

APPENDIX J
CITY OF MOORHEAD
SOURCE WATER ASSESSMENT

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September 5, 2002- FINAL DRAFT-

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PART I

INTRODUCTION

The 1996 amendments to the Federal Safe Drinking Water Act (SDWA) require the Minnesota Department of Health (MDH) to complete Source Water Assessments (SWA) for public water systems (PWS).

The requirements of SDWA addressed herein are intended to provide Moorhead drinking water customers with: 1) a general description of the area which supplies water to the Moorhead PWS; 2) an overview of why this water supply is susceptible to potential contaminants; 3) a description of the contaminants of concern which may impact the users of the public water supply; and 4) to the extent practical, the origins of the contaminants of concern.

The Department of Health used team members from the following resource agencies to guide the direction of the surface water component of the source water assessment: the City of Moorhead, Moorhead Public Service, Moorhead Public Works, City of Fargo, Clay County Planning, County Water Planning, Clay Soil & Water Conservation District, Buffalo-Red Watershed District, Clay County Emergency Response Coordinator, Minnesota Pollution Control Agency, American Crystal Sugar Company, Red River Basin Board.

The groundwater portion of this assessment has been prepared internally by an MDH hydrologist. Because the City of Moorhead relies on both surface water and groundwater each assessment section will address the two sources separately.

STATUS OF SOURCE WATER PROTECTION

The city of Moorhead intends to use this source water assessment as a basis and as the framework for the development and implementation of a source water protection plan. While this is not a requirement of the SDWA, Moorhead has been working jointly with other PWS of the Red River basin (including Fargo) and the MDH to develop a source water protection planning strategy. The cities of Fargo and Moorhead expect to start development of a joint source water protection plan in 2003. Currently the MDH has convened an ad hoc workgroup with State wide representation to determine guidelines for Source Water Protection Plans for PWS systems with surface water intakes. The City of Moorhead is currently working towards development of a wellhead protection plan for the seven groundwater wells utilized by the public water system.

SOURCE WATER DESCRIPTION

Surface Water Intake:

The City of Moorhead obtains the majority of its public water supply from the Red River of the North. A water treatment facility is located three miles north and east of the river intake. The entire Red River watershed upstream (South) of the Moorhead intake is the source of surface water for the Moorhead public water supply. The portion of the Red River basin upstream of Moorhead has been determined to have a watershed area of 6800 square miles. Average draw from the river by the Moorhead water utility is 3.25 million gallons per day while maximum pumping capability at the intake is 7.5 million gallons per day. Red River flow at the Moorhead intake is typically 380 million gallons per day (at 570cfs ave.). The City of Fargo's public water supply intake at approximately the same point of the river (within a city block) draws an average of 11 million gallons per day.

Groundwater Wells:

A second source of raw water exists for the city of Moorhead in the form of seven groundwater wells all of which are used on a rotational basis to provide about 15% of the city's drinking water. The wells are located in two separate aquifers, the Buffalo Aquifer and the Moorhead Aquifer. The wells in the Buffalo Aquifer are located in sands and gravels associated with a tunnel valley deposit that formed as meltwater discharged beneath the Red River lobe. The sands and gravels vary from a few feet thick to as much as 200 feet thick near its center. The material overlying the aquifer is made up of clay and silt that ranges in thickness from 80 to 120 feet thick near the outer edges to 20 feet thick or less in the middle of the aquifer. The wells in the Moorhead Aquifer are completed in a 100-foot thick Quaternary sand and gravel aquifer (QBAA) that is covered by more than 160 feet of sediment, mostly clay-rich till or lake clay. This second water supply source is capable of pumping 6.5 million gallons per day although not on a long term sustained basis due to aquifer limitations. The City is currently participating in the wellhead protection program under MN Rules 4720 for the wells.

**TABLE 1
MUNICIPAL GROUNDWATER SUPPLY INFORMATION
CITY OF MOORHEAD, MINNESOTA**

WELL NUMBER	UNIQUE NUMBER	AQUIFER	CASING DEPTH (FEET)	WELL DEPTH (FEET)	DATE CONSTRUCTED	VULNERABILITY STATUS
1	00511085	Buffalo (North)	148	190	1988	vulnerable
2	00511086	Buffalo (North)	147	203	1988	vulnerable
8	00222049	Buffalo (South)	63	122	1947	vulnerable
9	00222050	Buffalo (South)	78	114	1947	vulnerable
10	00222051	Buffalo (South)	84	124	1952	vulnerable
6	00241492	Moorhead (QBAA)	233	273	1933	very low vulnerability
6B	00437645	Moorhead (QBAA)	233 -	266	1987	very low vulnerability

SOURCE WATER SENSITIVITY

Surface Water Intake:

In determining the sensitivity of a source water, the intrinsic physical properties of the geologic setting or landscape within the watershed must be considered. The variable quantities of water in the Red River and the rate at which the river water flows influences attenuation of contaminants and affects the movement of same to the public water supply intake. Attenuation is significantly influenced by weather conditions. Sensitivity to seasonal weather conditions that influence decisions to release (or not release) upstream impoundment waters will impact the amount of contamination found in the river. Other factors influencing the sensitivity of a surface water body include topography, hydrology, geology, vegetation (presence or absence of best management or conservation practices) and the distribution of various soil types within the watersheds of the Red River. The closer the source of contamination or detrimental land use is to the water intake the greater the impact will be on the quality of the water used by Moorhead based upon the factors listed. The farther the contaminant is from the intake the more likely the factors described herein will lessen contaminant impacts.

Groundwater Wells:

The sensitivity of the aquifers used by the city wells varies over the source water assessment area because of differing geological conditions. The area encompassed by the delineated capture zones for the city wells (Figure 1) has been designated to be of low sensitivity for wells 6 and 6B because of approximately 160 feet of clay-rich till or lake clay deposited as Glacial Lake Agassiz sediment which serves to prevent the vertical movement of contaminants. The city wells identified as 1, 2, 8, 9 & 10 are found in a different aquifer (the Buffalo) which has areas where the protective soils over the aquifer are as little as 20 feet in thickness and have been determined to have a young-water component found by tritium analysis. The detection of tritium indicates that water found in the aquifer has been at least partially recharged since 1953 and is considered young water. The wells found in the Buffalo Aquifer are thus considered to have moderate to high sensitivity.

Well Construction Assessment:

The City of Moorhead wells meet current standards for construction and maintenance. These factors do not contribute to the susceptibility of the source water to contamination.

SOURCE WATER ASSESSMENT AREA

Surface Water Intake:

The source water assessment area for the City of Moorhead includes three distinct areas. The **inner emergency response area** is designed to help the city address contaminant releases which present an immediate (**acute**) health concern to water users. This geographic area is defined by the amount of notification time the city needs to close the surface intake and a "buffer" to accommodate unanticipated delays in notification and shut down. For source water protection planning purposes, the City of Fargo's needs for emergency response were taken into consideration in determining the emergency response area described herein. The upstream boundary of the Fargo source water area as delineated by the state of North Dakota was used as the South end of the inner emergency response area for this assessment. The **outer source water management area** is designed to enable protection of water users from long term (**chronic**) health effects related to low levels of chemical contamination or the periodic presence of contaminants at low levels in the surface water used by the city. Also, this area is intended to enable protection of users from contaminants that may 1) be usually present at treatable levels in the source water, and 2) occasionally present an acute health concern under certain conditions, such as low stage of the Red River. This area is to some extent thought of as the place where non point sources of contamination develop significant impacts. The third assessment area is the **entire watershed** above the water intake and is designed to provide the water supplier with a broad perspective in which to prioritize specific types of land uses that may impact the water quality of the source water used. If it becomes known that potential contaminant sources of specific concern are outside of the delineated areas, the boundaries of the assessment areas can be modified to apply the management techniques in the desired area.

For the Moorhead surface intake the inner emergency response area is identified as shown in Figure 1. Generally, the area is described as on the Red River main stem beginning at a point approximately seven miles (13.5 river miles) south of the surface water intake for the City. The area includes subwatersheds which border the river and in the cities of Fargo and Moorhead the watershed determined by storm water drainage. It is important to note that the subwatersheds on the North Dakota side of the river are defined to less detail than on the Minnesota side.

The outer source water management area designated for the Moorhead public water supply intake is mapped as shown in Figure 1 and includes an area along the Red River beginning at the source water intake extending upstream to the Christine dam which is approximately nineteen miles south. On the Minnesota side the outer source management area includes the watersheds of fifteen contributing county or judicial ditches and Wolverton Creek. On the North Dakota side of the river the outer source management area includes the watershed of the Wild Rice River south to a line formed by the quarter-section line at Christine dam and thence northerly along the common watershed boundary of the Wild Rice and the Sheyenne Rivers to Interstate Highway 94 at Fargo. The width of the management area is to the full width of the subwatershed and encompassing the inner emergency response area. For the Moorhead source water intake, this includes areas in the counties of Clay and Wilkin on the Minnesota side, and Cass and Richland on the North Dakota side.

The assessment area described as the entire watershed is shown in Figure 2 as the Red River Watershed upstream of the intake including approximately 6800 square miles.

Groundwater Wells:

The capture zones for the seven city wells are shown in Figure 1 as delineated and approved Wellhead Protection Areas and represent the source water assessment areas for these wells.

PART II

POTENTIAL CONTAMINANTS OF CONCERN

Surface Water Intake:

The contaminants of concern are the contaminants regulated under the Federal SDWA. They are divided into organic chemicals, inorganic chemicals, radionuclides, microorganisms and disinfection byproducts. The list can be found at <http://www.epa.gov/safewater>. For the Cities of Moorhead and Fargo the most important contaminants of concern include organics (TOC), turbidity/sediment (TSS), chemicals resulting from spills, and microbial contaminants. Emerging issues for future potential contaminants of concern include pharmaceuticals and endocrine-disrupting substances. These types of potential contaminants are not well understood at this time.

Groundwater Wells:

For the Moorhead aquifer wells the only potential source of contamination is that which may enter the aquifer through other wells or borings that penetrate through the clay to the drinking water supply. For the Buffalo aquifer wells the aquifer is considered vulnerable and contaminants regulated under the Federal Safe Drinking Water Act are a potential concern. The principal contaminants of concern for this aquifer are being inventoried as potential contaminants for the wellhead protection planning currently in process.

CONTAMINANT SOURCES

To the extent practical, Table 2 below is a listing of point sources of contamination and an estimate of the numbers of each type located in the inner emergency response area and the outer source water management area.

**TABLE 2
INVENTORY OF POTENTIAL CONTAMINATION SOURCES
RED RIVER INTAKE**

SOURCE WATER MANAGEMENT AREA	COUNT	PROGRAM NAME
Inner Emergency Response Area	19	Agronomy Data Management System
Inner Emergency Response Area	2	Cemetery
Inner Emergency Response Area	1	Discharge Sites (NPDES)
Inner Emergency Response Area	1	Hazardous Substance Emergency Events
Inner Emergency Response Area	28	Leaking Underground Storage Tanks
Inner Emergency Response Area	2	MPCA Master Entity System
Inner Emergency Response Area	1	EPA Resource Management Plan (RMP)
Inner Emergency Response Area	28	Tanks: Above/Below ground System
Outer Source Water Management Area	17	Agronomy Data Management System
Outer Source Water Management Area	5	Cemetery
Outer Source Water Management Area	2	Discharge Sites (NPDES)
Outer Source Water Management Area	1	Hazardous Substance Emergency Events
Outer Source Water Management Area	1	Leaking Underground Storage Tanks
Outer Source Water Management Area	4	MPCA Master Entity System
Outer Source Water Management Area	1	EPA Resource Management Plan (RMP)
Outer Source Water Management Area	15	Tanks: Above/Below ground System

The potential sources of contamination listed in Table 2 represent data collected from a number of state and federal data bases. Editing the data sets for duplication and the accuracy of the locations for potential contamination sources was not possible to perform as part of the preparation of the source water assessment. The above data is for the Minnesota side of the Red River only.

Surface Water Intake:

To the extent practical, Table 3 below is an estimate of percentages of land uses found within the Moorhead source water assessment area (inner emergency response area and outer source water management area) reflecting non-point sources of potential contamination.

**TABLE 3
LAND USE WITHIN MOORHEAD'S SOURCE WATER ASSESSMENT AREA**

LAND USE TYPE	ACRES INNER AREA	ACRES OUTER AREA	TOTAL ACRES
North Dakota	22641 (48.0%)	45888 (32.25%)	68,529
Open Water	356 (0.8%)	798 (0.56%)	1,154
Low Intensity Residential	1563 (3.3%)	46 (0.03%)	1,609
High Intensity Residential	717 (1.5%)	16 (0.01%)	733
Commercial/Industrial/ Transportation	594 (1.2%)	214 (0.15%)	808
Quarries/Strip Mines/Gravel Pits	0	83 (0.06%)	83
Barren Transitional	0	<1 (<0.01%)	<1
Deciduous Forest	533 (1.1%)	2483 (1.75%)	3,016
Evergreen Forest	7 (0.01%)	20 (0.01%)	27
Mixed Forest	4 (0.01%)	24 (0.02%)	28
Shrubland	0	0	0
Pasture/Hay	993 (2.1%)	2876 (2.02%)	3869
Row Crops	19116 (41%)	87331 (61.4%)	106,447
Small Grains	4 (0.01%)	1565 (1.10%)	1,569
Urban/Recreational Grasses	586 (1.2%)	147 (0.10%)	733
Woody Wetlands	0	47 (0.03%)	47
Emergent Herbaceous Wetlands	35 (0.07%)	759 (0.53%)	794

Both point sources (such as industrial or wastewater treatment plant discharges) and non-point sources (such as runoff from agricultural or urban lands) are present in the inner emergency response area and the outer source water management area. The inner emergency response area is experiencing rapid urbanization adjacent to Fargo and Moorhead. In the Red River watershed upstream of the drinking water intake the primary land use is agriculturally based, however, a significant portion of the Ottetail River watershed is recreational-lake based land use. Larger cities in the watershed upstream of the drinking water intake include Moorhead, Perham, Battle Lake, Fergus Falls, Pelican Rapids, Breckenridge Wheaton, and Browns Valley in Minnesota; and Fargo, Wahpeton, Fairmount, Hankinson and Wyndmere in North Dakota. Tributaries which contribute the majority of non-point contaminants to the source water include Wolverton Creek, Ottetail River, Boise de Sioux River, Rabbit River and Mustinka River in Minnesota and the Wild Rice River in North Dakota.

Groundwater Wells:

Land use in the drinking water supply management areas for the city wells is dominated by urban-residential and commercial-industrial activity around the Moorhead aquifer due to most of it being located in the city limits. Land use is significantly dominated by agricultural activity for the wells in the Buffalo aquifer. In areas of the Buffalo aquifer adjacent to or near to Interstate 94, Trunk Highway 336 and US Hwy. 10 there is moderate pressure for mining and urbanization development.

RESULTS OF SOURCE WATER MONITORING

Surface Water Intake:

Source water monitoring results can be found in the various programs present in the Red River Basin. Some of those programs include: Minnesota Pollution Control Agency's TMDL program, Riverkeepers/Riverwatch, County Water Planning, watershed districts, FDR program monitoring, Minnesota Dept. of Natural Resources fisheries monitoring, Department of Health's fish consumption advisory, Clean Water Partnership diagnostic studies, USGS NAWQA studies and US Bureau of Reclamation water needs assessment studies. Results of MPCA's monitoring has currently resulted in eight reaches (Minn. side) of the Red River and tributaries that are impaired water bodies (2000 Impaired Waters List) upstream of the Moorhead drinking water intake. Impairment is found due to contaminant levels affecting concentrations of ammonia, biotic community, turbidity, fecal coliform bacteria, and oxygen concentration. Of these, turbidity and fecal coliform levels are of most impact to the water treatment systems. Total organic carbon, not presently a TMDL impairment contaminant, is found at levels of concern to the public water suppliers because of resultant breakdown byproducts (tri-halo methane) during the treatment process. Since most monitoring is generally related to swimmable and fishable goals of the Clean Water Act, a greater emphasis on drinking water standards in the future would be beneficial to public water suppliers. While results of the various monitoring programs have verified the presence of many potential contaminants, the water treatment plant is designed to handle those contaminants. The public water supplier also operates a continuous monitoring program for raw and finished drinking water to assist in the treatment process.

Groundwater Wells:

Water in the Moorhead water distribution system is regularly sampled and analyzed for contaminants regulated under the Federal Safe Drinking Water Act. The City disinfects the water with ozone and chlorine to safeguard water users from disease organisms. A plasticiser (di-2 ethyl-hexyl phthalate) and nitrate-nitrogen have also been detected at low levels in the drinking water supply. It is difficult to determine if these detections of monitored contaminants in the distribution system are attributable to wells or surface water.

SUSCEPTIBILITY OF THE SOURCE WATER TO CONTAMINATION

Susceptibility is defined as the likelihood that a contaminant will enter a public water supply at a level which may result in an adverse human health impact.

Surface Water Intake:

The susceptibility of any surface water source is determined to be high because there is no practical means of preventing all potential contaminant releases into surface waters. The Federal SDWA recognizes the susceptibility of surface waters and requires filtration to remove pathogens and particulate contaminants. The susceptibility of the Moorhead surface water intake is considered to be high for a surface based public water supply system.

While it has been determined that the Moorhead source water is highly susceptible to contaminants found in the river, it is noted that historically, the Moorhead Public Service Water Division has effectively treated this source water to continually meet safe drinking water standards.

Groundwater Wells:

The source of water used by the City of Moorhead is of low susceptibility for wells located in the Moorhead aquifer and of moderate to high susceptibility for wells located in the Buffalo aquifer. This determination is due to the local geological setting for each aquifer.

USING THIS ASSESSMENT

Protecting the drinking water source is a wise and relatively inexpensive investment in the future of the community. The overall intent of this assessment is to provide background information for the community to use in developing a local drinking water protection program. The assessment benefits the community by providing the following:

- *A basis for focusing limited resources within the community to protect the drinking water source.* The assessment provides the community with information regarding activities within the source water area that may directly affect the water supply.
- *A basis for informed decision making regarding land use within the community.* The assessment provides the community with a significant amount of information regarding where the drinking water comes from and what are the risks to the quality of that source. Knowing where the resource is allows community planning authorities to make informed decisions regarding proposed land uses within the source water assessment area that are compatible with both the drinking water resource and the vision of growth embraced by the community.
- *A basis for informed source water protection planning efforts for the cities of Fargo and Moorhead.*

ACRONYMS USED IN THIS DOCUMENT

SWA = source water assessment

MDH = Minnesota Department of Health

TMDL = total maximum daily load

MPCA = Minnesota Pollution Control Agency

FDR = Flood Damage Reduction

SDWA = Safe Drinking Water Act

USGS NAWQA = U.S. Geological Survey National Water Quality Assessment

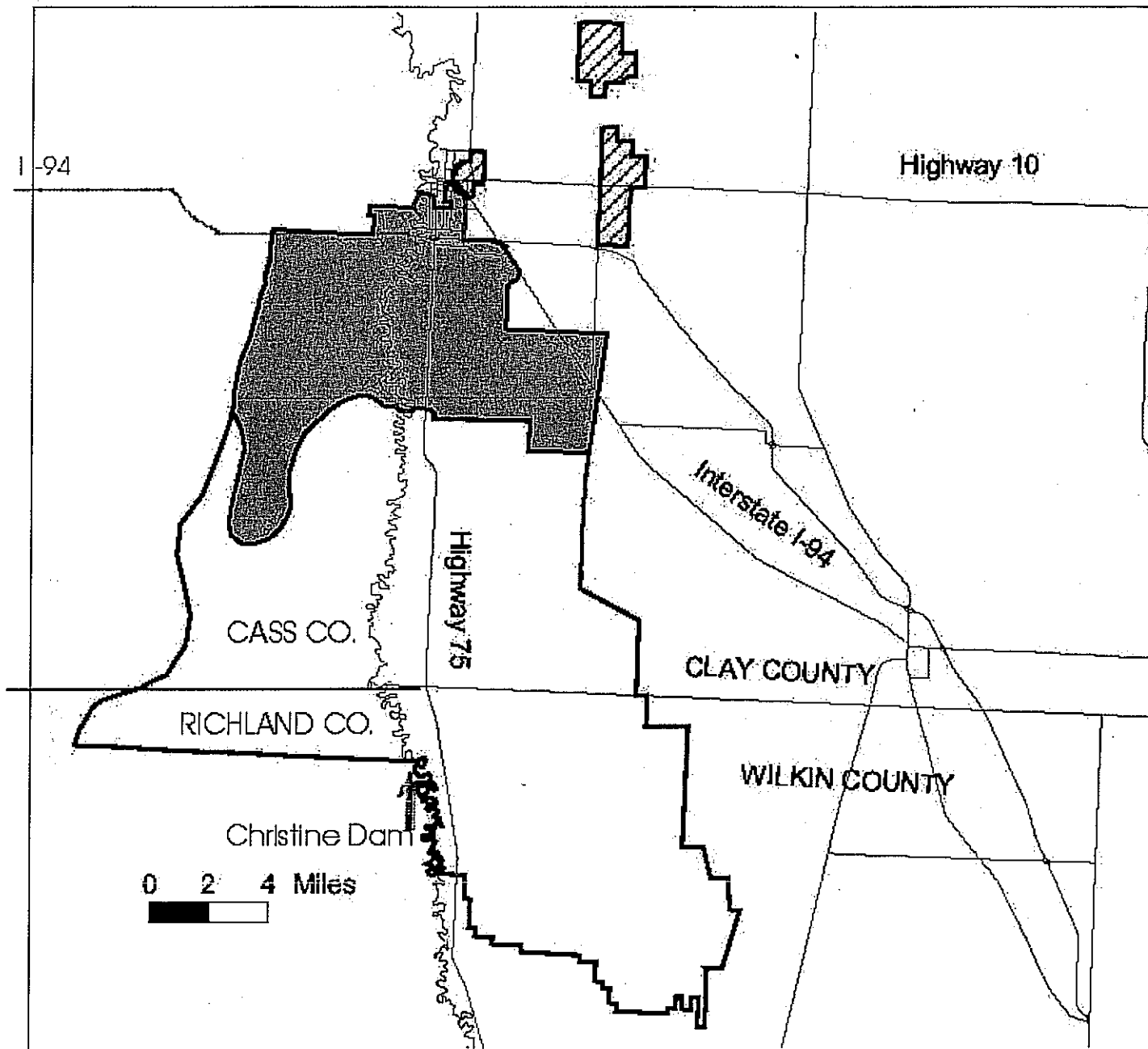
PWS = public water supply

EPA = U.S. Environmental Protection Agency

TSS = total suspended solids

TOC = total organic carbon

SOURCE WATER ASSESSMENT AREAS FOR THE CITY OF MOORHEAD



0 2 4 Miles

Source Water Assessment Areas

-  Inner Emergency Response Area
-  Outer Source Water Management Area

Wellhead Protection Areas

-  Drinking Water Supply Management Area

FIGURE 1

Prepared by
Minnesota Department of Health
July, 2002

