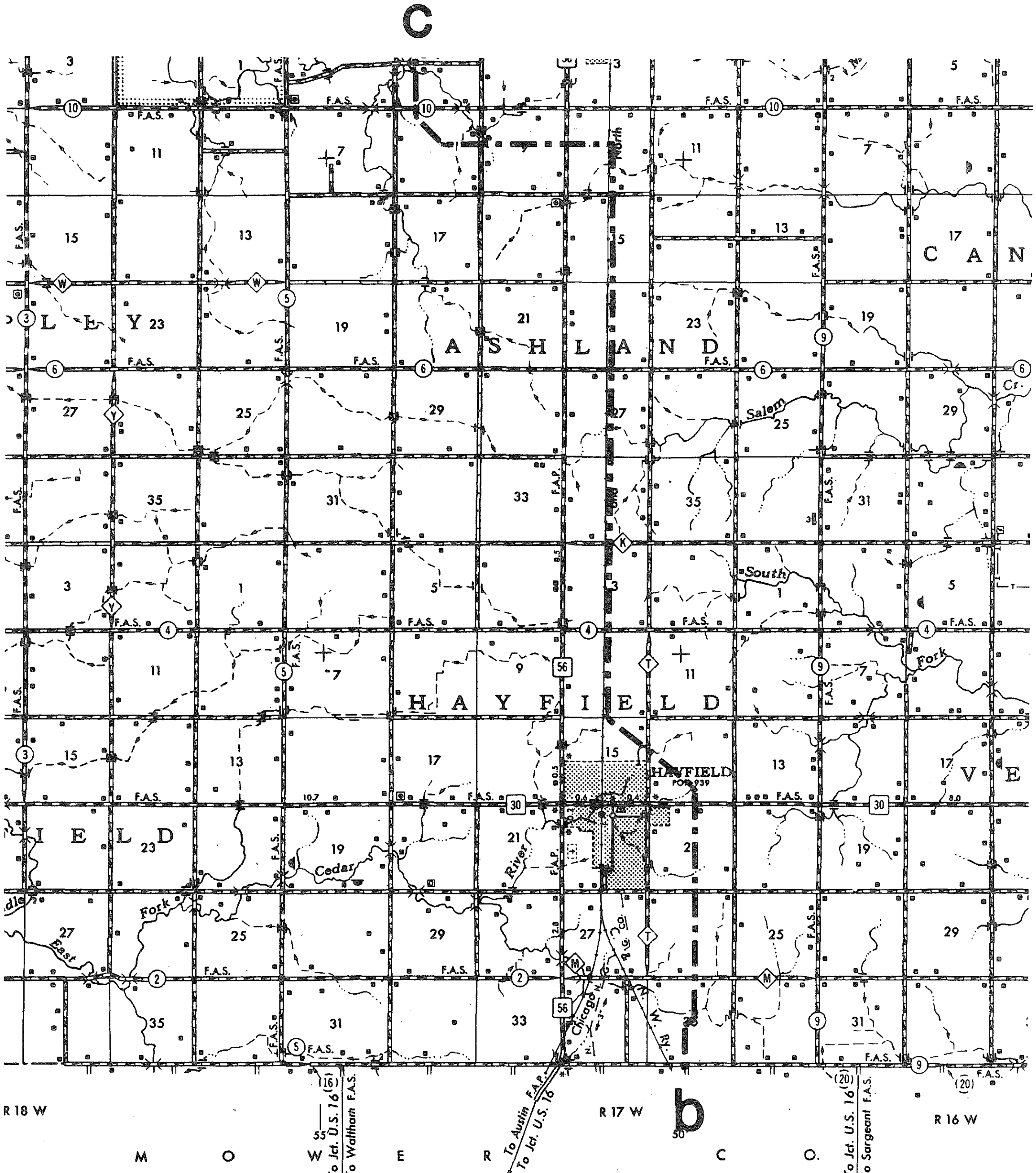


GOODHUE COUNTY

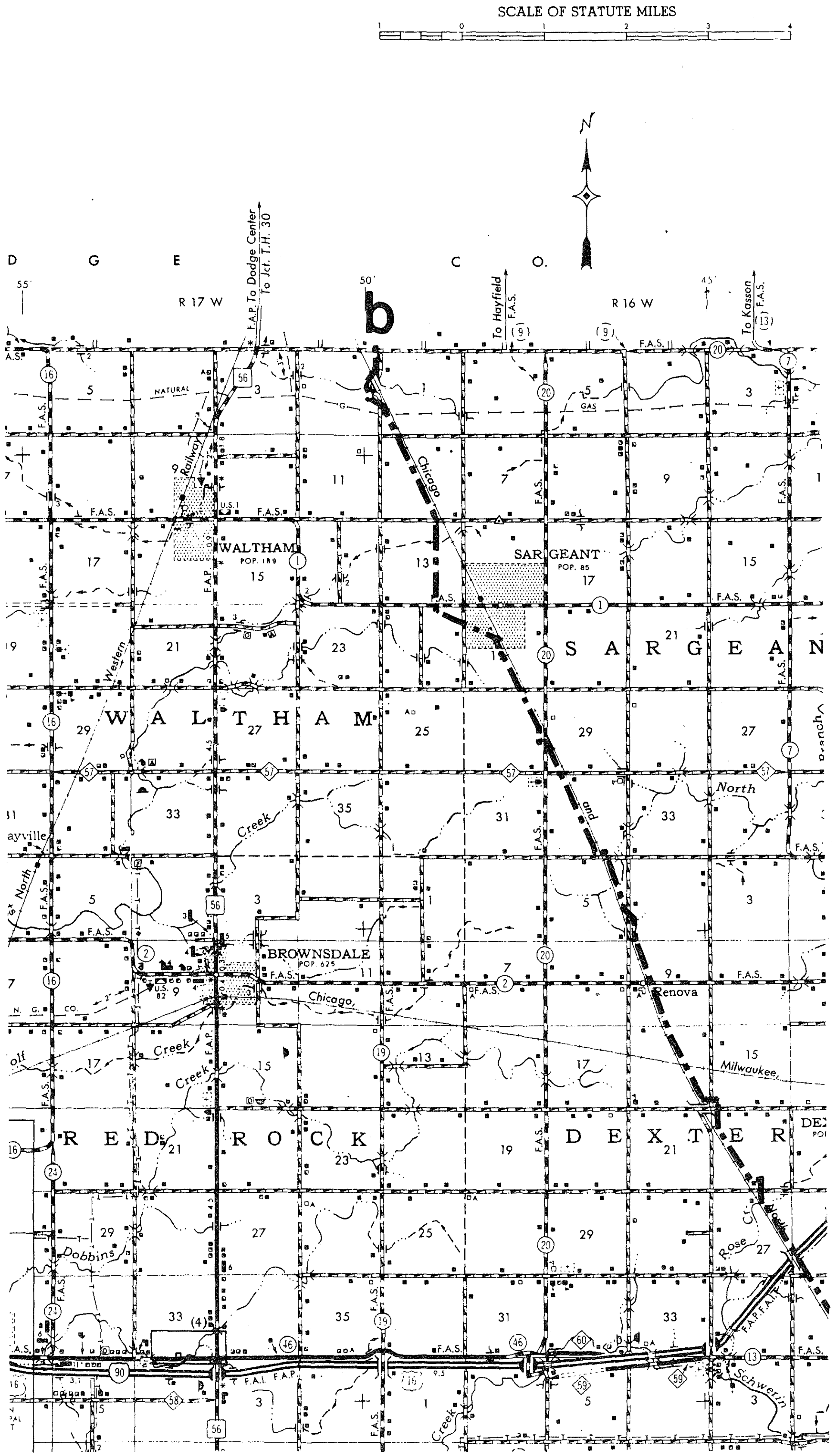


C

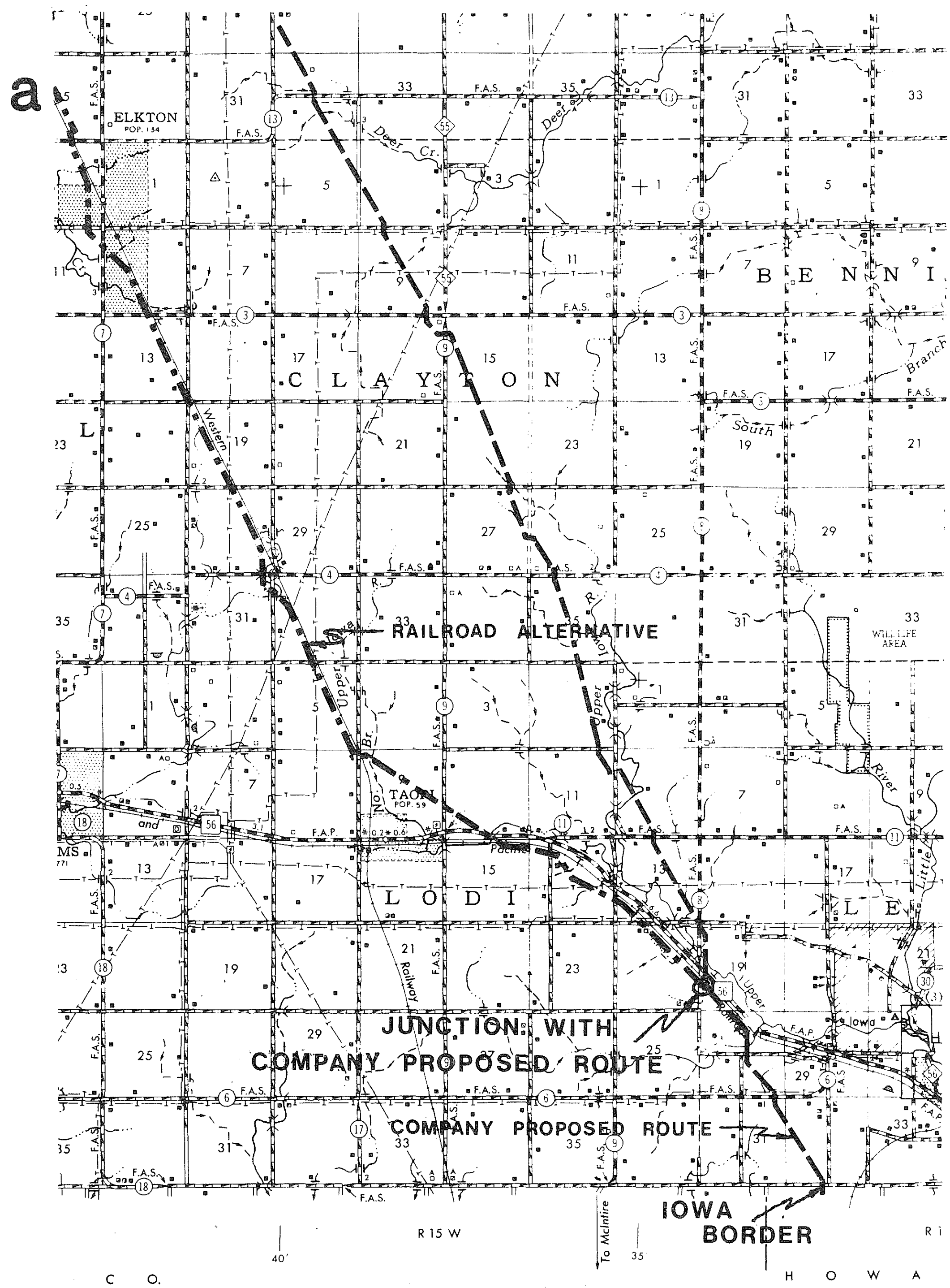
DODGE COUNTY



DODGE COUNTY



MOWER COUNTY



MOWER COUNTY

Appendix V

Special Design and Construction Techniques for a Proposed Crude Oil Pipeline between Iowa/Minnesota Border and Pine Bend, Minnesota

Prepared for

Minnesota Energy Agency
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St. Paul, Minnesota 55115

March 1978

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60340A

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This report presents our comments and opinions regarding issues of special concern to various public agencies and interested citizens in the State of Minnesota relative to the construction and operation of the Minnesota portion of a proposed crude oil pipeline from Patoka, Illinois, to Pine Bend, Minnesota. Their principal concerns are to minimize the frequency, magnitude, and effects of oil spills from the completed pipeline. Other major concerns include the effects of construction on farmlands crossed by the pipeline.

By letter of January 23, 1978, the Minnesota Energy Agency (MEA) requested the expert opinion of Woodward-Clyde Consultants (WCC) on the following special concerns:

1) The best way to lay a pipeline through tiled farmlands.
2) The value of x-raying welds and longitudinal seams in piping.
3) The value of and the problems that may be associated with the installation of a clay liner in the pipe trench.
4) The value of installing additional valves in sensitive areas such as stream crossings and bedrock outcrops.
5) The merits of using heavy walled pipe in sensitive areas.
6) The value of periodic hydrostatic testing.

An agreement between the MEA and WCC to respond to the above issues became effective February 28, 1978. For the purposes of preparing our report, we were furnished copies of the Draft Environmental Impact Statement for the Minnesota portion of the project and the Draft Addendum thereto, which were prepared by the Department of Natural Resources and National Biocentric, Inc.

Woodward-Clyde Consultants has engaged Hood Corporation as a subcontractor for this assignment. Hood Corporation has extensive experience in the construction and maintenance of crude oil and petroleum products pipelines, including pipelines in Minnesota, but no vested interest or involvement in the subject pipeline. Accordingly, their opinions on the merits and practicality of special pipeline design, construction, operation, and maintenance techniques and procedures were considered valuable to this study. However, the opinions expressed in this report are based on the experience and judgment of Woodward-Clyde Consultants.

It must be noted that the questions we were asked are of a general nature. Accordingly, our responses must also be general. However, in some situations and in some locations the best solutions to the specific problems are site-specific and the generalities expressed herein may not be applicable. Without a thorough on-site route reconnaissance and a review of the mile-by-mile project construction plans and specifications, it is not feasible for us to address site-specific issues.

The report is organized into four sections: Introduction, Historical Causes and Frequencies of Pipeline Accidents, Assessment of Proposed Measures, and Recommendations.

HISTORICAL CAUSES AND FREQUENCIES OF PIPELINE LEAKS

Pipelines are the most common means of transporting petroleum commodities in the United States. The Interstate Commerce Commission (1976) reported that 9.1 billion barrels of petroleum commodities were transported by 220,000 miles of pipelines of all diameters, ages, and conditions. During the same year the Department of Transportation (DOT), Office of Pipeline Safety (OPS, 1976) recorded spill losses totaling 255,037 barrels. These figures include spills of all types of petroleum commodities, in which crude oils are included. Based on these data, about 1.16 barrels were spilled per mile of pipeline in 1976, or 0.003 of 1 percent of the total volume transported. For 1976, the OPS recorded 208 accidents which led to a spill, an average of 0.000945 spill accidents per mile of pipeline. This can be translated into about 1,225 barrels per accident. An examination of similar statistics for the years 1968 through 1973 (U.S. Department of Commerce, 1974; U.S. Department of Transporation, 1969-1976) shows that the 1976 statistics are typical of recent years. The data, shown in Table 1, indicate a decreasing trend in the number of pipeline spills each year, while the average and total volume spilled varies from year to year.

TABLE 1

AVERAGES OF ESTIMATED ANNUAL SPILLAGE OF PETROLEUM COMMODITIES PER ACCIDENT 1968-1976

Year	Total Volume Lost (barrels)	Number of Spills	Average Volume Lost Per Spill (barrels)
1968	392,588	499	786
1969	343,691	403	852
1970	521,849	347	1,503
1971	245,057	308	795
1972	360,654	309	1,167
1973	379,365	273	1,389
1974	293,643	256	1,147
1975	383,929	255	1,505
1976	255,037	208	1,226

Source: Modified from U.S. Department of Commerce, 1974; U.S. Department of Transportation, 1969-1976.

Because these data include pipelines of all diameters, lengths, and ages, carrying various products and operating under various conditions, they should not be considered an accurate indication of potential spill frequency and volume that might occur from a new crude oil pipeline. Spill potential from the proposed pipeline should be significantly less than the averages represented by the above figures because of the special precautions taken in its location, and the rigorous specifications to which it must be constructed, operated, and maintained.

Department of Transportation, Office of Pipeline Safety data (1976) show that excavation equipment operated by others (third-party equipment) was the most frequent cause of losses from petroleum pipelines. It was also responsible for the highest volume loss. The next most frequent cause of loss was external corrosion, and the next highest volume was due to incorrect operations. In Table 2 are summarized the data on all reported causes and volumes lost for 1976, and the years in which the pipelines were constructed.

It should be noted that the data contained in Table 2 include all pipelines which transport petroleum commodities, regardless of size, age, and condition. These figures indicate that causes of loss due to the structural integrity of the pipe and its ability to withstand external forces (i.e., external corrosion, defective pipe seams, and internal corrosion) have generally decreased in frequency with newer pipelines. This reduction may be attributed to three primary factors: pipelines tend to decrease in integrity as they age; over the years materials and quality control used in the manufacture of pipe have improved significantly; and methods of construction have improved. It is difficult to assess the relative importance of each of these factors; however, it is likely that the latter two are the most important. The first six categories in the table account for about 76 percent of the causes and about 82 percent of the total volume spilled.

The data also indicate that third-party equipment puncturing pipelines and incorrect operation by carrier personnel have tended to increase in frequency as the age of the pipeline decreased. There are several possible explanations for this increase in frequency. Since 1960 approximately 30,000 miles of new pipeline have been installed; this, coupled with a large increase in population and the spread of building development, may explain the increase in accidents caused by third parties. The increase in number of miles of pipeline in operation, the increased importance of oil spill reporting, and the advent of computer monitoring of pipeline operations may also explain the increase of reported, operationally caused accidents. It is likely that when systems are manually controlled, operational failures may not always be accurately recorded.

TABLE 2

SUMMARY OF CAUSES OF PIPELINE LEAKS AND COMMODITY LOSSES FROM LEAKS

Cause of Accident	No. of Accidents	% of Total	Loss Commodity (bbl)	Before 1920	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1976	Not Reported
Equipment Rupturing Line	67	32.0	74,590	2	7	7	16	21	11	3	0
Corrosion - External	41	19.6	31,954	5	6	8	9	7	3	1	2
Incorrect Operation by Carrier Person-nel	20	9.6	40,155	1	3	1	3	3	6	3	0
Defective Pipe Seam	14	6.7	38,494	0	0	0	3	5	6	0	0
Corrision - Internal	10	4.8	3,249	2	0	3	2	1	1	0	1
Failure of Previ-ously Damaged Pipe	7	3.3	20,070	0	0	0	1	4	2	0	0
Malfunction of Con-trol or Relief Equipment	1	0.5	235	0	0	0	1	0	0	0	0
Defective Girth Weld	4	1.9	13,025	0	2	1	0	0	1	0	0
Vandalism	3	1.4	7,428	0	0	1	0	0	2	0	0
Malfunction of Valve	4	1.9	2,521	0	0	1	2	0	0	1	0
Threads Stripped or Broken	2	1.0	328	0	0	0	1	0	0	1	0
Cold Weather	5	2.4	4,365	1	0	1	0	1	0	2	0
Pump or Appurten-ance Facilities	5	2.4	1,550	0	0	1	1	0	2	1	0
Tank or Appurten-ance	5	2.4	1,560	0	0	0	1	1	1	1	1
Motor Vehicle	1	0.5	499	0	0	0	0	1	0	0	0
Miscellaneous	19	9.1	15,014	0	0	3	2	3	6	3	2
TOTAL	209	100.1	255,037	11	18	27	42	47	41	16	6

Source: Office of Pipeline Safety, 1976

Given the broad scope of available data and the difficulty in assigning causes of spills to various pipeline designs, sizes, and operating parameters, it would be misleading to assign definite probabilities of occurrence to any of the listed causes for a specific pipeline. Several pertinent assumptions can be made, however. Those causes related to quality of material are likely to continue to decrease as technical advances in fabrication and construction are made and as older lines are replaced by new ones. Considerable research has gone into the development of higher grade steels for pipeline construction. Technological improvement continues in the construction of pipelines and their appurtenances. Welding and testing procedures have improved singnificantly. Welds on high-pressure systems are x-rayed as required by pipeline codes to ensure quality welding, and pipelines are hydrostatically tested to at least 1.25 times the design operating pressures.

Before addressing the specific concerns about pipeline construction and operation, listed in the Introduction, it seems appropriate to present some general observations about pipeline construction which may be useful to those who are assessing the probable effects of the proposed pipeline.

Federal, state, and local construction codes and ordinances pertaining to pipeline construction and operation should be followed. At a minimum, all pipeline facilities should be designed, constructed, and operated to meet or exceed the minimum requirements of Part 195, Transportation of Liquids by Pipeline, Title 49, Code of Federal Regulations, and American National Standard Code For Pressure Piping, ANSI B31.4. Before pipeline construction across wetlands or waterways, applicable permits should be obtained from the U.S. Army Corps of Engineers. No aspects of pipeline work requiring a permit should be performed until such permits have been obtained.

After general route selection, the initial step in pipeline construction is the conduct of a field survey of the centerline of the pipeline alignment. Where onground crews are required, use should be made of existing roads as far as possible. No roads should be constructed during this phase of activity. Only vegetation that restricts visual contact between survey instruments should be removed.

Survey crews should plot topographic features that may affect construction. Additional information may be required on some features encountered to ensure construction of safe structures. Rivers are an example. Before construction of river crossings, river flow volumes, water use, and scour depths should be determined so that river crossings are properly designed and installed.

The extent of right-of-way clearing should be limited to that required for the safe and efficient operation of mechanical construction equipment. One side of the right-of-way would be devoted to ditching and spoil operations; the other, to construction activities such as welding and equipment transport. The entire right-of-way may have to be graded with either bulldozers or motorgraders so that these activities can take place safely and efficiently. Vegetation on the right-of-way should be removed only as required to effect safe and efficient construction practices.

In remote areas without access roads, the right-of-way should be the primary path of surface travel for pipeline construction. So that vehicles may safely traverse the right-of-way, it may be necessary to construct bridges or culverts across creeks and drainage channels on the working side of the right-of-way. Also, cutting and filling may be required in some areas. If such methods are employed, materials for approaches and fill should be obtained: (1) from the right-of-way; (2) from commercial sources and transported to the location; or (3) from adjacent lands where permitted. Grading should be performed in such a manner as to minimize effects on drainages. In steep terrain or in wet areas, where the right-of-way may be graded at two elevations (two-toning) or diversion dams must be built to facilitate construction, the areas should be contoured upon completion of construction to resemble the preconstruction grade.

If blasting is necessary, the following safety precautions should be adhered to:

- In areas having facilities that might be damaged by blast debris, the area to be blasted should be blanketed (matted) prior to detonation.

- Landowners or tenants in close proximity to blasting should be notified in advance so that livestock and other property can be protected.

- Before each detonation, the area should be cleared to ensure that construction personnel and equipment and local residents are not in danger.

Where fences are encountered along the right-of-way, adequate bracing should be installed at each edge of the right-of-way prior to cutting the wires and installing a temporary gate. The temporary gate should be constructed so that it can be readily retained, at the landowner's discretion, as a permanent fence-section upon completion of construction.

Where the proposed pipeline closely parallels or crosses existing pipeline rights-of-way, care should be taken to minimize the amount of heavy equipment crossing the existing pipeline. However, light equipment such as pickups may frequent existing rights-of-way.

Once a sufficient length of right-of-way had been cleared and graded, ditching operations would be initiated. The ditch would be excavated mechanically with ditching machines, backhoes, draglines, and clamshells. Exceptions to mechanical excavation would be hand-digging to locate buried utilities, such as other pipelines and buried cables.

Generally, ditching operations would utilize only ditching machines in open areas and backhoes near rivers, swamps and tight areas; sub-surface conditions may require different types of excavation, however. In areas where loose or unconsolidated rock is encountered, the ditch-line may be ripped mechanically. This involves a tractor dragging a long shank (ripper tooth) behind it to dislodge the material. Sometimes another tractor pushes the tractor equipped with the ripper. If the material encountered cannot be ripped, it would be blasted. In preparation for the blasting, unconsolidated material should be removed from the ditch-line. A series of holes would then be drilled by air-powered drills, generally suspended from a sideboom tractor, which also tows the compressor supplving the air. However, air-tracks may be used if a significant amount of drilling must take place in one location. The previously discussed blasting criteria should be met before any shots are detonated.

The topsoil should be saved in cultivated and grazing lands. An angle-bladed bulldozer or motorgrader could precede the ditching machine, casting the topsoil to the far side of the right-of-way. The ditching machine would then cast the ditch spoil to a location that precludes the two soils from mixing. Upon completion of construction, the ditch would be backfilled from the spoil pile and the topsoil spread across the right-of-way as the final construction operation.

The depth of the ditch would vary with the conditions encountered. The cover from the top of the pipe to ground level should generally be at least 3 feet. In areas near private dwellings or in areas where people congregate or work in which the ditch-line must be blasted, the minimum amount of cover should be 2.5 feet. In open areas where the ditch-line must be blasted, the minimum cover should be 1.5 feet. There are also situations where the ditch would be excavated to depths greater than the stated minimums. For example, in traversing lands where there are definite plans to level the land for farming or other purposes, the pipeline should be buried at a depth that would permit the land to be leveled as planned and still maintain the prescribed cover over the pipeline. Where the pipeline crosses canals, barrow ditches, or irrigation ditches that are dredged to maintain depth, the pipeline ditch should be excavated to a depth that permits future safe dredging operations. At railroad and highway crossings, the depth of the pipeline cover should conform to the appropriate regulations and the desires of the appropriate jurisdictional organization.

In order to reduce the hazard of accidents, ditching operations should be timed so that the ditch does not stand open longer than absolutely necessary. In areas where open ditch crosses range animal paths, driveways, or rural roads, temporary crossings, such as plank bridges or unexcavated ditch-line (plugs), should be provided so that safe and unimpeded passage is available.

In crossing rivers, the ditch should be excavated to a depth such that scour action would not affect the pipe during periods of high flows. The bottom of the ditch should be about 4.5 feet in width so that the coating would not be damaged when lowering the pipe into the ditch. Sag bends on either side of the river should be a sufficient distance inland from the river bank to ensure that erosion will not expose the pipe. Water crossings should be made in a manner that minimizes the effects of construction on water flow - i.e., the gradient of the stream should be maintained by removing all spoil from the river bed upon completion of construction; stream banks should be restored to resemble their original configuration; and sand-cement sacks, sack breakers, or riprap should be placed over or adjacent to the pipeline where stream flow characteristics indicate they are needed to restore the river bed to a stable condition. The pipeline should be weighted where it is situated under water, or in swampy areas, to ensure that it does not float out of the ditch.

Generally, roadbeds suporting paved highways or railroads should be bored. The cutting head (bit) of the auger should be slightly larger than the casing pipe or line pipe. The casing or line pipe should advance with the auger. Casing should be installed at crossings where required by federal, state, local, or railroad authorities and where specified by the design engineer.

Stringing, bending, welding, coating, testing, inspecting, and lowering the pipe are phases of pipeline construction that generally follow right-of-way and ditching operations. The pipe should be strung in a manner that allows interim access to landowners, tenants, and livestock.

The pipe would be coated with protective materials and lowered directly into the ditch. In rocky areas, the bottom of the ditch should be padded to provide a uniform and protective bearing for the pipe. As soon as the pipe is in the ditch, it should be shaded (backfill material in contact with the pipe) with fine materials to protect the wrap from backfill operations and movement (walking) during operations.

Backfilling should be done in such a manner as to ensure that the space below and beside the pipe is completely filled with fine materials. Backfill material that cannot be placed in the ditch should be crowned on top of the ditch to compensate for future settling. Where the backfill material must be highly compacted, this may be accomplished by flooding, tamping, or walking-in with a wheeled vehicle.

After the ditch has been backfilled, the right-of-way and any other areas affected by the construction should be dressed. The right-of-way should be graded and fences repaired. In areas where topsoil has been stored, it should be returned to its former position on the right-of-way.

Where required or practicable, all disturbed surfaces should be contoured to resemble their preconstruction grade. If required, reseeding should take place, and fertilizer should be applied. Erosion-control devices should be constructed on steep slopes on the right-of-way and along any cuts made through unconsolidated materials. Erosion-control devices that may be employed include, but are not limited, water bars, riprap, terracing, sand-cement sacks, and fencing. Access roads not required for future operations should be removed, and the road beds restored to approximate their preconstruction state.

The pipeline may be cathodically protected by coating, anodes, and induced currents. All girth welds in sections of pipe to be placed beneath railroad and highway rights-of-way and those used at river crossings should be radiographically inspected before installation. The entire pipeline should be hydrostatically tested to 125 percent of maximum operating pressure. Test water should be obtained through agreements negotiated with the authorities controlling the water resources. The exact amount of test water required depends on the testing procedures used. The test water should be disposed of in accordance with federal, state, and local agency requirements. After the water is removed from the tested section, the pipeline may be dried using compressed nitrogen.

If swamps or bogs are encountered along the right-of-way, construction across these areas may be feasible during the winter months when the ground is frozen. This may preclude the use of mats, and prevent extensive damage to the area. If such areas are crossed during the summer months (when the ground is not frozen), the area should be matted prior to construction.

The general construction procedures discussed above would likely be applicable in all areas. In crossing tiled farmlands additional construction constraints will be applicable. However, the best techniques to use in crossing a specific field must be determined from the conditions unique to that field. The generalizations which follow should not be considered applicable in all cases.

To evaluate the extent of the impacts of pipeline construction across tiled lands, it is first necessary to determine the purposes for which the tile drains were initially installed and how effectively the existing installation is serving the intended purposes. For example, the drains may have been intended to lower a permanent or seasonally high water table, and they may or may not be performing satisfactorily at the present time. Also, the depth, spacing, and slope of the drains need to be known. Similarly, the location and elevation of the drain field outlet need to be known to establish the design options available for reconstructing the drainage system after the pipeline is in place.

Typically, farmland drains will be buried from 2 to 6 feet below the surface. This is also the depth zone in which the oil pipeline will most likely be installed. For drains less than about 4 feet deep, it should be practical in most cases to install the oil pipeline extra deep and below the level of the drain pipes. If the existing drains are deeper than about 4 feet, it will rarely be practical to try to place the oil pipeline below the drain pipes. If it is necessary to have the oil pipeline and the drain pipes in the same depth zone, two options should be considered for reconstructing the drainage system. The first is to determine if it is practical to install new drains essentially parallel to the oil pipeline to serve the drainage function. If this is not possible, then installation of sag pipes as drains under the oil pipeline, and connected to the existing drains, should be considered.

If soils in the field being drained are shallow and bedrock is near the surface, it may not be practical to install the oil pipeline deep enough to avoid interference with the drainage system. Such a situation would require a special design and evaluation, and generalities about how the situation should be handled most likely would not be applicable.

It is common practice in the pipeline construction industry to require a separate unit price bid item to cover the cost of installing new drain tiles. This is useful because plans showing the numbers, depths, and locations of all existing drain lines are rarely available; it is generally simpler and less costly to determine the requirements for drain line reconstruction during the course of pipeline construction than to try to locate all the drains in advance of construction. It is suggested that some sort of performance guarantee for the reconstructed drainage systems should be offered the farmer, and that the guarantee should be good for at least one year following pipeline construction.

The following weld testing requirements have been extracted from Part 195.234, Welds: Nondestructive Testing and Retention of Testing Records, Title 49, Code of Federal Regulations. This section outlines the minimum federal requirements for field-testing of girth welds and is applicable to the subject pipeline.

(a) A weld may be nondestructively tested by any process that will clearly indicate any defects that may affect the integrity of the weld.

(b) Any nondestructive testing of welds must be performed -

(1) In accordance with a written set of procedures for nondestructive testing; and

(2) With personnel that have been trained in the established procedures and in the use of the equipment employed in the testing.

(c) Procedures for the proper interpretation of each weld inspection must be established to ensure the acceptability of the weld under §195.228.

(d) During construction, at least 10 percent of the girth welds made by each welder during each welding day must be nondestructively tested over the entire circumference of the weld.

(e) In the following locations, 100 percent of the girth welds must be nondestructively tested

(1) At any onshore location where a loss of commodity could reasonably be expected to pollute any stream, river, lake, reservoir, or other body of water, and any offshore area unless impracticable, in which case only 90 percent of each day's welds need be tested.

(2) Within railroad or public road rights-of-way.

(3) At overhead road crossings and within tunnels.

(4) At pipeline tie-ins.

(5) Within the limits of any incorporated subdivision of a State government

(6) Within populated areas, including but not limited to, residential subdivisions, shopping centers, schools, designated commercial areas, industrial facilities, public institutions, and places of public assembly.

(f) When installing used pipe, 100 percent of the old girth welds must be nondestructively tested.

(g) A record of the nondestructive testing must be retained by the carrier who is involved, including (if radiography is used) the developed film with, so far as practicable, the location of the weld. This record must be retained for 3 years after the line is placed in operation.

The above quoted regulations are also quoted in the American National Standard Code for Pressure Piping, B31.434.8.5, Welding Quality.

In our opinion it is appropriate for the State of Minnesota to require 100 percent radiological testing of girth welds on pipe to be installed in areas it considers sensitive, even though some areas the state might classify as sensitive would not be specifically included in areas requiring such testing according to the regulations quoted above.

Complete radiological testing of all longitudinal welds is recommended for the safe operation of the pipeline. It is standard practice for rolling mills to radiologically test their longitudinal welds (pipe seams) before pipe delivery to a customer. In many cases, each pipe joint is also hydrostatically tested at the factory. It is doubtful that a pipeline company would purchase non-tested pipe, because the pipe fabricators probably would not guarantee their product unless it had been tested. Thus, radiologically testing longitudinal welds in the field would probably be a test duplication, as well as being uneconomical and inefficient. We suggest that the State of Minnesota require factory radiological testing of longitudinal welds, as a minimum, but that they not require further routine field testing of longitudinal welds.

The use and value of a clay liner in a pipeline trench must be determined on a site-specific basis. The purpose of installing a liner would be to prevent spilled oil from percolating into the ground and polluting the groundwater. In theory, a clay liner will prevent the downward flow of leaking oil. Additionally, if the leaking oil is horizontally confined, it should be forced to the ground surface for easy detection. Before requiring installation of a liner at any location, careful analysis is needed to determine if the theory is applicable in the specific context where it is proposed. There may be situations where a clay liner would serve satisfactorily, but where it might not be the most cost-effective solution to the problem.

Areas where a clay liner might be appropriately installed include locations where pipe burial requires penetration of bedrock, or where bedrock is near the bottom of the pipe. If the bedrock is fractured and jointed, including as a result of blasting, so that leaking oil would flow unimpeded down into the groundwater, a clay lining in the trench may serve as an effective barrier to prevent the oil from entering the bedrock and the groundwater.

In our opinion a clay liner will be most effective for mitigating the effects of relatively small leaks. In this case the lining may be most effective if flow barriers (trench plugs) are placed across the trench at periodic intervals to prevent leaking oil from flowing longitudinally in the trench for any great distance. Large leaks will quickly appear at the ground surface even if the trench is not lined.

Lining probably should not be used in areas where the groundwater level is near the ground surface, because the lining could act as a barrier to groundwater migration and it could result in the formation of swampy areas upslope from the pipeline.

To reiterate, clay liners should be used in pipeline trenches only on a highly selective basis. Based on the information available to us at this time, it is not possible for us to make any recommendation concerning the use of a clay liner on the subject pipeline.

Both Part 195, Transportation of Liquids by Pipeline, Title 49, Code of Federal Regulations and American National Standard Code for Pressure Piping, ANSI B31.4 prescribe minimum standards for locating valves on mainlines. Pertinent portions of both are quoted below:

- ANSI B31.4

434.15 Block and Isolating Valves

434.15.1 General

(a) Block and isolating valves shall be installed for limiting hazard and damage from accidental discharge and for facilitating maintenance of the piping system.

(b) Valves shall be at accessible locations, protected from damage or tampering, and suitably supported to prevent differential settlement or movement of the attached piping. Where an operating device to open or close the valve is provided, it shall be protected and accessible only to authorized persons.

(c) Submerged valves on pipelines shall be marked or spotted by survey techniques to facilitate quick location when operation is required.

434.15.2 Mainline Valves

(a) Mainline block valves shall be installed on the upstream side of major river crossings and public water supply reservoirs. Either a block or check valve shall be installed on the downstream side of major river crossings and public water supply reservoirs.

(b) A mainline block valve shall be installed at mainline pump stations, and a block or check valve (where applicable to minimize pipeline backflow) shall be installed at other locations appropriate for the terrain features. In industrial, commercial, and residential areas where construction activities pose a particular risk of external damage to the pipeline, provisions shall be made for the appropriate spacing and location of mainline valves consistent with the type of liquids being transported.

(c) Maximum spacing of mainline block valves in industrial, commercial, and residential areas shall not exceed 7.5 miles for piping systems transporting LPG, and 10 miles for systems transporting other liquid petroleums.

(d) A remotely operated mainline block valve shall be provided at remotely controlled pipeline facilties to isolate segments of the pipeline.

§195.258 Valves: General.

(a) Each valve must be installed in a location that is accessible to authorized employees and that is protected from damage or tampering.

(b) Each submerged valve located offshore or in inland navigable waters must be marked, or located by conventional survey techniques, to facilitate quick location when operation of the valve is required.

§195.260 Valves: Location.

A valve must be installed at each of the following locations:

(a) On the suction end and the discharge end of a pump station in a manner that permits isolation of the pump station equipment in the event of an emergency.

(b) On each line entering or leaving a tank farm in a manner that permits isolation of the tank farm from other facilities.

(c) On each main line at locations along the pipeline system that will minimize damage or pollution from accidental liquid discharge, as appropriate for the terrain in open country, for offshore areas, or for populated areas.

(d) On each lateral takeoff from a trunk line in a manner that permits shutting off the lateral without interrupting the flow in the trunk line.

(e) On each side of a water crossing that is more than 100 feet wide from high-water mark to high-water mark unless the Secretary finds in a particular case that valves are not justified.

(f) On each side of a reservoir holding water for human consumption.

As evidenced by the above regulations and guidelines, there are mandatory requirements for the installation of valves on crude oil pipelines. However, only minimum requirements are specified; those specifications may at the owner's or agency's discretion be exceeded. Generally, valves installed along a main line are limited to block and check valves, both of which serve to control the flow of oil. Block valves can be utilized in normal day-to-day operations, whereas the purpose of check valves is to prevent backflow during shutdown or in the event of an accident.

The quoted regulations state that valves must be installed on either side of a stream that is more than 100 feet wide from high-water mark to high-water mark. Consequently, there is no option regarding installation of valves on streams this size or larger; they must be installed. In these cases and in others discussed below, the purpose of valving near watercourses is to minimize spill volumes in the event an accident occurs in the segment of pipeline between valves. In some instances, the stated requirements for the installation of valves at stream crossings may be inadequate. For example, there is the possibility that an important stream may be confined to an area of less than 100 feet in width at a pipeline crossing. At these locations, the pipeline owner and/or the regulatory agency must assess the potential effects of an accident occurring at the crossing, and agree upon the safeguards that should be taken. It is likely that valves should be installed at some crossings that do not meet the minimum requirements of the regulations. Factors to consider in placing valves at stream crossings are (1) downstream uses of the water, (2) the amount of oil that would be released in the event of an accident, and (3) the potential effects of released oil on the immediate and downstream environments.

The need for and value of special valving to isolate pipeline segments laid on or near bedrock must be determined on a site-specific basis. If the bedrock under the pipe is fractured, jointed, or otherwise open to the flow of water so that it serves as an area of recharge for an aquifer, then the potential exists for spilled oil to contaminate the groundwater. However, the extent to which adding valves to a pipeline can reduce its pollution potential can be determined only from an analysis of the pipeline design.

It must be appreciated that for a pipeline to operate all the valves must be open. The value of any valve in reducing the magnitude of an oil spill is therefore related only to the effectiveness of the valve in reducing further spillage after a leak is detected. In all spill situations the first, and most effective, action that must be taken is to stop the pumps delivering oil into the pipeline (reduce the pressure at the leak). After those pumps are stopped, judicious use of downstream pumps, if these exist, may further reduce the pressure which causes the flow at the leak. If the leak is at or near a high point on the pipeline, it may not be necessary to close any valves to stop further flow through the leak. At other leak locations valves may have to be operated to limit the amount of additional oil that will be spilled after all pumps are stopped. In this event, the distance to valves in both directions from the leak will establish the amount of pipeline that may be drained through the leak. In the design of a pipeline the proper locations for valves may be established from a study of the ground profile along the line of the pipeline, the pressures in the pipeline with and without pumps operating, and from the soils (geologic formations) which the pipeline crosses.

We suggest that one of the most effective techniques for limiting the magnitude of oil spills along any pipeline is to make sure that any person who detects a leak can and is encouraged to communicate with the pipeline operator, and that to do so will incur a minimum of personal inconvenience and no personal expense. After a leak is reported, it is the responsibility of the pipeline operator to implement contingency plans for spill control and mitigation; those plans should include expeditious means for the operation of those valves which will minimize further spillage at the specific leak.

Proper selection of the type of valves installed can also serve to minimize the volume of oil spilled. Remotely operated block valves should be placed in areas that are not readily accessible. Check valves should be installed at low points where long portions of line may drain backward in the event of an accident. The use of accessible manual block valves, remote-controlled block valves in inaccessible areas, check valves, and a sophisticated monitoring system should provide adequate safeguards on the proposed pipeline.

We do recommend that the State of Minnesota carefully review the construction plans for the proposed pipeline, and that valves be required at all locations where the State determines that significant benefits may be realized, in the event of pipeline leaks, from the availability of the required valves.

The use of heavy wall pipe generally should be restricted to (1) areas where the rate of corrosion will be high; (2) where required by regulations, e.g., highway and railroad crossings; and (3) areas where repair or replacement will be difficult, e.g., at road, rail, and river crossings. The use of heavy wall pipe in all areas considered sensitive may not be cost-effective and it may not significantly reduce the potential for oil spills. As shown in the section dealing with the historical causes and frequencies of pipeline accidents, the primary causes for spills are (1) interference by third parties, (2) external corrosion, (3) incorrect operations, and (4) defective pipe seams. Table 2 also indicates that accidents caused by structural failures (corrosion and defective pipe seams) have been decreasing. This is attributable to advancements in pipeline cathodic protection, use of higher grade steels, and more effective pipeline testing. The primary means of abating accidents due to interference by third parties are properly marking pipeline routes and establishing procedures whereby third parties can request the pipeline owner to locate the line prior to third-party activity. Accidents caused by incorrect operations can be minimized by properly training and supervising operations personnel.

The use of heavy wall pipe will not significantly reduce the probability of oil spills. The exceptions are in areas with the potential for a high corrosion rate, i.e., beneath high-voltage transmission lines and in certain soils.

Thorough hydrostatic testing of a new pipeline, before it is put in service, is the ultimate test of its construction. In this connection we think it is important that each segment of pipe constructed across sensitive areas, and at road, rail, and river crossings, should be separately tested. These pipeline segments will be subjected to a second hydrostatic test when the entire pipeline is tested for overall acceptability.

Periodic hydrostatic testing of an operating pipeline is not considered the best presently available technology for establishing the continued integrity of a pipeline. A well-designed and properly functioning pipeline cathodic protection system is considered the best means for preventing the types of leaks that would be discovered by hydrostatic testing, and hydrostatic testing is not required to establish the performance of a cathodic protection system. We suggest that rigorous monitoring of the performance of the required pipeline cathodic protection system will better serve the interests of the State of Minnesota and its citizens than will hydrostatic testing. The suggested monitoring includes periodic inspection of the pipeline by line-a-log techniques. Line-a-log inspection at 3-month intervals is considered appropriate for the subject pipeline.

The primary means of minimizing the occurrence and effects of oil spills from the proposed crude oil pipeline is through proper design, stringent construction inspection, and well-planned and rigorously executed operating and maintenance procedures performed by properly trained operating personnel. However, the information presently available to us does not indicate that adequate measures have been planned for mitigating the effects of an oil spill should one occur. Minnesota Energy Agency rule EA 1055, subpart C.3., states: "Oil spill safeguards. Describe measures that would be taken to prevent oil spills or to minimize the environmental impact of a spill on surface waters or groundwaters of the state." The statement is repeated in rule EA 1065, subpart C.3.

Based upon the information available, it appears that adequate design and operational criteria have been incorporated into the pipeline planning; thus, oil spill prevention measures appear adequate. There appears to be a need to address the response to an oil spill in areas other than the notification procedures included in the Draft Environmental Impact Statement, and for a more detailed presentation of the types of environments oil spills may effect, together with measures to mitigate those effects. Preparation of a complete oil spill contingency plan is recommended.

REFERENCES

Interstate Commerce Commission
1976 Transportation revenue and traffic of large pipeline companies: U.S. Government Printing Office, Washington, D.C.

U.S. Department of Transportation, Office of Pipeline Safety Operations (OPS)
1969, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1970, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1971, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1972, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1973, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1974, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1975, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1976, Summary of liquid pipeline accidents: U.S. Government Printing Office, Washington, D.C.

1977, Summary of liquid pipeline accidents reported on DOT Form 7000-1 from January 1, 1976, through December 31, 1976: U.S. Government Printing Office, Washington, D.C.

Appendix VI

RECEIVED APR - 1 1978

FROM: . (Chicago Northwestern Railroad)

March 30, 1978

Honorable Charles Grassley
House of Representatives
1213 Longworth House Office Bldg.
Washington, D. C. 20515

Dear Congressman Grassley:

As you know, we have been working with the Northern Pipeline Company of Delaware, Inc. in an effort to determine the feasibility of relocating the proposed pipeline scheduled to traverse Buchanan, Chickasaw, Delaware, Fayette and Howard Counties in the State of Iowa, and Mower, Dodge, Dakota, Rice Steele Counties in the State of Minnesota.

For the purpose of discussion of the proposal of utilization of C&NW Transportation Company right-of-way all of these counties of course are not directly affected. A segment of approximately 82 miles of Transportation Company right-of-way however was considered in the proposal.

After study of all of the pertinent factors involved with the location of the pipeline the resultant conclusion was that approximately 4.2 to 4.8 miles of pipeline could be placed on C&NW Transportation Company right-of-way but would result in construction of approximately 15 additional miles of pipeline in the segment considered.

Probably the most significant problem encountered was the availability of existing right-of-way. While the C&NW Transportation Company owns, for the most part, right-of-way of 100 foot width from fence to fence there is on either side of the main track approximately 47.5 feet of open ground in which the pipeline could, from a practical standpoint, be laid. The pipeline company indicated they need a 25 foot easement in which the pipeline would be laid. This, because of severe grade, would result in excavations from 20 to 25 feet in depth at many locations making an occupation of the adjoining farmland a virtual necessity to support the excavation slopes, etc. A second problem area was encountered when consideration was given toward crossing the numerous natural waterways which by necessity almost always crossed the Transportation Company's property at right angles. In many instances these waterways parallel the Transportation Company property or are barely on it and then turn at right angles to pass under its main track. In such locations it is impossible to excavate to any depth because of the water problem. In the Iowa portion of the segment considered there are 136 locations where either culverts, pipes or bridges are located. In the Minnesota portion there are 155 such locations.

bc: Mr. J. W. Conlon - Chicago
bc: Mr. B. D. Martin - Hazelwood, Mo.

Because of track engineering procedures at the time the line was originally constructed the main line at this location is located on grades varying from 0.00 thru 0.99%. Grades of 0.50/0.60% are fairly common and are of such length as to require placement of lift stations or provide an unusually hazardous condition in the event of accidental repture of the pipeline which would in locations be thinly covered with earth by engineering necessity.

The C&NW Transportation Company felt at the outset that this was a very reasonable and real possibility; that is to have a large portion of the pipeline relocated to its right-of-way to eliminate the need for crossing valuable farmland. On the other hand, we were well aware of the severe change in grades on the line involved and fill sections of our right-of-way which were engineered many years ago without consideration of longitudinal occupation of any pipeline. It was obvious to us that the pipeline company proposed to locate their pipeline in what their engineers and geologists had determined to be the safest and best location from an engineering and environmental standpoint. Because of the location of our right-of-way which in some cases is several miles distant from the proposed pipeline location it was difficult to find terrain conditions that would compare with the location the pipeline engineers had selected.

The pipeline people and specifically Mr. B. D. Martin, Project Manager, and I discussed all of these possibilities thoroughly and were convinced that there was a very small portion of Transportation Company right-of-way that could be used. But obviously the construction of an additional 15 miles of pipeline to get to the Transportation Company's right-of-way was not really practical and had a tendency to add even more miles of pipeline occupation when it was not necessary to do so.

I believe that Mr. Martin and I both agreed throughout the investigation of the possibility of longitudinal occupation of railroad right-of-way that the idea was basically sound but because of geographical and natural terrain problems it was not really feasible in this particular location. There are a number of locations on this railroad as well as others wherein this proposal can be applied and particularly in those areas where track has been or is expected to be abandoned at some future date. It appears that while in this instance it did not prove out to be a practical solution to the problem it did present to the pipeline people the possibility for utilization of railroad right-of-way in the future and it appeared that the various states, specifically the States of Iowa and Minnesota, who have outstanding Departments of Transportation, could dovetail such future proposals into their respective state transportation plans.

Both Mr. Martin and myself have discussed this matter in detail with Mr. Pete Conroy, your Administrative Assistant, who I might add was extremely cooperative and contributed significantly in the number of meetings that were held between this Company and the representatives of Northern Pipeline Company of Delaware, Inc.

If there is any further information that you feel you would like to have concerning our activities in this investigation I would be most happy to provide them upon request and if in the future a similar proposal should present itself involving the C&NW Transportation Company I would appreciate your calling upon me for whatever assistance I may be able to provide.

Yours truly,

Assistant Vice President

cc: Rep. H. T. Blouin
Rep. A. H. Quie

Appendix VII

SOIL COMPACTION

Serious attention has been given to the problem of soil compaction in the past several years by farmers, farm machinery manufacturers, and soil scientists. Soil compaction has increased due to the use of today's heavier machinery and increased machinery traffic on fields. Not only has the amount of compacted soil increased but the depth of compaction is deeper than ever before.

Compaction is the reduction in air and water pore space between soil particles. The total volume of soil is made up of the volume of soil mineral grains and the volume of pores between the grains. The pore volume is usually partially filled with water, with air occupying the balance. Soil is compacted when the proportion of total soil volume is inadequate for maximum crop growth.

The reduction in pore space reduces air and water flow to plant roots. Thus soil compaction has been known to cause agricultural plants to emerge slowly, have stunted growth, off-colored foliage, malformed roots, or wilt early during droughts. Because of this decrease in soil air and water content, soil structure breakdown occurs resulting in soil crusting, standing water, excessive soil erosion and greater tillage requirements.[1]

Soil compaction affects life within the soil. It reduces the space available for air diffusion to the roots and decreases the intake rate and transmission of water. As a root grows, it will pass through a space only as small as a root tip. A smaller passage area will cause the plant to exert extra energy for penetration and root growth. It was discovered by William Gill that "the internal anatomy of roots which were grown under conditions of restraint, exhibited a wrinkling or folding of cell walls within the roots."[2] In some cases, the layers of soil may become so compact that the root cannot penetrate, resulting in lack of moisture for growth.

Recent studies on compaction indicate that use of heavy equipment on fields actually prevents the full development of the root system. When root expansion is confined or restricted, the rate of moisture and nutrient pickup cannot meet the peak demands of the plant. If only a small volume of soil supplies the total moisture needed by the plant, that soil is soon depleted of its moisture. As water stress develops, the whole plant begins to malfunction; growth is stunted and quality is reduced.[3]

Under good soil conditions, crop roots can elongate more than two and one-half inches per day, reaching depths in excess of six feet within a month. During this same period, they can spread laterally as much as four feet.[4] However, heavy compaction often results in root growth of only one-eighth to one-fourth inch per day.[5] To assure optimum plant growth, moisture must be retrieved by the roots in adequate quantity. Even if this moisture is available within the soil. roots confined within compacted soils cannot reach the necessary moisture and nutrients either in the compacted soil or in the loose soils beyond. As long as the root system has room to expand and it remains active, the plant can obtain the required moisture and nutrients. Plants with retarded root systems are the first to be short of moisture during the plant's peak demand periods and droughts. Thus, Albert Trouse, USDA soil scientist concludes, "insufficient moisture and sometimes poor nutrition appear to be correlated with loss of yield."[6]

Soil compaction also affects irrigated crops. Trouse believes that "when traffic compaction is present, no amount of irrigation will guarantee superior crop yields."[7] Compacted soils do not absorb the required amount of moisture. Often water drains off the fields before it can be taken in by the soil. Many times, summer rain is shed from the plant canopy onto compacted soils. The density of this soil does not permit absorption thus the moisture drains off the field and away from plant roots. This rapid drainage not only reduces soil moisture but will also carry topsoil, fertilizers, and pesticides off the fields, away from crops.

Compacted soils may affect soil temperature. When soil is packed into a solid mass, it loses much of its insulating properties. Heat can easily move through it. This special property could possibly be used to the farmer's advantage, especially during planting. Slight compaction can increase soil temperature more rapidly. However, wet compacted soils are slow to dry out. Wet soils are also generally cold soils. Thus soils compacted when top- and subsoils are moist could cause slow seed germination from cool, moist conditions that are created.[8]

Howard Rogers, Agronomist at Auburn University cited compaction as the "number one problem for soybeans...most everywhere."[9] Again, the problem becomes one of getting the proper amounts of moisture to the plants. It was discovered that wheel traffic from normal farming operations alone has compacted the soil enough to decrease the number and size of nodules on soybean roots. When this occurs, soybean plants must rely on nitrogen from fertilizers rather than nitrogen in the air, resulting in greater demands for fertilizers and higher expenses for farmers. Other tests have found that moisture stress commonly caused by compaction stunts soybean plants by restricting root development. The result-- yields cut by 60 per cent compared to normal soybean plants, once again cutting into profits. Similar tests have been conducted on corn crops with similar results.[10]

Many variables affect the degree to which soil may be compacted. Different types of soils can withstand different loads. Clays and loams appear to be more affected than sandy soils. Soils high in organic matter which have good structure seem to be more resistant to compaction than soils in poor physical condition. Also, the compactibility of a soil and its bearing capacity for machinery are greatly affected by moisture content. Sand seems to offer very low bearing capacity for machines when dry, but can be fairly firm when wet. Heavier textured soils have higher capacities when dry. However, tests have shown that "when the soil is wet, compaction includes destruction of the small and otherwise stable particles which give the soil a desirable structure. Under such conditions, the soils becomes puddled."[11] Table 1 indicates the effects of soil condition on the compactive effects of tractor tires. It is evident upon examination of the table, what drastic compaction effects wet and moist soils can produce.

It must be pointed out that compaction is relative to load and inflation pressure, not tire size. Therefore, radials and dual tires are being incorporated as an aid to soil compaction reduction. Radials, however, give better traction with their more even weight distribution but this only results in a more evenly spread out compaction tendency across the width of the tread. Duals, on the other hand, spread the weight over more area, reducing the amount of sinkage in soft soils. The addition of this second wheel reduces total wheel pressure but affects a greater total area than would have been affected by single tires. Most tend to believe that although duals compact more total area, they will not compact as deeply. At this point in time, there seems to be no feasible way to reduce soil-tire contact pressure to a point which will not affect root growth. In their article, Voorhees and Hendrick explain that "as little as four (4) pounds per square inch may be harmful..."[12]

TABLE 1 Effect of soils conditions on the compactive effects of a tractor tire.*

	COMPACTION		
SOIL CONDITION	INCREASE BELOW LUGS %	PENETRATION DEPTH INS.	TRACK DEPTH INS.
Loose soil:			
Wet	49	17	7.0
Moist	53	16	6.5
Dry	20	13	5.0
Compact subsoil:			
Wet	41	16	5.0
Moist	32	15	4.5
Dry	8	6	2.5
Compact surface and subsurface:			
Wet	29	12	2.5
Moist	22	12	2.0
Dry	2	2	1.0

*Taken from What's New in Crops and Soils, Vol. 5, No. 1, "Heavy Machinery... New Problem in Soil Management, " p. 12, 1952

Crawler tractors and four-wheel drives are also under investigation. Crawler tractors generally apply less pressure to soils. Also, the pressure under these tracks is more uniform compared to a regular tire track. However, some tests indicate pressures exerted by crawlers can be equal to that of wheel tractors. Four-wheel drives are being tested for compacting ability also. On a four-wheel drive, the front wheels cause most of the compaction while the rear wheels add very little additional compaction.

Tillage practices have also become very controversial. After a soil has been tilled it loses much of its ability to support loads. When these tilled soils are subjected to vehicular traffic, almost all loosened soils become compressed. Just one pass of a light vehicle can cause compaction severe enough to affect root growth. The use of heavy construction equipment on freshly tilled soils could have an extreme compacting effect. Trouse warns that deep tillage "cannot improve the storage capacity of the deeper soil anyway and unnecessary tillage will only weaken the existing structural strength."[13] Tillage reduces soil strength and makes the soil more susceptible to compaction. Once a farmer has plowed, further traffic on that area will compact the soil to the maximum depth of the tillage operation.[14]

As previously indicated, it is not only the increased weight of today's farm implements which increases compaction but also the increased number of passes made across a field. Farmers use tractors for several individual operations across fields, treading over and compacting the soil with each pass. Even the deep, hard freezes and heavy rains cannot loosen compacted soils between operations. It has become extremely important to control in-field traffic for this reason. However, even if traffic is reduced, compaction cannot be eliminated. According to Voorhees and Hendrick "the first pass of a wheel on a loose soil does about 80 per cent of the total compaction resulting from four passes in the same sport."[15] If mechanical operations are imperative, preset paths should be used continually, thus eliminating further compaction of fresh untouched soils.

It has been noted by Dr. Trouse that "superior yields are obtained only when soils are loose--either under ideal natural conditions or where soils is tilled to remove man-made barriers and left to settle without traffic of any kind."[16] According to a University of California report, "deeply loosened soil did not recompact when traffic was controlled, and yield increases were significant."[17] This report stated that "control of machinery traffic reduces soil compaction and increases growth and yield of cotton... The average yield from the controlled traffic treatments was 14 per cent more than the average yield from the traffic treatments regardless of tillage imposed."[18]

International Harvester Company's engineers estimate than an average two-wheel drive farm tractor of 130 horsepower, weighing approximately 15,000 pounds, without dual tires, will induce pressure of 9.5 to 10 psi on the soil. With dual tires in the rear, this is reduced to approximately 5.3 psi. The largest model two-wheel drive (160 H.P.) with standard tires and duals in the rear, will exert six (6) psi on the soil. The largest four-wheel drive (300 H.P.) with duals, has an average pressure of 11.3 psi. However, four-wheel drive tractors, which are becoming increasingly popular, may weigh up to 40,000 pounds. According to tire companies, "all-weather treads...ground pressure under the loaded tire runs about 1 to 3 psi more than the tire's inflated pressure."[19] Many tires inflate to 30-40 pounds. The use of the tire companies' estimates would substantially increase the original estimates of pressure.

The equipment used on pipeline construction will exert pressures slightly greater than farm tractors. A D8 caterpillar exerts approximately 9.90 psi, while a D9 will exert 10.70 psi. A tracked front end loader will have 11.79 psi and the pipe layer will be about 13.59 psi.

Although there is not a great weight differential between farm and construction equipment, the additional equipment continuously crossing a field will result in a tremendous compacting effect. Dr. Trouse explains, "once a field is tilled, the tilled horizon loses much of its...ability to resist a force. Consequently, soil is compressed under every tractor wheel...Even the first pass of a wheel compacts the soil...Heavier loads or <u>additional traffic</u> can compact soil to a greater density, but even mild compression restricts crop potential. Later passes of equipment frequently travel partially upon untrafficked soil so that the percentage of soil compacted...increases with each pass. Dual tires and wider tires may not compact the soil as densely...they compress a wider swath of land severely enough to cause additional production losses."[20] Trouse concludes that there is evidence but not concrete proof that controlling traffic can increase crop yield.[21] Increased traffic in the fields generated by construction equipment will result in greater areas of compacted soil than produced by normal farming operations.

Soil compaction and its effects on crop yields is a well documented area, yet there is presently no information or test results available indicating any quantitative or monitary measure of yield losses. It is for this reason that information on this area of extreme importance and interest cannot be produced in this report.

REFERENCES

[1] Albert C. Trouse Jr., "Soil Compaction Robs Growers by Cutting Into Profits," Cotton International, 40th International Edition, 1973, p. 38-44.

[2] W.R. Gill, "The Mechanical Impedence of Plants by Compact Soils," Transactions of the ASAE, Vol. 4, No. 2, 1961, p. 238-242.

[3] Albert C. Trouse, Jr., "Improve the Soil Environment to Boost Fiber Yields," American Cotton Grower, March 1977, p. 22-23, 55.

[4] Albert C. Trouse, Jr., "Traffic Compaction and Irrigation," 1977 Annual Technical Conference Proceedings of the Irrigation Association, Irrigation For All Reasons, Salt Lake City, Utah, February, 1977, p. 50-53.

[5] "Soil Compaction, How to Make the Least of It," Successful Farming, January, 1976, p. 28-29, 34.

[6] Trouse, "Soil Compaction Robs Growers," p. 40.

[7] Trouse, "Traffic Compaction and Irrigation," p. 50.

[8] W.B. Voorhees, "Our Newest Natural Resource Soil Compaction, How it Influences Moisture, Temperature, Yield, Root Growth," Crops and Soils March 1977, p. 7.

[9] "Soil Compaction: How To Make the Least of It,"p. 28.

[10] Ibid., p. 29.

[11] Vernon C. Jamison, "Heavy Machinery... New Problem in Soil Management," What's New in Crops and Soils, Vol. 5, No. 1, p. 13, 1952.

[12] W.B. Voorhees and J.G. Hendrick, "Our Newest Natural Resource Compaction, Good and Bad Effects on Energy Needs, " Crops and Soils, April 1977.

[13] Albert C. Trouse and C.A. Reaves, "The Bottom of the Wheel in the Orchard," Procedures of the Southeastern Pecan Growers Association, 65th Annual Convention, Atlanta, Georgia, March 1972, p. 69-71.

[14] Ibid.

[15] Voorhees and Hendrick, "Compaction, Good and Bad Effects on Energy Needs," p. 13.

[16] Trouse, "Traffic Compaction and Irrigation," p. 52.

[17] "Traffic Control as a Means of Increasing Cotton Yields by Reducing Soils Compaction," University of California, June 22-25, 1975, p. 1.

[18] Ibid., p. 6

[19] Bob Coffman, "Soil Compaction, Getting Worse, But Why," Farm Journal December 1977, p. 25.

[20] Trouse, "Traffic Compaction and Irrigation."

[21] Albert C. Trouse, Jr. and Arthur W. Cooper, "Control of the In-Field Traffic Practices to Maintain Good Soil Conditions for Plant Growth," from Procedures of the FIEI Power Sprayer and Duster Council's, "What's Coming Conference," Atlanta, Georgia, File #17974, II, December 1969, p. 1.

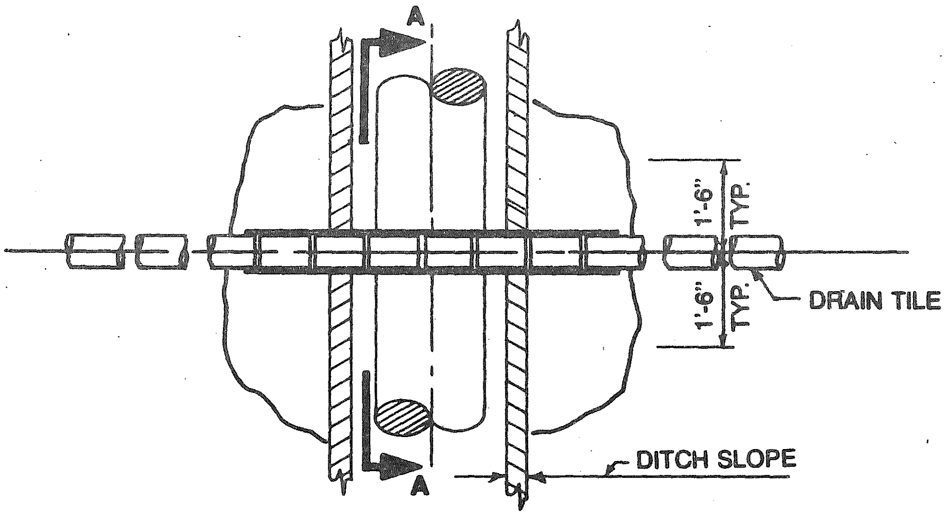
Appendix VIII

TILE REPAIR PROCEDURES

1. Comments received on the Draft EIS and Draft Addendum indicated that many landowners concerns regarding the tile repair procedures proposed by the company. Subsequently, the company has revised its proposed tile repair procedures to provide for "in-kind" repair of the three common types of tile -- clay, plastic and fiberglass. See Attachments A,B, and C for drawings of the revised tile repair methods.

2. The Department of Natural Resources retained the services of a consulting agricultural engineering firm Jones, Haugh and Smith, Inc., of Albert Lea, (in part) to make recommendations that would help insure the adequacy of tile repairs. The firm made several recommendations. Attachments D and E show suggested typical tile repair procedures. Attachment F shows a suggested tile inlet structure which could be used to prevent soil and debris from entering the tile system should the pipeline trench fill with water. It was also suggested that landowners may want to request temporary drain tile connections during the construction period. It is recommended that such connections be made of metal or plastic pipe, supported to prevent sag or grade separation, and be constructed by reasonable means to prevent dirt and debris from entering the drain system.

3. It should be noted that the state has no authority to require the pipeline company to adopt the procedures suggested in the paragraph 2 above, but landowners may wish to consider these procedures when negotiating the Grant-of-Easement.

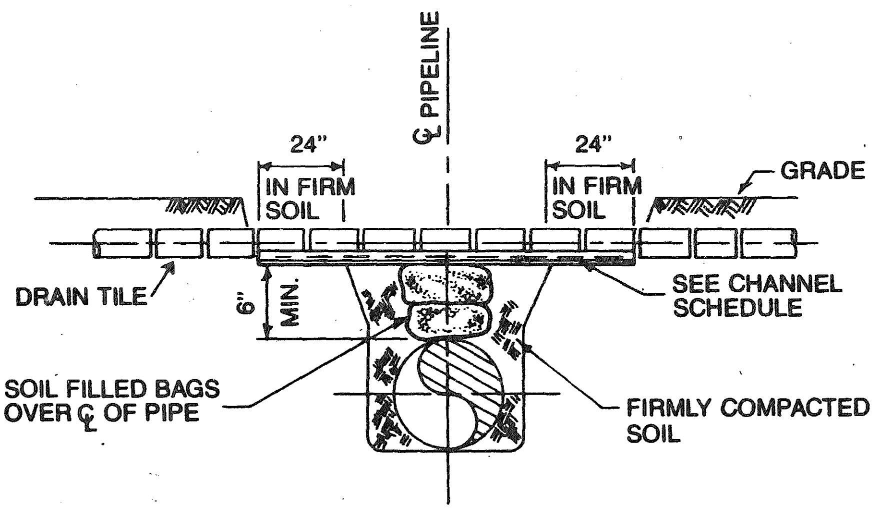


PLAN

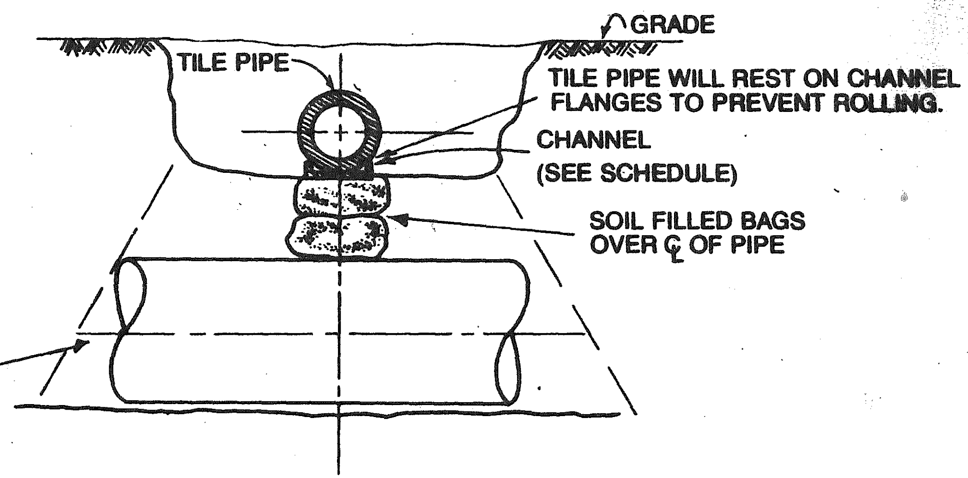
CHANNEL SCHEDULE	
PIPE (O.D.)	CHANNEL
4	4x5.4#/FT.
5	4x5.4#/FT.
6	4x5.4#/FT.
8	5x6.7#/FT.
10	8x13.75#/FT.
12	8x13.75#/FT.
14 & UP	10x15.3#/FT.

GENERAL NOTES

1. MINIMUM ANGLE OF TILE CROSSING WITH RESPECT TO PIPELINE 60°
2. DESIGN DATA: DEPTH OF COVER OVER DRAIN - 2'-6" MAX.
   DISTANCE BETWEEN BEARING POINTS - 8'-0" MAX.
3. COMPLETED ASSEMBLY TO BE COATED WITH ENDCOR 750 PRIMER AND 772 TOP COAT.
4. CHANNELS TO BE PROVIDED IN ACCORDANCE WITH A15C PROVISIONS FOR ASTM A-36 STEEL.
5. FILL IN THE REGION BETWEEN THE PIPELINE AND THE TILE CROSSING FOR A DISTANCE 5' EACH WAY FROM THE ℄ OF THE TILE CROSSING WITH THROUGHLY COMPACTED GRANULAR MATERIAL.



PROFILE

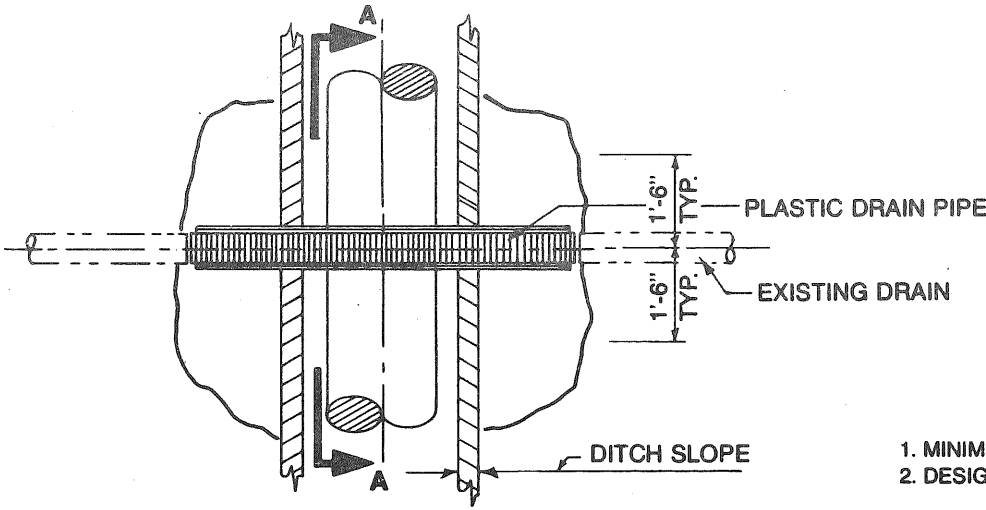


SECT. A-A

CLAY TILE REPAIR

ATTACHMENT A

NORTHERN PIPELINE COMPANY

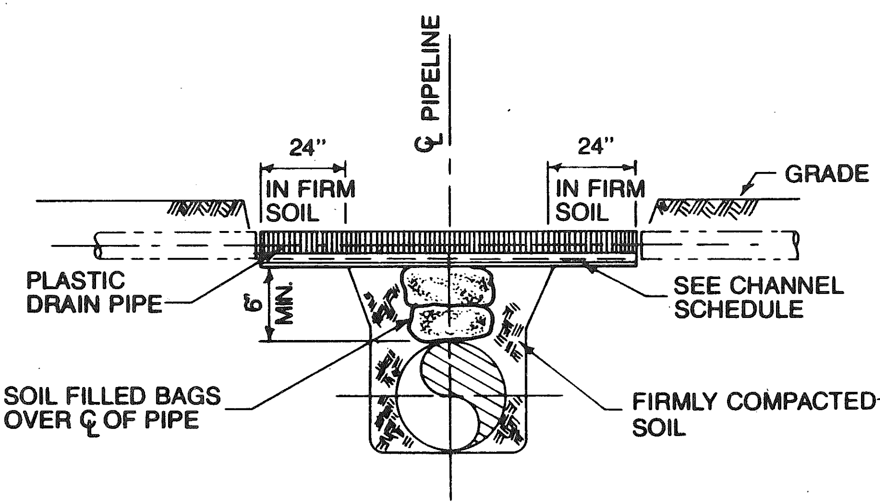


PLAN

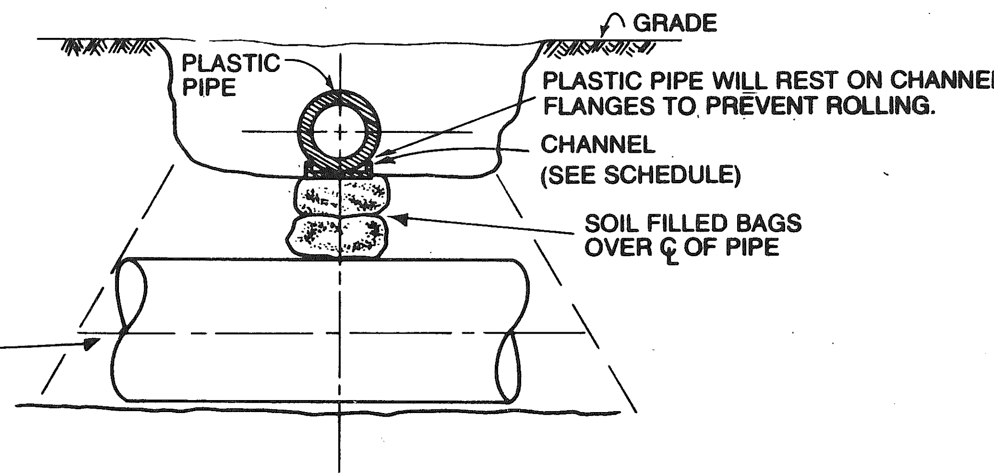
CHANNEL SCHEDULE	
PIPE (O.D.)	CHANNEL
4	4x5.4#/FT.
5	4x5.4#/FT.
6	4x5.4#/FT.
8	5x6.7#/FT.
10	8x13.75#/FT.
12	8x13.75#/FT.
14 & UP	10x15.3#/FT.

GENERAL NOTES

1. MINIMUM ANGLE OF TILE CROSSING WITH RESPECT TO PIPELINE 60°
2. DESIGN DATA: DEPTH OF COVER OVER DRAIN - 2'-6" MAX.
   DISTANCE BETWEEN BEARING POINTS - 8'-0" MAX.
3. COMPLETED ASSEMBLY TO BE COATED WITH ENDCOR 750 PRIMER AND 772 TOP COAT.
4. CHANNELS TO BE PROVIDED IN ACCORDANCE WITH A15C PROVISIONS FOR ASTM A-36 STEEL.
5. FILL IN THE REGION BETWEEN THE PIPELINE AND THE PLASTIC PIPE CROSSING FOR A DISTANCE 5' EACH WAY FROM THE ℄ OF THE PLASTIC PIPE CROSSING THROUGHLY COMPACTED GRANULAR MATERIAL.



PROFILE

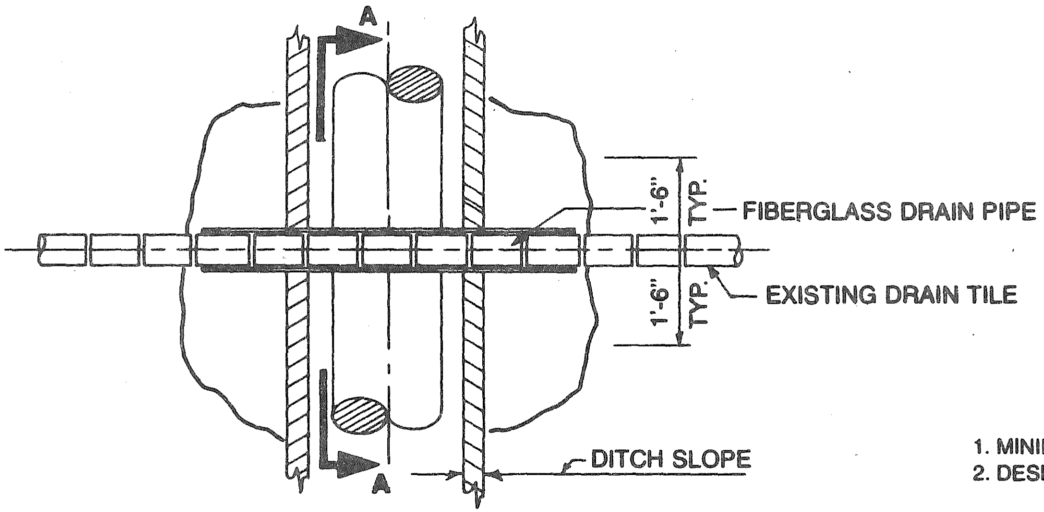


SECT. A-A

PLASTIC DRAIN REPAIR

ATTACHMENT B

NORTHERN PIPELINE COMPANY



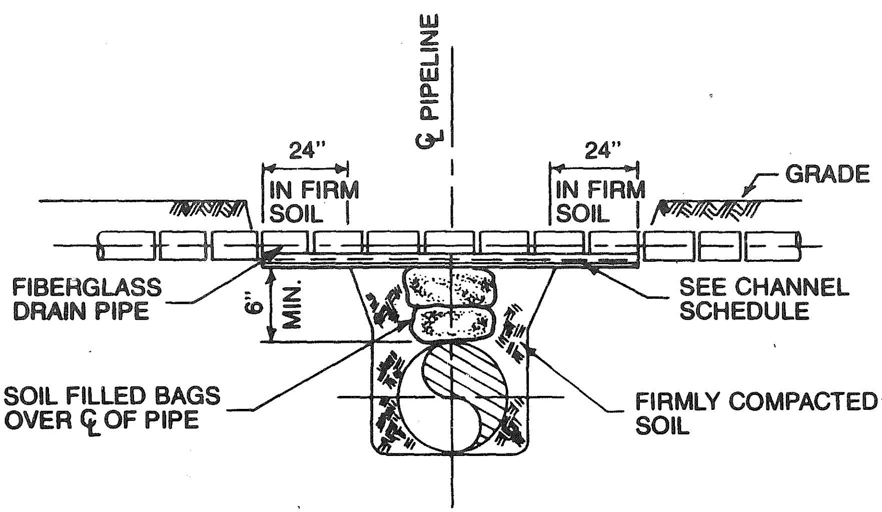
PLAN

CHANNEL SCHEDULE

PIPE (O.D.)	CHANNEL
4	4x5.4#/FT.
5	4x5.4#/FT.
6	4x5.4#/FT.
8	5x6.7#/FT.
10	8x13.75#/FT.
12	8x13.75#/FT.
14 & UP	10x15.3#/FT.

GENERAL NOTES

1. MINIMUM ANGLE OF TILE CROSSING WITH RESPECT TO PIPELINE 60°
2. DESIGN DATA: DEPTH OF COVER OVER DRAIN - 2'-6" MAX.
   DISTANCE BETWEEN BEARING POINTS - 8'-0" MAX.
3. COMPLETED ASSEMBLY TO BE COATED WITH ENDCOR 750 PRIMER AND 772 TOP COAT.
4. CHANNELS TO BE PROVIDED IN ACCORDANCE WITH A15C PROVISIONS FOR ASTM A-36 STEEL.
5. FILL IN THE REGION BETWEEN THE PIPELINE AND THE FIBERGLASS PIPE CROSSING FOR A DISTANCE 5' EACH WAY FROM THE ℄ OF THE FIBERGLASS PIPE CROSSING THROUGHLY COMPACTED GRANULAR MATERIAL.



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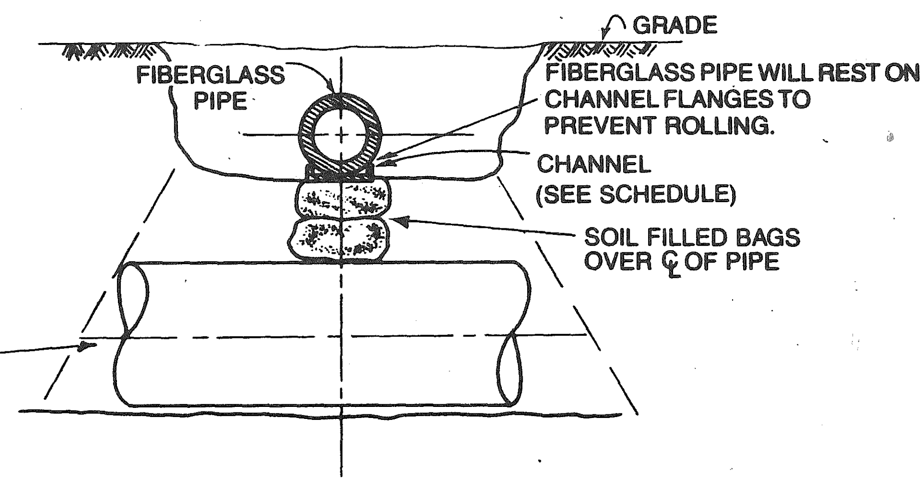


SECT. A-A

FIBERGLASS TILE REPAIR

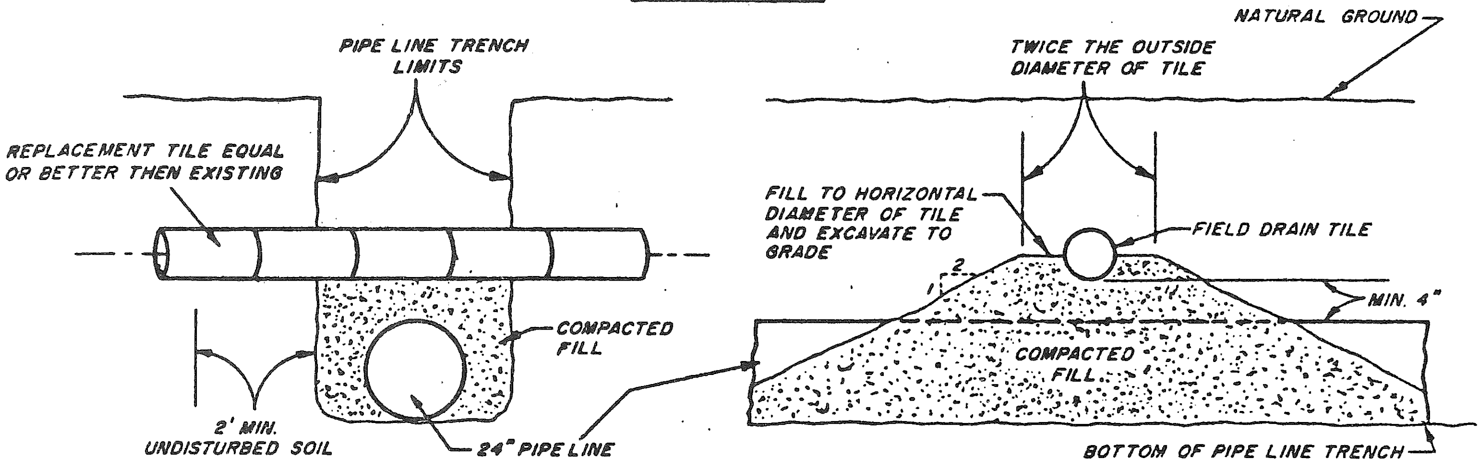
ATTACHMENT C

NORTHERN PIPELINE COMPANY

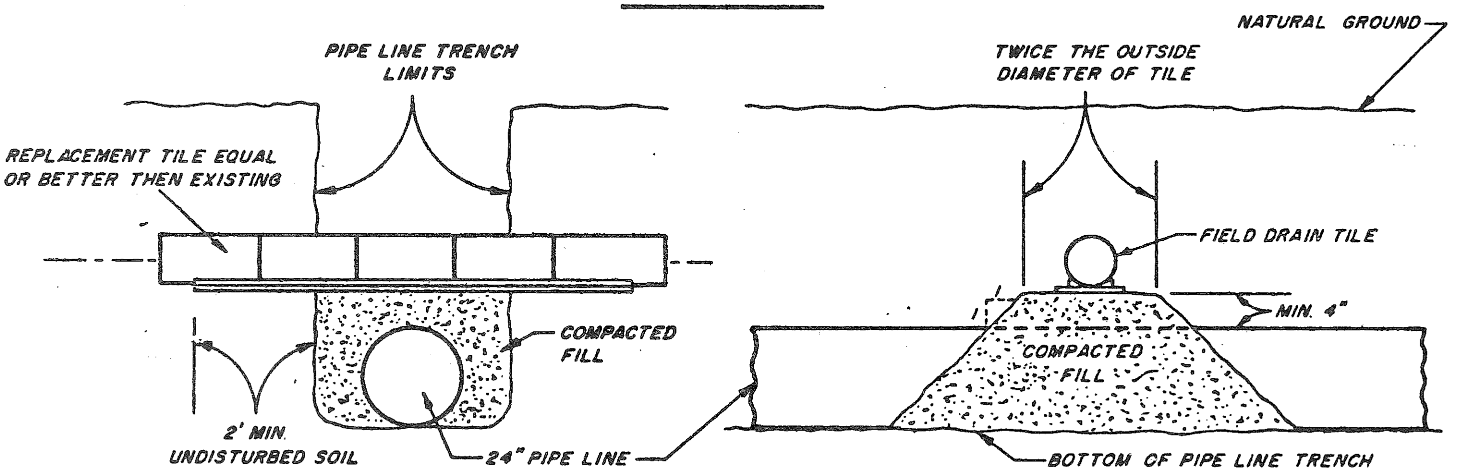
ATTACHMENT D

Typical Field Tile Repair

Type I



Type 2



NOTES:

1. Tile used for repair shall meet ASTM standards for quality, size and type, at least equivalent to the pipe removed.
2. Tile shall be replaced at a uniform grade, and connected to undisturbed tile at the original elevation at each end of the repair.
3. Backfill to be compacted in layers not exceeding 6", to the same density as adjacent undisturbed soil. A penetrometer shall be used to measure the density.
4. Whenever adequate compaction of material excavated from the trench cannot be obtained, crushed rock (1" maximum dimension) shall be used and compacted as described in Item 3.
5. Where conditions warrant or if requested by property owners, bridging such as channel iron or creosoted plank shall be used to obtain proper alignment and grade. Use of bridging will not change compaction requirements.
6. All tile joint gaps exceeding ¼" shall be covered with mortar at least 4" thick, and 2" either side of the joint.

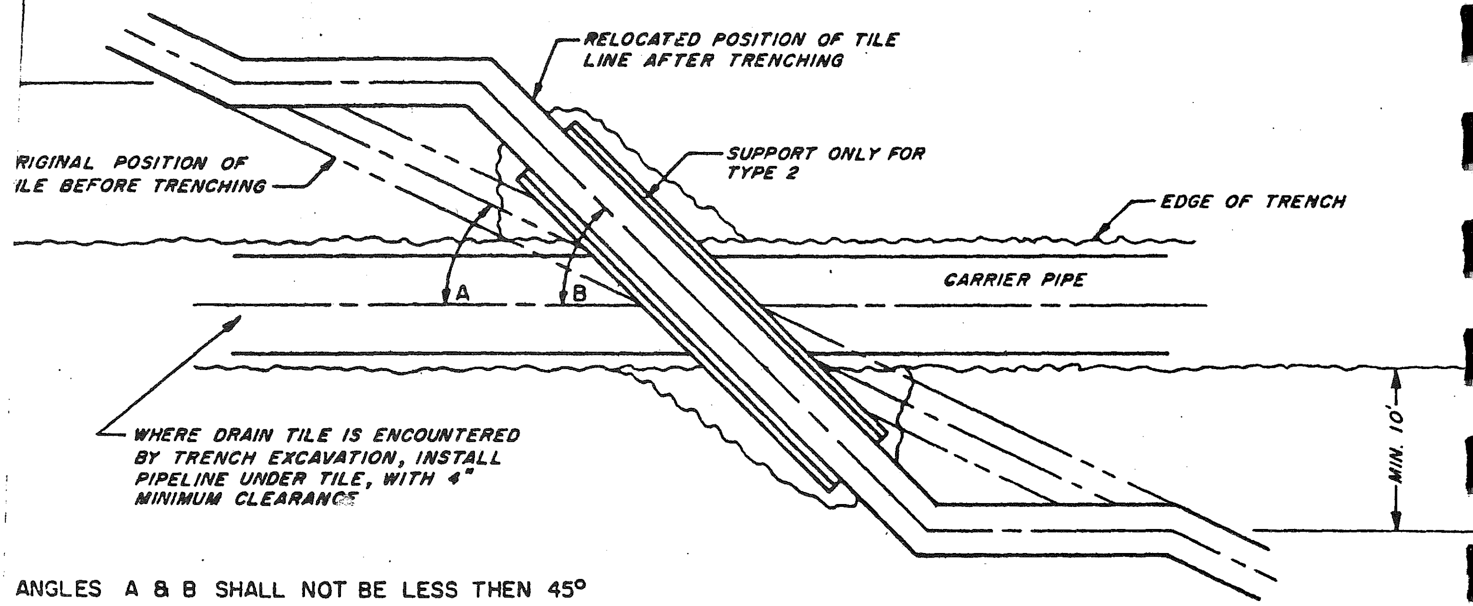
Prepared by

Jones, Haugh, and Smith, Inc.

Consulting Engineers

ATTACHMENT E

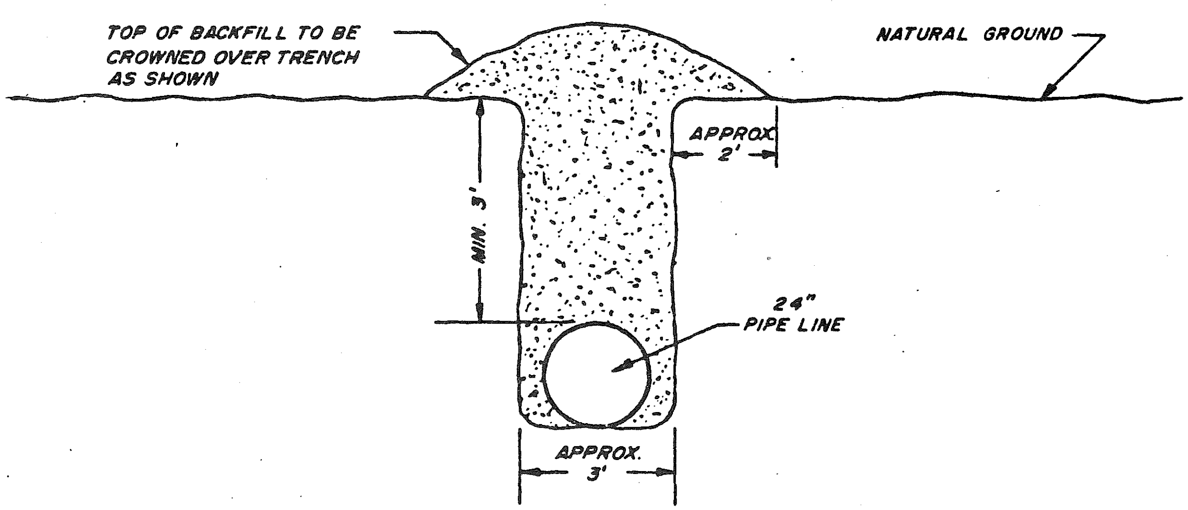
Typical Field Tile Repair For Skew Crossing



ANGLES A & B SHALL NOT BE LESS THEN 45°

ALL DRAIN TILE BENDS TO BE MANUFACTURED OR FITTED WITH A MAXIMUM OF 1/4" GAP IN JOINT

Typical Backfill Cross-section



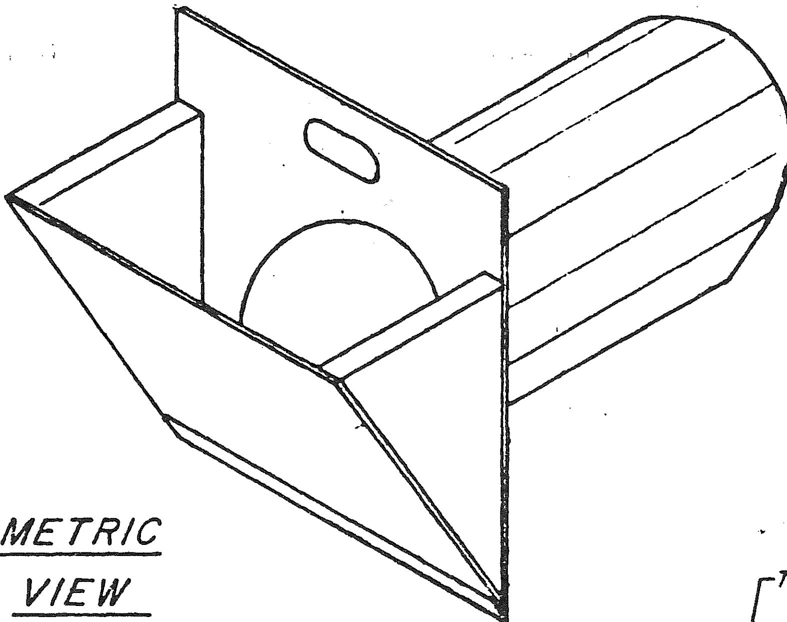
Prepared by

Jones, Haugh, and Smith, Inc.

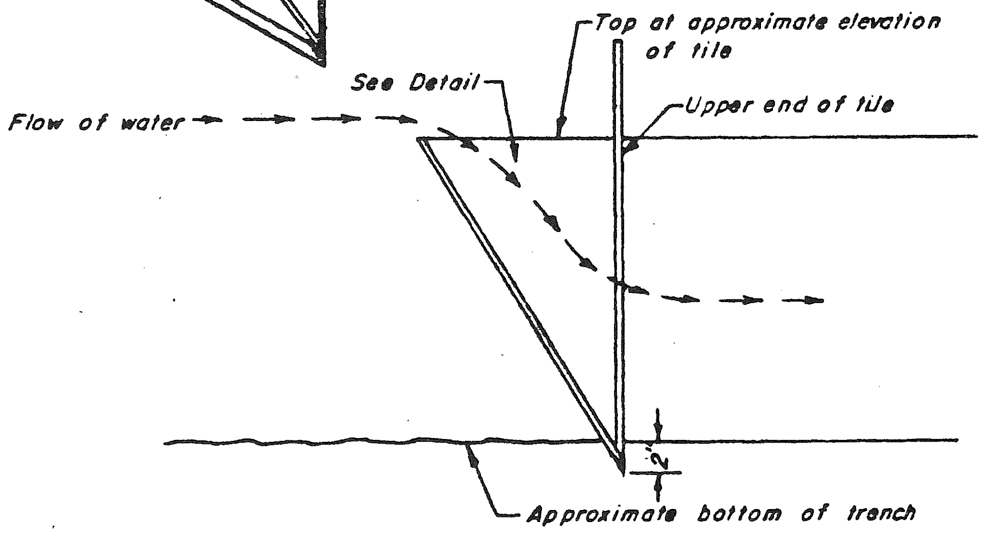
Consulting Engineers

ATTACHMENT F

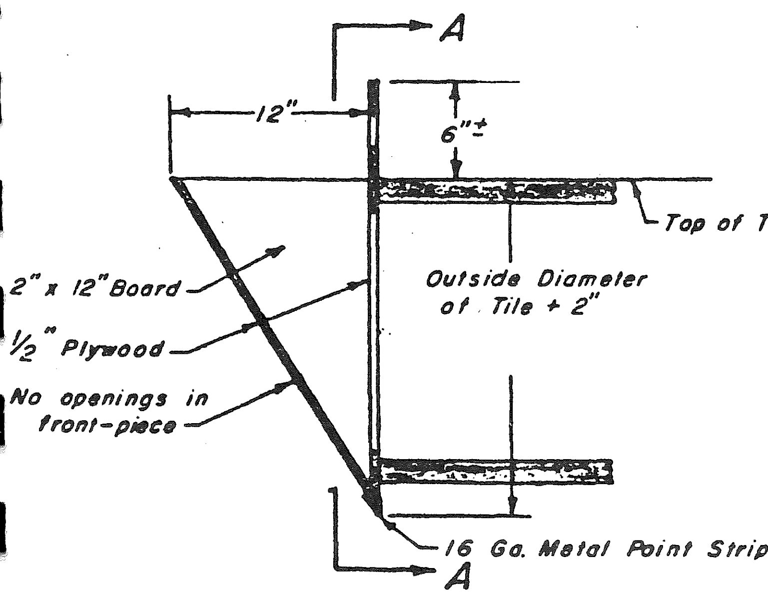
TEMPORARY TILE INLET STRUCTURE



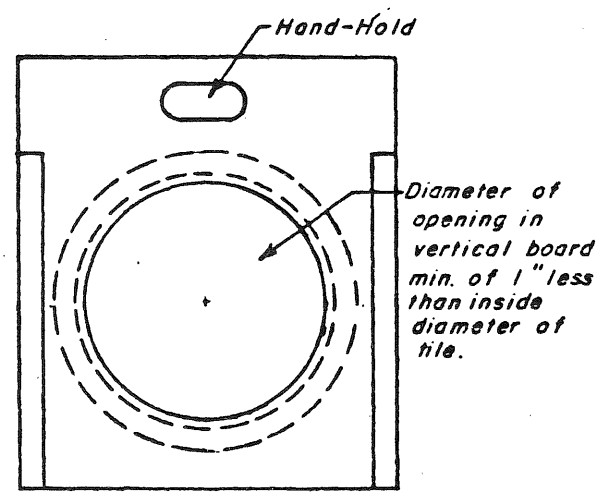
ISOMETRIC VIEW



GENERAL ELEVATION



SIDE VIEW
(Cross Section)



SECTION A-A
(Front View)

Prepared by

Jones, Haugh, and Smith, Inc.
Consulting Engineers

Appendix IX

LEAK DETECTION

Prepared by Northern Pipeline Co.

Leak detection for liquid pipelines is a rather complex topic, yet there is a definite need to perform this task with the most exacting techniques possible. Several methods have been commonly used by the industry to detect leaks. These methods include the detection of pressure and flow rate deviations as well as the detection of flow rate and volume imbalances. These methods lend themselves well to the rapid detection of relatively large leaks. A large break, such as might be experienced when an earth-moving machine strikes a pipeline, can be detected almost instantly with a very high degree of certainty.

The volume imbalance method has proven to be the most effective method utilized to date to detect small leaks. The constant quest within the industry to improve the state-of-the-art has resulted in the recent application of mathematical pipeline models along with the volume imbalance method. When the flow rate of a given fluid through a pipeline is known, the pressures along the line are predictable. Conversely, with the pressures being known, the flow rates are predictable. Comparisons can then be made between known and predicted values, and when these values differ by more than a reasonable tolerance, an alarm can be signalled. These methods will certainly provide detection for the larger leaks, yet their effectiveness in detecting the smaller leaks is subject to continued evaluation.

The volume imbalance method is based upon the following relationship:

Net Volume Imbalance = (Net volume taken from the line - Net volume put into the line from time t_1 to t_2) + (Net line fill at t_2 - net line fill at t_1)

Time t_1 represents the beginning of a time period, while t_2 represents the ending of the period. The monitoring system for the Northern Pipe Line will use a time period of 15 seconds; i.e., $t_2 - t_1 = 15$ seconds. The net volume put into the line is the quantity of oil measured by the input meters from time t_1 to t_2 and, similarly, the net volume of oil taken from the line is the quantity measured by the output meters from time t_1 to t_2. Line fill volumes at times t_1 and t_2 are calculated based upon known line size (length and internal diameter) with appropriate adjustments for temperature and pressure.

A negative Net Volume Imbalance will indicate a possible leak or shortage, while a positive Net Volume Imbalance will indicate a gain or overage. When net volumes put into the line are greater than the net volumes taken from the line and the difference cannot be reconciled as a line fill difference, the line is said to be short (-). When the reverse is true, the line is said to be over (+).

In order to provide the most rapid leak detection response, the Net Volume Imbalances should be calculated as frequently as possible. The central control and monitoring system with its master station at Cottage Grove will provide the capability to perform these calculations every 15 seconds. They will be performed on both a short-term and long-term basis. The short-term period (say 10 minutes) will provide detection of relatively small leaks. Both calculations will be based upon a "sliding time window" concept; i.e., the system is always using the most recently expired time intervals equal to the short- and long-term periods at the time of each calculation.

When a calculated Net Volume Imbalance is more negative than the specified limit for either a short-term or a long-term period, an alarm will be signalled. The pipeline operator will make an immediate evaluation and proceed to shut down the pipeline. The operator will further proceed to implement established procedures to locate the leak and to notify appropriate authorities.

The matter of specifying an established Net Volume Imbalance limit is further explored here. Many factors prevent the specified limit values from approaching zero. Ideally, the limit should be set as near zero as absolutely possible. Yet such factors as metering accuracy, transient responses, and physical size influence the specified limit value. In actual practice, metering accuracy has less influence on setting the limit than other factors; e.g., consider the initial design flow rate of 5702 BPH (130,000 BPD with a five percent downtime allowance) and a metering accuracy of 0.15 percent. While modern pipeline metering systems afford ± 0.02 percent repeatability under similar operating conditions (similar fluid characteristics, flow rates, etc.), they typically afford linearity over an operating range of only ± 0.15 percent. With meters at both ends of the pipeline, the combined metering accuracy could approach ± 0.30 percent. Using this accuracy relative to a 10-minute short-term time base and the 5702 BPH flow rate, it might be concluded that a short-term detection threshold might be 2.85 barrels. This threshold would correspond to leak rates of 17.1 BPH on the 10-minute time base and 1.71 BPH on the 10-hour time base.

At an ultimate design flow rate of 10,329 BPH (235,500 BPD with a five percent downtime allowance and 8 pumping stations), the corresponding leak rates would be 51.6 BPH and 5.16 BPH for the short- and long-term periods, respectively. The leak detection capability may well approach these low limits, perhaps more than 90 percent of the operating time, as experience is gained with respect to the operation of this particular pipeline. Unfortunately, the discussion of leak detection limits cannot end here.

In actuality, the transient responses within the flowing crude oil stream and the physical size of the volume stored within the pipeline have far greater significance in the determination of the detection threshold than does metering accuracy. In the event it were physically possible to have a perfectly rigid pipeline and the crude oil were perfectly incompressible with neither being affected by volumetric expansion due to temperature, metering accuracies would play a more significant role. Again, in actuality, both the crude oil and the pipeline are subject to volumetric variation as functions of both temperature and pressure.

There is a common tendency to think of a pipeline as being rigid and oil to be incompressible, but to the contrary neither assumption is correct; i.e., the pipeline's internal volume slightly increases and decreases along with the oil becoming more or less compressed with variations in internal pressure and temperature. The internal volume of the Northern Pipe Line (presently estimated at some 475 miles) is calculated to be 1,338,340 barrels. This large volume is subject to small variations caused by changes in operating pressures. Temperature has a lesser effect, since ground temperature is essentially constant over the time-base periods and is the principal factor controlling the pipeline temperature.

The volume variations resulting from the pressure changes will be accounted for in the Net Volume Imbalance calculations; however, the transient response times must also be considered. When the pressure is either increased or decreased at a point along a pipeline, the change is not reflected at all points along the pipeline at the same time. Pressure changes are propagated along a pipeline at velocities characteristic for that pipeline. This phenomenon, therefore, requires wider detection limits to accommodate for the variations caused by operational changes. The detection limits given previously included an allowance to provide reliable leak detection at all times, including periods of operational changes.

In addition to the leak detection system described above, two additional features are planned. These features are new and represent state-of-the-art design. Both will provide trending information with which to monitor and evaluate the pipeline over a much longer term. First, it is planned to continuously record on strip-chart recorders the short- and long-term Net Volume Imbalance values. These recordings will then permit visual observation of imbalance trends with respect to the alarm limit values. It is anticipated that normal operational changes on the pipeline will result in smooth curves having recognizable characteristics. Similarly, any imbalance resulting from a leak will be reflected by a characteristic trend that is distinguishable from a normal operational change; perhaps even a step-wise change may result.

The second feature involves storing net volumes in and out of the pipeline along with line fill calculations and all associated temperature and pressure variables in the control system computer. These values will be stored every hour on the hour. Printed copies of this data will be made each day including data for each of its 24 hours. The pipeline over and short balance will be reflected on a cumulative basis. Hence, it will be possible to evaluate imbalance trends cumulatively over long periods of time. An obvious advantage of this feature is the potential for detecting very small leaks by observing negative trends in the cumulative pipeline over and short balances.

It is anticipated that as the Northern Pipe Line is put into operation and more experience is gained with respect to its operating characteristics, the leak detection capability can be improved. Further, as state-of-the-art developments are made, the monitoring system can and will be further enhanced.

Appendix X

LETTERS OF INTENT
TO PARTICIPATE

Ashland

ASHLAND OIL, INC. • POST OFFICE BOX 391 • ASHLAND, KENTUCKY • 41101 • PHONE (606) 329-3333

JOHN R. HALL
Executive Vice President and
Group Operating Officer
(606) 329-3621

March 2, 1978

Mr. Roger L. Williams, President
Northern Pipe Line Company of Delaware, Inc.
Box 2256
Wichita, Kansas 67201

Dear Mr. Williams:

Re: Your Wood River/St. Paul Pipeline

This confirms my prior telephone advice to you that Ashland Oil, Inc. supports your efforts to build the captioned pipeline.

Ashland Oil, Inc. intends to ship crude oil over your new pipeline, once it is built, in order to supply at least in part our refinery at South St. Paul. Presently, the exact level of our expected shipments is uncertain because of the variables involved in our overall supply picture. However, we anticipate that the volumes to be shipped by Ashland will be significant.

This letter is an expression of intent and in no way obligates Ashland nor limits Ashland's right to use alternate delivery routes or methods.

We are very interested in your company's plans to provide an alternative supply route for the Minnesota refiners.

Sincerely yours,

John R Hall

CONOCO

RECEIVED

MAR 20 1978

Engineering Department

Continental Oil Company
P.O. Box 2197
Houston, Texas 77001

FH

March 16, 1978

Mr. Roger Williams
Koch Oil Company
Box 2256
Wichita, KS 67201

Conoco considers Koch's proposed pipeline from Wood River to the Twin Cities area as being a possible alternative supply system for delivering crude oil to our Wrenshall Refinery. Conoco's utilization of any pipeline alternative would be based on which system provides us the most economical means of supplying Wrenshall. Also, Conoco's potential utilization of the Koch Line or any pipeline from the South capable of moving crude oil is however predicated upon our being able to move the crude from the Twin Cities to Wrenshall; the existing capability of which is extremely limited.

As you know, Conoco remains of the opinion that Kitimat will provide the most economical means of long-term supply to Wrenshall as well as other refineries in the Minnesota/ Wisconsin area. However, if Kitimat were not to be constructed, Koch's Line would be considered as an alternative supply system for Conoco as would any other system capable of delivering crude oil to our Wrenshall Refinery.

Sincerely,

David

David O. Kem
Manager, Crude Oil Regulations
Crude Oil Supply and Trading/
North America

/lg

Fritz Hansen

DOW / DOW CHEMICAL U.S.A.

December 16, 1977

BARSTOW BUILDING
2020 DOW CENTER
MIDLAND, MICHIGAN 48640

Mr. Wm. Hogland
Koch Oil Company
P.O. Box 2256
Wichita, Kansas 67202

RECEIVED
DEC 23 1977
LEGAL DEPARTMENT
KOCH INDUSTRIES, INC.

Dear Bill:

I enjoyed our visit in Calgary this week and I would like to confirm our possible interest in the movement of crude oil through your new pipeline connection into the Minnneapolis area when it is completed in 1979.

As I explained to you, we have only one pipeline connection to crude oil and that is to the north loop of the Interprovential/Lakehead system.

It is anticipated that we may require 10,000 to 15,000 barrels per day of crude oil to be moved from a Gulf Coast port up to the Interprovincial system and then down to our Bay City, Michigan refinery starting on or about July 1, 1979 and continuing probably through 1982.

Please consider the possibility of assisting us in this movement by use of your new pipeline.

Very truly yours,

Jack

J. E. Charters
Hydrocarbons Department

cp

LIFE IS FRAGILE HANDLE WITH CARE

Appendix XI

STATE LIAISON PROCEDURE

State agencies granting permits and preparing the EIS for the Northern Pipeline will set up a state liaison to ensure that the landowner rights are protected during pipeline construction. No statutory authority exists for the liaison, so cooperation from the company and landowners is necessary to make it work. The liaison will be under the supervision of the Minnesota Department of Agriculture and financed by member agencies of the Environmental Quality Board (EQB).

Before construction begins, the liaison will be provided the list of all special construction conditions, permit conditions, and all grants of easement. These will be compared and any discrepancies will be reported to the state, the company inspector, or the landowner, as may be appropriate.

During construction the liaison will fill out a daily log and a tract log. The daily log will follow construction progress and note all road crossings, interactions with local governments, conversations with pipeline inspectors, etc. The tract log, one for each tract of land crossed, will record company compliance with the terms of the grant of easement. The liaison has no authority to stop construction or resolve disputes. However, the logs and reports prepared by the liaison worker will be available to all parties.

Appendix XII

ENVIRONMENTAL IMPACT ASSESSMENT

Submitted by

RCO/Harold Froehlich

The following environmental impact assessment was submitted by Reroute Crude Oil (RCO) and Harold Froehlich for inclusion in the Draft Addendum released in January, 1978, but was received too late to be included at that time.

To: MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Re: ENVIRONMENTAL IMPACT STATEMENT (EIS) NORTHERN PIPE LINE CO. OF DELAWARE

ENVIRONMENTAL IMPACTS OF PIPELINES

I. Construction of Pipelines (3.1 Construction)

   A. Methods Currently Employed: Observations, Experiences & Violations

   B. Areas of Concern to the Agricultural Landowner

      1. Selection of a Pipeline Route (1.3 Location of Proposed Pipeline) (2.1.1 Land Ownership Patterns) (5.2.1 Proposed Routes) (5.2.2 Alternate Routes)

      2. Topsoil and Productivity Loss (3.1.1 Land Use) (3.1.3 Soils and Topography) (6.2 Uses Preempted)

      3. Impact upon Drainage Systems—Present and Future (1.6 Drain Tile) (3.1.3 Drainage) (6.2 Uses Preempted)

      4. Lack of Authority

         a. To thoroughly explore and address alternatives (1.1 Summary Statement) (5.1.2 Other Pipelines) (5.2.1 Proposed Route) (5.2.2 Alternate Routes)

         b. During the physical construction of pipelines (1.4.2 Easement Fees) (4.1 Land Use) (4.3 Soils & Topography)

   C. Experienced Contractor's Recommendations

      1. Right-of-Way Width Required (1.4.1 Right-of-Way)

      2. Topsoil Segregation (3.1.1 Land Use) (3.1.3 Soils—Mixing) (6.2 Uses Preempted)

      3. Easement Contract (4.1 Land Use) (4.3 Soils & Topography)

      4. Tile Damage and Repair (1.6 Drain Tile) (3.1.3 Soils—Drainage) (6.2 Uses Preempted)

ENVIRONMENTAL IMPACTS OF PIPELINES

I. Construction of Pipelines

   A. Methods Currently Employed

Exhibit A is documentation of pipeline construction observed in the summer of 1977 in Minnesota and Iowa by the same construction firm proposed to be hired by Northern Pipe Line Co. of Delaware for the Wood River, Illinois to Pine Bend, Minnesota line. Below are excerpts from this account which was published October 28, 1977.

PIPELINE ISSUE: PROPERTY RIGHTS VS. PUBLIC INTEREST

"What is best in the interest of the public?

Are the interests of the majority of people served best by a pipeline running through prime farmland in an era of petroleum shortages, or is there a long-term interest in sparing prime farmland for future food needs?

And how much responsibility does the state, which grants eminent domain rights to a pipeline company, have towards the property owners whose land is crossed after the domain rights are awarded?"

Construction Observation, 1977

"Farmers and conservationists stood aghast when the crews who cleared and dug the pipeline trench arrived and rushed pellmell through the fields preparing the way for installation. Neither rain nor literal muck stopped the caterpillars and drag-lines from cutting across the fields despite near record rainfalls which turned the fields to quagmires. When semi-trucks hauling the pipes couldn't drive into the right-of-ways because of the mud, the bulldozers hooked chains to the front of the vehicles and dragged them to their unloading points."

Attempt to Restore Fields

". . . from outward appearances, it seems the topsoil has been laid back in place. But the looks can be deceiving . . . piles of yellow and blue clay, which turns rock-hard in two days of sun and into soupy muck in rainfall, have been returned to trenches, but not in the same formations as before. And those areas won't necessarily support the weight of farm machinery."

Oil or Soil?

"A conversation with members of the pipeline crew as they passed through the area, indicated they felt they were performing a great service to the needs of the country as far as petroleum is concerned. But additional comments about not understanding why the farmers in the area were getting so upset about 'digging up a little bit of land,' also revealed unawareness of the importance of topsoil."

"It is a short-sighted America that begins to look for energy when it is wasted and scarce and for food when too much land is ruined and the world has starvation."

Exhibit B is a detailed example of a landowners experience. Below is a listing of the most common violations of easement agreements cited by landowners involved in construction on their land in 1977.

1. Notification of Entry
Notification of the landowner or tenant before entering property was ignored or made too late for removal of crop from right-of-way.

2. Easement Width Violation
Construction workers used as much as 200 feet of width although a 50 foot easement had been purchased. Violations occur more frequently during construction in wet conditions when work on farmland should be prohibited. Cropland not covered by easement was used to pull out stuck construction equipment.

3. Soil Abuse
Some landowners realized they could request separation of topsoil in the easement. However, in a 50 foot easement it was leveled and used as a "road" for the duration of the construction. When the "road" along the trench became rutted too deeply a new "road" was made. Work continued regardless of weather and the valuable topsoil became a compacted, homogenized mess often buried in deep ruts.

4. Tile Damage
Tile lines were to be capped or bridged with a temporary connector immediately after the trench was dug. Neglect of this responsibility allowed dirt and debre to be washed into tile lines. Repair of lines consisted of packing mud over the pipeline, placing a channel iron on top and laying the tile in the channel iron. It is reasonable to doubt the effectiveness of such a procedure when the land drys and compacts. Tile lines crossed with heavy machinery making ruts four feet deep were crushed. Only time will tell how many crushed lines went undetected.

5. Fence Destruction
Fencing crews were unskilled in fence building and unable to build adequate temporary fences or replace fences to original condition. Temporary fences were an easy mark for cattle, gates were left open, cattle mixed with neighbors cattle and hours spent chasing and sorting.

6. Ditch Crossings, Field Accesses and Road Travel
The easement provision to build suitable ditch crossings for the landowner was disregarded. Lack of a crossing shut dairy heifers away from grain for over two weeks. There were frequent complaints of being unable to harvest crops for lack of a crossing.
Existing entrances to fields were used by heavy equipment during very wet conditions and caused them to be unusable to the farmer because of deep ruts. Road travel was blocked by construction equipment for as long as 45 minutes during critical hours of the day.

XII-2

7. Rock, Water and Trash Disposal
Easements require removal of rock brought to the surface and of the materials and wastes from construction. Rocks and debre were windrowed into the trench. Junk was buried so that pieces of cable are picked up by corn pickers, plows hook 4 x 4's used in cribbing the pipe and farmers pick, up boards, tires, metal objects and oil, pop and beer cans. Water pumped from the ditches left piles of sand and swamp areas in the field along the trench.

B. Areas of Concern to the Agricultural Land Owner

1. Selection of a Pipeline Route

Pipeline companies propose routes preceded by a wide variance in the amount of "homework" as to the impact of a 'shortest route' which Northern claims is cheapest for them. However, the shortest route does not always run through areas of least costly construction problems. In addition, Impact Statements were created to uncover reasons for certain areas to be inappropriate. A sincere preliminary environmental study by a company, prior to the presentation of a proposed route, is needed. The irresponsible original proposal of Northern to endanger the Midwest's water supply points up this need.

The Northern proposal has been called "inaccurate", "incomplete" and "shoddy" by governmental agency heads in Minnesota who examine a proposal before it is approved. This proposal is a witness to the fact that landowners can be harassed by proposals that should never be allowed past governmental agencies who could review, report and stop an unneeded, ill-prepared, inappropriate route before it plagues the public and wastes the taxpayers money. Prior investigation would save a company expense in the long-run.

Examples of Northern's lack of "homework":

a. "We've picked the shortest and therefore the most economical route," but they had ". . . no idea of the average number of tile lines" and said ". . . we are not familiar with plastic tile."

b. "If oil gets into the water supply we will clean it up." (A statement too broad to be truth. Routing crude oil over aquifers can create a situation that could make that impossible.)

Lack of "homework" has wasted huge amounts of time, money and energy in pipeline construction and its consequences. Farmers are qualified to speak on the make-up of their property and its drainage systems. Their expertise could be utilized in selection of specific route locations. Information which individual landowners could provide would be in the best interest of the companies, the landowners and most of all the priceless natural resources of topsoil and water. Examples of situations where unpreparedness and unwise route selection meant waste:

a. A landowner spent $7,000 to build a waterway to be wrecked and open to erosion from pipeline construction. Moving the line 30 feet would have avoided the damage.

b. A pipeline was routed in the exact location of a large tile main. A few feet could have avoided the destruction of the costly main.

c. Pipelines which are not run parallel to the contour of the land work as a dam and create wet holes upon which tiling has little effect.

The "homework" requirement regarding route selection of pipelines is inadequate as it has allowed the waste of huge amounts of time and energy by citizens harassed by an irresponsible proposal trying to gain approval through the pressures which wealth can exert.

2. Topsoil and Productivity Loss

Topsoil is in limited supply on this earth. Five million acres are removed from potential agricultural production each year according

to the associate administrator of the Soil Conservation Service, Norman Berg. At least one million acres of the total is "prime" farmland. When topsoil is destroyed by being buried in a ditch, mixed with a high percent of inorganic matter, or soaked with oil, it is gone forever. Topsoil is not for sale in acre quantities which pipeline construction and leaks can destroy. A Soil Conservation Service publication says that it takes nature 250 to 1,000 years to build an inch of topsoil. Farmers can help nature along by an intensive program of adding organic matter and soil, but the resulting soil would not be like that which was lost. The soil may be ready to grow crops in 8 to 10 years with the farmer's help. Cost to the farmer would include time and practices beyond which the farmer normally uses, as well as, loss of income from the crops usually grown on the area.

Pipeline construction methods that have been allowed up to the present time have left a homogenized mess of inorganic material mixed with topsoil and which consistently yields 30 to 60 percent less than adjacent land. A farm dissected by a pipeline absorbs an ongoing reduction in land value. A strip that is open to the troubles of a weakened tile system, perpetual yield reductions and is a pipeline alley where crews can service a utility in the middle of a corn field, lowers the appraised value of a farm.

No machine on the market today can adequately apply herbicide when organic matter changes from 0 to 4½ percent within inches. (Crop lines and pipelines also are not parallel.) If pre-plant or pre-emergence herbicides are applied at the required rate it will kill plants on the pipeline route. If the rate is lowered to tolerate highly inorganic land over a pipeline there is no weed control.

3. Impact upon Drainage Systems—Present and Future

Existing drainage system destruction is an impact of grave concern to a large majority of landowners. Thousands of tile lines are cut by diagonal pipeline installation. This easily renders them ineffective, troublesome and often hard to repair for generations. Cut tile lines can disturb the drainage of hundreds of feet; in other situations it can disturb a hundred or more acres. The problem can mean complete or partial crop failure for an area for as many seasons as it takes to correct the problems.

Insurmountable problems confronting the landowner in future drainage installations are also a major concern. Diagonal installation in cropland that is to be tiled creates additional, costly and often ineffective tiling procedures for the landowner. Shallow pipelines prevent engineering the correct fall of a tile line and interfer with correct layout. Tile lines are restricted to a shallow depth by pipelines which are not installed with a cover of five foot. Also a minimum number of crossings of the pipe is necessary to keep tiling costs from becoming prohibitive. A backhoe and hand shoveling, needed for each crossing, causes expenses which the pipeline company creates but for which the landowner pays. The tiler or landowner is technically liable if the pipe is hit. "We could lose our business or farm," is the unfair burden about which they have reason to object. Another procedure a landowner could follow is to install parallel tile mains on either side of the pipe which would require shorter laterals, many more junctions and increased cost. This has proven ineffective in land contours and soils which, when disturbed, act as a water holding dam that does not drain, and produces a permanent

wet area in the field. In some soils parallel tile mains placed close enough to the pipe to drain the area will be damaged and/or crushed by heavy equipment in the event of pipeline repair. Parallel tile mains placed away from the pipe to avoid damage will not drain the pipeline strip.

A large percentage of highly productive farmland's profit is in direct relation to the drainage systems involved. In the interest of maintaining the productivity of the American food belt, the complex and essential tile drainage systems need to be left in tact; their destruction is a wasteful use of energy. (It is dictatorship, not free enterprise, when one segment of society can say to another you will sell or we take by condemnation. A common false idea about eminent domain is that the landowner is paid for the land and then given it back to use just as he would have used it before.)

4. Lack of Authority

a. Lack of authority to thoroughly explore and address alternatives

The authority and expertise of companies proposing pipelines should end with the engineering of pipeline construction. An Environmental Impact Statement (EIS) should provide information for agencies and private persons to evaluate the impacts of proposed actions which have the potential for significant environmental effects, and consider alternatives and institute methods for reducing adverse environmental effects. When the tile and topsoil of highly productive land which is very sensitive to the impact of pipeline construction is involved in a proposed route, alternative means or routes to obtain the supply should be recommended. All possible alternatives should be addressed and thoroughly explored. If an alternative is available in which highly valuable topsoil, row crops, drainage systems and other conservation practices are <u>not</u> disturbed or not as prevalent—

that alternative should be recommended by "the powers that be". (Regarding crude oil supply for the Twin Cities area, a pipeline from the Pacific northwest through the very northern area of Minnesota and connecting with an existing line at Clearbrook, should be recommended to prempt a line that is proposed to run diagonally through highly productive cropland, complex drainage systems and in addition represents possible future damage to the acquifer water system which underlies the route.)

To thoroughly address and explore alternatives within the entire route proposed by a company the expertise of the landowner regarding his property should be included. Landowners should be provided with the oppprtunity to submit routes within their property where pipeline constuction would give the least impact. It should be recognized that some agricultural and acquifer areas provide no route in which pipeline construction is appropriate, and information regarding these areas is available to pipeline companies for st[illegible] prior to submitting a proposal. When a proposed route is determined, a five mile wide path should be drawn and notification should be given all landowners within that area 30 days prior to a scheduled informational meeting. These meetings could become an invaluable tool if the landowner's rights were not stripped. His right to provide alternatives and information could be recorded by an attorney appointed to represent the landowners. Statements would have no legal bounds but help determine possible least-impact, negotiable routes before a center line is set and an EIS is written and approved. The pipeline company would be responsible for collecting impact information from landowners under the supervision of legal representation.

b. Lack of authority in the physical construction of pipelines

Lack of authority during construction of pipelines is the major

cause of abuse. States do not provide for personnel with authority to require pipeline companies to carry out responsibilities. In the case of damages the parties must arrive at a settlement independently and if no relief can be obtained then it must be sought in court. Relief in court may sound adequate on paper. On close examination it is not hard to see how any given, individual landowner would be challenging a major petroleum firm or contractor in court. These firms know this is the only recourse the individual has under the law. The contractor knows he doesn't have to heed a landowner's request and the pipeline company knows its power and money, coupled with the lack of law, are their protection.

C. Experienced Contractor's Recommendations

Should there ever be a proven need to construct pipelines across an area of prime agricultural land, the right-of-way topsoil must be entirely removed and the pipeline must follow existing parcel boundaries. Fields and farms must not be crossed at a diagonal but follow parcel boundaries to avoid the excessive destruction of drainage systems. Recommended construction procedures of a veteran contractor follow:

1. Right-of-way width required

Construction of a 24 inch diameter pipe requires 75 feet of right-of-way. An additional 25 feet is needed to store topsoil. Grantee gives 100 feet of construction right-of-way and 25 to 50 feet of permanent easement.

"It's all hogwash to say they can go in and lay that job on 50 feet. Any ditch machine on the market today that will cut and put in a 24 inch pipe requires 22½ feet from inside edge of the ditch line to the outside of backfill. On the working side of the ditch the skid on which the pipe lays requires 4 feet, and to lay the pipe along the ditch and room for walking requires two to four feet for a total of a least 30 feet. This leaves only 20 feet for working room and that is not enough or safe for a contractor to pass his equipment. You can't get emergency vehicles or anything else past the equipment without getting into the farmer's field."

2. Topsoil Segregation

Topsoil is segregated by moving it off the entire 75 foot right-of-way with an angle blade dozer so the topsoil will "shed" to one side and can latter be put back in place. Removing topsoil from the trench width alone is not satisfactory as soils will become mixed. Topsoil can be placed on topsoil and subsoil on subsoil satisfactorily when the entire width is cleared and additional land provided for storage. The topsoil must be cut to the depth at which the topsoil occurs at any given place. Segregation must be done when the ground is in tilable condition.

3. Easement Contract

Contractors have been and should be required to keep up contracts for at least three years. Before a company can ask for bids from contractors the requests and restrictions of landowners must be entered on a "line list". The landowner must make all desires known to the agent for listing on the "line" or "restriction list" which will be used by the contractor that is hired. Examples of requests landowners can make:

a. Timber to be cleared cut in firewood length and hauled to location specified by grantee;

b. Fence built along entire right-of-way to keep livestock away from construction areas;

c. Bridges built for equipment and livestock crossings;

d. Rocks picked up and disposed of in designated area.

4. Tile damage and repair

Pipeline companies should be responsible to identify for the contractor any tile lines that cannot be avoided. Tractors weigh 140,000 pounds and will break the tile the entire width of the right of way. The machinery compacts the dirt and either crushes the tile, or, if working in soft material, will push them down and off grade. Pockets are created where the tile are pushed out of line and this allows tile lines to fill with dirt. Tile repair is therefore necessary and should be required the full width of the right-of-way. Ditches may cave in to 20 feet or more. At present there are no proven methods of tile support. Some methods that have been tried are the use of gravel for a base on which to lay the tile and the use of channel iron with cement at either end.

Parcel boundaries, topsoil segregation, and adequate right-of-way are three of the major factors necessary should any crossing of prime agricultural land be allowed. Parcel boundaries will avoid approximately 95% of the tile. When encountering a main or tile in a parcel boundary it should be bored and cased rather than cut and disturbed.

All construction should be carried out when field conditions are fit for land cultivation. Landowners and a government inspector shall determine if ground conditions are fit for construction. No construction shall proceed without permission and it shall cease upon joint order of landowner and inspector.

Exhibit B

Ken

DOME CORPORATION CONSTRUCTION
DETAILED EXAMPLE OF A LANDOWNERS EXPERIENCE
Lee and Cindy Franck, Stanley, Iowa, Buchanan County

June 1977. Signed a contract with Dome Corp. for a 50 foot easement. A number of heirs were involved requiring a statement and map to be printed in the Independence paper for three consecutive weeks. The map published was not the map agreed to by the Francks. The condemnation board came to look at the property and the Francks told them of the mistake. As the Williams Brothers Company did not wish the added expense of time and money they asked to settle on the map in the paper. They agreed on 5 foot of cover and a thousand dollars.

July 12, 1977. Signed second contract. A letter required by law to be sent by the construction company stated, "We sincerely hope that our construction does not cause you any unnecessary hardships or inconveniences. If you have problems call . . (Cedar Rapids) 319—364 8157 in order that we might be able to correct the problem as quickly as possible.

September 5, 1977, Labor Day. Survey crew drove into their field without permission, driving on corn outside the easement. Notification of entrance had been promised.

September 6, 1977. Franck called number to report erratic behavior of survey crew. Recording said number no longer in service. Franck was given number by construction worker to call at New Hampton. Collect call not accepted so they called direct. Right of way agent, Mr. Young, not in so left word for him to call. Later they tried the Cedar Rapids number again and found the phone had earlier been out of order. A company man told them not to call the number but to call their lawyer, he should call the company lawyer and the company lawyer would call the state lawyer in Des Moines who would in turn tell the company. The Franck's comment is it seems the company expected the problem to go away meanwhile. They told their lawyer of their concern.

Week of September 12. Crew cut fence and chopped off the corn. Crew told by Francks they were in the wrong place according to map on contract but they continued their work. Bulldozed sides of a creek to make a higher bottom so construction equipment could be driven to two pieces of property on the farm. Right-of-way man arrived but just laughed off the situation saying they would just have to pay them for the damages. Friday night a second survey crew arrived but the head man quit saying he wasn't going to put up with all the mistakes which they had been making all the way from Canada.

Sunday, Sept. 18. The Francks repaired temporary gate made by the company. Temporary fence was poorly constructed--fence leaned because brace poles didn't touch uprights. Gate was 50 foot long with no support offering an easy out for their cattle.

Monday, Sept. 19. Chopper to make second easement cut arrived. Crew began pulling out posts of fence Francks had repaired and the bulldozer waited for fence crew. The Francks told them to stay on the company easement and then it was suggested they check with survey crew on the road to see if their maps were the same. Mrs. Franck took copy of their easement and

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PLANNING

asked if they had a copy of the map. The answer was, "Yes, but we aren't going to show it to you, you bitch." Mrs. Franck could hardly believe what she heard; she asked if he spoke for the group and other obscene words were expressed. She asked why they felt that way and he said it was because they wouldn't let them remove the fence. Later Mr. Franck asked that the inspector from Williams Brothers ask the crew for an apology. The inspector claimed he wasn't their boss. (The survey crew is hired by Williams). Mr. Franck and a friend asked for an apology and to see the map. Both were given in a contemptuous manner. The survey crew tried to run over their dog when they left.

Later that week. Called New Hampton office and new right-of-way agent, Mr. Russell (Mr. Young had quit) said he would come out—did not. Mr. Russell did call that he wouln't come out without a lawyer and made the statement that the company had the right to go where they chose. He said he would get a map but never returned to the phone in 25 minutes.

The topsoil machine came through and then a second layer was cut and thrown on the opposite side. The topsoil was leveled so they could drive and work on it. Semis, caterpillars, bus with welders, drag lines, numerous pick-ups and all construction machinery traveled over the top soil, leaving ruts 4 feet deep. Mr. Francks feels the soil is ruined for production for at least several years.

The trench kept caving in; a drag line was needed to clean out most of the ditch.

The Francks requested a cross-over which the company is required to maintain but this was denied.

According to the easement a qualified inspector from the Commerce Commission was to inspect the line. The inspector marked the tile and wrote something down but was not seen again. His information was dated May and stated 4 foot of cover; their easement was dated July and required 5 foot of cover. Company inspector were seen sitting in the car much of the time. The pipe was left uncovered at tile junctions for a time. The Francks measured depth of cover and found it varied from $3\frac{1}{2}$ to 6 foot; the majority 4 to $4\frac{1}{2}$.

Water was pumped into the creek and ditch or the water was pumped onto the field, leaving piles of sand.

The correct easement required the pipe to bend with the creek. The catepillar operator couldn't figure how to construct the line. An official from Dome said that as constructed, it will wash out every 60 days, but no one seemed to be in power to make the correction. The engineer admitted it wouldn't work but would have to come back to change it. He said it would require a 50 foot wide hole with 100 feet on each side to fix the creek. Dirt pushed in the creek for crossing washed out.

The construction crew left, huge tracks, rock, damaged crops and tile and liter. Rolls and used tape to bind the pipe and painting materials, both poisonous to animals were left. Fencing material, welding rod, cans, cribbing lumber, etc., which are destructive in farm machinery, were strewn about off and on the right-of-way.

Exhibit C

EXPERIENCED CONTRACTOR'S RECOMMENDATIONS REGARDING PIPELINE CONSTRUCTION

1. Construction of a 24 inch diameter pipe requires 75 feet of right-of-way. An additional 25 feet is needed to store topsoil. Grantee gives 100 feet of construction right-of-way and 50 feet of permanent easement.

2. Topsoil is segregated and moved off the 75 foot right-of-way:
   a. with angle blade dozer to move topsoil to the side;
   b. must be done when ground is in tilable condition;
   c. trench width alone is not satisfactory because soil will become mixed unless topsoil is placed on topsoil and subsoil on subsoil.

3. Common requests landowners can make:
   a. Timber to be cleared cut in firewood length and hauled to location specified by grantee;
   b. Fence built along entire right-of-way to keep livestock away from construction areas;
   c. Bridges built for equipment and livestock crossings;
   d. Rocks picked up and disposed of in designated area.

4. Requests and restrictions must be entered on a "line list" before pipeline company submits to a contractor for a bid. The landowner must make all desires for "line list" known to right-of-way agent.

5. Contractors have been and should be required to keep up contracts for at least three years.

6. Pipeline company should provide contractor with a tile map of every farm proposed to cross.

7. Tractors weigh 140,000 pounds so tile may be crushed or pushed down and off grade. Pockets may be created which allow tile lines to fill with dirt and tile repair may be required the full width of the right-of-way. Ditches may cave in to a width of 20 feet or more.

8. Repair of tile:
   a. At present there are no proven methods of tile support satisfactory in all soils;
   b. Common repair methods are: 1) gravel for a base; 2) channel iron with another on edge as a stiffner; 3) corrigated pipe.

(9.) EDO says drainage systems should be avoided by the use of partial boundaries. When encountering a main it should be bored and cased. All construction should be carried out when field conditions are fit for land cultivation.

Appendix XIII

EFFECT OF PIPELINE ON

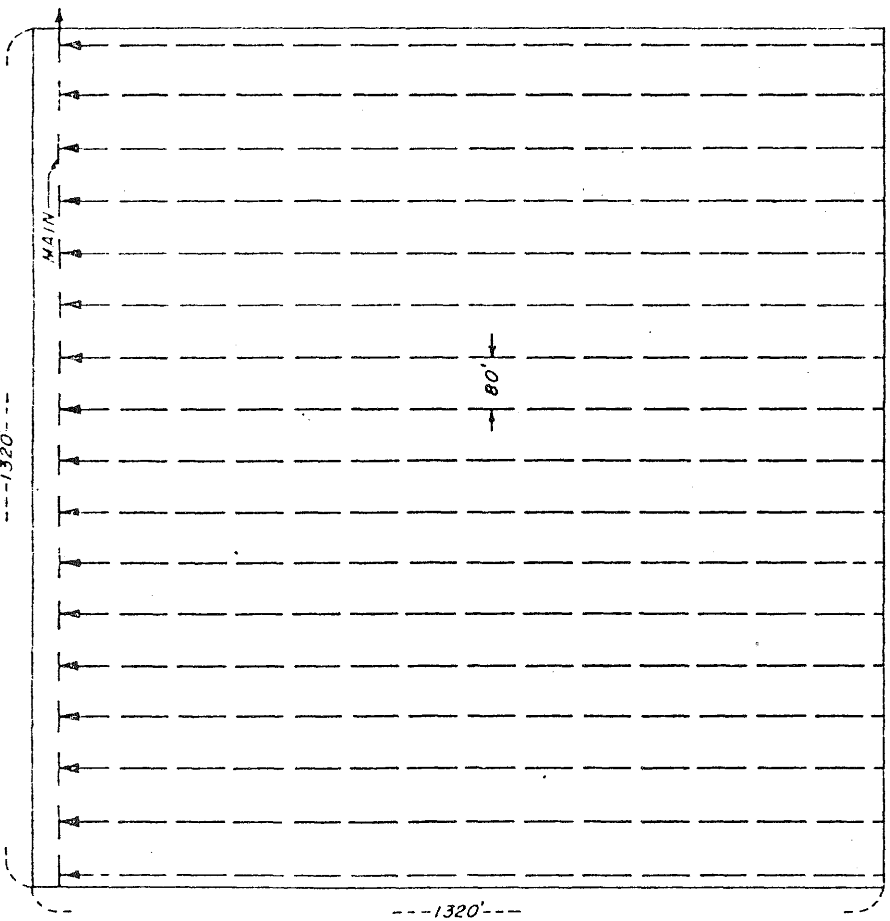
FUTURE DRAIN TILE INSTALLATION

The presence of a pipeline can greatly affect the complexity and cost of subsequently installing drain tile systems, especially if the tile system cannot be layed out with the laterals running parallel to the pipeline. As the attached diagram shows, if the laterals would normally cross the pipeline, considerably more connections and length of tile will be required as compared to a similar field without a pipeline.

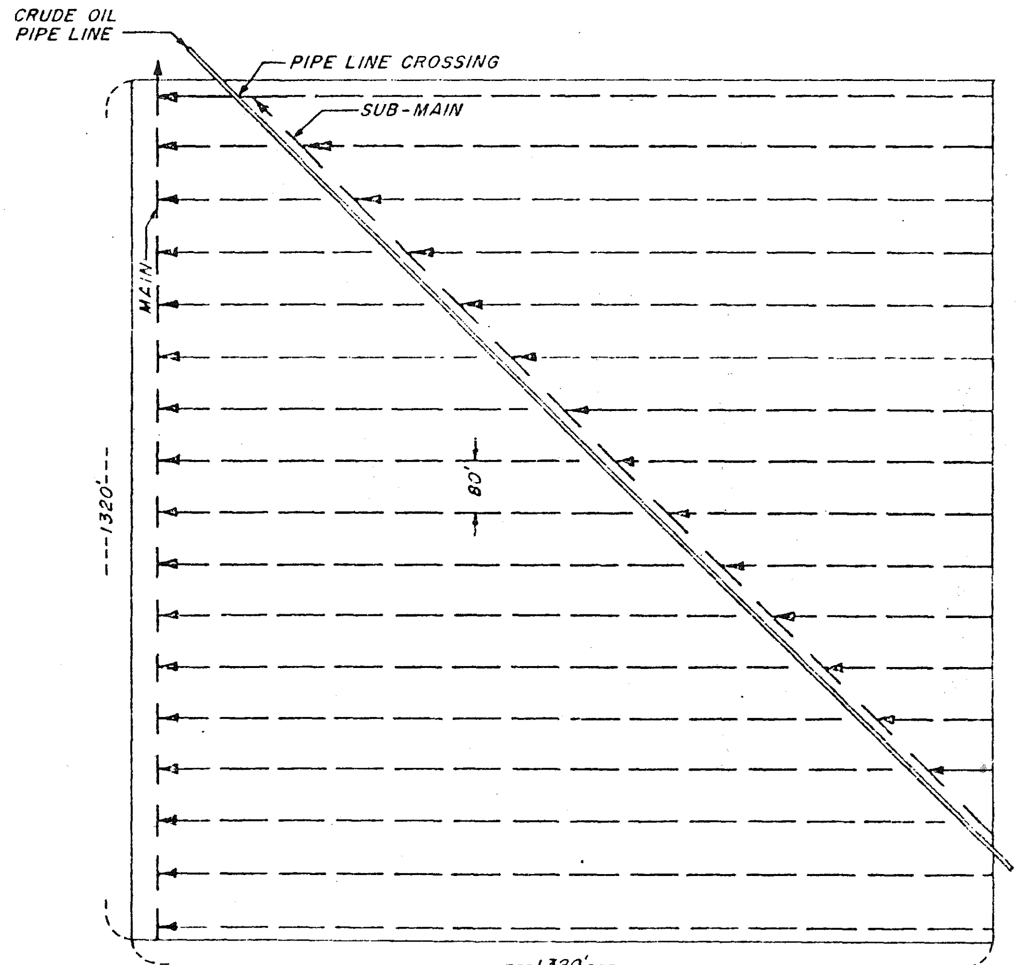
However, in many cases it would be possible to design a tile system "around" a pipeline so as to have fewer additional connections and less additional length than shown in the diagram, by running laterals parallel to the pipeline, or running them outward each way from the pipeline, etc., to the extent that this would be possible given topographic conditions, compatibility with drain fields in adjacent fields, location of tile mains, and other factors.

TYPICAL TILE SYSTEM FOR 40 ACRE PARCEL

IF CONSTRUCTED BEFORE OIL PIPE LINE INSTALLATION



IF CONSTRUCTED AFTER OIL PIPE LINE INSTALLATION



LEGEND

TILE CONNECTIONS
TILE

17 TILE CONNECTIONS

31 TILE CONNECTIONS

1600 LINEAL FEET ADDITIONAL TILE CONSTRUCTION

Appendix XIV

AGRICULTURAL IMPACT ADDENDUM

Jones, Haugh and Smith, Inc.

To address the matter of drain tile systems and other impacts to agricultural practices, and to develop an alternate route paralleling the railroad right-of-way, the State contracted for the services of Jones, Haugh and Smith, Inc., Consulting Engineers in Albert Lea.

Defining the alternate route developed into a two-step process that resulted in two reports and a final map that is too large for incorporation into this Environmental Impact Statement.

We recognize the reader will have difficulty without the large scale maps, however, reference to the maps included in Appendix IV may be helpful. Because much of the information developed by the consultant has been utilized not only for the E.I.S., but also for the landowner's booklet and a State liaison procedure, it seemed appropriate to include both reports despite these difficulties. The reader is also advised that the recommendations contained in the two reports are those of the consultant and, in some instances, do not recognize the State's lack of authority for implementation.

AMENDED AGRICULTURAL IMPACT ADDENDUM

Minnesota Portion of
A Crude Oil Pipeline
From Wood River, Ill
to Pine Bend, MN

Prepared By

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HAROLD H. HAUGH
Reg. Civil Engineer
Reg. Land Surveyor
ARTHUR W. SMITH
Reg. Civil Engineer

C. V. JONES
Senior Consultant

October 11, 1978

State of Minnesota
Department of Natural Resources
Bureau of Environmental Planning
Centennial Office Building
658 Cedar Street
St. Paul, MN 55155

RE: Crude Oil Pipeline Amended
Agricultural Impact Addendum

Gentlemen:

Pursuant to your request, we have made a further study of the above referenced matter to investigate specific concerns and herewith submit for your consideration our report of the Amended Agricultural Impact Addendum for the Minnesota portion of a Crude Oil Pipeline.

We are prepared to review the report with Department personnel or others at any time you select.

Respectfully submitted,

JONES, HAUGH & SMITH INC
CONSULTING ENGINEERS

Harold H Haugh

Harold H. Haugh, P.E.

HHH:egp

Enclosure

AMENDED AGRICULTURAL IMPACT ADDENDUM

1 GENERAL

1-1 INTRODUCTION: Subsequent to several meetings with Minnesota State Officials and Northern Pipeline representatives reviewing the Agricultural Impact Addendum, dated July 13, 1978, a further investigation was ordered by the State to determine possible beneficial routing changes.

1-2 PREVIOUS REPORT: Reference is hereby made to the previous report filed in this matter, dated July 13, 1978, consisting of a typewritten report, and map, and supplement dated July 31, 1978. All details of said report are confirmed as a part of this report unless specifically changed in this report or shown on the map, designated as Exhibit "A".

1-3 PURPOSE OF REPORT: The purpose of this addendum is to determine possible alignment changes for the pipeline company's proposed route and the alternate route, which is basically adjacent to railroad property. Pipeline company representatives believe their proposed route can be shifted in certain areas to bypass extensive subsurface drain fields. Also they have objected to the additional length of the alternative route and sharp turns required to permit alignment adjacent to railroad and property boundaries.

The general guidelines used in this investigation were to minimize difficult construction procedures, reduce the length of the alternate route and to obtain the least adverse agricultural impact to agricultural lands insofar as practical.

1-4 SCOPE OF REPORT: The scope of this report is limited to investigation of certain detours for the pipeline company's proposed route and to several alternative alignments for the alternate route.

2 INVESTIGATION AND FINDINGS

2-1 ROUTE LOCATION: The two separate routes previously described and shown on the map, designated as Exhibit "A", were investigated in conjunction with pipeline representatives. Specific areas where changes in alignment would be more practicable or feasible, are listed and effects thereof summarized.

2-2 PROCEDURE: Both routes were flown by helicopter and were field checked later. Drain tile information was obtained by the same method used as in the previous investigation.

2-3 NORTHERN PIPELINE COMPANY'S PROPOSED ROUTE: Alignment changes to the Northern Pipeline Company's proposed route, referred to as detours, are basically a shifting of the route to bypass extensive subsurface drain tile areas. Generally alignment was selected to traverse lands of higher elevations where subsurface drainage would be less predominant.

The following is a discussion of the detours which were investigated. The location and alignment of each detour is shown on revised Exhibit "A".

2-3.1 DETOUR NO. 1: The alignment of Detour No. 1 in LeRoy Township, Mower County, is adjacent to the railroad right-of-way for approximately 3/4 of a mile, and then crossing said railroad and State Highway No. 56; then northerly to the northwest corner of Section 19. The resultant agricultural impact changes are:

1) 10 tile crossings are eliminated.
2) 55% of the route is adjacent to railroad with no significant change in pipeline length.
3) A better crop management potential will be provided.

2-3.2 DETOUR NO. 2: The alignment of Detour No. 2, Clayton Township, Mower County, will bypass extensive tile drain fields in Sections 15, 22 and 27, by following an alignment on, or adjacent to right-of-way of an unmaintained township road. Near the northeast corner of Section 15, the detour alignment would course northwesterly across Sections 9 and 10 and intercept the proposed route on the north line of Section 9. The resultant agricultural impact changes are:

1) 133 tile crossings are eliminated.
2) 3200 lf additional length of pipeline required with 56% of the route on or adjacent to road right-of-way.
3) Better crop management potential provided for approximately two sections of farm land.

2-3.3 DETOUR NO. 3: The alignment of Detour No. 3 in northern Mower County consists of shifting the proposed alignment to avoid numerous drain tile areas and locate the pipeline on generally higher topography. The detour deviation proposed is from a point in Section 19, Grand Meadow Tosnwhip to a point in Section 4, Sargeant Township. The detour is approximately 10.8 miles long and deviation from the proposed route varies from approximately 100 to 3000 feet. The resultant agricultural impact changes are:

1) 95 tile crossings are eliminated.
2) No significant change in pipeline length.
3) No change in crop management potential.

2-3.4 DETOUR NO. 4: The alignment of Detour No. 4, in Dodge County, would deflect from the proposed route in Section 30, Vernon Township, and course northwesterly to the Chicago Great Western Railroad, approximately 1 mile north of Hayfield. The detour alignment would then course north, approximately 3½ miles, adjacent to the railraod east right-of-way and then deflect northwesterly near the center of Section 27, Ashland Township to intercept the proposed alignment in Section 21 of said township. The resultant agricultural impact changes are:

1) 121 tile crossings are eliminated.
2) 4400 lf additional pipeline length with 36% of the route adjacent to railroad right-of-way.
3) A better crop management potential available for those lands adjacent to the railroad.

2-3.5 DETOUR NO. 5: The alignment of Detour No. 5, in Claremont Township, would deflect westerly from the proposed route in Section 25 and intercept said route near the north line of Section 4. Several extensive drain systems will be bypassed and the alignment is generally on high topography with only minimal subsurface drainage. The resultant agricultural impact changes are:

1) 64 tile crossings are eliminated.
2) 1200 lf additional pipeline length required, with 17% of the route adjacent to property boundaries.
3) A better crop management potential available for Section 23.

2-3.6 SUMMARY: The five detours outlined will eliminate approximately 420 field tile crossings, utilize 2.5 miles of unmaintained township road right-of-way if permitted by the Road Authority, and parallel approximately 4 miles of railroad property. The significant decrease in tile crossings occur in Detours No. 2 and 4. The pipeline length will be increased approximately 1 2/3 miles. Crop management potential will be improved on lands where the alignment parallels railroad or property boundaries.

2-4 ALTERNATE ROUTE: The previously proposed alternate route, which basically followed adjacent to railroad and property boundaries, should be modified in certain areas due to anticipated construction difficulties. The alignment modifications to the alternate route are referred to as Alternatives. The most significant route change is in the Dodge Center area. A more feasible location was found by helicopter and field-confirmed later. The following is a discussion of the Alternatives investigated. The location and alignment of each Alternative is shown on revised Exhibit "A".

2-4.1 ALTERNATIVE NO. 1: The alignment of Alternative No. 1 in Lodi Township, is proposed to eliminate several sharp turns on property boundaries which have objectionable construction procedures and to relocate the crossing of SH 56 and the Railroad to a more advantageous location. The resultant agricultural impact changes are:

1) No significant difference in number of tile crossings.
2) 3000 lf less pipeline length required.
3) Approximately 2 miles of farm land will be traversed diagonally.

2-4.2 ALTERNATIVE NO. 2: The alignment of Alternative No. 2 in Marshall Township consists of a diagonal course across two farms for the City of Elkton bypass, to eliminate sharp pipeline bends. The resultant agricultural impact changes are:

1) Increase of 8 tile crossings by pipeline construction.
2) 1000 lf less pipeline length required.
3) Approximately 0.6 miles of farm land will be traversed diagonally.

2-4.3 ALTERNATIVE NO. 3: The alignment of Alternative No. 3 in Waltham Township, consists basically of a more distant bypass of the City of Sargeant and a diagonal alignment south of the City to eliminate several sharp turns. The alignment north of Sargeant was determined to be more practical adjacent to the west railroad right-of-way rather than the east right-of-way as previously shown. The resultant agricultural impact changes are:

1) Increase of 20 tile crossings by pipeline construction.
2) 800 lf less pipeline length required.
3) Approximately 1.15 miles of farm land will be traversed diagonally.

2-4.4 ALTERNATIVE NO. 4: The alignment of Alternative No. 4 in Hayfield Township, consists of a diagonal course north of SH 30 to complete the bypass of the City of Hayfield. The alignment will be generally on high topography having no significant subsurface drainage. The resultant agricultural impact changes are:

1) No change in the number of tile crossings by the pipeline.
2) 1600 lf less pipeline length required.
3) Approximately 1.3 miles of farm land will be traversed diagonally.

2-4.5 ALTERNATIVE NO. 5: The alignment of Alternative No. 5 in Dodge County is a westerly bypass of the City of Dodge Center, which is more feasible than the easterly route previously proposed. A corridor, approximately 2 miles west of the City, was located from the air that was not evident on the ground during the first investigation. Although the Alternative route utilizes less railroad boundaries than the route first proposed, the new alignment can be kept generally along property boundaries and is considerably shorter. Approximately 2 miles of the westerly bypass would be across pasture land. There is a small platted area being developed in the NE¼ SE¼ Section 29, Wasioja Township, but it is unlikely that adjacent lands would be used for residential purposes. The resultant agricultural impact changes are:

1) Approximately 30 tile crossings are eliminated.
2) 5200 lf less pipeline length required.
3) Approximatley 2 miles less farm land will be traversed diagonally, resulting in availability for better crop management potential.

2-4.6 ALTERNATIVE NO. 6: The alignment of Alternative No. 6, south of Kenyon, consists of several diagonal routings on the westerly course to connect the proposed alternate with the pipeline company's proposed route at the terminus point of this investigation. Basically the changes proposed will eliminate several pipeline construction problems involving road and railroad crossings and sharp turns. The alternative alignment adjacent to the east and west railroad in Rice County should be adjacent to the south right-of-way instead of the north right-of-way where land topography is too steep for normal construction activity. The resultant agricultural impact changes are:

1) Increase of 10 tile crossings by pipeline construction.
2) 4000 lf less pipeline length required.
3) Approximately 3.6 miles of farm land will be traversed diagonally.

2-4.7 SUMMARY: The six Alternatives outlined will not significantly change the number of field tile crossed and will decrease the length of pipeline construction by approximately 3 miles. Crop management potential will be adversely effected by diagonal traversing of farm land on approximately 6½ miles of the Alternate route or approximately 6% of the total distance.

3 HIGHWAY AND RAILROAD CROSSINGS: Consideration should be given to the crossing of Highway and Railroads at an angle whenever practical, to reduce damage to adjacent agricultural lands. A perpendicular crossing requires a curved pipeline alignment on either side of the road bed which usually results in additional pipeline right-of-way width. There are numerous locations where

two highways and or railroads, could be crossed simultaneously at a skew by a single crossing, thus eliminating one crossing and several curves in alignment. Where boring techniques are required, the length of bore would be longer but would cause less agricultural problems and costs of an additional crossing. Open cutting of gravel surfaced road crossings would also reduce damage to agricultural lands since a large area is required for boring pits, which are partially outside of road right-of-way. It is assumed all open cut crossings, if permitted by the road authority, would be properly backfilled and surfaces restored to prior condition.

Road Authorities may have other reasons for not allowing skew or open cut crossings but it is our opinion that there would be less damage to agricultural lands from both procedures.

4 MISCELLANEOUS CHANGES: There are several locations on the Alternate Route where the line shown has been curved to shunt certain structures or building sites. Said locations have not been specifically addressed in this report since the changes would be minor and will not significantly alter the agricultural impact.

5 SUMMARY: The Northern Pipeline Company's proposed route as modified by the aforedescribed detours will be approximately 1 2/3 miles longer and cross approximately 420 less drain tile than the previous alignment. Only certain farms will experience improved crop management potential and shifting of alignment to adjacent farms may result in individual landowner objections. Overall, the changes do not alleviate the agricultural concerns of diagonal traversing of crop lands, anticipated damage to drain systems and future design of drainage systems.

The Alternate Route as modified by the aforedescribed alternatives will be approximately 3 miles shorter than the previous alignment, with no significant change in number of drain tile crossings. Crop management potential will be decreased slightly but is not significant when compared to the proposed route.

6 RECOMMENDATIONS: Based on the information obtained and submitted in this and previous report, the firm of Jones, Haugh & Smith, Inc., concludes the alternate route, as modified herein, as the most practical and feasible for agricultural impact considerations.

AGRICULTURAL IMPACT ADDENDUM

Minnesota Portion of
A Crude Oil Pipeline
From Wood River, Ill
to Pine Bend, MN

Prepared By

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July 13, 1978

State of Minnesota
Department of Natural Resources
Bureau of Environmental Planning
Centennial Office Building
658 Cedar Street
St. Paul, Minnesota 55155

RE: Crude Oil Pipeline
Agricultural Impact Addendum

Gentlemen:

In accordance with our agreement, we herewith submit for your consideration our report of the study made for the Agricultural Impact Addendum for the Minnesota portion of a Crude Oil Pipeline.

All pertinent data available from Department records was assembled and studied. Topographic maps of the routes were prepared, and field investigations made for use in this study.

Based on these data and investigations, recommendations are made as to the route and conditions.

We wish to express our appreciation for the cooperation and assistance of employees of the Department of Natural Resources and Division of Environmental Planning in supplying data necessary for this study and report.

We are prepared to review the report with Department personnel at any time you select.

Respectfully submitted,

JONES, HAUGH & SMITH INC
CONSULTING ENGINEERS

Harold H Haugh

Harold H. Haugh, P.E.

HHH:egp
Enclosures

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AGRICULTURAL IMPACT ADDENDUM

1 GENERAL

1-1 INTRODUCTION: The glacial soils of south central Minnesota have outstanding crop production capabilities when adequately drained. The mean rainfall for south central Minnesota is approximately 30 inches per year, which is above average for most prime agricultural areas. The short growing season as compared to southern states has been overcome by improved seed varities for early maturing crops, and yields are normally equal to or above those of Iowa and Illinois. Not until recent years, when agricultural drainage was extensively promoted, has the full potential been realized.

Rising prices, unavailability of additional land and increased operating costs have caused farmers to be extremely concerned with anything which would impair or interrupt their agricultural activity. Many have experienced previous utility construction on their property with resulting conditions causing future management problems and economic losses. Any action in agricultural areas by outsiders is generally met with scepticism and suspicion. Rural people have been historically independent and resent infringements on their domains.

Considering the many unforeseen problems and circumstances that will evolve from the construction of a 24" crude oil pipeline across prime agricultural land, it is not unreasonable to investigate various alternatives.

This report is a factual, comprehensive, and objective anaylsis of the agricultural impact from pipeline construciton. There has been no communication on this matter with the Northern Pipeline Company or their representatives.

1-2 PURPOSE OF REPORT: The purpose of this report is to assist the State of Minnesota in its analysis of the impacts of construction of the proposed Northern Pipeline on agricultural lands and practices in Southern Minnesota, to investigate, analyze and document the impact of the pipeline construction on agricultural lands to be traversed by their proposed route versus an alternative route adjacent to Railroad property whenever feasible. Recommendations and specifications included herein or appended to this report are to be considered as means of reducing damage to agricultural lands and drainage systems and to alleviate concerns of property owners.

1-3 SCOPE OF PROJECT: The scope of the project is limited, by agreement, to the following:

1. Recommendations for conditions to be included in standard landowner easement agreements including, but not limited to: drainage system repair, post construction cleanup, top soil separation, soil stabilization, and plans for future tile systems together with other recommendations as may be desirable to facilitate the expeditious return to the property's former condition and usefulness.

2. Recommendations for conditions to be included in the construction company's agreement with Northern Pipeline for construction of the proposed facility to insure that the conditions as specified in the landowners easement agreement are met.

3. Recommendations for methods of repair of tile systems and ditch systems disturbed as a result of pipeline construction.

4. Recommendations on other matters upon the written approval of the STATE's authorized agent.

5. Estimation of the number of tile lines, including tile mains, which will be crossed by the following routes:

   a) Northern Pipeline Company's proposed route from the Iowa border near LeRoy, Minnesota north to a point directly west of Kenyon, Minnesota as identified in a map which will be provided to the contractor by the State.

   b) An alternate route paralleling the Chicago Northwestern Railroad from Taopi, Minnesota north to Kenyon, Minnesota as identified in a map which will be provided to the contractor by the State.

   Sources for the above estimations shall include, but not be limited to: records of the Soil Conservation Service, the Agricultural Extension Service, and other organizations such as tile contractor's associations together with information from existing aerial photos showing soils disturbed by construction and installation of tile lines.

   Field investigations and interviews with landowners shall be undertaken as may be reasonably necessary to verify the accuracy of the estimation.

   The above estimations shall be provided for each route by county and township in tabular form, and may include graphic depiction to aid understanding of the information.

2 INVESTIGATION AND FINDINGS

2-1 ROUTE LOCATION: Two separate routes were investigated to estimate the number of agricultural drain tile to be crossed by each route.

2-1.1 NORTHERN PIPELINE COMPANY'S PROPOSED ROUTE: The location of the Northern Pipeline Company's proposed route was marked on the plat map furnished by the State. The general description of the proposed alignment is from the Iowa - Minnesota border near the S¼ corner of Section 32 - T101N - R14W (Mower County), then northwesterly across Mower, Dodge, Steele and Rice Counties to a point on the west line of Section 9 - T109N - R19W (Rice County), approximately six miles west of Kenyon.

2-1.2 ALTERNATE ROUTE: The location of the alternate route is shown on Exhibit A of this report. The general description of the alternate alignment is from the Iowa - Minnesota border at the same location as the proposed route, then northwesterly across Mower, Dodge, Goodhue and Rice Counties, generally adjacent to railroad right-of-way or property boundaries when necessary to bypass cities, to the point where it intercepts the proposed route on the west line of Section 9, Richland Township in Rice County.

2-2 SOURCES OF INFORMATION: The number of agricultural drain tile to be crossed by each route was determined by various means such as:

1. Tile layout maps on record in Soil Conservation Service offices or in land owners' possession.

2. Records of tile contractors or private surveyors.

3. Conversations and interviews with land owners.

4. Visual inspection and judgmental analysis of subsurface drainage requirements.

5. Aerial photo inspection.

2-3 SITE EVALUATION

2-3.1 GENERAL: Depending on soils types, land contours, shallow ground water and farming uses, the location and size of underground drain systems vary considerably from farm to farm. Many systems are old and will require replacement in future years. Other systems need extensions or additions, and some farms require complete new systems to obtain top crop production potential.

Rocks and stones are abundant in approximately the southern half of Mower County. The balance of the route does not appear to have unusual quantities other than that normally encountered on most agricultural land.

Most of the land is used for the production of corn and soybeans. Pasture or waste land consists of small isolated parcels which may be developed in the future.

Except for isolated areas in Mower County where there may be an acid subsoil, mixing of the subsoil and topsoil should not cause any long term crop yield reductions. Additional fertilizer may be required to restore fertility. Observations of similar soils crossed last year by pipeline construction do not show significant differences in crops where properly managed.

2-3.2 PROPOSED ROUTE: The proposed route courses diagonally across prime agricultural farm land which requires adequate drainage for crop production. Some subsurface drainage systems are constructed in parallel patterns coursing east and west or north and south while others follow land contours with many changes in direction.

It appears most tile lines will be crossed at a skew with many at less than a 45^{o} angle. There are numerous open ditches and grassed waterways to be crossed, in addition to the larger streams and rivers. Some are in need of deepening and most will require future improvement to maintain adequate outlets for subsurface drainage. Based on observation of erosion from recent heavy rainfalls, more grass waterways should be constructed in areas of rolling topography.

2-3.3 ALTERNATE ROUTE: The alternate route generally is adjacent to the railroads. Since the railroads were built before agricultural drainage became a necessity, most tile systems were constructed on either side of the railroad and only when absolutely required was pipe installed through the road bed. Some tile lines parallel the railroad right-of-way but are usually 40 to 50 feet away. Underground lines crossing railroad property are usually perpendicular to the trackage. Many existing tile lines either outlet or terminate near the railroad right-of-way and would be crossed at approximately right angles.

Waterways, open ditches and most stream and river crossings adjacent to the railroad will be crossed perpendicularly without a change in pipeline alignment.

There is no significant difference in soil types or agricultural crops from that of the proposed route except that there may be more undeveloped and pasture land along the railroads.

2-4 FINDINGS: Summaries of the estimated number and location of tile lines to be crossed by each route are included as Appendices 1 and 2 to this report.

Specific problems likely to be encountered were noted and are listed under the heading of "Remarks" in the appendices.

2-5 CONCERNS OF LANDOWNERS: Various concerns regarding the pipeline were expressed by many of the landowners during the course of the investigation for this report. Some concerns are beyond the scope of investigation for this project, but are listed for information:

1. Crude oil leaks or spills polluting well systems.
2. Damage to or impairment of drainage systems, and methods of restoration proposed.
3. Difficulty of concurrent crop management and tilling operations on land adjacent to pipeline on diagonal alignment.
4. Mixing of subsoil with topsoil will lessen crop yields for many years.
5. Cleanup and excessive damage to the land by operation of heavy equipment.
6. Difficulty in obtaining satisfactory settlements and payment.
7. Responsibility for, and expiditious correction of future problems.
8. Liability of landowner for accidents on his property involving the pipeline.
9. Pipeline interference with future drainage plans.
10. Payment rate for right-of-way and damages.
11. Is the pipeline really needed or should Alaskan oil be piped into Minnesota.
12. Quality of pipe material to be used.

3 ROUTE COMPARISON: The advantages and disadvantages of each route, within the limits and scope of this report, are summarized in this section.

3-1 NORTHERN PIPELINE COMPANY'S PROPOSED ROUTE: (Appendix 1)

3-1.1 ADVANTAGES:

1. The direct diagonal route will be a shorter distance.
2. Alignment changes to bypass building sites or other obstacles is more flexible and unrestricted.

3-1.2 DISADVANTAGES:

1. It is estimated there will be approximately 1130 subsurface drain tile crossings of all sizes encountered.
2. Most of the field drain tile will be crossed at an angle less than a right angle. Crossings less than 45° would require extensive relocation of drain tile away from the pipeline trench to permit appropriate restoration.
3. Greater trenching depths will be required when crossing existing or future planned subsurface drainage systems. Many lands are systematically tiled at spacings of 80 to 100 feet. Future drainage systems will most likely

be at approximately 50 to 60 foot spacings, which currently is a practice employed on some lands. Tilney Farms at Lewisville, Minnesota has recently documented, on the basis of trial plot results, the economic advantages of closer spacing of drain tile systems.

4. The proposed diagonal route across agricultural lands will cause farm management problems during and for an indefinite period following the construction.

5. Based on conversations with landowners and others, the diagonal route will be opposed and easements difficult to obtain. Apparently, there is organized resistance to the construction location, and farmers are vociferous in their objections.

3-2 ALTERNATE ROUTE ADJACENT TO RAILROAD OR PROPERTY BOUNDARIES: (Appendix 2)

3-2.1 ADVANTAGES:

1. It is estimated there will be approximately 200 subsurface drain tile crossings of all sizes encountered.

2. Crossings will be at approximately a 90° angle and, except for tile mains through railroad property, all lines would be intercepted near the outlet or upper terminus. Therefore restoration of existing systems should be less expensive than repair of skewed crossings.

3. Since railroad right-of-way was acquired before the installation of underground drain tile, most systems were designed with no construction within approximately 50 feet of said right-of-way. The same criteria has been followed for individual farm units. Due to economic and easement requirements, property boundary (railroad or private) crossings have been restricted to those essential for obtaining drainage outlets for particular tracts of land.

4. Future drainage needs will generally follow the course of existing systems or will be typical of inplace design and construction.

5. Pipeline construction adjacent to field boundaries will cause less interruption of agricultural pursuits than the proposed diagonal route. Field crop management procedures will be enchanced and farmers could employ more practical measures to restore the soil productivity.

6. Although no calculations have been made, it is our opinion that generally lands adjacent to railroads are not cropped as extensively as lands coursed by the diagonal route.

7. It appears from the route as marked on Exhibit A to this report (Topographic Map) that less bends will have to be made for highway crossings.

8. Depending on railroad company permission, approximately a 10 foot wide strip of land at the outer right-of-way boundary could be used for access during pipeline construction.

9. Based on conversations with landowners and others, the alternate route will not have unified opposition such as the diagonal route. It is our opinion that easement acquisition and damage settlements will be easier to obtain on the alternate route.

3-2.2 DISADVANTAGES:

1. The alternate route is not as direct a route as that proposed and will require approximately 14 miles of additional pipeline construction.
2. Bypassing of cities and several building sites or other obstructions may result in a less flexible construction alignment selection.
3. Railroad companies may object to the close proximity of the pipeline. However, none of the rail lines appear to be heavily traveled.
4. Relocation of the pipeline from one area to another may result in individual landowner objection.

3-3 SUMMARY: The alternate route has many advantages from an agricultural standpoint, and will probably be more acceptable to the landowners and counties. When comparing costs of the two routes, consideration should be given to possible delays and other extenuating circumstances if the diagonal route is implemented.

The alternate route appears to be a more acceptable route than the diagonal route. Unknown construction and right-of-way costs prohibit a comprehensive economic evaluation in this report.

For years, utility development, such as electrical and telephone lines, roads and drainage ditches have been constructed on or adjacent to property lines wherever practical. However, pipelines have usually been constructed by the shortest possible underground route. Design of agricultural drainage in recent years has been complicated by existing pipelines, resulting in extra costs and occasional inferior systems. Pipeline owners have been reluctant to modify existing lines to accommodate agricultural needs and consequently landowners resist such development. Adequate explanations and excellent public relations with farmers are necessary for any venture such as this.

3-4 ROUTE RECOMMENDATIONS: Based on the information obtained and submitted in this report, the firm of Jones, Haugh & Smith, Inc., recommends the alternate route; and that the Northern Pipeline Company and various governmental bodies involved consider the recommendations and special provisions submitted herein.

4 RECOMMENDED CONDITIONS: Based on our objective analysis of the impact of pipeline construction on agricultural lands, and the requirements stipulated in the contract, we have prepared recommended conditions to help minimize/mitigate rural opposition to the proposed construction. These recommendations are included in this report as the following Appendices.

Appendix 3 - Recommended Special Provisions with Explanatory Notes.

Appendix 4 - Landowner Easement Recommendations

Appendix 5 - Recommended Field Tile Repair Agreement

Appendix 6 - Recommendations for County Special Use Permit

ESTIMATED FARM DRAIN TILE CROSSINGS ENCOUNTERED BY PROPOSED 24" CRUDE OIL PIPELINE CONSTRUCTION THROUGH MOWER, DODGE, STEELE AND RICE COUNTIES

ROUTE PROPOSED BY NORTHERN PIPELINE COMPANY WOOD RIVER, ILLINOIS TO PINE BEND, MINNESOTA

MOWER COUNTY

Tract No.	Description	No. Tile Crossed	Remarks
	T101N-R14W (LEROY)		
1	SW¼ Sec 32	6	Random tiled
2	W½ NW¼ Sec 32	1	
3	NE¼ Sec 36	1	
4	SE¼ Sec 30	4	Alignment must course due north at a point approximately 500 ft. southeasterly of the NW corner of tract to avoid gravel pit area in NW¼ Sec 30
5	N½ Sec 30	2	Route change from that shown on plat map
6	S¼ Sec 19	1	Upper Iowa River crossing
7	N½ S½ & NW¼ Sec 19	10	
8	SW¼ Sec 18	0	
	T101N-R15W (LODI)		
9	SE¼ Sec 13	0	
10	E½ NE¼ Sec 13	1	
11	W½ NE¼ Sec 13	0	
12	SW¼ Sec 12	20	At a skew
13	NW¼ Sec 12	3	
14	N½ NE¼ Sec 11	0	
15	SE¼ Sec 2	14	Random tiled
16	NE¼ Sec 2	0	Tile outlet recently installed across road. Possible new tile construction soon.
	T102N-R15W (CLAYTON)		
17	S½ SE¼ Sec 35	0	Open ditch crossing
18	W½ Sec 35	8	

MOWER COUNTY (CONTINUED)

Tract No.	Description	No. Tile Crossed	Remarks
19	SW¼ Sec 26	3	Non-maintained road on west boundary
20	E½ SE¼ Sec 27	3	
21	NE¼ Sec 27	30	Severe skew
22	Sec 15 & 22	135	Plastic tile all crossed at a skew
23	NE¼ Sec 16	0	Tiling project under construction with 15 crossings estimated when completed
24	SE¼ Sec 9	8	Grass waterway on route
25	W 3/4 of N½ Sec 9	10	Cross open ditch; Additional tiling planned for 1978
26	SW¼ Sec 4	5	No road on west boundary as shown on plat map
27	NE¼ Sec 5	3	Skewed
	T103N-R15W (GRAND MEADOW)		
28	SE¼ Sec 32	15	Cross shallow ditch
29	NW¼ Sec 32	10	Road ditch used as drainage ditch
30	SW¼ Sec 29	15	Skewed; plans for future tiling
31	E½ NE¼ Sec 30	0	
32	SE¼ Sec 19	0	
33	NE¼ Sec 19	0	
34	NW¼ Sec 19	6	Cross open ditch & railroad
35	SW¼ Sec 18	4	Cross I-90
36	NW¼ Sec 18	0	
	T103N-R16W (DEXTER)		
37	NE¼ Sec 13	3	
38	SE¼ Sec 12	24	
39	NE¼ Sec 12	3	
40	SW¼ Sec 1	2	
41	NW¼ Sec 1	27	Grass waterways and tile at a skew

Tract No.	Description	No. Tile Crossed	Remarks
	T104N-R16W (SARGEANT)		
42	SE¼ Sec 35	13	
43	NE¼ Sec 35	7	2 open ditch crossings
44	SE¼ Sec 26	0	
45	W½ Sec 26	10	Additional tile construction planned for 1978
46	SW¼ Sec 23	5	
47	SE¼ Sec 22	4	
48	NE¼ Sec 22	8	At a skew
49	W½ SE¼ & E½ SW¼ Sec 15	12	Cross waterway
50	NW¼ Sec 15	20	
51	S½ SW¼ Sec 10	10	Cross open ditch
52	N½ SW¼ Sec 10	0	
53	N½ SE¼ Sec 9	0	
54	NE¼ Sec 9	4	
55	SE¼ Sec 4	4	
56	W½ Sec 4	6	Open ditch crossing, parcel needs more subsurface drainage
57	NE¼ Sec 5	6	At a skew
	DODGE COUNTY		
	T105N-R16W (VERNON)		
58	SW¼ Sec 32	10	At a skew
59	E½ NE¼ Sec 31	14	At a skew
60	W½ NE¼ Sec 31	11	At a skew
61	W½ SE¼ Sec 30	4	At a skew
62	E½ SW¼ Sec 30	7	At a skew
63	NW¼ Sec 30	4	At a skew

Tract No.	Description	No. Tile Crossed	Remarks
	T105N-R17W (HAYFIELD)		
64	NE¼ Sec 25	2	
65	E½ Sec 24	15	At a skew
66	NW¼ Sec 24	0	Drainage system planned for 1978 or 1979; artesian flow in area
67	SW¼ Sec 13	5	Artesian surface flow drained by field tile
68	SE¼ Sec 14	15	At a skew
69	NE¼ Sec 14	1	Has plans for future drainage
70	SE¼ Sec 11	0	
71	SW¼ Sec 11	3	
72	NW¼ Sec 11	17	Severe skew and numerous diagonal alignment
73	S½ SW¼ Sec 2	8	At a skew
74	N½ SE¼ Sec 3	16	At a skew
75	NE¼ Sec 3	0	Plans for future drainage, Owner prefers railroad route
	T106N-R17W (ASHLAND)		
76	SW¼ SE¼ Sec 34	10	At a severe skew
77	N 3/4 of W½ Sec 34	33	2 large mutual main tile will be crossed at several locations
78	SW¼ SW¼ Sec 27	4	
79	SE¼ Sec 28	17	At a skew
80	NE¼ Sec 28	1	
81	NW¼ Sec 28	13	At a skew
82	S 3/4 of W½ Sec 21	15	At a severe skew
83	NE¼ Sec 20	11	At a skew
84	S½ SE¼ Sec 17	8	Main tile at severe skew
85	N½ SE¼ Sec 17	27	At a skew
86	NW¼ Sec 17	6	At a skew
87	SW¼ Sec 8	11	At a skew

Tract No.	Description	No. Tile Crossed	Remarks
88	N½ SE¼ Sec 7	2	
89	NE¼ Sec 7	11	At a severe skew
90	E 3/4 of S½ Sec 6	4	Random pattern
91	NW¼ Sec 6	0	Dodge Center Creek crossing is in ravine type flow area
	T107N-R17W (WASIOJA)		
92	W 1/3 SW¼ Sec 31	4	
	T107N-R18W (CLAREMONT)		
93	E½ NE¼ Sec 36	0	
94	W½ NE¼ Sec 36	8	
95	SE¼ Sec 25	0	
96	NE¼ SW¼ Sec 25	12	
97	NW¼ Sec 25	10	At a skew
98	S½ SW¼ Sec 24	0	
99	E½ Sec 23	38	At a severe skew
100	E½ SW¼ Sec 14	10	Random pattern; cross open ditch
101	W½ SW¼ Sec 14	0	
102	W½ NW¼ Sec 14	0	
103	NE¼ NE¼ Sec 15	0	
104	E½ SE¼ Sec 10	4	
105	W½ NE¼ Sec 10	10	
106	E½ NW¼ Sec 10	0	
107	SW¼ Sec 3	8	At a skew
108	NW¼ Sec 3	2	
109	NE¼ Sec 4	18	At a skew

Tract No.	Description	No. Tile Crossed	Remarks
	T108N-R18W (ELLINGTON)		
110	E3/4 of SE¼ Sec 33	5	
111	W¼ of SE¼ Sec 33	0	Cross open ditch
112	E½ SW¼ Sec 33	7	
113	NW¼ Sec 33	28	Cross open ditch
114	NE¼ Sec 32	0	
115	SE¼ Sec 29	5	Planned complete tile system for 1979
116	S½ NE¼ Sec 29	0	
117	NW¼ Sec 29	13	
118	SW¼ Sec 20	3	Cross open ditch
119	SE¼ Sec 19	4	3 building site locations near east ¼ corner of said section
120	S½ NE¼ Sec 19	3	
121	N½ NE¼ Sec 19	13	Large main to be crossed at a skew
122	S½ SE¼ Sec 18	4	At a skew
123	SE¼ SW¼ Sec 18	2	At a skew
124	N½ SW¼ Sec 18	4	At a skew
125	NW¼ Sec 18	14	At a skew
	STEELE COUNTY		
	T108N-R19W (MERTON)		
126	SE¼ Sec 12	8	
127	E3/4 of NE¼ Sec 12	2	
128	W¼ of NE¼ & NW¼ of Sec 12 & S½ SW¼ Sec 1	17	At a severe skew
129	N½ SW¼ Sec 1	14	At a skew; cross open ditch
130	NE¼ Sec 2	17	At a skew

RICE COUNTY

Tract No.	Description	No. Tile Crossed	Remarks
	T109N-R19W (RICHLAND)		
131	SW¼ SE¼ Sec 35	3	
132	NE¼ SW¼ Sec 35	5	
133	E½ NW¼ Sec 35	4	Property owner states there are numerous surface flow springs in the area
134	SW¼ Sec 26	6	
135	NW¼ Sec 26	0	
136	NE¼ Sec 27	1	Needs additional tiling
137	E 3/4 of SE¼ Sec 22	2	
138	W¼ of SE¼ & E¼ of SW¼ Sec 22	3	Stream crossing
139	NW¼ Sec 22	0	
140	SW¼ Sec 15	0	Existing waterway will parallel route; farm needs subsurface drainage
141	SE¼ Sec 16	4	
142	NE¼ Sec 16	5	Stream crossing
143	E½ SW¼ Sec 9	10	At a skew and stream crossing
144	NW½ Sec 9	6	Cross railroad near west line of tract
		1127	Grand Total, Estimated Number of Tile Crossed

ESTIMATED FARM DRAIN TILE CROSSINGS ENCOUNTERED
BY PROPOSED 24" CRUDE OIL PIPELINE CONSTRUCTION
ADJACENT TO THE RAILROAD RIGHT-OF-WAY & PROPERTY
BOUNDARIES THROUGH MOWER, DODGE, GOODHUE AND RICE COUNTIES

ALTERNATE ROUTE PROPOSED FOR NORTHERN PIPELINE COMPANY
WOOD RIVER, ILLINOIS TO PINE BEND, MINNESOTA

MOWER COUNTY

Tract No.	Description	No. Tile Crossed	Remarks
	T101N-R14W (LEROY)		
1	SW¼ Sec 32	6	Random tiled
2	W½ NW¼ Sec 32	1	
3	NE¼ Sec 36	1	
4	SE¼ Sec 30	4	Alignment must course due north at a point approximately 500 ft. southeasterly of the NW corner of tract to avoid gravel pit area in NW¼ Sec 30
5	N½ Sec 30	2	Route change from that shown on plat map.
6	SW¼ Sec 19 SW of R.R.	0	
	T101N-R15W (LODI)		
7	SE¼ Sec 24	0	Tile lines parallel to and approximately 50 feet from railroad right-of-way
8	N½ Sec 24	2	May intercept tile near outlet into open ditch; parallel tile lines approximately 50 feet from railroad right-of-way
9	SW¼ Sec 13 SW of R.R.	0	
10	E½ Sec 14 SW of R.R.	2	Add 10 tile crossings if large tree grove area is shunted by alternate route around southerly edge; cross open ditch
11	E½ NW¼ Sec 14	0	Tree grove on north boundary next to railroad
12	W½ NW¼ Sec 14	0	
13	NE¼ Sec 15	1	Turn due north on west boundary
14	S½ SW¼ Sec 10	1	Cross railroad, SH 56 and North Branch Upper Iowa River
15	N½ SW¼ Sec 10	1	Parallel tile
16	SE¼ Sec 9	0	

Tract No.	Description	No. Tile Crossed	Remarks
17	NW¼ Sec 9	2	Cross North Branch Upper Iowa River and railroad
18	NE¼ Sec 8	0	
19	SE¼ Sec 5	1	
20	SW¼ NE¼ Sec 5	0	
21	NW¼ NE¼ Sec 5	0	
	T102N-R15W (CLAYTON)		
22	SW¼ Sec 32	0	
23	SW¼ NW¼ Sec 32	0	
24	NW¼ NW¼ Sec 32	0	Meandering stream may require shunting near the northwest corner of Sec 32
25	SE¼ Sec 30	0	
26	W½ NE¼ Sec 30	1	Tile main
27	W½ SE¼ & E½ SW¼ Sec 19	0	
28	NW¼ Sec 19	1	
29	SW¼ Sec 18	0	
	T102N-R16W (MARSHALL)		
30	E¼ & SW¼ NE¼ Sec 13	2	
31	NW¼ NE¼ Sec 13	1	
32	W 3/4 of S¼ Sec 12	1	May have to shunt for perpendicular crossing of CR 3 and creek crossing
33	N 3/4 of W½ Sec 12	2	Open ditch crossing, turn due west to bypass city of Elkton
34	NE¼ Sec 11	0	
35	SE¼ Sec 2	2	
36	NE¼ Sec 2	1	Cross open ditch
	T103N-R16W (DEXTER)		
37	Parcel SW of R.R. in SW¼ SE¼ Sec 35	1	Cross to east side of railroad
38	SE¼ Sec 35	0	
39	NW¼ Sec 35	1	

Tract No.	Description	No. Tile Crossed	Remarks
40	W½ SW¼ Sec 26	0	Cross stream and I-90
41	Parcel NE of RR in SE¼ Sec 27	3	
42	NE¼ Sec 27	5	Building site near S¼ corner Sec 22 may require shunting
43	E½ W½ Sec 22	2	
44	W½ NW¼ Sec 22	1	Shunt road intersection and wood road trestle over railroad
45	SE¼ Sec 16	2	Parallel tile lines
46	N½ Sec 16	1	Cross C.M. St P & P Railroad
47	S½ Sec 9	2	Bypass Renova on east side
48	N½ Sec 9	1	Tile lines outlet near railroad right-of-way
49	SW¼ Sec 4	3	Lines outlet near railroad right-of-way
50	SE¼ Sec 5	0	
51	N½ Sec 5	1	Cross to west side of railroad
	T104N-R16W (SARGEANT)		
52	SE¼ Sec 32	1	
53	SW¼ Sec 32	0	
54	NW¼ Sec 32	0	
55	SW¼ Sec 29	1	
56	NE¼ Sec 30	0	
57	SE¼ Sec 19	0	
58	NE¼ SW¼ Sec 19	0	
59	NW¼ Sec 19	1	Turn due west for bypass of Sargeant, and northerly adjacent to east township road right-of-way. Tile line will be paralleling route.
60	W½ SW¼ Sec 18	0	Parallel tile line; cross railroad to northeast side & N - S township road.

Tract No.	Description	No. Tile Crossed	Remarks
	T104N-R17W (WALTHAM)		
61	NE$\frac{1}{4}$ SE$\frac{1}{4}$ Sec 13	0	
62	E$\frac{1}{2}$ NE$\frac{1}{4}$ Sec 13	1	Cross stream
63	S$\frac{1}{2}$ Sec 12	1	
64	SE$\frac{1}{4}$ NW$\frac{1}{4}$ Sec 12	1	
65	N$\frac{1}{2}$ NW$\frac{1}{4}$ Sec 12	0	
66	SW$\frac{1}{4}$ Sec 1	0	Cross stream and township road
67	E$\frac{1}{2}$ NE$\frac{1}{4}$ Sec 2	2	Turn due north adjacent to west township road right-of-way
	DODGE COUNTY		
	T105N-R17W (HAYFIELD)		
68	S$\frac{1}{2}$ Sec 35	4	Locate pipeline to parallel north and south drain tile lines
69	NW$\frac{1}{4}$ Sec 35	0	50' wide right-of-way on east boundary will miss all tile lines
70	SW$\frac{1}{4}$ Sec 26	21	No tile will be crossed if construction is less than 40' from railroad right-of-way
71	N$\frac{1}{2}$ Sec 26	0	
72	SW$\frac{1}{4}$ Sec 23	1	
73	E$\frac{1}{2}$ NW$\frac{1}{4}$ Sec 23	0	
74	SW$\frac{1}{4}$ Sec 14	0	Turn due west near center of section
75	S$\frac{1}{4}$ NW$\frac{1}{4}$ Sec 14	0	
76	NE$\frac{1}{4}$ Sec 15	0	Turn due north adjacent to east railroad right-of-way
77	SE$\frac{1}{4}$ Sec 10	0	
78	S$\frac{1}{2}$ NE$\frac{1}{4}$ Sec 10	0	
79	N$\frac{1}{2}$ NE$\frac{1}{4}$ Sec 10	0	
80	SE$\frac{1}{4}$ Sec 3	2	Locate pipeline to parallel existing tile
81	NE$\frac{1}{4}$ Sec 3	0	

Tract No.	Description	No. Tile Crossed	Remarks
	T106N-R17W (ASHLAND)		
82	E½ Sec 34	3	Approximately 2200 lf of parallel tile line
83	SE¼ Sec 27	2	Approximately 1550 lf of parallel tile line
84	NE¼ Sec 27	2	Parallel lines are over 50' east of railroad right-of-way
85	E½ Sec 22	0	
86	S½ SE¼ Sec 15	8	Lines end east of railroad right-of-way and may not be crossed
87	N 3/4 of E½ Sec 15	1	2000 lf parallel tile line
88	S½ SE¼ Sec 10	0	1300 lf parallel tile line; cross open ditch
89	N½ SE¼ Sec 10	0	
90	S½ NE¼ Sec 10	0	
91	N½ NE¼ Sec 10	0	
92	SE¼ Sec 3	0	Turn due east adjacent to north right-of-way of CR 10
93	SW¼ Sec 2	2	Turn due north adjacent to east boundary of tract
94	NW¼ Sec 2	1	East boundary of airport
	T107N-R17W (WASIOJA)		
95	S½ SW¼ Sec 35	1	
96	NE¼ SW¼ Sec 35	5	Cross C. & N.W. railroad
97	SE¼ NW¼ Sec 35	8	Cross SH 14 and open ditch
98	NE¼ NW¼ Sec 35	2	
99	SE¼ SW¼ Sec 26	2	
100	NE¼ SW¼ Sec 26	6	Cross open ditch
101	S½ NW¼ Sec 26	2	Turn northwesterly
102	NW¼ NW¼ Sec 26	2	Diagonal alignment
103	N½ Sec 27	8	Cross Dodge Center Creek; pipe alignment should be southerly of grass waterway

Tract No.	Description	No. Tile Crossed	Remarks
104	NE¼ NE¼ Sec 28	0	Pasture land; turn northerly adjacent to east railroad right-of-way
105	E½ Sec 21	2	Parallel lines
106	SE¼ SW¼ Sec 16	0	
107	N 3/4 of W½ Sec 16	0	Gravel borrow pit area may have to be bypassed; cross South Branch Middle Fork Zumbro River
108	NE¼ NE¼ Sec 17	0	
109	E½ SE¼ Sec 8	0	
110	N½ Sec 8	1	
111	S½ Sec 5	2	
112	SE¼ NW¼ Sec 5	0	
113	NE¼ NW¼ Sec 5	0	
	T108N-R17W (CONCORD)		
114	Part of E½ SW¼ Sec 32 lying east of R.R.	0	Cross Milliken Creek
115	S½ NW¼ Sec 32	0	
116	N½ NW¼ Sec 32	1	Parallel tile lines
117	SW¼ Sec 29	0	2600 lf of parallel tile line
118	NW¼ Sec 29	3	At end of tile line
119	SW¼ Sec 20	6	Shunt building site near south line of tract and near the railroad
120	NW¼ Sec 20	?	Northerly course approximately 800' east and parallel to railroad for bypass of West Concord
121	SW¼ SW¼ Sec 17	?	Turn due west on the north line of tract
122	NW¼ SW¼ Sec 17	0	
123	SW½ NW¼ Sec 17	0	Adjacent to east right-of-way of township road; turn due west to east right-of-way of railroad
124	Parcel east of R.R. in E½ NE¼ Sec 18	8	

Tract No.	Description	No. Tile Crossed	Remarks
125	E½ SW¼ Sec 7	2	
126	NE¼ Sec 7	1	4 evergreen trees to be removed, cross Middle Fork Zumbro River
127	E½ SW¼ Sec 6	0	
128	SW¼ Sec 6	0	
129	NW¼ Sec 6	1	600 lf of parallel tile line
	GOODHUE COUNTY		
	T109N-R18W (KENYON)		
130	SE¼ Sec 36	0	
131	NE¼ Sec 36	0	North 80 rods is pasture, old elevator foundation at north line
132	SE¼ Sec 25	0	Old abandoned house near tract may have to shunt area
133	SW¼ Sec 25	0	All pasture, cross stream
134	NW¼ Sec 25	1	Pasture area in S½ of tract; cross stream and township road
135	NE¼ NE¼ Sec 26	0	Pasture area; diagonal route north to by-pass building site on south line of Sec 3 near railroad
136	SE¼ Sec 23	0	
137	NW¼ Sec 23	1	Parallel tile lines; outlets into railroad ditch near north line
138	W½ SW¼ Sec 14	0	Adjacent to east right-of-way of diagonal township road
139	NE¼ SE¼ Sec 15	2	
140	SE¼ NE¼ Sec 15	1	Turn due west crossing railroad and SH 56
141	SW¼ NE¼ Sec 15	0	Deflect northerly around building site near south property line
142	NW¼ Sec 15	2	
143	SE¼ NE¼ Sec 16	3	Abandoned building site deflect northerly around site
144	SW¼ NE¼ Sec 16	0	High ground

Tract No.	Description	No. Tile Crossed	Remarks
145	S½ NW¼ Sec 16	1	
146	NE¼ Sec 17	2	
147	NW¼ Sec 17	2	
148	E½ NE¼ Sec 18	1	Deflect northerly around building site
149	W½ NE¼ Sec 18	2	High ground
150	NW¼ Sec 18	0	Deflect northerly around building site; cross stream in pasture
	RICE COUNTY		
	T109N-R19W (RICHLAND)		
151	E½ NE¼ Sec 13	0	High ground
152	W½ NE¼ Sec 13	0	High ground
153	E½ NW¼ Sec 13	3	Turn due north to east side of CR 26 which has been staked for possible regrading
154	E½ SW¼ Sec 12	0	Approximately 6 evergreen trees to be removed 200' south of railroad. Good location for railroad crossing; turn westerly adjacent to north railroad right-of-way
155	W½ NW¼ Sec 12	0	Building site on south side of railroad
156	E½ NE¼ Sec 11	0	
157	W½ NE¼ Sec 11	0	
158	E½ NW¼ Sec 11	0	
159	W½ NW¼ Sec 11	0	
160	NE¼ Sec 10	0	
161	E½ NW¼ Sec 10	0	Pasture
162	W½ NW¼ Sec 10	0	Pasture
163	N½ NE¼ Sec 9	1	
164	N½ NW¼ Sec 9	1	Intercept proposed pipeline company route on west line of tract
		199	Grand Total, Estimated Number of Tile Crossed

SPECIAL PROVISIONS

CRUDE OIL PIPELINE CONSTRUCTION

These special provisions shall supplement, amend, modify or void the standard pipeline company provisions for drainage ditch and tile construction, back-filling, land restoration, coordination of construction activities, and ingress and egress over private property.

1. Drainage Ditch Crossings (includes streams used for drainage purposes)

All open drainage ditch crossings shall be constructed by procedures necessary to preserve and maintain the utility of the systems. Open ditch slopes shall be compacted to the same density as the undisturbed earth to prevent slumping, for a minimum distance of 10 feet as measured perpendicular to the slope. Riprap shall be used whenever adequate compaction cannot be attained with the excavated material. Any silt or material washed downstream as a result of the construction shall be excavated and leveled, and bank berms restored to facilitate prior agricultural uses. If the landowner requests, and fill is not restricting upstream flow, excavation could be delayed until after harvest or to accommodate agricultural pursuits.

Where the pipeline crosses open drainage ditches, the top of the pipe should be at a minimum of four feet below established ditch grade, or at a lower elevation if requested by the landowner to accommodate future improvement of the system. Landowners may wish to coordinate with adjacent landowners in their determination of anticipated future improvement of open ditch systems.

Prior to the pipeline construction, the pipeline company should obtain recommendations for all open ditch and tile crossings from the respective ditch authority for all drainage systems established under Minnesota Drainage Statutes, Chapter 106.

Wherever the pipeline construction traverses a grass waterway the trench backfill shall be compacted to the grade and density of the undisturbed earth, and all disturbed areas reseeded to the existing vegetation or other if specified by the landowner.

A typical drawing for pipeline crossings of open ditches is shown on page D-3 appended to this report.

2. Drain Tile Repair/Restoration

The repair of tile severed by the pipeline construction will vary depending on the angle of crossing, size and type of tile, and soil conditions at the time of construction. Typical types of repairs are shown in drawings D-1 and D-2 appended to this report under the heading "Typical Drain Tile Repair". In no case shall pipe or tile be laid across the ditch without compacting the backfill beneath said pipe to the same density as undisturbed earth or providing permanent structural support for the pipe or tile to prevent settlement. Each landowner shall specify the type of repair for each crossing. All drain tile crossed shall be repaired as soon as possible following the pipeline placement in the trench. No trench backfilling will be permitted which would block drain tile flow, even temporarily, or cause soil to enter the system. If the pipeline trench should fill with water causing flow to enter the drainage system, structures shall be used preventing soil or debris from entering the system. Typical structures commonly used by drainage contractors are shown on page D-4 appended to this report under the headings "Tile Inlet Structure".

Upon completion of tile repair/restoration on any particular tract, the tile repair contractor shall notify the property owner or appointed representative, and secure his/their approval before any trench backfilling is permitted.

The pipeline contractor shall maintain a complete and accurate record of the type and location, by engineer's stationing, of all crossings, connections, plugs, or other repairs of existing tile lines which are crossed. If requested, copies of such records shall be provided to landowners upon completion of the project.

3. Backfilling

Breaking down one side of the trench to blind the pipeline will be prohibited. Such procedures increases the amount of topsoil buried resulting in a greater width of less fertile subsoil on the surface. Only material excavated from the trench shall be used for backfilling, except as otherwise required for tile repair. If topsoil stripping has been stipulated by the property owner, said topsoil shall be backfilled near the surface insofar as practicable. Hand replacement of topsoil will not be required. Methods used shall be similar to those normally specified for similar work by the Minnesota Department of Transportation.

No mechanical or hand tamping will be required except for open ditch and tile repair areas previously described in Items 1 and 2.

Surplus material shall be placed as a crown over the trench except as otherwise required for crossings of waterways. The leveled backfill shall be sufficiently smooth and level so an ordinary automobile may be safely driven upon it in any direction.

4. Land Restoration

All equipment, material and debris used during the pipeline construction shall be removed within 48 hours after completion of the backfilling.

Rocks, trees brush or other obstructions encountered in the course of the work shall be removed or buried at locations designated by the landowner.

All of the traveled area used during the construction shall be chisel plowed at least twice, and rocks equivalent to a diameter exceeding three inches shall be removed before and after each chisel plow operation.

When requested by property owners, all fences, posts or gates shall be restored to their former utility and conditions. If not repaired or replaced, fencing and posts or gates shall be piled neatly at the edges of fields or other locations so as not to interfere with normal agricultural operations.

Pasture or grassed areas shall be seeded to vegetation equal to or better than that existing prior to the construction. The rate and type of seeding shall be as specified by the landowner.

5. Coordination of Construction Activities

All phases of the pipeline construction shall be coordinated activities as timely as practical. Except during extreme weather conditions, the construction contractors should not have more than 7 days time interval between various phases of the construction, such as blocking and pipe delivery, welding and bending, installation, backfilling, and cleanup.

Unwarranted destruction of soils could result in additional claims of damage by the landowner.

Failure to following these specifications could result in additional damage claims for loss of crops.

6. Rights of Ingress or Egress

The right of Ingress or Egress over private lands shall be restricted to that as described in the right-of-way easement agreement unless otherwise or subsequently agreed on by the landowner. No construction or delivery of material shall be done when ground conditions are such that extensive damage to lands may result. Practical measures, and reasonable judgment shall be used in construction pursuits. In no event shall activity be allowed when alternate solutions or short waiting periods for drying will eliminate excessive damage to lands.

7. Temporary Drain Tile Repairs

When requested by landowners or required to accommodate the pipeline construction, existing drain tile shall be temporarily connected to permit normal flow. Connections shall be made with metal or plastic pipe and supported to prevent sagging or grade separation. All temporary repairs shall be constructed by reasonable means to prevent dirt or other debris from entering the drain systems. No temporary repairs shall alleviate or preclude the permanent drain tile repair provisions as described in Item 2.

INDIVIDUAL LANDOWNER EASEMENT RECOMMENDATIONS

The following recommendations are submitted to be considered for inclusion in the pipeline company's standard landowners' agreements and are based on past observations of similar construction and conversation with landowners.

1. Landowners shall have the option of repairing their tile. The agreement should specify the price per lineal foot of each size tile. An agent for the pipeline contractor and the landowner shall agree at the time of the trenching the amount of repair required. Forms for identification, length, size and type of each drain tile crossing shall be furnished by the pipeline company. (Appendix 5)

2. Landowners shall have the option of restoring the land surface, including rock removal, at a specified per acre price. Equipment material and debris resulting from the construction shall be removed by the pipeline contractor within 48 hours of trench backfilling unless otherwise agreed upon.

3. The landowners shall have the option to designate areas where the contractor shall install the pipeline at sufficient depth to accommodate future drainage construction. It will be the landowners' responsibility to provide grade elevations and locations to the pipeline contractor.

4. Encroachments outside of the acquired pipeline right-of-way shall be measured and computed and damage payment made at the specified rate contracted for in the easement agreement.

5. Landowners shall have the option of requesting stripping of top soil for replacement on top of backfilled trench.

<u>NOTE</u>: It is assumed if this practice is employed that damage payments would be less than if not used.

6. If seepage areas along the course of the pipeline trench occur after the completion of the construction, the pipeline company shall be responsible for correcting the condition as recommended by a professional engineer or local U.S. Soil Conservation Service personnel.

<u>NOTE</u>: Only construction necessary to correct the seepage problem should be considered in such corrective measures.

7. Disagreements on the meaning of terms of the executed agreement or settlements by the landowner or pipeline contractor shall be referred to an arbitration committee of three persons selected as follows:

    1 person appointed by a state agency such as The Department of Natural Resources or the State Department of Agriculture.

    1 person appointed by the Board of Commissioners of the county wherein the disagreement exists.

    1 person appointed by the pipeline company.

All disagreements shall be investigated within 7 days of a complaint and arbitrated as soon as possible.

8. Following notification by a landowner of a violation of the contract or easement agreement. The pipeline company shall respond or commence corrective action within 48 hours.

RECOMMENDED

FIELD TILE REPAIR INSPECTION REPORT

The contractor, ______________________________, performing the work for Field Tile Repair on the Northern Pipeline construction across the ______ ________________, has completed the following types of said repair as described in the easement documents. The work has been inspected by the undersigned landowner or his or her designated representative, and is hereby approved as evidenced by the signatures hereon.

This agreement shall not eliminate any future liability of the Northern Pipeline Company as to defective work or materials, unless otherwise specifically stated.

Number of Crossings	Size	Material Description	Type of Repair

Date: ____________________________

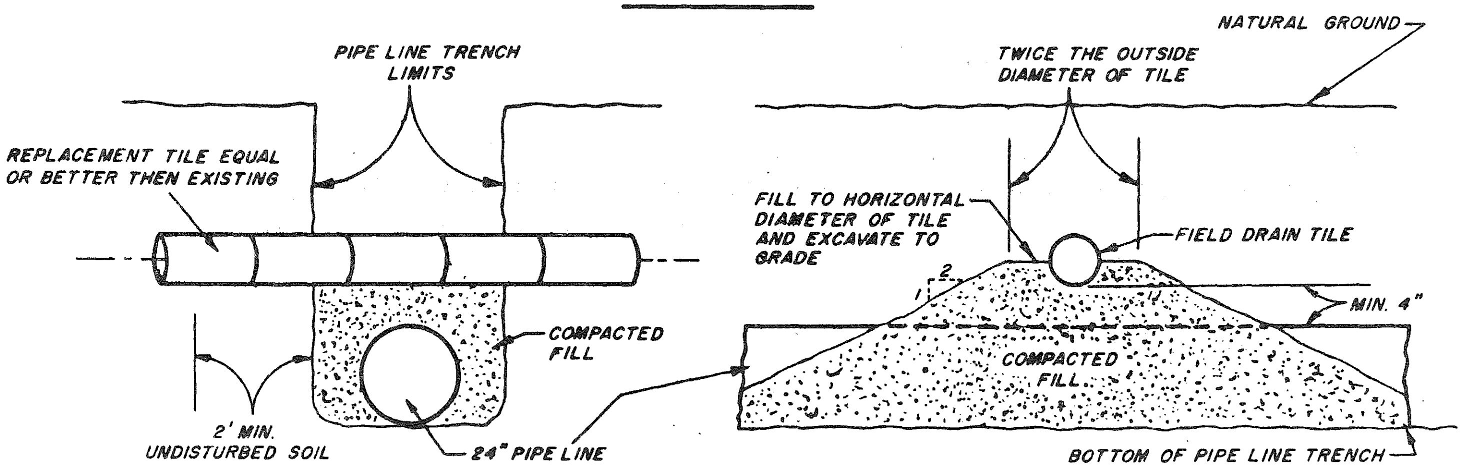
/s/ ________________________________
Landowner or representative

/s/ ________________________________
Contractor or representative

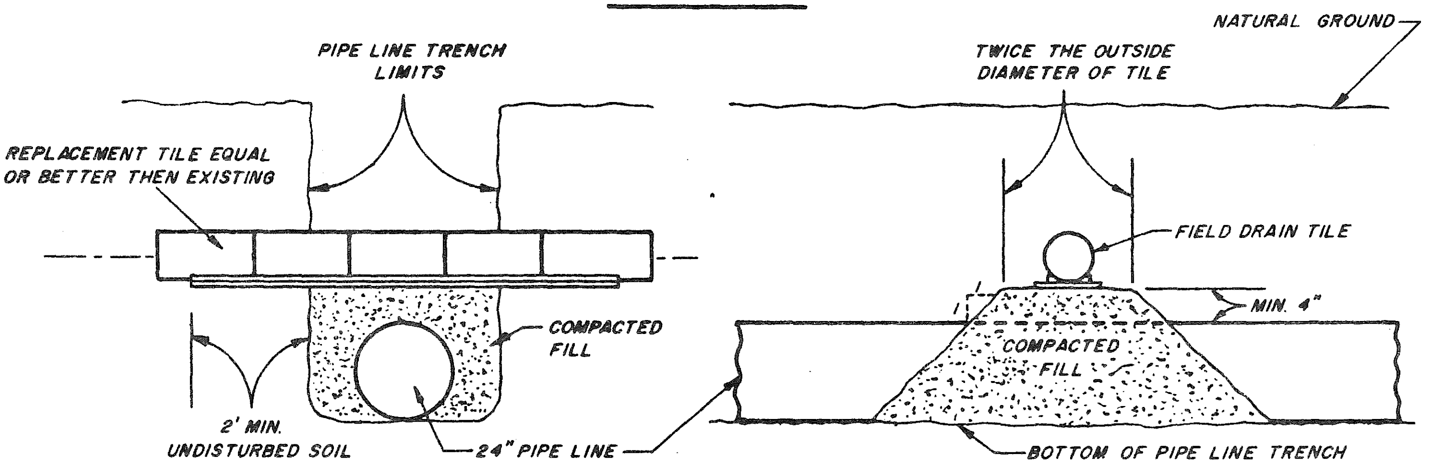
(One signed copy to be retained by landowner)

Typical Field Tile Repair

Type 1



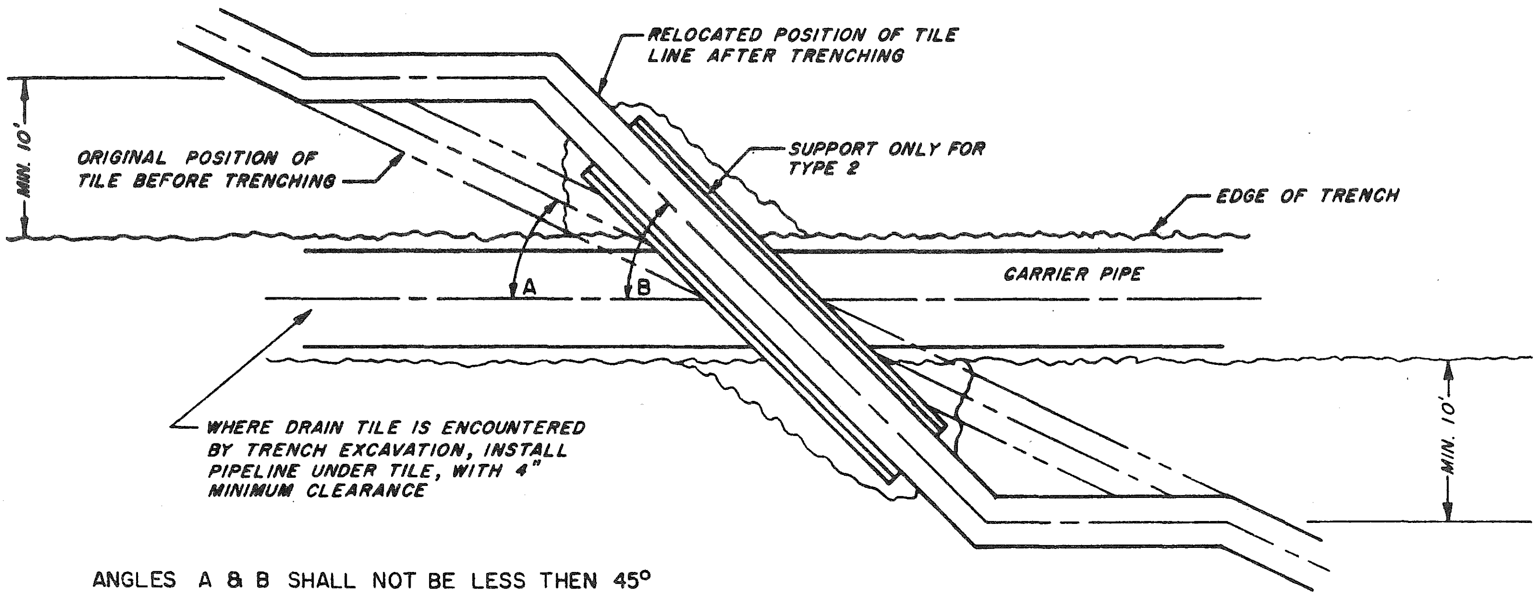
Type 2



NOTES:

1. Tile used for repair shall meet ASTM standards for quality, size and type, at least equivalent to the pipe removed.
2. Tile shall be replaced at a uniform grade, and connected to undisturbed tile at the original elevation at each end of the repair.
3. Backfill to be compacted in layers not exceeding 6", to the same density as adjacent undisturbed soil. A penetrometer shall be used to measure the density.
4. Whenever adequate compaction of material excavated from the trench cannot be obtained, crushed rock (1" maximum dimension) shall be used and compacted as described in Item 3.
5. Where conditions warrant or if requested by property owners, bridging such as channel iron or creosoted plank shall be used to obtain proper alignment and grade. Use of bridging will not change compaction requirements.
6. All tile joint gaps exceeding ¼" shall be covered with mortar at least 4" thick, and 2" either side of the joint.

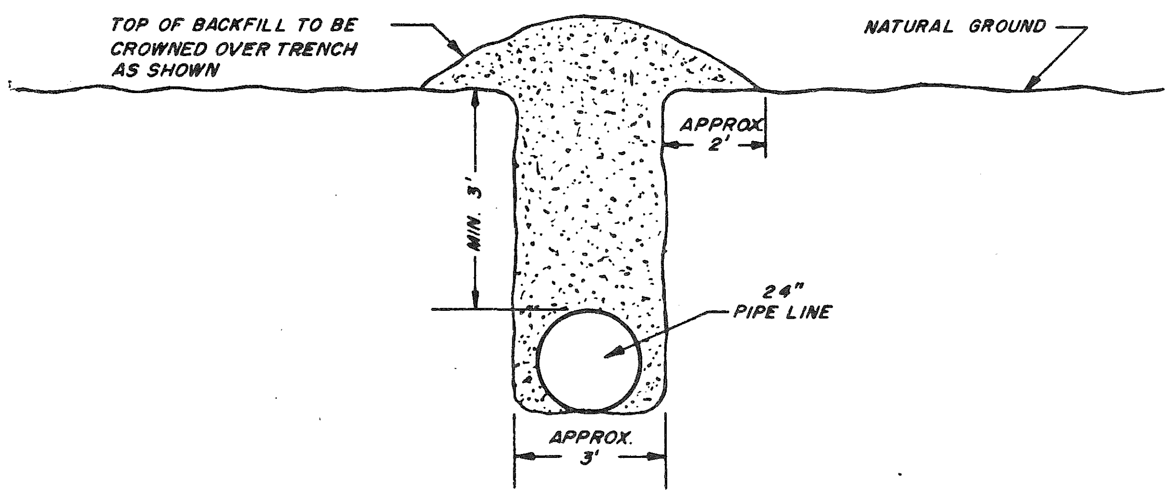
Typical Field Tile Repair For Skew Crossing



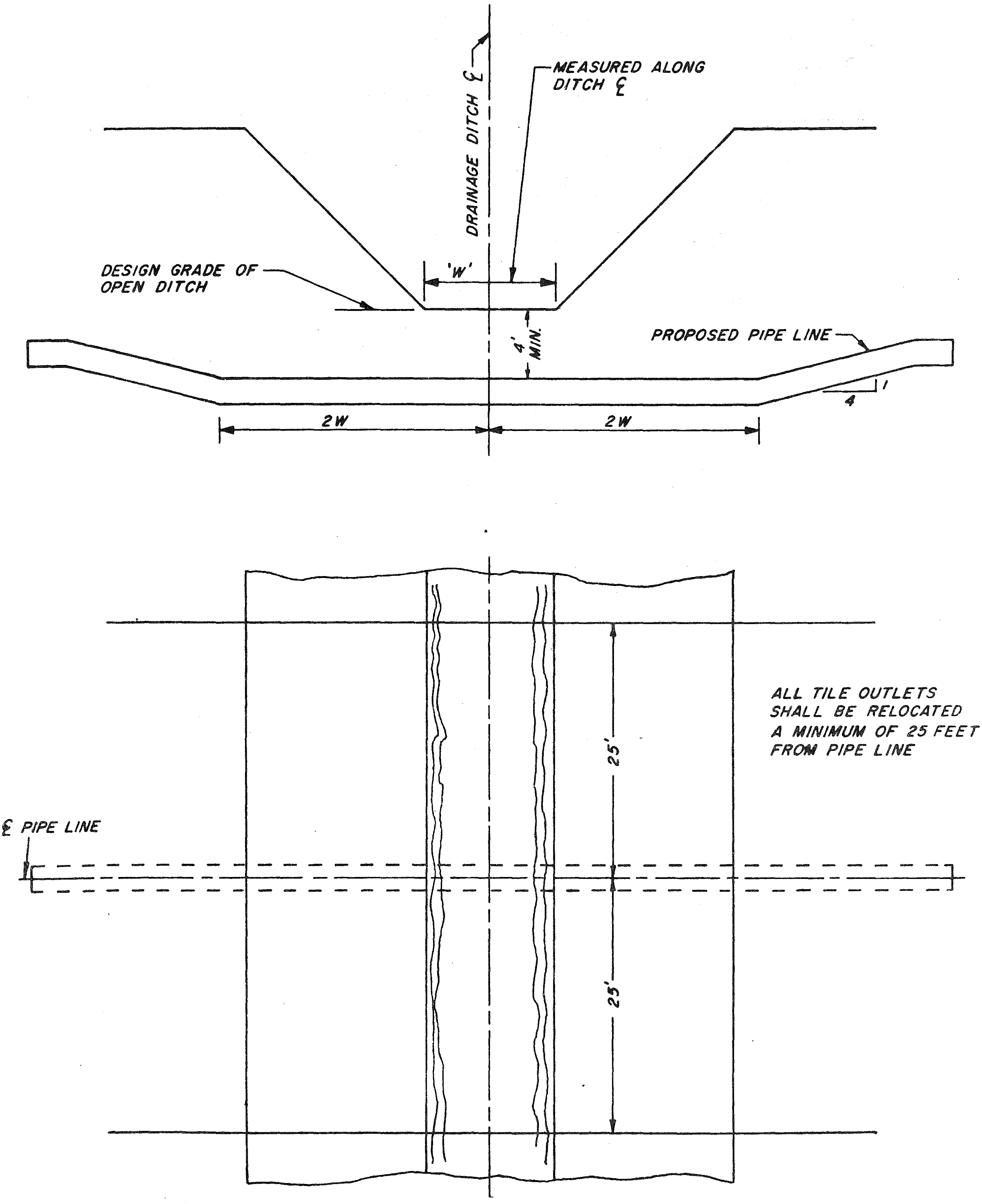
ANGLES A & B SHALL NOT BE LESS THEN 45°

ALL DRAIN TILE BENDS TO BE MANUFACTURED OR FITTED WITH A MAXIMUM OF 1/4" GAP IN JOINT

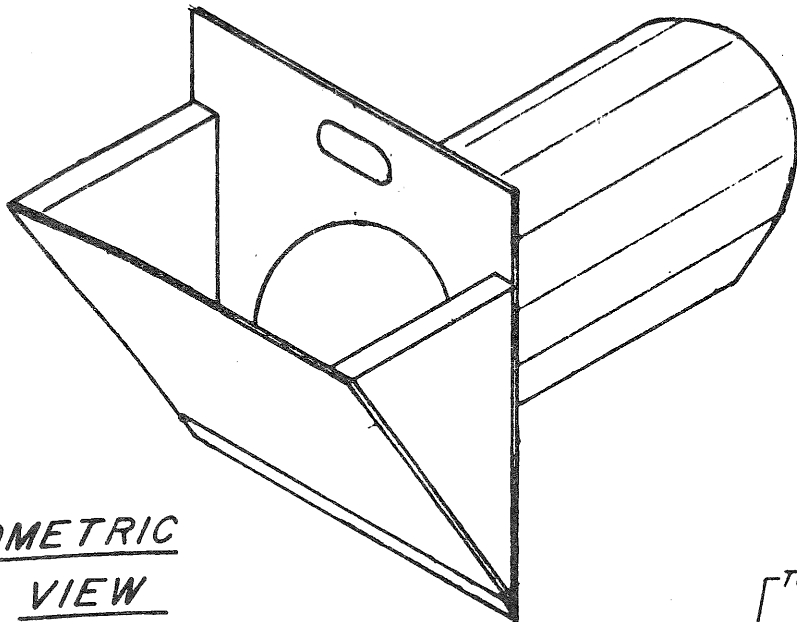
Typical Backfill Cross-section



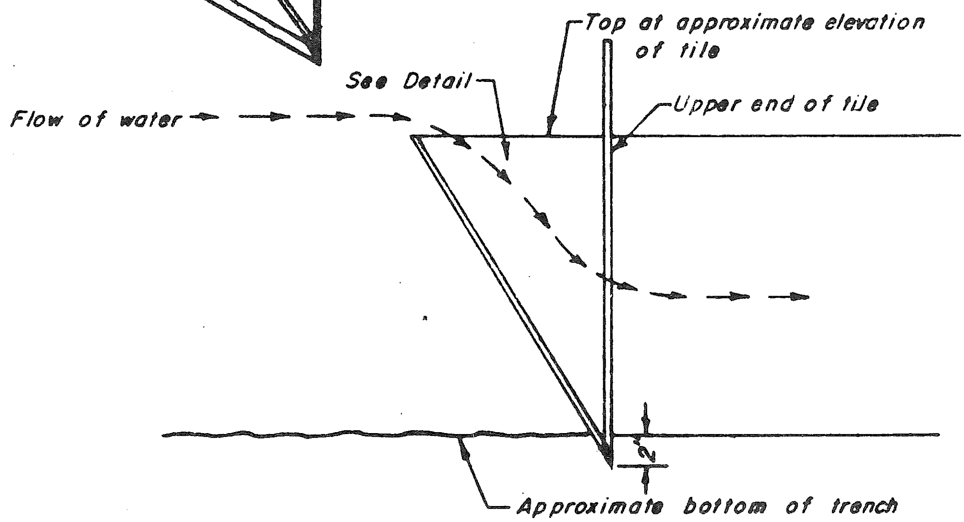
Typical Open Ditch Crossing



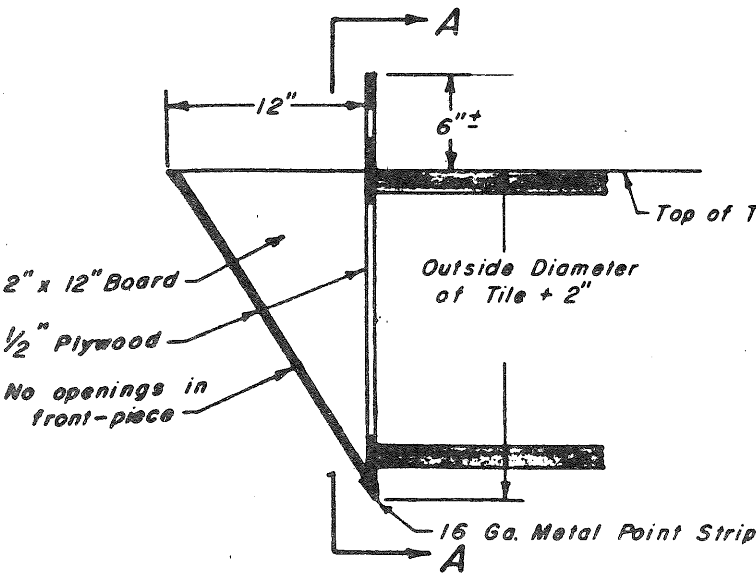
TEMPORARY TILE INLET STRUCTURE



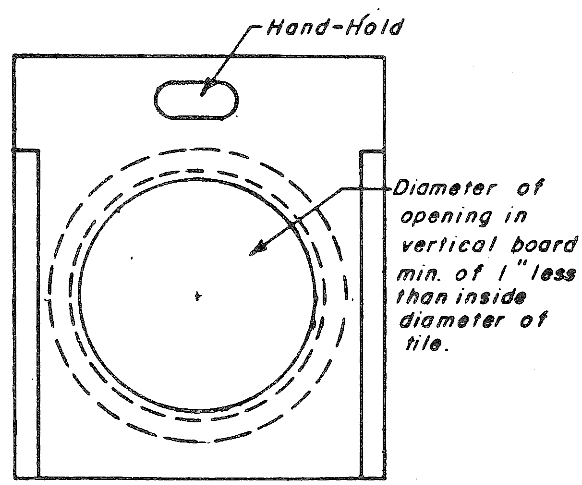
ISOMETRIC VIEW



GENERAL ELEVATION



SIDE VIEW
(Cross Section)



SECTION A-A
(Front View)