NORTH DAKOTA

SOURCE WATER ASSESSMENT PROGRAM

STRATEGIC PLAN

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BMP	Best Management Practices
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
EPA	Environmental Protection Agency
GIS	Geographic Information Systems
GTS	Geographic Targeting System
MCL	Maximum Contaminant Level
mg/L	Milligrams per Liter
NDAC	North Dakota Administrative Code
NDCC	North Dakota Century Code
NDDH	North Dakota Department of Health
NPS	Nonpoint Source
PSC	Potential Sources of Contamination
PWS	Public Water Supply System
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SWAP	Source Water Assessment Program
SWPCB	State Water Pollution Control Board
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
USGS	United States Geological Survey
WHP	Wellhead Protection

INTRODUCTION

In 1996, the United States Congress amended the federal Safe Drinking Water Act (SDWA) requiring states to take an active role in the identification and assessment of potential threats to the quality of public drinking water supplies. The amendments specifically found in PL. 104-182, Section 1428 and 1453, require states to fully implement a federally approved Source Water Assessment Program (SWAP) plan by the year 2003. It was the intent of Congress that completion of source water assessment activities will lead to the establishment of local water protection programs. In compliance with the federal SDWA amendments, the state of North Dakota has developed a SWAP plan which identifies an implementation strategy designed to complete source water assessments for all public drinking water supply systems (PWS).

The objective of this document is to present the North Dakota SWAP plan and implementation strategy. This SWAP plan includes a description of the following: delineation of source water assessment areas; completion of contaminant source inventories; and completion of susceptibility determinations for each PWS system.

This document combines the federal mandates addressed in the 1996 SDWA amendments with the natural, economic, social, and regulatory environments unique to North Dakota. The North Dakota SWAP plan is described in four chapters of this document as follows:

Chapter 1: Public Participation: A description of how North Dakota solicited and incorporated public participation in developing the SWAP plan, and the process by which results of the source water assessments will be made available to the public.

Chapter 2: Natural Environment and Existing Environmental Protection Programs: A description of the existing level of knowledge of natural resources in the state, coupled with a description of the existing state environmental protection programs.

Chapter 3: Source Water Assessment and Completion Criteria: A description of the North Dakota SWAP plan.

Chapter 4: SWAP Plan Implementation: A description of how the SWAP plan will be implemented in North Dakota.

CHAPTER 1. PUBLIC PARTICIPATION

Section 1428(b) of the federal Safe Drinking Water Act requires that each state establish procedures to encourage the public to participate in the development of a SWAP plan. The public participation process is intended to build public support, increase awareness of water quality protection issues, and result in the development of a plan that is responsive to the needs of the public.

To assist in developing the North Dakota SWAP plan, the North Dakota Department of Health (NDDH) solicited comment and active participation from a diverse group of stakeholders. Environmental organizations, industry representatives, water suppliers, academia, and the general public were all encouraged to provide guidance and comment. Through public notification, news releases, in addition to the activation of Technical and Citizens Advisory Committees, public access and input during the development of the North Dakota SWAP plan was solicited. Although comments relating to the scope and direction of the North Dakota SWAP plan were submitted to the NDDH, no major issues or significant discussion points were identified by the general public or advisory committees. Documentation of comments, and how they were addressed during SWAP plan development, are discussed in Appendix A.

This chapter will describe the extent to which the NDDH solicited public comment, and encouraged participation during the developmental phases of the North Dakota SWAP plan in 1998, and the strategy to be used to continue public participation after all assessments have been completed.

1.1 Public Participation: SWAP Plan Development

Section 1428(b) of the SDWA requires that, "each state shall establish procedures, including, but not limited to, the establishment of technical and citizens advisory committees, to encourage the public to participate in developing the protection program for wellhead areas, and SWAPs under section 1453. Such procedures shall include notice and opportunity for public hearing on the state program before it is submitted to the Administrator." The primary focus of the Technical Advisory Committee is to provide guidance and comment relating to the technical feasibility and effectiveness of a state's SWAP approach, while the Citizens Advisory Committee is intended to provide comment on the desirability and appropriateness of a state's SWAP approach.

1.1.1 Technical Advisory Committee

To encourage public participation during the development of the North Dakota SWAP plan, a Technical Advisory Committee (TAC) was established. The goal of the TAC was to provide guidance and comment relating to the technical feasibility and effectiveness of a North Dakota SWAP plan. An existing state sanctioned committee acted as the TAC whose historical purpose has been to advise the NDDH "in development of programs for the prevention and

control of pollution of waters in the state."[1] The advisory board, referred to as the State Water Pollution Control Board (SWPCB), consists of 13 members. Membership on the board includes the State Health Officer, State Engineer, Director of the Game and Fish Department, State Geologist, and nine other members appointed by the Governor. The nine members represent the following sectors:

Production Agriculture (three members)
Manufacturing and Processing (two members)
Solid Fuels Industry (one member)
Fluid and Gas Fuels Industry (one member)
Environmental Sciences (one member)
County or Municipal Government (one member)

Comments relating to the technical feasibility and effectiveness of a North Dakota SWAP plan were solicited from the SWPCB from June 1998 to January 1999. During this time, two meetings of the board were convened to discuss water quality pollution issues, including the development and implementation of the North Dakota SWAP plan. The meetings were convened on June 23, 1998, and November 23, 1998, at the Environmental Training Center located in Bismarck, North Dakota. Participating members, meeting agenda, technical input, and a responsiveness summary are presented in Appendix A.

1.1.2 Citizens Advisory Committee

To ensure that all interested parties had adequate opportunity to participate in the development of the proposed SWAP plan, the NDDH solicited input from the general public through the formation of a Citizen (a.k.a. Community) Advisory Committee. The Citizen Advisory Committee's primary purpose was to provide comment and guidance as to the desirability and appropriateness of the proposed plan. The public notification and comment period was initiated in November 1998, and concluded at the end of January 1999. During this time period, information was distributed through radio, newspaper, direct contact, and the NDDH Internet home page as identified in Appendix A.

During the notification and comment period, two meetings were convened to provide a public forum in which the proposed SWAP plan was presented and discussed. The Citizen Advisory meetings were convened in Bismarck, North Dakota, at the Environmental Training Center on December 21, 1998, and January 19, 1999. Attendees at both meetings were encouraged to provide comment on all aspects of the document, including the overall appropriateness of the proposed SWAP plan.

In addition to the comments received as part of the Citizens Advisory meetings, written comments were received from six different individuals or organizations. Comments were

[1] Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Waters, North Dakota Century Code, Section 61-28-03.

received from the North Dakota Oil and Gas Division, North Dakota State Water Commission, North Dakota Geological Survey, North Dakota Chapter of the Sierra Club, United States Environmental Protection Agency, and the North Dakota Public Drinking Water Program. Copies of the entire comments, meeting synopsis and a responsiveness summary have been provided in Appendix A.

1.2 Source Water Assessment Reports and Public Notification

Source water assessments provide the initial elements considered to be a precursor to voluntary local water protection programs. However, to realize the optimum benefit from each assessment report, they must be readily accessible to the general public in a timely, accurate and understandable format. To insure adequate public access to each source water assessment report, the NDDH will implement a variety of traditional and electronic media information distribution strategies. These will include an information format and distribution policy established for the existing North Dakota Wellhead Protection Program.

1.2.1 Source Water Assessment Report Format

Upon completion of a PWS source water assessment an official report will be completed for distribution to the general public. The amount of information in a report will be dependant upon the availability of site-specific information (i.e., local geology, hydrology, well construction and use), the complexity of the source water delineation, contaminant source inventory, and susceptibility analysis. The North Dakota source water assessment report format will include the following sections:

- ➤ Discussion of the Source Water Assessment Delineation
- ➤ Source Water Assessment Delineation Map
- ➤ Geologic Cross Section Illustration (if applicable)
- ➤ Contaminant Source Inventory
- ➤ Susceptibility Determination

The source water assessment delineation map and locations of significant potential contaminant sources will be displayed utilizing Geographic Information System (GIS) technology. Past experience has shown that information presented in this format is readily understood by the public and is easily updated. Based upon availability, information such as lithologic logs, soil risk assessment, water quality analytical results, and location of water quality observation stations may be included in the report. An example of the a North Dakota Wellhead Protection report is provided for illustration purposes in Appendix A (Exhibit 12).

1.2.2 Source Water Assessment Report Distribution

After completion of each source water assessment, public notification of its availability will be the responsibility of the NDDH and the individual PWS. Notification by the NDDH will be accomplished through direct mailings, Internet technology, periodic newsletters and newspaper releases. Notification by each PWS will be accomplished as part of the Safe Drinking Water Act Consumer Confidence Reporting requirements.

Each community PWS source water assessment report will be distributed to parties expressing a technical interest in the completed reports, environmental protection agencies, or the owner or operator of the PWS. Direct mailings of the completed report will be transmitted at a minimum to:

- ➤ Community PWS system owner or operator
- ➤ North Dakota Rural Water Association
- ➤ University of North Dakota - Geology Department
- ➤ North Dakota Agricultural Extension Service - North Dakota State University
- ➤ Natural Resources Conservation Service - District Office
- ➤ North Dakota State Water Commission
- ➤ North Dakota Geological Survey
- ➤ North Dakota Agriculture Department

This list may be modified to include other federal, state or local agencies and other interested individuals upon request of the NDDH. Due to the limited area of impact and number of affected parties, noncommunity source water assessment reports will be transmitted to the owner of the facility only. However, the NDDH will provide copies of a report to interested parties upon a written request.

In addition to direct mailings, notification of the availability of the completed source water assessment reports will be accomplished through the NDDH Internet home page. Information on the Internet will include report availability, GIS source water assessment delineation map and, if available, a geologic cross section associated with the source water assessment area. Contact names and addresses will also be identified at the Internet address. The NDDH home page for completed source water assessments can be accessed at the following address: http://www.health.state.nd.us/ndhd/envrion/wq/gw/gwindex.htm.

The NDDH will also provide notification of source water assessment report availability through a biannual newsletter distributed to PWS systems and interested parties. Additional notification is provided to the general public through the development and distribution of news releases to the North Dakota Newspaper Association. These releases will be directed to those counties in which the source water assessments have been completed.

Pursuant to the requirements of the SDWA, each community PWS system will notify the interested public of the availability of a source water assessment report as part of Consumer Confidence Reporting. The NDDH will review the initial Consumer Confidence Report for each PWS, to insure that the susceptibility summary, information of where to obtain a full source water assessment, and other statutorily required information is included in each Consumer Confidence Report.

CHAPTER 2. NATURAL ENVIRONMENT AND EXISTING PROTECTION PROGRAMS

Since the late 1960s and arguably prior to that time, the citizens of North Dakota have acknowledged the importance of a clean, plentiful supply of water for a variety of uses. Examples of this awareness can be found in reviewing state laws, especially North Dakota Century Code (NDCC) 61-28 entitled "Control, Prevention, and Abatement of Pollution of Surface Waters." In NDCC 61-38, the Statement of Policy declares:

> It is hereby declared to be the policy of the state of North Dakota to act in the public interest to protect, maintain and improve the quality of the waters in the state for continued use as public and private water supplies, propagation of wildlife, fish and aquatic life and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses, to require necessary and reasonable treatment of sewage, industrial, or other wastes and to cooperate with other agencies in the state, agencies of other states and the federal government in carrying out these objectives.

In recent years the U.S. Environmental Protection Agency (EPA) has promoted similar policies through federal mandates identified in the Clean Water and the Safe Drinking Water Act.

The objective of this chapter is to identify the existing status of North Dakota's water resources and the programs designed to protect their quality. The natural environment and existing regulatory infrastructure are integral to the development and implementation of a comprehensive North Dakota SWAP plan. This chapter includes a description of:

- ➤ the status of surface and ground water resources;
- ➤ the existing quality of source waters;
- ➤ the status of North Dakota PWSs;
- ➤ the primary sources of water quality contamination; and,
- ➤ the status of existing source water protection programs

2.1 Natural Environment and Source Water Description

Sections 2.1 through 2.5 - - provide information pertaining to a variety of factors describing the natural environment, the source waters of PWSs, sources of contamination, and the existing quality of source waters. Local geology, hydrology, and other features provide various levels of natural protection from manmade contamination. These factors play an important role in the development and implementation of a comprehensive SWAP strategy and allow for site-specific protection plans.

2.1.1 State Geography and Surficial Geology

North Dakota is located in two provinces of the Interior Plains: the Great Plains, and the Central Lowlands provinces (Figure 1). The Missouri Escarpment that traverses the state is considered to mark the boundary of the Great Plains province to the west and the Central Lowlands province to the east (Bluemle, 1973). The separation of the physiographic provinces is based on the sharp land surface elevation increase accompanying the Missouri Escarpment toward the west to the Missouri Coteau. In some locations, the rise of the escarpment may be as great as 500 feet per mile, although a more gradual increase of 100 to 200 feet per mile is more common (Bluemle, 1991). The surface elevation of North Dakota generally decreases from the southwest corner to the northeast corner of the state. Elevations range from the highest point of 3,506 feet above sea level at White Butte in Slope County of southwestern North Dakota to the lowest point of 730 feet above sea level near Pembina in northeastern North Dakota.

The land surface elevation of the Great Plains province generally exceeds 2,000 feet above sea level. The Missouri Slope Upland and the Coteau Slope consist of rolling to hilly plains, except in badlands areas where relief is very steep. Surface drainage is well developed on the older, erosional landscapes of the province, including the Missouri Slope Upland that was unglaciated and the Coteau Slope that was covered by thin or discontinuous glacial deposits. By contrast, the Missouri Coteau section is characterized by a depositional landscape created by large-scale stagnation of thick glacial deposits consisting primarily of glacial till, but also including large areas of glaciofluvial sand and gravel deposits. The Missouri Coteau landscape is a hummocky, irregular plain. Drainage of the Missouri Coteau is non-integrated or non-contributing; meaning that no streams flow through the area. Wetlands and small lakes, however, are common in the area and serve as collection and storage locations for local precipitation.

The Central Lowlands province is characterized primarily by depositional landscapes formed in thick glacial deposits. The province includes the Glaciated Plains and the Red River Valley physiographic regions (Figure 1). The Glaciated Plains region is a rolling, gently sloping landscape formed in glacial deposits consisting primarily of glacial till, but also including fine-grained glacial lake deposits and glaciofluvial sand and gravel deposits. Surface elevation of the Glaciated Plains averages 1,400 to 1,700 feet above sea level (Bluemle, 1973).[2] Surface drainage of the Glaciated Plains is poorly integrated and includes closed basins.

The Red River Valley region is a flat, gently sloping plain formed as the result of deposition of silt and clay sediments on the floor of former glacial Lake Agassiz (Figure 1). The Pembina

[2] Bluemle, John P., 1973. Topographic Setting in: Mineral and Water Resources of North Dakota. ed by E.R. Landis, North Dakota Geological Survey Bulletin, 63. 252 p.

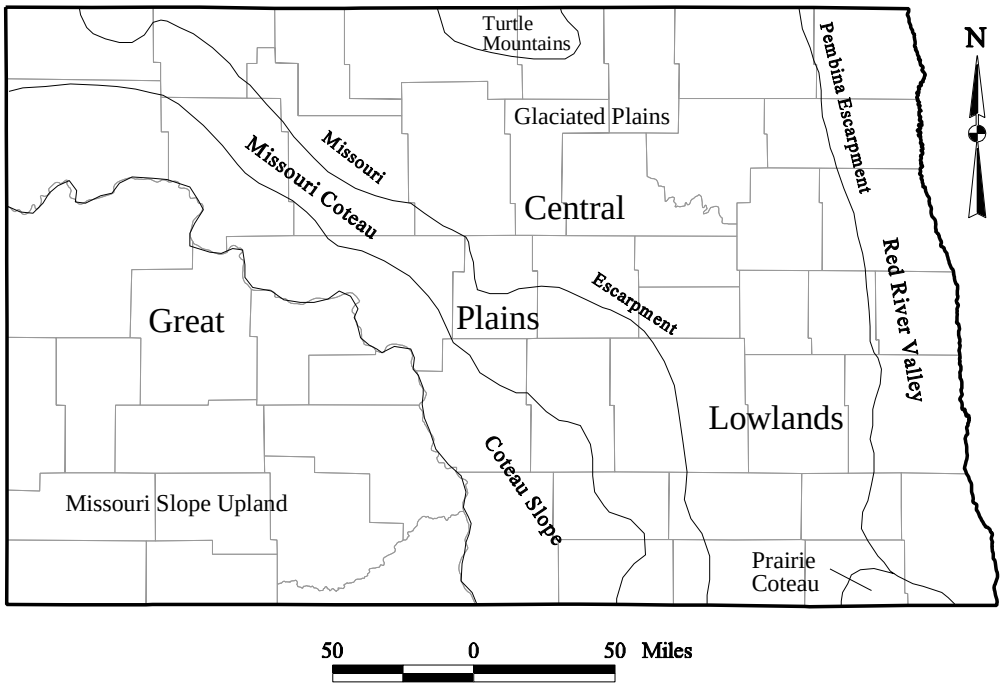

Figure 1. Geographic divisions of North Dakota (modified from Bluemle, 1991)

Escarpment marks the boundary between the Red River Valley and the Glaciated Plains. Surface elevation of the Red River Valley averages 800 to 1,000 feet above sea level. Surface drainage of the Red River Valley is integrated by low-gradient streams that drain into the Red River Valley of the North, which defines the eastern boundary of the state.

2.1.2 Precipitation

North Dakota's average annual precipitation ranges from about 13 inches in the northwest to about 20 inches at the state's eastern border. The precipitation is generally derived from air masses originating in the Gulf of Mexico. Summer rainfall is primarily from local thunderstorms, resulting in large variations in the space and time of precipitation events. About 60 percent of the annual precipitation occurs between April and July, with an estimated 75 percent of the annual precipitation occurring between April and September.

2.1.3 Surface Water Resources

Prior to glaciation, all streams in North Dakota flowed northeastward to the Hudson Bay basin (Bluemle, 1991). Present-day North Dakota, however, is separated hydrologically by a

continental divide between the Missouri Region and the Souris-Red-Rainy Region (Geological Survey (USGS) 1986).[3]

The Missouri Region in North Dakota includes the Missouri River basin and the James River basin. Both drain south to the Gulf of Mexico (Figure 2). The Missouri Region drainage covers about 34,600 square miles or 49 percent of the state (Bluemle, 1991).[4]

The Souris-Red-Rainy Region includes the Red River of the North basin and the Souris River basin that drains north to Hudson Bay. The Souris-Red-Rainy Region drainage covers about 27,000 square miles or about 38 percent of the state (Bluemle, 1991). The Devils Lake basin is a closed sub-basin. Currently, Devils Lake has no active outlet; however, a natural drain into the Red River of the North basin by way of the Sheyenne River would occur if the lake were to rise to an estimated elevation of 1457 feet above sea level.

The remaining 9,000 square miles (13 percent) of the state, including the Missouri Coteau section of the Great Plains province, is undrained, or noncontributing. The Continental Divide follows the Missouri Coteau from the northwestern corner of the state to the center of the state, where it deviates from the Missouri Coteau to separate the James River basin from the Red River of the North basin (Figure 2).

2.1.3.1 Surface Water Quantity

Surface water is a vital resource to North Dakota cities, industry, and agriculture. About 40 percent of the state's population relies on surface water for domestic water supplies (State Water Commission [SWC] 1993).[5] Six of the ten largest cities in the state, including Fargo, Bismarck, and Grand Forks, depend on surface water for public water supplies. In addition, surface water supplies 60 percent of the water used for irrigation and 99 percent of the water used by industry (SWC, 1993).

The Missouri River discharges the largest quantity - and the best quality - of water of all rivers in North Dakota. The Missouri River discharges at least six times more water than the Red River, the second largest river in the state. The combined annual flow of the Red River at Fargo, the Sheyenne River at Valley City, the James River at Jamestown, and Souris River at Minot is less than 4 percent of the annual flow of the Missouri River at Bismarck.

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[3] U.S. Geological Survey, 1986. North Dakota Surface Water Resources, p.361-368. In National Summary 1985 - Hydrologic Events and Surface Water Resources. USGS Water Supply Paper 2300. 506 p.

[4] Bluemle, John P., 1991. The Face of North Dakota, Revised Edition. North Dakota Geological Survey Educational Series, 21. 177 p.

[5] North Dakota SWC, 1993. North Dakota Water - A Reference Guide, North Dakota SWC, 27 p.

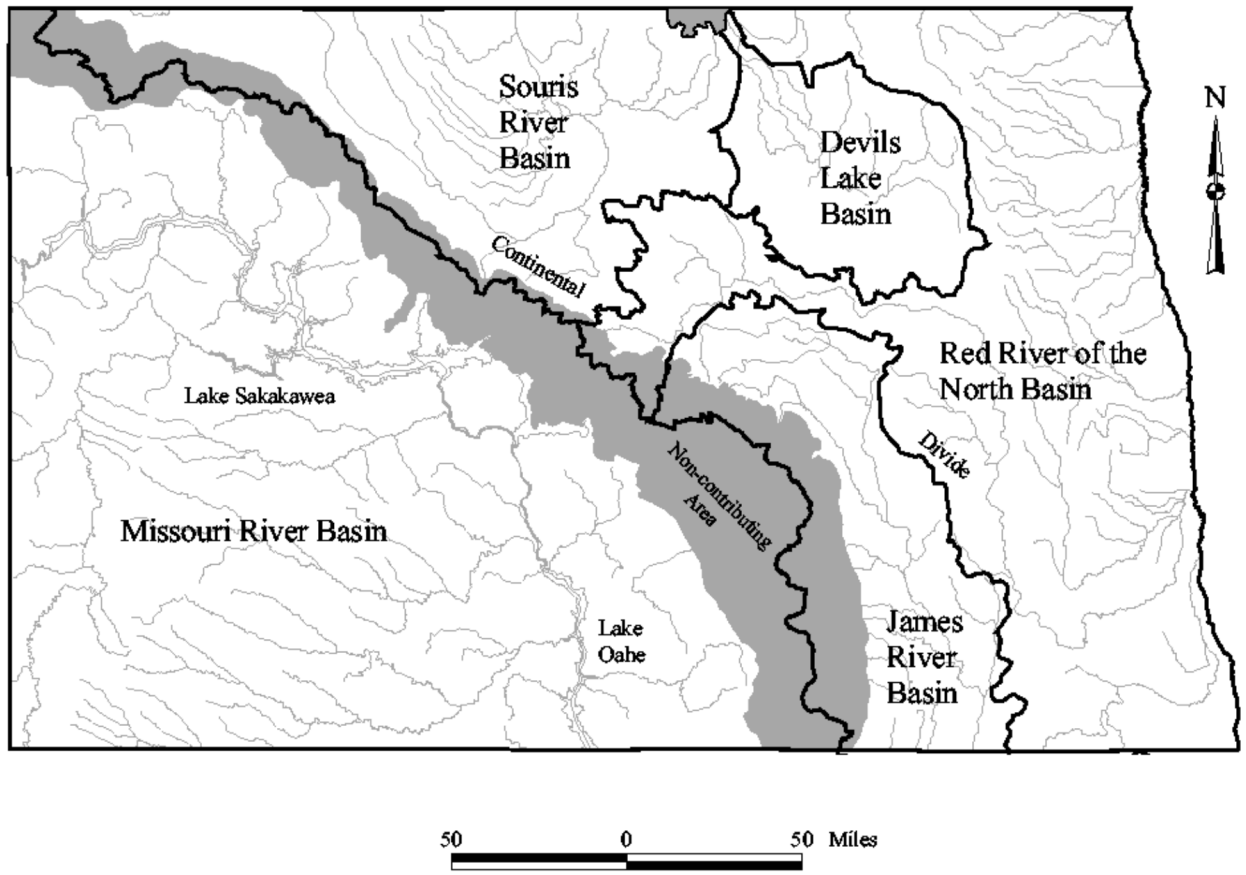

Figure 2. Drainage Basins in North Dakota

Within the state, there are 53,989 miles of rivers and streams: 11,795 in the Red River basin; 3,645 miles in the Souris River basin; 13,867 miles in the Upper Missouri (Lake Sakakawea) basin; 21,930 miles in the Lower Missouri (Lake Oahe) basin; and 2,753 miles in the James River Basin. Of the total river miles in North Dakota, 427 are shared borders with other states or Canadian provinces.

About 20 million acre feet of total normal storage is available in North Dakota reservoirs; with 97 percent of this storage within the Missouri River reservoirs of Lake Sakakawea and Lake Oahe (SWC, 1993). Table 1 presents a summary of characteristics of the five hydrologic basins and the major streams in North Dakota.

The NDDH recognizes only those lakes and reservoirs which are primarily publicly owned. Within the state, water quality assessments are ongoing for 219 lakes and reservoirs: 131 are manmade reservoirs and 88 are natural lakes. Reservoirs are defined as water bodies formed as a result of dams or dugouts constructed on natural or manmade drainages. Natural lakes are water bodies having natural lake basins; a natural lake can be enhanced with outlet control structures, diversions, or dredging. The 88 natural lakes cover

111,824 acres, with 74,500 attributed to Devils Lake. The remaining lakes average 424 acres in size, but the majority are smaller than 200 acres.

2.1.3.2 Surface Water Quality

The NDDH, as well as other state and federal agencies, have a history of evaluating the quality of North Dakota's surface water resources. This information has been utilized to characterize the potential of primary water bodies for beneficial uses such as domestic, agricultural, industrial and recreational. Each of the major lakes and streams have been classified according to their potential to meet beneficial use criteria as identified in North Dakota Administrative Code (NDAC) 33-16-02 Standards of Water Quality for State of North Dakota. The classifications for streams are defined in Table 2.

The classification of North Dakota lakes is different from the stream classification as it is based upon the type of fishery a lake may be capable of supporting. Class 1 is considered to be of the highest quality, with Class 5 lakes considered to be of the poorest quality. The Classification for North Dakota lakes as defined in NDAC 33-16-02 is presented in Table 3.

Table 1.

Summary of Characteristics for Hydrologic Basins and Major Streams in North Dakota (SWC, 1993)

	Missouri River Basin	James River Basin	Souris River Basin	Red River Basin	Devils Lake Sub-basin
Drainage Area (square miles)	33,902	6,800	9,100	17,300	3,580
Population (urban/rural)	102,000 (u) 104,000 (r)	16,000 (u) 31,000 (r)	49,000 (u) 50,000 (r)	166,000 (u) 91,000 (r)	7,700 (u) 21,800 (r)
Number of Communities	106	33	59	141	26
Normal Reservoir Storage (1,000 acre- feet)	19,500	82	250	142	16
Dominant Land Uses	46% crop 39% range	71% crop 14% range	68% crop 19% range	81% crop 5% range	78% crop 7% range
Average Discharge[1] (cubic feet/sec)	22,740 at Missouri River at Bismarck	62 at James River at Jamestown	171 at Souris River above Minot	2,500 at Red River at Grand Forks	N/A
Average Total Dissolved Solids[2] (milligrams per liter)	461 at Missouri River at Garrison Dam	650 at James River at Jamestown	950 at Souris River near Velva	485 at Red River at Emerson, Man.	N/A

[1] (U.S.G.S., 1986) [2] (U.S.G.S., 1993)

Table 2.
Definition of Stream Classifications in North Dakota

Class	Characteristics
Class I	The quality of waters in this class shall be such as to permit the propagation of life, or both, of resident fish species and other aquatic biota and shall be suitable for boating, swimming, and other water recreation. The quality shall be such that after treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the treated water shall meet the bacteriological, physical, and chemical requirements of the NDDH for municipal use. The quality of water shall be such as to permit its use for irrigation, stock watering, and wildlife use without injurious effects.
Class IA	The quality of this class of waters shall be such that its uses shall be the same as those identified for Class I, except that treatment for municipal use may also require softening to meet the chemical requirements of the NDDH. The physical and chemical criteria shall be those for Class I.
Class II	The quality of this class of water shall be such that its uses shall be the same as those identified for Class I, except that additional treatment may be required over that noted in Class IA to meet the drinking water requirements of the NDDH. Streams in this classification may be intermittent in nature which would make some of these waters of questionable value for beneficial uses, such as irrigation, municipal water supplies, or fish life.
Class III	The quality of this class of waters shall be suitable for industrial and agricultural uses, i.e., cooling, washing, irrigation, and stock watering. These streams all have low average flows, and generally, prolonged periods of no flow and are of marginal or seasonal value for immersion recreation and fish aquatic biota. The quality of the water must be maintained to protect recreation, fish, and aquatic biota. The physical and chemical criteria shall be those for class II, with the following exceptions: Sulfate (total) -maximum limit 750 mg/l (milligrams per liter).

Table 3.
Definition of Lake Classifications in North Dakota

Class	Characteristics
1	Cold water fishery. Waters capable of supporting growth of salmonoid fishes and associated aquatic biota.
2	Cool water fishery. Waters capable of supporting growth and propagation of nonsalmonoid fishes and marginal growth of salmonoid fishes and associated aquatic biota.
3	Warm water fishery. Waters capable of supporting growth and propagation of nonsalmonoid fishes and associated aquatic biota.
4	Marginal fishery. Waters capable of supporting fishery on a seasonal basis.
5	Not capable of supporting a fishery due to high salinity.

Based upon the information collected as part of the North Dakota water quality monitoring and assessment effort identified later in this section, each of the major surface water systems utilized as domestic drinking water supplies have been classified as identified in Table 4.

Table 4.
Classification of Surface Water Systems Used to Supply a Public Drinking Water System

Source Water	Standards Classification(*)
Missouri River	I
Red River	I
Sheyenne River	IA
Park River	II
Goose River	IA
Souris River	IA
Pembina River	IA
Lake Sakakawea	1**
Mt. Carmel Dam	2**

* As identified in NDAC 33-16-02 Standards of Water Quality for State of North Dakota
** Lake Classification

Prior to 1993, the NDDH conducted surface water quality monitoring through established chemical monitoring stations. Many of these stations were located immediately below point source discharges or near the confluences of major streams. Typical water quality variables analyzed were temperature, dissolved oxygen, pH, major ions, nutrients, and fecal coliform bacteria. Trace elements were also analyzed at a few select sites. At its peak in 1993, the network included 61 ambient chemical monitoring sites on 31 rivers and streams.

This monitoring strategy was ineffective in assessing trends in water quality across the state, nor did it provide the spacial resolution necessary to conduct beneficial use assessments for a significant portion of the river and stream miles in the state. The data was only indirectly related to beneficial use impairment. In 1993, the NDDH changed emphasis to biological monitoring in watersheds, and it started with the Red River basin. This was implemented by reducing the number of chemical monitoring sites from 61 to 27 in 1994. Where practical, sites were co-located with USGS flow gauging stations, thereby facilitating the analysis of chemical data with stream hydrologic data. All 27 sites are located as basin or sub-basin integrator sites, where the chemical data reflects water quality from a watershed. The program was expanded into the James River basin in 1995 and the Souris River basin in 1997. It will extend to the Upper Missouri and Lower Missouri basins in 1998/99.

In addition, the USGS also operates and maintains several water quality monitoring sites which provide data used by the NDDH for assessment of beneficial use impairment. The NDDH also cooperates with Clean Lakes projects; many of these projects conduct intensive water quality and biological assessments.

Through 1995, 11,928 miles of rivers and streams had been evaluated for four forms of beneficial use impairment: industrial or agricultural use, aquatic life use, recreational use, and drinking water use. A river or stream mile can support one or more beneficial uses. In descending impact, the primary causes of beneficial use impairment are nutrient loading (phosphorous and nitrogen as ammonia), siltation (total suspended solids), habitat degradation, pathogens (fecal coliform bacteria), organic enrichment (low dissolved oxygen), flow alteration, mercury, metals, and salinity/total dissolved solids (TDS). The primary sources of beneficial use impairment are confined animal feedlots, riparian grazing, non-irrigated crop production, drainage/filling of wetlands, pasture land, upstream impoundments, urban runoff/storm sewers, and flow modification.

Approximately 10 percent, or 5,320 miles, of the rivers and streams in the state are classified for use as drinking water.[6] Only 687 miles have been assessed, and only 34 miles (5 percent) were assessed as partially supporting use for a drinking water supply. The primary causes of this impairment are taste and odors. Sources have not been specifically identified, but causes are likely linked to agricultural field runoff, wetland drainage, and industrial and/or municipal discharges.

2.1.4 Ground Water Resources

Ground water is one of North Dakota's most valuable resources. Sixty percent of the state's population relies on ground water for domestic water supplies. Ninety-four percent of the state's 365 incorporated communities rely on ground water, either from municipal systems, rural water systems, or private wells (SWC, 1993). In addition, ground water is essentially the only source of water supply for farm families and their livestock, and residents of small communities that are not served by public water systems. In recent years, the emphasis on value-added agriculture has resulted in increased demand for ground water used for irrigation. Figure 3 depicts the major uses of ground water in North Dakota.

Ground water resources in North Dakota occur in two principal aquifer types: (1) unconsolidated glacial deposits and (2) sedimentary bedrock. The bedrock geology of North Dakota is dominated by the Williston Basin, a sedimentary basin centered southeast of Williston, North Dakota, where its maximum depth is approximately 15,000 feet deep.

There are four major bedrock aquifer units within the Williston Basin. Water quality varies considerably within the aquifer units, with the deeper units generally considered highly saline and the shallower units exhibiting saline to brackish to moderately low TDS.

The best quality water in the bedrock aquifer units almost always occurs in the shallowest unit at any given location. In some near-surface bedrock aquifers in southwestern North Dakota, TDS may occasionally be as low as 1000 mg/L.

[6] Class I and Class II waters per NDAC, Article 33-16.

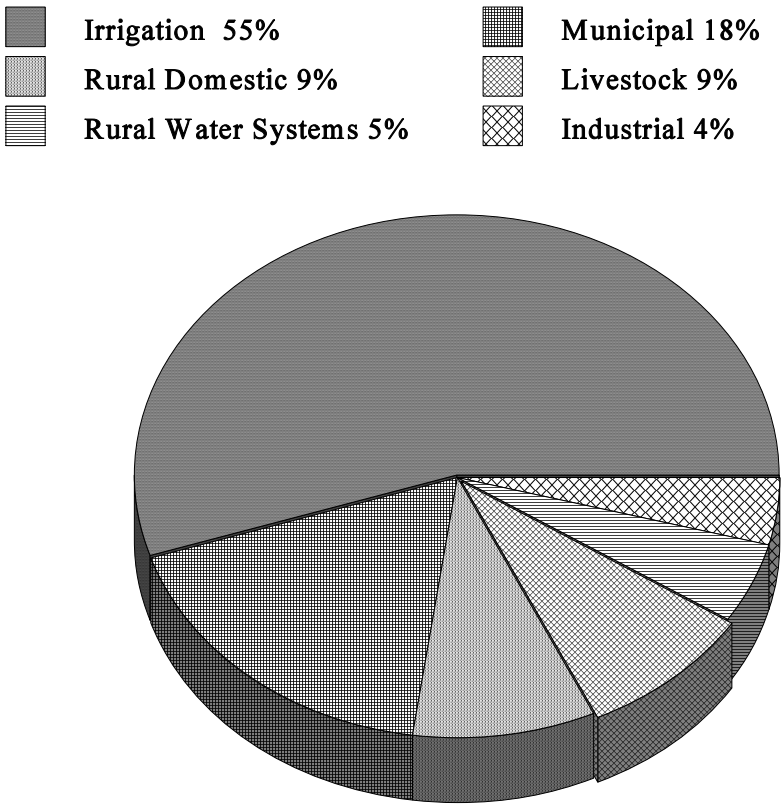

Figure 3. Ground Water Use in North Dakota (SWC 1993)

The majority of high quality ground water (less than 2000 mg/L TDS) in North Dakota is contained within glacial drift aquifers (Figure 4). These aquifers are generally composed of sand and/or gravel deposited by glacial activity. Most of the glacial drift aquifers are located at or near the surface, though some are buried by till deposits from subsequent glacial advances.

Ground water quality in the glacial drift aquifers generally ranges from as low as 200 mg/L TDS to several thousand mg/L TDS. Some areas that discharge ground water mainly through evapotranspiration processes may have TDS in excess of 10,000 mg/L.

The ground water resources of North Dakota have been extensively studied and catalogued. Every county in the state has had a geology and ground water resource study completed through a cooperative effort by the USGS, the North Dakota Geological Survey and the North Dakota SWC. [7] [8] More than 15,000 geological test holes were drilled through the state for

[7] County Ground Water Studies, (Adams through Williams Counties), North Dakota SWC

[8] County Geological Studies, (Adams through Williams Counties), North Dakota Geological Survey

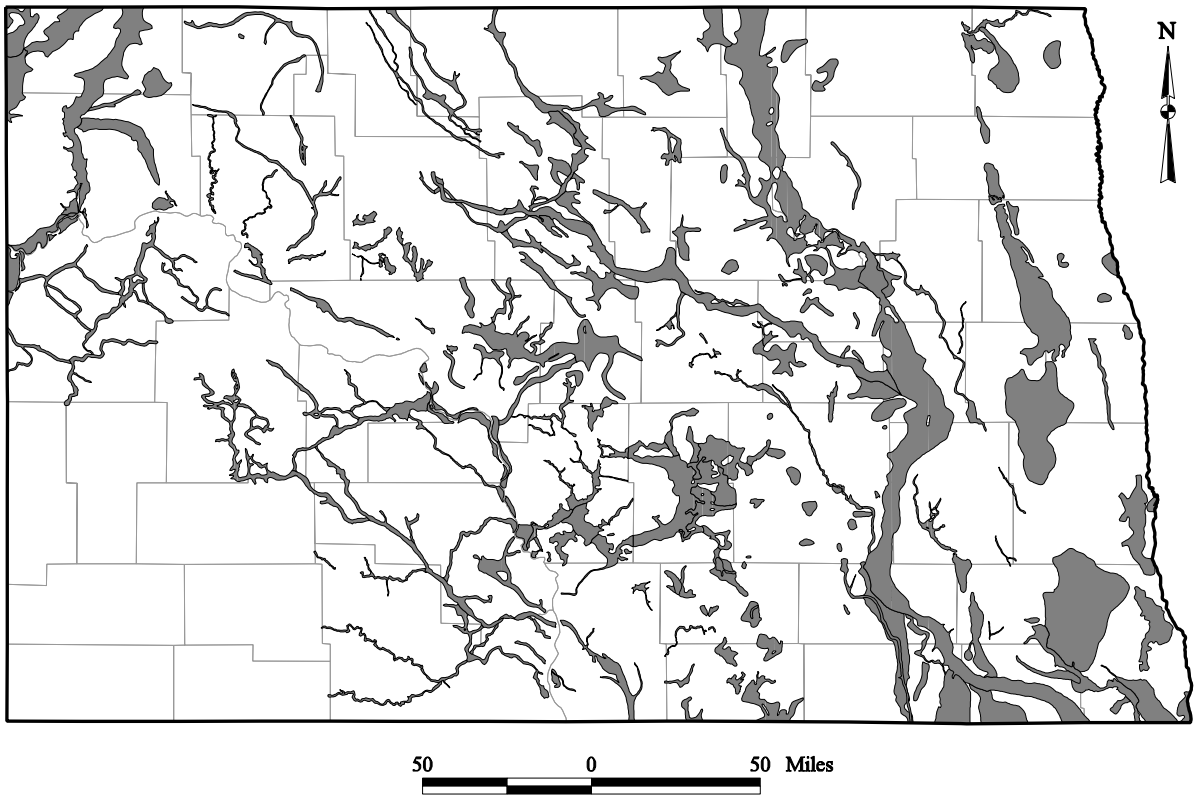

Figure 4. Major Glacial Drift Aquifers in North Dakota

these studies, with almost 6,000 completed as observation wells. Several state and federal agencies continue to characterize and survey the quality and quantity of North Dakota's water resources.

In 1991, the NDDH developed an aquifer sensitivity prioritization system designed to assist in identifying areas in the state where ground water resources are potentially more susceptible to contamination. This approach to prioritizing aquifers is identified as the Geographic Targeting System (GTS).[9] [10] The GTS method combines, by addition, rating factors representing aquifer vulnerability, sensitivity, and risk.

Aquifer vulnerability is determined using the DRASTIC model, developed by the EPA to be a standardized system for evaluating ground water pollution potential. The DRASTIC model incorporates consideration for several aquifer characteristics which include the depth to water,

[9] North Dakota Geographic Targeting System for Ground Water Monitoring, Scott Radig, February 1997.

[10] Funding for development and implementation of GTS and aquifer monitoring investigations has been provided through the Rangeland Environmental Protection Fund, which was authorized by the State Legislature in 1991.

net recharge, aquifer media, soil media, topography, impact of the vadose zone, and hydraulic conductivity. Sensitivity primarily relates to the usage of agricultural chemicals and fertilizers. The market value of agricultural production per acre, for both crops and livestock, was used as a beneficial use of the water or amount of harm which may result from aquifer contamination. The total volume of ground water permitted for withdrawal from an aquifer for domestic irrigation and industrial use was identified to represent the aquifer's potential risk.

The outcome is a numeric score which ranges from a low priority rating of 3 to a high priority rating of 9. This systematic approach has been used to prioritize monitoring activities associated with the NDDH Ambient Ground Water Monitoring Program. The overall aquifer sensitivity ratings are reviewed once every five years and amended as needed to reflect changes in water and land use, as well as from results of water quality monitoring activities. Figure 5 identifies a GTS map rating of each of the glacial drift aquifers in the state of North Dakota. A complete listing of each GTS aquifer rating is provided in Appendix D.

Starting in 1992, the NDDH initiated routine monitoring of the 50 most susceptible aquifers as identified by the GTS. Approximately 10 aquifers a year are monitored for general anion/cation chemistry and agricultural chemicals. The analytes of concern have been general anions and cations, total nitrate plus nitrite (N), 32 base-neutral pesticides, 10 chlorinated pesticides, and eight carbamate pesticides. The three pesticide groups include all parameters identified in the SDWA Phase II/V sampling requirements. Criteria used for sample site selection in each of the aquifers includes: 1) location and construction of wells, 2) one well sampled per section, and 3) accessibility. Private and public wells, in addition to monitoring wells constructed by the SWC and the USGS, are included. Each year the quantitative results are presented in a report identifying the analytical detection of pesticide compounds, discussing general water quality, and suggesting possible sources of contamination. The findings of these investigations are summarized in Table 5.

2.2 Public Water Supply System Definition and Status

A PWS is defined as a system that provides water via piping or other constructed conveyance for human consumption to at least 15 service connections or serves at least 25 people for at least 60 days each year. Acknowledging the fact that not all PWSs are operated for the same objective or require the same level of regulatory oversight, EPA has divided PWSs into two primary categories. These are:

- **Community water supply systems** are defined as a PWS that pipe water for human consumption to at least 15 service connections used by year-round residents, or that regularly serves at least 25 year round residents (e.g., municipality, subdivision, mobile home park).

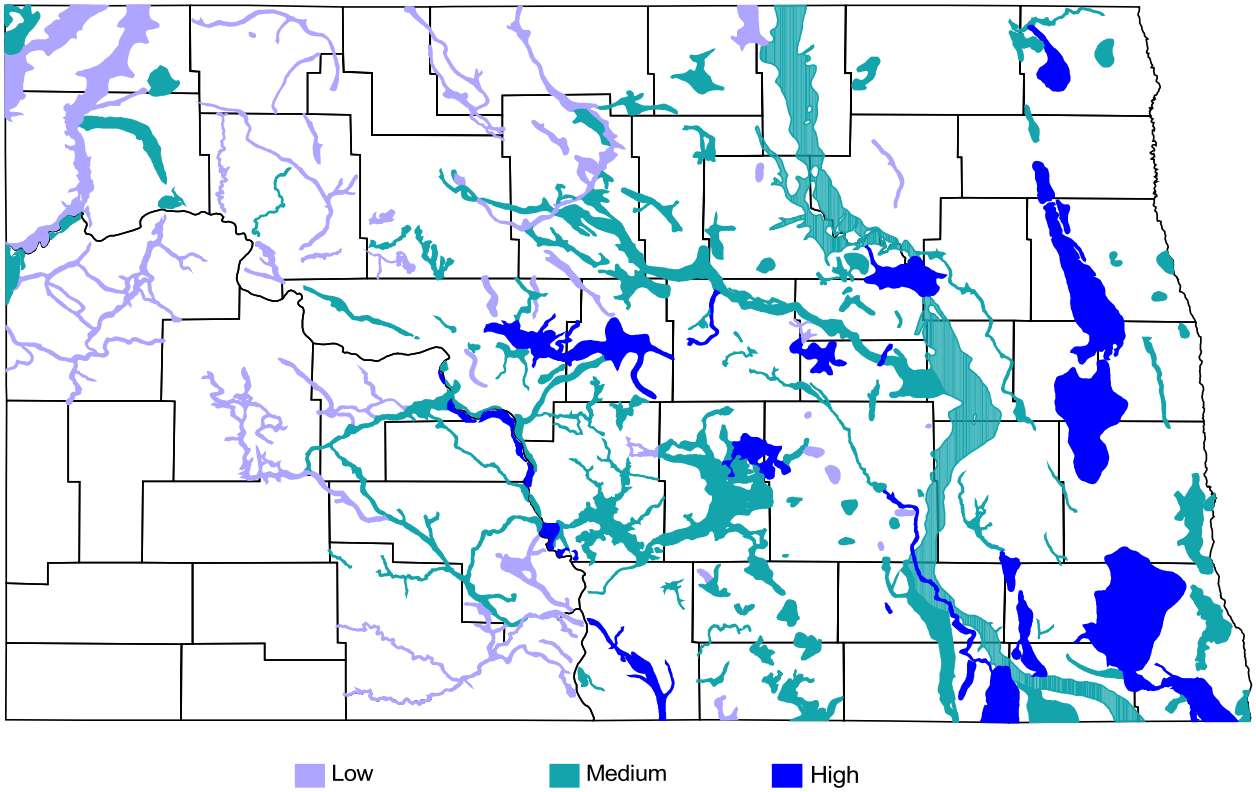

Figure 5. Total Monitoring Priority Scores for Major Glacial Drift Aquifers in North Dakota

➤ **Noncommunity water supply systems** are defined as a PWSs that pipe water for human consumption to at least 15 service connections used by individuals other than year-round residents for at least 60 days a year, or that serve 25 or more people at least 60 days a year (e.g., schools, factories, rest areas). Noncommunity water supply systems are further categorized:

Nontransient noncommunity water systems are defined as systems that serve at least 25 of the same people over six months per year (e.g., schools, factories, industrial parks, office buildings).

Transient noncommunity water systems are defined as systems that do not meet the definition of nontransient noncommunity water system (e.g., highway rest stops, restaurants, motels, golf courses, parks).

Table 5
Ambient Ground Water Quality Monitoring Results in North Dakota

Study Region	# of Wells	Analytes Detected	%Positive Detects	Reference/Year
Oakes, Warwick, Icelandic aquifers	137	Nitrate => 10 mg/l - 8 Picloram - 1	6 % 0.07	Radig & Bartelson, 1992
Elk Valley, Inkster, Fordville, Shell Valley, Lake Souris, Denbigh aquifers	117	Nitrate => 10 mg/l - 4 Picloram - 6 Trifluralin - 1	3 % 6 %	Radig & Bartelson, 1993
Sheyenne Delta, Galesburg/Page, Sand Prairie, Milnor Channel, Hankinson, Marstonmoor Plain	149	Nitrate => 10 mg/l - 4 Picloram - 12 Bentazon -1 Atrazine - 2	2.7 % 10 %	Radig & Bartelson, 1994
Carrington, Englevale, Edgeley, LaMoure, Guelph, Juanita Lake, Lake Nettie, Manfred, Missouri River, Painted Woods Lake, Glenview , Wagonsport, Burnt Creek, Bismarck, Strasburg	186	Nitrate => 10 mg/l - 9 Picloram - 4 Bentazon - 2	5 % 3 %	Radig & Bartelson, 1995
Pembina River, Pleasant Lake, Esmond, Tokio, Kilgore, Heimdal, James River, Pipestem Creek, Tappen, Horseshoe Valley, Lower Apple Creek, Trenton, Yellowstone-Missouri, Seven Mile Coulee, Stoney Slough	163	Nitrate => 10 mg/l - 12 Picloram - 1 Atrazine - 1 Aldicarb-sulfoxide - 1	7 % 2 %	Bartelson & Gunnerson, 1996
Oakes, Warwick, Icelandic, Spring Creek, Streeter aquifers	179	Nitrate => 10 mg/l - 13 Picloram - 2 Endrin - 1	7 % 2 %	Bartelson & Gunnerson, 1997

Across North Dakota, there are 318 community PWSs, 34 nontransient noncommunity PWSs and 252 transient noncommunity PWSs. A complete list of these systems currently regulated in the state can be found in Appendix B and C.

2.2.1 Surface Public Water Supply Systems

Thirty PWSs pump source water from defined surface water resources throughout North Dakota. Twenty are community water systems; nine serve communities larger than 3,300 in population. Ten noncommunity PWSs utilizing surface water include eight nontransient water systems and two transient water systems. Table 6 identifies the PWSs in North Dakota which utilize surface water to supply all or a portion of their drinking water needs.

Table 6
Public Water Systems
Drawing Source Water from Surface Waters

PWS Name	PWS City	Population	Source	PWS Type
Antelope Valley Station	Beulah	207	Lake Sakakawea	NT/NC
Bismarck, City of	Bismarck	49,256	Missouri River	Community
Coal Creek Station	Underwood	486	Missouri River	NT/NC
Coyote Station	Beulah	227	Missouri River	NT/NC
Dakota Gasification Co	Beulah	700	Lake Sakakawea	NT/NC
Dickinson, City of	Dickinson	16,097	Lake Sakakawea	Community
Downstream Campground	Riverdale	280	Lake Sakakawea	T/NC
Drayton, City of	Drayton	961	Red River	Community
Fargo, City of	Fargo	74,111	Sheyenne River	Community
Fargo, City of	Fargo	74,111	Red River	Community
Garrison, City of	Garrison	1,530	Lake Sakakawea	Community
Garrison Power Plant	Riverdale	26	Lake Sakakawea	NT/NC
Grafton, City of	Grafton	5,086	Park River	Community
Grafton, City of	Grafton	5,086	Red River	Community
Grand Forks, City of	Grand Forks	49,425	Red River	Community
Grand Forks, City of	Grand Forks	49,425	Red Lake River	Community
Lake Sakakawea State Park	Pick City	300	Lake Sakakawea	T/NC
Langdon, City of	Langdon	2,241	Mulberry Creek Res. 2nd Line	Community
Langdon, City of	Langdon	2,241	Mulberry Creek Res. 1st Line	Community
Langdon, City of	Langdon	2,241	Mt. Carmel Dam	Community

Table 6 (Continued)

PWS Name	PWS City	Population	Source	PWS Type
Leland Olds Station	Stanton	50	Missouri River	NT NC
Mandan, City of	Mandan	15,177	Missouri River	Community
Mayville, City of	Mayville	2,092	Goose River	Community
Minot, City of	Minot	34,544	Souris River	Community
Park River, City of	Park River	1,725	Homme Dam (Park River)	Community
Parshall, City of	Parshall	943	Lake Sakakawea	Community
Pembina, City of	Pembina	642	Red River	Community
Pick City, City of	Pick City	203	Lake Sakakawea	Community
Progold, Inc.	Wahpeton	65	Red River	NT NC
Riverdale, City of	Riverdale	283	Lake Sakakawea	Community
United Power Association	Stanton	75	Missouri River	NT NC
Valley City, City of	Valley City	7,163	Sheyenne River	Community
Washburn, City of	Washburn	1,506	Missouri River	Community
Williston, City of	Williston	13,131	Missouri River	Community

T = Transient NT = Nontransient NC = Noncommunity

All of the 30 PWSs identified in Table 6 are in compliance with the requirements of the SDWA including the Surface Water Treatment Rule (SWTR) promulgated by the EPA.

The SWTR became effective on December 31, 1990. Under this rule, filtration and disinfection for surface water and ground water systems under the direct influence (UDI) of surface water is required. One of the objectives of the SWTR is to provide water free from certain microbiological organisms for which no enforceable Maximum Contaminant Level (MCL) standards have been established. Systems may avoid this requirement provided specific source water quality and system operation criteria are met. These include compliance with established microbiological and turbidity criteria in the raw water source prior to any treatment. The water system must also operate in a way to minimize consumer risk from microbiological contamination. This can be accomplished by:

- The establishment and maintenance of a watershed control program;
- Having no more than two monthly total coliform MCL violations in any consecutive two month period;
- Not exhibiting a history of waterborne disease outbreaks; and
- Being in compliance with total trihalomethane requirements for systems serving 10,000 or more people.

Systems which filter source water must ensure that filtration and disinfection are effective as demonstrated by turbidity and disinfection criteria. As with unfiltered systems, effectiveness is demonstrated in part by the amount of disinfectant and the length of time it is in contact with the water before reaching the first customer.

2.2.2 Ground Water Public Water Supply Systems

North Dakota currently regulates 495 ground water PWSs throughout the state. Of these 495 systems, 255 are community PWSs and 240 are noncommunity PWSs. Appendix C provides a complete list of the community and noncommunity PWSs including the name, location, population served, source of water, and type of PWS.

2.2.3 PWS Compliance Status

The EPA has established enforceable MCLs for specific inorganic, organic, and microbial contaminants in drinking water. The SDWA requires each PWS to routinely monitor the quality of the drinking water in distribution systems for compliance with each of the established MCLs. The compliance status of PWSs with the SDWA for year 1997 is shown in Table 7.

Table 7
PWS SDWA Compliance Status (1997)

Parameter/PWS Classification	Total Number of PWSs	Percentage of Systems in Compliance
Primary Inorganic		
Community	318	98.1
NTN Community	34	100
TN Community	252	98.8
Regulated Organics		
Community	318	99.7
NTN Community	34	100
TN Community	N/A	N/A
Coliform Rule		
Community	318	92.1
NTN Community	34	94.1
TN Community	252	95.2

NTN = Nontransient non TN = Transient non

PWSs have historically achieved exceptional compliance with the SDWA MCL standards. This is attributed, in part, to effective operator training, routine sanitary surveys/ inspections, and an effective point source regulatory program. Of the systems that exhibited MCL

violations, one system had one exceedance of the benzene MCL, five systems had one exceedance of the fluoride MCL, and three systems had one violation of the total nitrate plus nitrite MCL. Finally, eight systems had a total of ten exceedances of the coliform MCL for the year 1997.

2.3 Contaminant Source Overview

The degradation of waters of the state can result from a variety of sources involving both natural processes and manmade activities. Because natural impacts to water quality are usually widespread and occur over long periods of time, cost-effective remedies are usually limited. However, when land use activities accelerate the natural degradation rate, overwhelm natural attenuation processes, or introduce contaminants not native to the environment resulting in adverse impacts, these sources are considered to be contaminants of concern. North Dakota citizens, through the enactment of legislation, have mandated that contaminants of concern be regulated for the protection of public health and the environment, and to safeguard social, economical, and industrial development associated with the water resource.[11] [12] The sources of water contamination in North Dakota are associated with domestic, municipal, agricultural, surface mining, oil and gas extraction, and industrial sectors within the state, as well as naturally occurring nonpoint surface soil erosion and atmospheric deposition of chemical contaminants.

Through years of regulatory attention and environmental water quality monitoring, the NDDH has developed a list of activities that, if conducted improperly, can result in adverse impacts on the beneficial uses of the state's water resources. Table 8 identifies the major water quality contaminant sources and parameters of concern for surface and ground water resources as identified in the 1996-1997 North Dakota Water Quality Assessment Report[13] and from ambient surface/ground water monitoring activities. It is important to note that this list does not include all contaminant sources occurring in North Dakota.

Sections 2.3.1 through 2.3.6 provide additional insight as to the magnitude of the issues for some of the contaminants of concern in North Dakota.

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[11] NDCC 61-28 Control, Prevention and Abatement of Pollution of Surface Waters.

[12] NDAC 33-16-02 Standards of Water Quality for the State of North Dakota.

[13] North Dakota Water Quality Assessment 1996-1997, The 1998 Section 305(b) Report to Congress of the United States, NDDH, Bismarck, ND.

Table 8
Major Sources of Water Quality Contamination in North Dakota

Contaminant Source	Factors Considered in Selecting a Contaminant Source	Typical Contaminants
Agricultural Chemical Facilities	-Human Health and Environmental Risk (Toxicity) -Number and/or Size of Contaminant Sources -Geographic Distribution/Occurrence	Pesticides Nitrates Ammonia
Animal Feedlots	-Human Health and/or Environmental Risk (Toxicity) -Number and/or Size of Contaminant Sources -Geographic Distribution/Occurrence	Nitrate /Ammonia Sulfate Bacteria Chloride Phosphorous
On Farm Agricultural Mixing and Loading Procedures.	-Human Health and/or Environmental Risk (Toxicity) -State Findings	Pesticides Nitrate
Storage Tanks (Above Ground)	-Human Health and/or Environmental Risk (Toxicity) -Location of Sources Relative to Drinking Water Sources -Number and Size of Contaminant Sources -Documented from Mandatory Reporting	Petroleum Compounds Salinity/Brine Nitrate/Ammonia
Storage Tanks (Below Ground)	-Human Health and/or Environmental Risk (Toxicity) -Location of Sources Relative to Drinking Water Sources -Number and Size of Contaminant Sources -Documented from Mandatory Reporting	Petroleum Compounds Halogenated Solvents
Surface Impoundments	-Number and Size of Contaminant Sources	Nitrate Sulfate Total Dissolved Solids Chloride Nutrient Loading
Large Industrial Facilities	-Human Health and/or Environmental Risk (Toxicity)	Petroleum Compounds Nitrate Sulfate Total Dissolved Solids Chloride
Accidental Spills	-Human Health and/or Environmental Risk (Toxicity) -Documented from Mandatory Reporting -Geographic Distribution/Occurrence	Pesticides Petroleum Compounds Nitrate Salinity/Brine
Urban Runoff/Storm Sewers	-Human Health and/or Environmental Risk (Toxicity) -Geographic Distribution/Occurrence	Petroleum Compounds Metals/Mercury Total Dissolved Solids Salinity
Agricultural Field Runoff	-Human Health and/or Environmental Risk (Toxicity) -Geographic Distribution/Occurrence	Total Dissolved Solids Nutrient Loading: (Phosphorous/Nitrogen/ Ammonia)
Industrial/Municipal Discharges	-Human Health and/or Environmental Risk (Toxicity) -Geographic Distribution/Occurrence -Documented from Mandatory Reporting	Nutrient Loading: (Phosphorous/Nitrogen/ Ammonia) Bacteria

2.3.1 Industrial/Municipal Wastewater Discharges

Across North Dakota, wastewater impoundments are the most widely accepted and used method of wastewater storage and treatment. The reasons for their use are related to their low cost of operation and maintenance, and the availability of land. Operators, who receive permission to discharge wastewater from lagoon treatment facilities, are required by state law to monitor and report the quality and quantity of any discharges. The general quality of wastewater is commonly indicated by 5-day biochemical oxygen demand (BOD-5) and total suspended solids (TSS) analytical results. Typically, high concentrations of BOD-5 and TSS indicate poor treatment performance. The mean annual concentrations of BOD-5 and TSS in discharges from 1981 through 1995 have trended to lower concentrations, except during 1993 and 1994. During 1993 and 1994, abnormally higher precipitation than the annual average has been identified as the reason for the increase.

Municipal wastewater lagoons receive domestic sewer wastes, as well as commercial and industrial discharges. The NDDH has inventoried 312 sites where such lagoons are in operation. Of the 364 incorporated communities across the state, 295 of them operate one or more wastewater lagoons. Lagoons are also used by mobile trailer courts, campgrounds and parks, a country club, two hospitals, non-incorporated communities, and two air force bases.

Toxic pollutants in wastewater discharges are controlled by the industrial pretreatment program administered in North Dakota by the EPA - Region VIII. This program regulates individual industries using municipal sewer systems. Whole effluent toxicity (WET) testing of treated wastewater discharged from all major permittees, including industries, is required.

Several cities and industries have selected nontraditional biological treatment methods to improve the quality of their wastewater discharges. Examples of these systems are: (1) a unit at the Amoco Refinery near Mandan for organic removal; (2) the city of Devils Lake's "lemna" system for nutrient removal; (3) the city of Minot's artificial wetland; and (4) the American Crystal Sugar's artificial wetlands near Hillsboro and near Drayton for ammonia removal. These systems allow continuous discharging while achieving quality effluent well below permit limits.

2.3.2 Underground Storage Tanks (USTs)

Underground storage tanks (USTs) are commonly used for storage and dispensing of motor fuels. The NDDH has maintained an inventory of active underground tanks since 1989. The inventory is limited to regulated tanks, which are defined as those having a capacity of greater than 1,100 gallons. The number of underground tanks has declined over the years from a high of 8,573 tanks to a current level of 3,086 tanks at 891 active fueling sites.

Releases of petroleum products associated with the operation of USTs can result in significant contamination of ground water resources, some of which can go undetected for

many years. Adverse impacts include required abandonment of wells and the development of explosive atmospheres in buildings and underground piping.

As of 1997, the NDDH had confirmed releases of petroleum products at 510 sites. Remedial action activities had been completed at 372 sites. To assist in addressing contamination associated with USTs, the North Dakota Insurance Department administers the Petroleum Release Compensation Fund, which reimburses owners of registered tanks for costs associated with remedial measures taken at sites of leaking tanks.[14] Remedial actions at ten sites were elevated to federal Leaking Underground Storage Tank (LUST) Trust Fund projects, although the fund was used to finance preliminary investigations of contamination at 29 sites.

2.3.3 Pesticide Usage

The state's 45,249,000 acres of land surface are primarily used as rangeland, tilled crop land, federal parks, or set-aside lands under federal and private conservation programs. Herbicides, insecticides, and fungicides were applied one or more times in the treatment of 19,527,400 acres - or about 43 percent of the state - during 1992.[15] [16] Furthermore, approximately 24 percent of total tilled agricultural land was planted with treated seed.

The North Dakota Department of Agriculture is responsible for registering of pesticides and ensuring proper application of pesticides through education, applicator certification, and enforcement. In addition, the Department of Agriculture has operated Project Safe Send since 1991. Project Safe Send, a state program supported by pesticide registration fees, collects and disposes of unusable or unwanted pesticides throughout North Dakota. The project has collected about 280,000 pounds of pesticides since inception, and another collection occurred in 1998.

In response to federal concerns over pesticide use and application, the North Dakota Department of Agriculture has prepared the State Management Plan, which is a water quality protection strategy for pesticide applications.[17] The State Management Plan identifies the roles of various federal and state agencies in protection of the state's water resources. It also establishes a Contaminant Response Task Group, and describes the group's role in implementing voluntary and nonvoluntary remedial actions when contamination is identified.

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[14] NDCC Chapter 45-10.

[15] Pesticide Use and Pest Management Practices for Major Crops in North Dakota - 1992, Published by the NDSU Extension Service, Extension Report No. 15.

[16] Statewide surveys are conducted every five years, and the findings for 1997 are not yet completed.

[17] North Dakota Water Protection Strategy for Pesticides: Generic State Management Plan, 1998, Pesticide Division, ND Department of Agriculture.

To complement the State Management Plan, the NDDH implements the Ambient Ground Water Quality Monitoring Program. The state-funded program was initiated to determine the occurrence and concentration of pesticides in ground water resources. Annual reports identify monitoring activities in aquifers considered to be most susceptible to contamination. A synopsis of the annual reports completed since 1992 can be found in Table 5.

2.3.4 Fertilizer Storage and Application

Natural or commercial fertilizer, when managed properly, is a valuable tool used to increase crop yields for the producer. However, when mismanaged, fertilizer compounds can adversely impact the quality of both surface and ground water resources. Increased eutrophication of lakes or excessive ammonia/nitrate concentrations in ground water can occur in areas of improper application or handling of fertilizer.

At the present time, approximately 460 fertilizer distribution or storage facilities are licensed in the state. These facilities range in size from retail department store outlets to the larger bulk dealerships. Fertilizer compounds include granular, liquid, and anhydrous ammonia compounds, used in a variety of applications. To date, approximately 40 different water quality contaminant assessment and remedial action activities have been initiated to address improper disposal, storage, or handling of fertilizer compounds. These remedial or cleanup activities range from removal of contaminated soil to the treatment of contaminated ground water. Documented cases of nitrate and ammonia contamination from fertilizers have identified water quality impacts which exceed EPA MCLs or Health Advisories.

2.3.5 Livestock Operations

Pursuant to NDAC 33-16-02, the NDDH requires that all confined animal feeding operations, with 200 animal units or more, apply for and receive approval to operate. Requirements for appropriate waste storage and handling practices, coupled with compliance monitoring to minimize impacts to water and air quality, are addressed by the NDDH. Since 1973, over 1,000 livestock operations have received approval to operate in North Dakota. As of January 1998, 417 operations were verified as active. Most of the livestock operations are cattle wintering operations, hog operations, and dairy operations, that are part of a larger farming unit. During the last few years, there has been an increase in large, confined, animal feeding operations for turkeys, hogs, and dairy cattle. To address the increase in larger operations, the NDDH review process addresses potential environmental impacts from wastes generated by these large operations. The review process helps to ensure that operators are responsible for proper facility construction, operation, and waste handling to minimize adverse water and air quality impacts. In some cases, the NDDH has required ground water monitoring and the development of spill contingency and nutrient management plans.

Finally, the NDDH works with county commissions, local zoning boards, livestock producers, and concerned citizens to assist them in recognizing sensitive areas where livestock operations may impact waters of the state.

2.3.6 Accidental Contaminant Release and Emergency Response

The accidental release of compounds into the environment from operator error or equipment failure has the potential to cause severe and lasting impacts to water quality. Accidental releases from any public or private sector activity can contain both hazardous and nonhazardous compounds. The resulting environmental impact from a released compound depends upon the type and quantity of the compound released, natural protection (e.g., site-specific geology, depth to ground water, etc.), proximity to receptors, and the time required to initiate a reasonable response or cleanup action.

To minimize the adverse environmental impacts of an accidental release, North Dakota has established a contaminant release reporting requirement and an Emergency Response Program. As part of the state statutory requirement identified in NDAC 33-16-02, Standards of Water Quality for the State of North Dakota, " ... any spill or discharge of waste which causes or is likely to cause pollution of waters of the state must be reported immediately." The spill must be reported to the NDDH or the North Dakota Hazardous Materials Emergency Management Center which is accessible 24 hours a day. The Emergency Management Center ensures immediate response action in cases of potential life-threatening or severe environmental impacts. They facilitate and mobilize the necessary local, state, and federal agencies immediately after notification of a spill, resulting in immediate and appropriate prevention/cleanup action.

2.4 Pollution Prevention and Environmental Protection Programs

Over the years the state of North Dakota has developed comprehensive environmental protection programs designed to address state-specific concerns and/or comply with federal mandates. The state and federal laws and regulations address a wide variety of point[18] and nonpoint source (NPS)[19] contaminant sources. The primary aim of each program is to promote North Dakota's antidegradation[20] and beneficial use[21] policies as they relate to the water resources of the state. This is accomplished through the implementation of rules which establish minimum design/operation standards, prohibition of specific activities,

[18] Point source pollution is defined as pollution that can be traced to a specific, known source, such as a sewer pipe, ditch, or industry.

[19] NPS pollution is defined as pollution that cannot be traced to a specific point of origin. Runoff from agricultural land may be an example of NPS pollution.

[20] Antidegradation Policy is defined in NDCC 61-28-01, Statement of Policy.

[21] Beneficial Use is defined in several state law and rules, but is primarily the use of water for a purpose consistent with the best interests of the people of the state. It identifies both present and potential uses in accordance with economic and social development of an area. Best uses for agricultural, industrial, municipal (domestic) and recreation and wildlife are considered part of the definition.

inspection/reporting, environmental impact monitoring, and appropriate penalties for noncompliance. The regulations have been developed with full public participation as required by state law. Table 9 lists the activities or sources known to impact water quality and also identifies the state law, rules, and the primary governing agency which has the responsibility to implement the appropriate protection or pollution prevention program(s).

Because the state agencies identified in Table 9 have established the fiscal and technical capacity to operate several federally mandated programs, they have been granted federal primacy to implement these programs. Primacy programs include the SDWA; the Resource Conservation and Recovery Act; the Clean Water Act; and the Federal Insecticide, Fungicide, and Rodenticide Act. The NDDH also works closely with EPA in the implementation of the Comprehensive Environmental Response, Compensation, and Liability Act (commonly called Superfund) and the Toxic Substance Control Act. Primacy is granted to states which have demonstrated that their laws can achieve equivalent or better environmental protection than the federal laws. Primacy also establishes a state's capacity to administer and implement the laws.

Table 9 is a comprehensive listing of the water quality protection programs and regulations in North Dakota.

2.4.1 Existing Water Quality Assessment and Protection Programs

The following is a discussion of several programs which help to assess contaminant potential or provide protection of the state's water resources. These programs are considered integral components of the North Dakota SWAP.

The NDDH administers NDAC, Article 33-16, State Water Quality Standards, for the waters of the state. Beneficial use, water body classifications, as well as narrative and numeric standards are defined to preserve the state's water resources.

Numeric criteria are provided for chemical, biological, and physical parameters. Many of these parameters are naturally occurring in surface waters. When concentrations for a parameter become elevated so as to impair a beneficial use, the parameter is defined as a pollutant.

Surface waters are classified into five categories; Class I, IA, II, III, and IV. The assignment of a water body to a classification is based on the quality of record hydrology, and natural factors. Refer to section 2.1.3.2 of this document for an additional description of the classification levels.

Table 9
Summary of North Dakota Water Quality Protection Laws, Rules and Programs

Sources of Water Quality Contamination	Statutes Governing Sources of Contamination (NDCC)	Rules Established Under Statute (NDAC)	Governing Agency	Brief Description of Regulatory Authority and Guidelines
1. Waste Impoundments a. Industrial b. Municipal	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Water	Chapter 33-16-01 North Dakota Pollutant Discharge Elimination System	WQ	The statute requires plans and specifications for all industrial and municipal impoundments be submitted to the NDDH for approval. The rules establish water quality standards for surface discharges and construction design standards to reduce ground water quality impacts.
c. Livestock		Chapter 33-16-03 Control of Pollution from Livestock Enterprises	WQ	The rules require livestock operations of 200 animal units or more to be permitted by the NDDH. Permit requirements may include compliance with design standards to address impoundment and waste handling as well as ground water quality monitoring.
d. Hazardous Waste	Chapter 23-20.3 Hazardous Waste Management	Article 33-24 Hazardous Waste Management	WM	Section 33-24-05 (115-121) Surface impoundments requirements set standards for design, operation, monitoring, and inspection of hazardous waste impoundments.
2. Solid Waste Disposal a. Sanitary Landfills b. Special Use Landfills 1. Fly Ash 2. Drilling Fluid 3. Lime Sludge 4. Construction Waste	Chapter 23-29 Solid Waste Management	Article 33-20 Solid Waste Management and Land Protection	WM	The rules prescribe minimum standards for the storage, collection, transportation and disposal of solid wastes. Construction and operation requirements have been developed to protect ground and surface water from contamination. All locations are geologically sited to protect ground water. Ground water monitoring may be required.
c. Hazardous Waste Disposal Sites	Chapter 23-20.3 Hazardous Waste Management	Article 33-24 Hazardous Waste Management	WM	Chapter 33-24-05 Sets standards for the treatment, storage, and disposal of hazardous waste. Section 33-25-05-{47-58) Ground water protection requirements set minimum standards for ground water protection, including monitoring and corrective action programs.
3. Injection Wells a. Oil and Gas	Chapter 38-08 Control of Gas and Oil Resources	Chapter 43-02-05 Underground Injection Control	OGD	The rules for all underground injection control programs require permits for all injection wells and establish construction, operating, monitoring, and reporting requirements to protect surface and ground water. The rules address Class I, II, III, IV, and V underground injection well categories.
b. Mining	Chapter 38-12 Regulation Development	Chapter 43-02-01.1 Underground Injection Control	NDGS	
c. Municipal	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Water	Chapter 33-25-01 Underground Injection Control	WQ	

Sources of Water Quality Contamination	Statutes Governing Sources of Contamination (NDCC)	Rules Established Under Statute (NDAC)	Governing Agency	Brief Description of Regulatory Authority and Guidelines
4. Well Construction a. Improper Well Construction b. Abandoned Wells	Chapter 43-35 Water Well Contractors	Article 33-18-01 Water Well Construction and Water Well Pump Installation	SWC/MF/ WQ	The statute requires all firms engaged in water well construction to be certified and establishes a state board of water well contractors. The rules establish location and construction requirements for water wells, irrigation wells, monitoring wells, abandoned wells, and geothermal return wells. Section 33-18-01-05 Protection of Ground Water Sources requires specific grouting and construction features to ensure the protection of ground water.
c. Seismic Holes	Chapter 38-08.1 Geophysical Exploration Requirements	Chapter 43-02-12 Geophysical Exploration Requirements	OGD	The rules set requirements for permitting geophysical exploration, including requirements for plugging and abandoning drilled holes.
d. Monitoring Well Construction	Chapter 43-35 Water Well Contractors	Article 33-18-02 Ground Water Monitoring Well Construction Requirements	SWC/WQ	The statutes requires all firms engaged in the construction of ground water monitoring wells to be certified. The rules establish construction, siting, protection, and abandonment requirements.
e. Geothermal Energy Recovery Wells	Chapter 38-19 Geothermal Resource Development	Article 43-02-07 Geothermal Energy Production	NDGS	Establishes construction, installation, and permitting requirements for private and industrial geothermal recovery wells. Refers to Article 33-18 Water Well Construction and Water Well Pump Installation for some construction requirements.
5. Subsurface Sewage Disposal a. Drain Field Systems b. Mound Systems	Chapter 61-28 Control, Prevention, and Abatement of Pollution and Surface Waters	Guidelines	WQ	The statute requires the submission of plans and specifications for public subsurface disposal systems. Individual systems are approved by local health units. The NDDH has established guidelines for the construction, operation, and maintenance of subsurface disposal systems.
c. Cesspools	Chapter 43-18 State Plumbing Law	Article 62-03-16 Individual Sewage Disposal Systems for Homes and Other Establishments	SPB	The rules specify minimum requirements for individual sewage disposal systems for homes and other establishments.
d. Septage	Chapter 23-19 Liquid Wastes and Commercial By-Products	Article 33-21-01 Operation of Cleaning, Pumping, and Servicing of Cesspools, Septic Tanks, or Privies	WQ/MF	The statute requires all septic tank pumpers to obtain a license. The rules require pumpers dispose of waste in a manner which will not endanger surface or ground water.
6. Land Application of Wastes a. Wastewater Irrigation	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Waters	Guidelines	MF	All wastewater irrigation projects, including plans and specifications, are reviewed and approved by the NDDH. Ground water monitoring is required on a case-by-case basis.
b. Land Application of Sludges	Chapter 23-29 Solid Waste Management and Land Protection Act	Article 33-20-05 Standards for Performance of Disposal Operations	WM	The rules established permitting requirements for sludge disposal.
c. Land Treatment of Contaminated Soils	Chapter 23-29 Solid Waste Management and Land Protection Act	Guidelines	WM	Provides guidance on the site selection, sampling requirements, management, and notification requirements for land treatment areas for petroleum contaminated soils.

Sources of Water Quality Contamination	Statutes Governing Sources of Contamination (NDCC)	Rules Established Under Statute (NDAC)	Governing Agency	Brief Description of Regulatory Authority and Guidelines
7. Accidental Spills				
a. Hydrocarbons	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Waters	Response Plans	WQ/MF	The NDDH utilizes the Pollution Control Contingency Plan for Oil and Hazardous Materials when accidental spills occur.
b. Chemicals				
c. Salt Water			SHP	The patrol utilizes the Pollution Control Contingency Plan for Oil and Hazardous Materials when accidental spills occur.
d. Hazardous Material	Chapter 23-20.3 Hazardous Waste Management	Article 33-24-02 Standards for Transporters	WM	The rules specify the type of immediate action to be taken and cleanup responsibilities in the event of a spill.
8. Mining				
a. Mine Development	Chapter 38-14.1 Surface Mining and Reclamation Operations	Article 69-05.2 Surface Mining and Reclamation Operation	PSC	Article 69-05.2 -16 Performance Standards-Hydrologic Balance- General requirements include surface and ground water protection and monitoring requirements for mine development and reclamation to protect water quality.
b. Reclamation	Chapter 61-02 State Water Commission	Article 89-04-08 Ground Water Protection	SWC	Article 69-05.2-25 Performance Standard Operations in Alluvial Valley Floors- This section establishes requirements to protect ground water systems surrounding a mine area and to ensure reestablishment of ground water systems.
	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Water	Article 33-16-01 North Dakota Pollutant Discharge Elimination System	WQ	The rules set forth ground water monitoring requirements to determine the effects of surface coal mining and reclamation on ground water.
	Chapter 38-12.1 Coal Exploration	Article 43-02-01	NDGS	The rules address water issues as they relate to coal exploration.
9. Oil and Gas Development a. Blowouts	Chapter 38-08 Control of Gas and Oil Resources	Article 43-02-03 General Rules Oil and Gas Development	OGD	Section 43-02-03-23 Blowout Prevention-Requires installation and maintenance of blowout prevention equipment.
b. Reserve Pits				Section 43-02-03-19 Pits for Drilling Mud and Drill Cuttings- requires lined pits to prevent ground water contamination.
c. Evaporation Ponds				Section 43-02-03-53 Saltwater Handling Facilities-prohibits evaporation ponds.
d. Communication Between Water-Bearing Strata.				Section 43-02-03-20-21 Sealing of Strata-All oil, gas, and water formations above the production zone must be sealed.
e. Abandoned Wells				Section 43-02-03-(33-36) Abandonment and Plugging of Wells-requires plugging of abandoned wells.
10. Storage Tanks a. Regulated Underground Storage Tanks I. Petroleum	Chapter 23-20.3 Hazardous Waste Management	Article 33-24-08 Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (USTs)	WM	The underground storage tank rules specify the technical standards, corrective action, and financial responsibility requirements that apply to owners and operators of underground storage tanks.
ii. Hazardous Substances as Defined in Section 101(14) of CERCLA				
b. Above Ground Storage Tanks and Unregulated Underground Storage Tanks	Chapter 18-01 Fire Marshal Department	Article 10-07-01 Fire Marshal	FM	Rules specify National Fire Protection Association Standards for storage and handling of hydrocarbons.
I. Petroleum	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Waters		WQ	

Sources of Water Quality Contamination	Statutes Governing Sources of Contamination (NDCC)	Rules Established Under Statute (NDAC)	Governing Agency	Brief Description of Regulatory Authority and Guidelines
11. Agriculture a. Fertilizer	Chapter 19-20.1 Fertilizer and Soil Condition Law		AGD	The statute requires fertilizers be registered and retailers who sell fertilizers be licensed.
b. Pesticide	Chapter 4-35 Pesticide Act	Chapter 4-35-01 Pesticide Control Board	AGD	The rules regulate the labeling and use of pesticides and establish a pesticide control board.
	Chapter 23-33 Ground Water Protection Act		WQ/AGD/ SWC	The statute directs the NDDH to conduct ground water quality monitoring activities, in cooperation with the SWC. The statute also requires chemical use data from product registrants, develops ground water protection education programs, and allows the Agriculture Department to develop pollution prevention criteria.
	Chapter 19-18 Insecticides, Fungicides, and Rodenticides		AGD	The statute requires all pesticides which are sold within the state be registered.
c. Leaching of Salts and Pesticides.	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Water		WQ	The SWC and the NDDH can reduce or discontinue an irrigation project if they feel it may cause ground water or surface water contamination. This decision may be based on monitoring results or applied research.
	Chapter 61-04 Appropriation of Water		SWC	The SWC issues permits for all irrigation projects and monitors both quality and quantity of the water resource. The statute also requires specific well construction and backflow prevention equipment in the irrigation permit to prevent ground water contamination.
12. Road Salt Application	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Water		WQ	Sand or other inert materials, rather than salt, are being increasingly used on North Dakota highways. Therefore, the state has not experienced problems associated with de-icing of highways.
13. Other	Chapter 61-28.1 Safe Drinking Water Act	Chapter 33-17-01 Public Water Supply Systems in North Dakota	MF	The rules establish sampling and monitoring requirements and MCLs for chemical and biological parameters for public water supply systems. Under this program, all public water supply systems are monitored to ensure clean drinking water and to detect trace contaminant levels prior to them becoming a public health hazard.
	Chapter 61-28 Control, Prevention, and Abatement of Pollution of Surface Water	Article 33-16-03 Water Quality Standards	WQ	Water quality standards apply to both surface and ground water resources.

North Dakota Governing Agencies

AGD - North Dakota Department of Agriculture
AGES - Agricultural Experiment Station
FM - Fire Marshal
MF - North Dakota Department of Health - Division of Municipal Facilities
NDGS - North Dakota Geological Survey
OGD - Industrial Commission - Oil and Gas Division
PSC - Public Service Commission
SHP - Highway Patrol
SIC - State Industrial Commission
SPB - North Dakota State Plumbing Board
SWC - North Dakota State Water Commission
WM - North Dakota Department of Health - Division of Waste Management
WQ - North Dakota Department of Health - Division of Water Quality

All rivers and streams and 180 lakes and reservoirs are designated a specific classification in the standards. All lakes, except Lake George in Kidder County, are designated Class I (suitable for all beneficial uses).

The standards implement the beneficial use policy of the state pertaining to waters used for the propagation of wildlife, fish and aquatic life; domestic and municipal water; recreation and agricultural and industrial activities.

2.4.2 Section 305(b) Program

"The 305(b) Program," which fulfills requirements of Section 305(b) of the federal Clean Water Act, requires the monitoring and assessment of the quality of surface waters across the state. The NDDH, Division of Water Quality, implements this program and develops a report for public review once every two years.[22]

An ambient surface water quality monitoring network was initiated with five sites during November 1967, and expanded to 23 sites during 1968. Expansion of the number of sites continued until October 1993, when the NDDH maintained 61 monitoring sites on 31 rivers and streams. Stream segments and lakes have been, and continue to be, assessed using ambient water quality data collected by the NDDH, the USGS, the U.S. Army Corps of Engineers, the EPA, and the state of Minnesota. This data is contained in EPA's Storage and Retrieval (STORET) data system.

After 1994, the NDDH revised the objectives for surface water quality monitoring to incorporate a basin-wide biological monitoring approach. The historic strategy of monitoring trends in water quality was ineffective, and it did not provide adequate spacial resolution for the beneficial use assessments of many stream and river miles in the state. For example, copper concentrations which exceed the state copper standard can have a toxic effect on the biological community. Therefore, the occurrence of copper in excess of the state standard would be an indicator of aquatic life use impairment. In addition, historic monitoring ignored the effects of nutrients, sediment, and habitat alterations on aquatic life in surface waters.

The basin-wide biological monitoring approach began as a cooperative effort with the Minnesota Pollution Control Agency and the USGS's Red River National Water Quality Assessment Program during 1994. That year, data was obtained from approximately 100 sites on the Red River, and an Index of Biotic Integrity for fish in the Red River Basin was developed. The project continued during 1995, with the addition of 50 biological monitoring sites along the Upper Red River Basin, as well as the Sheyenne River and tributaries of the Sheyenne. This basin approach allows more intense monitoring, includes biological indicators

[22] North Dakota: Water Quality Assessment, 1992-1993, Division of Water Quality, 89 pages.

such as macro invertebrate sampling, and does not rely exclusively on surrogate measures such as chemical concentration data.

2.4.3 Section 319 Program

In 1972, Congress passed the Clean Water Act to restore and maintain the quality of the nation's water resources. This Act was amended in 1987 to include Section 319. This section emphasizes voluntary control of NPS pollution.

NPS pollution can be defined as contaminated precipitation runoff from city streets, construction sites, and agricultural areas. The runoff can contain sediments, nutrients, pesticides, and other contaminants which are deposited in receiving wetlands, streams, rivers, reservoirs, and lakes.

Under Section 319, the EPA is authorized to award grants to states or local entities on an annual basis. In North Dakota, the NDDH administers and implements the NPS program. EPA provides 60 percent of the funding; the remaining 40 percent must come from local sources.

Three categories of projects are eligible for Section 319 funding: developmental, educational, and watershed. Watershed projects are usually preceded by developmental projects which (1) identify beneficial use impairments or threats and (2) determine the extent to which any impairments or threats are due to NPS pollution. Watershed projects are then designed to mitigate the documented NPS pollution impacts within the watershed. The goals of watershed projects are to: (1) reduce/prevent NPS pollution by promoting voluntary application of Best Management Practices (BMPs); (2) disseminate information on effective solutions to NPS impacts; and (3) evaluate the project's progress and benefits.

Across North Dakota, agriculture and its associated activities have been the primary focus of the state's NPS program. Since 1990, a majority of the state's Section 319 funds have been awarded to locally sponsored projects promoting voluntary NPS pollution control on agricultural lands. The projects have implemented various information and educational activities and/or provided financial and technical help to landowners for implementation of BMPs on their farms. The BMPs typically installed include conservation tillage, grassed waterways, crop residue use, integrated crop management, or upgrading of livestock waste management facilities. In recent years, Section 319 funding has also been used to support local initiatives to evaluate water quality conditions and determine sources of NPS pollution within watersheds.

2.4.4 The Wellhead Protection Program

The primary water protection activity for PWSs in North Dakota has been the Wellhead Protection (WHP) Program. The NDDH WHP program was approved by the EPA in August

1992. It consists of seven essential elements: (1) community participation and commitment, (2) delineation of a wellhead protection area, (3) completion of a potential contaminant source inventory, (4) development of management strategies, (5) preparation of contingency plans, (6) siting of new wells, and (7) public education and involvement.

More than 180 community water systems currently participate in the WHP program (Figure 6). This represents 90 percent of the population served by community water systems utilizing ground water. Nearly 50 percent of the participating communities have initiated all of the essential elements. The rapid advancement and success of this voluntary program, only five years after federal approval, is a tribute to community leaders and the people of North Dakota.

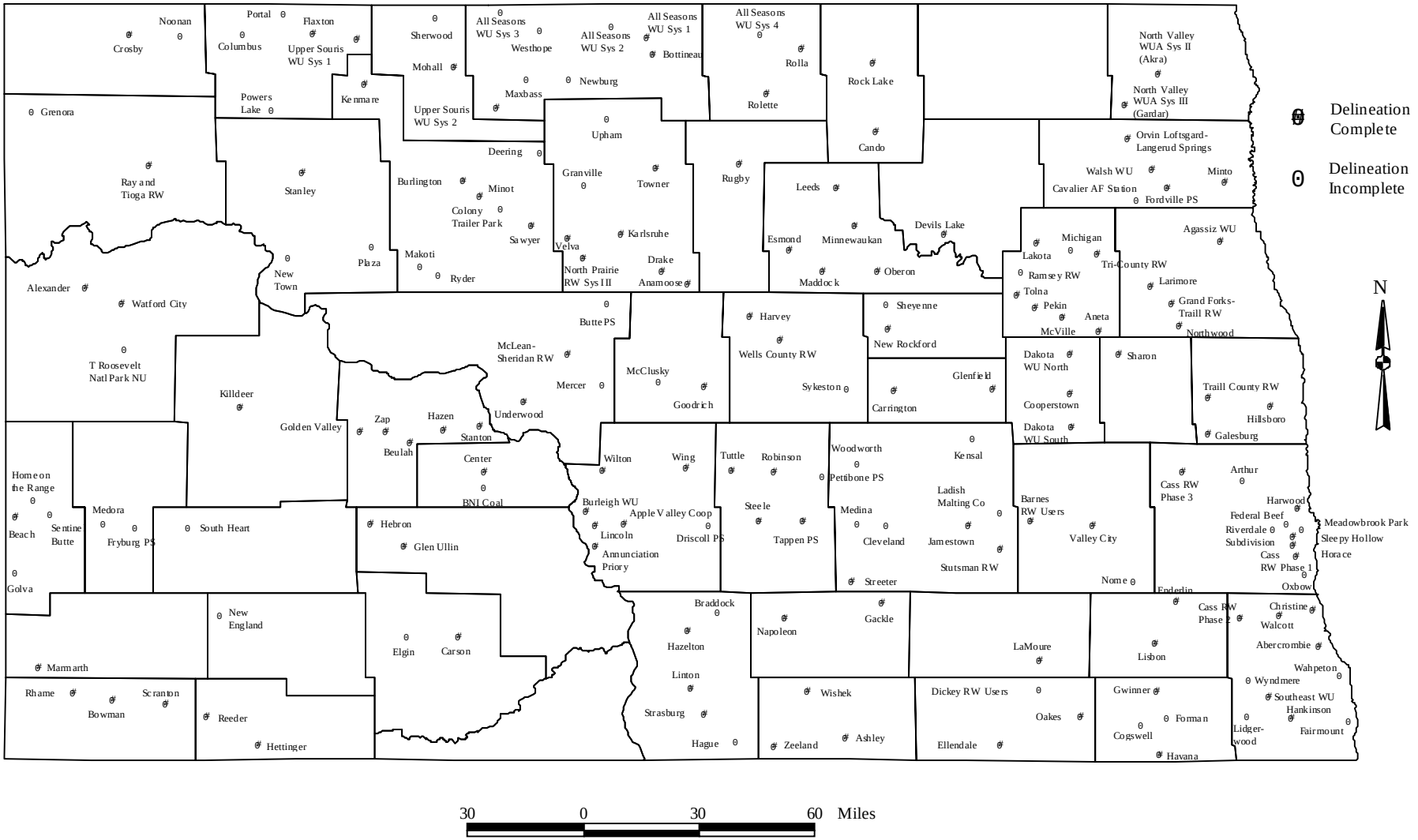
In an effort to promote the WHP program, town meetings and public workshops continue to be conducted throughout the state. WHP presentations are given at city council and PWS operator meetings to help achieve the program's goal of 100 percent participation. Additional public outreach includes WHP articles published in local newspapers, the Official Bulletin of the North Dakota Water and Pollution Control Conference, and private water utility company newsletters.

Hydrogeologic reports are typically prepared by the NDDH for PWSs participating in the WHP program. These reports document the characteristics and configurations of the source water aquifers, the direction and velocity of the ground water flow, and the vulnerability of the aquifers to contamination.

Information from the reports is entered into a database designed to organize, search, and display wellhead protection information. The database focuses on delineation information, including surface and subsurface geology, hydrogeology, well construction, and type and size of the WHP area. The benefit of the database has been to expedite responses to questions or concerns of WHP participants.

Geographic information systems (GIS) have become increasingly important in the management and display of geographic, cultural, and environmental data. The WHP program uses GIS for preparing and updating WHP maps. GIS manages and displays data in a spatial framework, or by location through a system of overlying themes.

Although GIS can be used to prepare informative and descriptive wellhead protection area maps, its greatest potential lies in contaminant source inventory and management. After being assigned a location (i.e., latitude, longitude), the contaminant sources can be placed on an electronic wellhead protection area map. Use of GIS for contaminant source inventory allows the inventory to be easily updated. Management of the wellhead protection area can be enhanced by GIS through the analysis of related themes, including production well



Wellhead Protection Program Participation and Delineation Status

North Dakota Department of Health, Division of Water Quality, September 1998

Note: Not all participating non-community public water systems are shown.

Figure 6. Map of PWSs currently participating in the WHP.

locations, aquifer boundaries, and ground water flow models. At the present time, WHP information, including delineations and geological cross-sections, has been placed on the NDDH Internet home page for viewing at "www.health.state.nd.us/ndhd/environ/wq/wellhead/maps/front.htm."

2.5 Summary of Natural and Regulatory Water Quality Protection

The information provided in sections 2.1 through 2.4 is summarized below.

- Forty-two percent (252) of the PWSs across the state are transient, noncommunity systems.
- The majority of PWSs across the state draw source water from ground water.
- The geographic region of the state is contained within five surface watersheds.
- The surface and subsurface hydrogeology across the state are not neatly coupled, which makes detailed delineation of source water a unique analysis for each PWS.
- The GTS method of prioritizing aquifers for water quality monitoring has delineated those aquifers in the eastern half of the state as having medium or high exposure vulnerability to contamination and those aquifers in the western half as mostly low with some medium vulnerability.
- The existing surface water quality information has shown that the primary causes of surface water pollution and beneficial use impairment, are related to NPS runoff from watersheds into streams and rivers.
- The existing ground water quality information has not identified hydrogeological conditions which merit more -- or less -- detail in source water assessments.
- The state currently implements pollution prevention and control programs addressing a wide variety of potential pollution sources.

The information provided in the preceding sections is considered essential for the development of a comprehensive SWAP, specifically, elements relating to the natural environment, assessment activities, and current regulatory/enforcement capacity. These elements will be considered part of, and referred to in this North Dakota SWAP Plan.

CHAPTER 3. SOURCE WATER ASSESSMENT STRATEGY

3.1 Source Water Assessment Strategy and Completeness Criteria

Section 1453 of the SDWA Amendments of 1996 requires states to complete source water assessments within two years of SWAP Plan approval or within an approved time extension. EPA's State Source Water Assessment and Protection Programs Guidance has defined "complete" as the status achieved when the state fulfills all actions in a state-approved SWAP and meets all requirements of sections 1453 and 1428(b) of the SDWA. To achieve monitoring flexibility under section 1418(b), the state must also have an EPA-approved SWAP and any PWS seeking such flexibility must have completed a source water assessment.

EPA's guidance indicates that a SWAP plan must describe how assessments will protect and benefit PWSs and the level of detail that "completed" assessments will achieve. A completed assessment must include three elements: (1) a delineation of the source water assessment area; (2) a contamination source inventory for that source water assessment area; and, (3) a determination of the PWS's susceptibility to contamination by sources inventoried within the source water assessment area. The EPA guidance also indicates that states can propose alternatives to the guidance's mandates and recommendations for each of the three elements.

The NDDH SWAP plan provides unique considerations to achieve and maintain the beneficial use of all waters of the state as identified in state law (ND Century Code 61-28 and NDAC 33-16). For example, the first actions in achieving the goals of the SDWA Amendments of 1996 are pollution prevention and mitigation; these actions are consistent with beneficial use policy, and existing regulatory structure in North Dakota.[23]

Chapter 3 describes the proposed exactness and detail criteria for the North Dakota SWAP.

3.1.1 Source Water Assessment Goals

EPA's SWAP guidance states that "source water assessments will generate information on significant potential contamination sources and on the susceptibility of [public water] systems to contamination by these sources that may help states target systems for additional or reduced monitoring, or for actions to assure compliance with drinking water standards, . . ." [emphasis added]. In other words, the SWAP plan goals need to identify assessment areas where the public may implement water quality protection activities.

[23] EPA's guidance acknowledges other federal water quality protection programs by recommending that state SWAP plans describe the linkage of a proposed state SWAP to these federal programs.

The following goals are proposed to meet the expressed federal requirement for a state SWAP plan:

G1. Complete source water assessments for all PWS systems, which include noncommunity water supply systems;

G2. Increase stakeholder involvement in the assessment and protection of the state's water resources; and

G3. Use the SWAP to maintain the quality of the state's water resources, protect beneficial uses and implement remedial action, as provided by state law.

3.1.2 Source Water Assessment Objectives

EPA's guidance acknowledges that a source water assessment for a PWS provides only the first three elements in a water quality protection program, and it notes that a complete prevention program would include: " ... monitoring source water quality, implementing management measures for sources of contamination, and contingency planning." The SDWA amendments of 1996 do not require these other actions, although they are considered to be elements of a fully implemented SWAP, and many are addressed through existing state regulatory and monitoring programs.

In program planning, objectives express tasks directed at achieving goals. The NDDH proposes to complete the following objectives.

O1. Complete source water assessments for ground water and surface water-based PWSs (Goal G1);

O2. Educate the public on the benefits of establishing a local proactive water quality protection program (Goal G2); and

O3. Where feasible, adjust the strategies of programs which protect the water resources of the state to be compatible with the protection of the source waters of PWSs (Goal G3).

3.2 Differential Levels of Source Water Assessment

EPA has recognized that one level of detail may not be possible or appropriate in assessments for all PWSs. Its guidance recommends different degrees of detail in source water assessment delineations, contamination source inventories and susceptibility determinations for categories of PWSs. However, its guidance also indicates that a differential approach must have a coherent rationale for the protection and benefit of each

PWS. Assessments can be completed on an area wide basis to include more than one PWS. In an effort to provide a coherent assessment strategy, the NDDH proposes:

- A defined methodological approach for each element of a source water assessment for PWSs which draw source water from ground water;

- A defined methodological approach for each element of a source water assessment for PWSs which use surface water; and

- A protective, yet less detailed, approach for the 252 noncommunity PWSs. All but two of noncommunity PWSs draw source water from ground water, as listed in Appendix C; the two noncommunity PWSs which use surface water are listed in Appendix B.

3.3 Delineation of Source Water Assessment Areas

The first element and foundation of the SWAP plan is the delineation of the water quality protection area. Section 1453(a)(2)(A) of the SDWA requires states to:

> ... delineate the boundaries of the assessment areas in such state from which one or more public water systems in the state receive supplies of drinking water, using all reasonably available hydrogeologic information on the sources of the supply of drinking water in the state and the water flow, recharge and discharge and any other reliable information as the state deems necessary to adequately determine such areas.

A source water assessment area delineation may address either surface water or ground water systems and can be defined as a surface or subsurface area over or through which contaminants are likely to move toward and reach a PWS. The delineation is intended to define an area where PWSs can best utilize public funds to concentrate water quality protection measures. The following paragraphs will define the various source water delineation methods for surface and ground water resources in North Dakota.

3.3.1 Source Water from Ground Water

EPA's guidance defines the source water assessment area for a PWS dependent upon ground water, as that area delineated with methods accepted under an EPA-approved Wellhead Protection Program. Consideration must also be given to conjunctive delineation of source water assessment areas where the hydraulic connection between surface and ground water may occur.

The North Dakota Wellhead Protection Program was approved by the EPA in December 1992. Since that time the NDDH, Division of Water Quality, has used four

methods to delineate source water assessment areas for ground water-based PWSs. These methods are approved for use in the SWAP plan.

The North Dakota Wellhead Protection Users Guide defines a wellhead protection area as:

> "... the surface and subsurface area surrounding a water well or well field, which supplies a public water system and through which contaminants are likely to move toward and reach such water well or well field."

In other words the wellhead protection area ideally coincides with the area from which a PWS well(s) receives ground water. It should be noted that the delineation of recharge areas for confined aquifer systems will not be addressed in the North Dakota SWAP plan. The primary justification for this approach relates to the fact that the most extensively used aquifers are unconfined with well-defined recharge areas, while confined aquifers are typically overlain by several hundred feet of dense geologic material providing natural protection from contamination. In addition, recharge areas for confined aquifer systems are ill defined, and typically at a distance from the wellhead, making a meaningful assessment difficult.

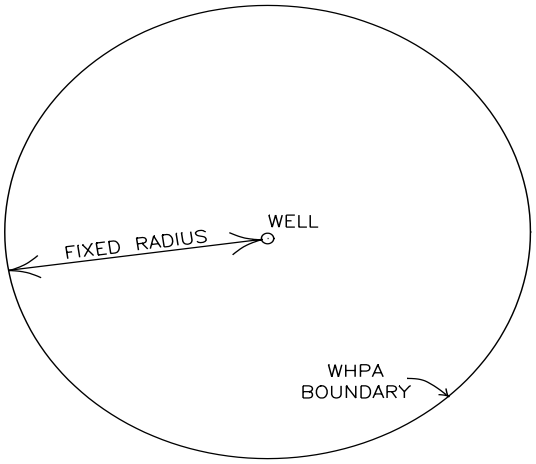
The degree of detail in the delineation of the source water assessment area for ground water depends upon several factors, including availability and accuracy of site-specific hydrogeologic data. The NDDH Wellhead Protection Users Guide describes four different wellhead protection area delineation methods. These methods provide a delineation protocol for systems with little or no available hydrogeological information, as well as for systems with extensive site-specific information. The four methods are briefly described in the following sections.

3.3.1.1 Arbitrary Fixed Radius

The simplest of the delineation methods is called the arbitrary fixed radius method (Figure 7). An arbitrary fixed radius protection area is defined as a circle (with a given radius) around a specific PWS wellhead. The minimum recommended radius is 1200 feet; however, the actual radius chosen may vary depending upon site-specific conditions. This method is typically utilized when the primary well is more than 100 feet deep and is known to be drawing from a confined aquifer recharged at a considerable distance from the wellhead. The arbitrary fixed radius approach can also be used in cases where the rapid delineation of a wellhead assessment area is desired, or if little or no site-specific hydrogeological information is available, as is typical of many noncommunity PWSs.

3.3.1.2 Calculated Fixed Radius

The second method that may be used to delineate a wellhead assessment area is the calculated fixed radius (Figure 8). This method utilizes site-specific information to calculate



(map view)

Figure 7: Arbitrary Fixed Radius

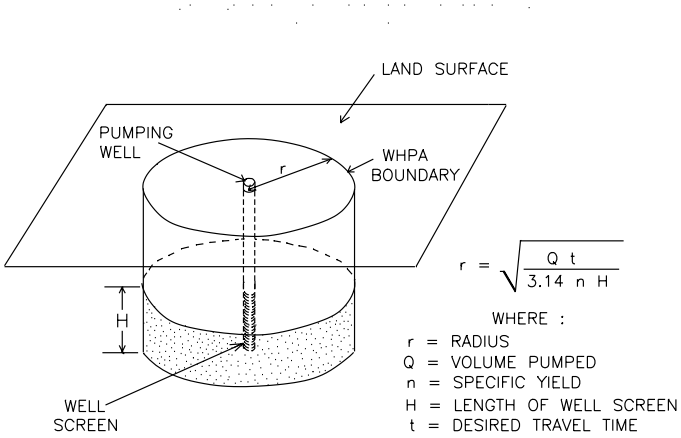


Figure 8. Description of a Calculated Fixed Radius Wellhead Protection Delineation

an appropriate radius. The site-specific information may include specific yield or porosity of the aquifer, well screen interval, aquifer thickness, volume of water pumped and desired time of travel. The NDDH currently requires a minimum of a 15-year time of travel to be used in determining a calculated fixed radius for a PWS.

3.3.1.3 Zone of Contribution

The third delineation method is a uniform flow analytical method that results in the calculation of a zone of contribution (ZOC) as indicated in (Figure 9). The ZOC method attempts to approximate the actual aquifer area that contributes water to the well system during a specified amount of time. Data required to apply this method includes well pumping rates, specific yield or effective porosity, saturated thickness, hydraulic conductivity and hydraulic gradient. Because the ZOC calculation theoretically allows the boundary to extend indefinitely in an upgradient position, an appropriate time of travel distance is needed to provide a realistic upgradient boundary. The time of travel is defined as the distance the water will travel through the aquifer in a given amount of time. For the North Dakota Wellhead Protection Program, a minimum of a 10-year time of travel is considered acceptable with increased time of travel values being selected for specific PWSs.

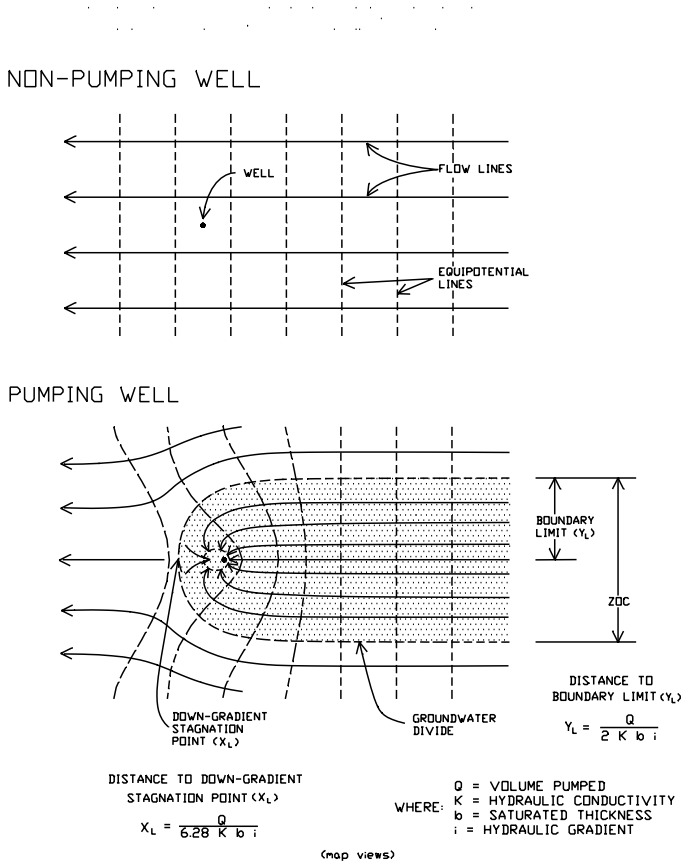


Figure 9. Description of a Zone of Contribution Wellhead Protection Delineation

3.3.1.4 Hydrogeologic Mapping

The last method that may be utilized to develop a source water assessment area is termed hydrogeologic mapping. To define the assessment area, this method utilizes the natural characteristics or man induced changes to an aquifer flow system. Elements which can impact the flow of ground water include rivers or manmade artificial boundaries (e.g., pumping wells, holding ponds, or injection wells) and low permeable soils. For example, if a river crosses through a calculated wellhead assessment area, the river may influence the flow of ground water in the area resulting in a change in the size or configuration of the assessment area. Figure 10 depicts an example of hydrogeologic mapping.

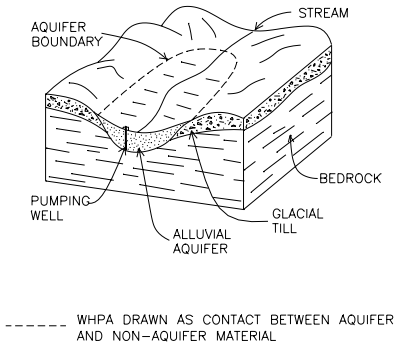


Figure 10. The Hydrogeologic Mapping Method of Wellhead Protection Area Delineation.

* WHPA defined as wellhead protection area

The method(s) selected to define a ground water-based source water assessment area is a function of site-specific conditions and the availability of applicable hydrogeologic information. It should be noted that the final source water assessment area configuration for any PWS may be the result of the application of one or more delineation method(s). The final method(s) selected typically will be determined by the NDDH in an effort to provide reasonable and consistent representation of the water used by a PWS. However, a PWS may request that a more technical or extensive delineation method be implemented by the NDDH. The extent to which these requests will be accommodated will be based upon technical feasibility and availability of site-specific information.

3.3.1.5 Conjunctive Delineation

The NDDH has completed conjunctive use determinations for all community PWSs, and nearly all noncommunity PWSs. Conjunctive use is defined as ground water under the influence of surface water. These determinations have been accomplished through an evaluation of site-specific well construction, geology, and hydrology. In some cases, microscopic particulate analyses have been used to identify the influence of surface water on ground water. Of all the community PWSs, two wells have been identified as under the influence of surface water. In addition, with the evaluation of over 95 percent of the noncommunity PWSs completed, only one well has been identified as under the influence.

The delineation of source water assessment areas for PWSs under the influence of surface water will be completed by: (1) delineation of an assessment area around each well utilizing the appropriate method (Sections 3.3.1.1 to 3.3.1.4), and (2) assuming the location of the furthest downstream well as the intake structure, identify the surface water assessment area by utilizing one of the delineation methods identified in Section 3.3.3.

3.3.2 Source Water From Ground Water Delineation Strategy

Based upon the current status, use, diversity of available hydrogeologic information, and number of PWSs in North Dakota, ground water-based source water assessment areas in North Dakota will be implemented by one of the following methods:

- Assessment areas for transient noncommunity PWSs will be developed utilizing the fixed radius method with a minimum radius of 1200 feet around each well or well field. If appropriate site-specific information is available, other methods may be applied at the request of the well owner.

- For PWSs determined to be: (1) located in a low vulnerability region based upon the results of the North Dakota Geographic Targeting System (refer to section 2.1.4 and Appendix D of this document), or (2) determined to have in excess of 30 feet of low permeable geologic material between the surface and the aquifer, and (3) a recharge area located in excess of one mile from a wellhead, the fixed radius method using a minimum radius of 1200 feet will be used. For wells which have sufficient site-specific use and hydrogeologic information, a calculated fixed radius may be implemented.

- For all other PWS delineations, a case by case technical analysis defining the hydrogeologic setting and zone of contribution utilizing site-specific data, will be implemented. A minimum of a 10-year contaminant time-of-travel value will be used to define the assessment boundary.

➤ For ground water-based PWS systems determined to be under the influence of surface water, source water assessment delineations for each well or well field will include one of the four methods identified in Sections 3.3.1.1 to 3.3.1.4, and a surface water delineation method as defined in Section 3.3.3.

A listing of all PWSs which utilize ground water as their primary source of water can be found in Appendix C.

3.3.3 Source Water From Surface Water

For PWSs which rely on surface water to supply a portion or all of their drinking water supply needs, the EPA source water assessment guidance states:

> ...the state program submittal needs to adopt a policy that sets the delineation of the source water protection area to include the entire watershed area upstream of the PWS's intake structure, up to the boundaries of the state's borders.

The guidance also indicates that if water is diverted from another watershed into a surface water resource used by a PWS, the watershed upstream of each diversion structure would need to be delineated in a similar manner. Information outlining the aerial extent of each watershed from which a surface water-based PWS system receives their water will be provided to each PWS system as defined in Figure 11.

However, the delineation of the state into large source water assessment areas covering the majority of the land mass in the state is considered to be unmanageable when attempting to complete meaningful susceptibility analyses, contaminant source inventories or implement water protection programs. It is the opinion of the NDDH that large source water assessment areas may not be necessary as they do not take into account the positive natural cleansing impact of buffer zones, the natural attenuation/remediation of contaminants that occurs in surface water, or the environmental protection regulations currently implemented at the federal, state, and local level (Section 2.1.3.2 and 2.4). Acknowledging these issues, the EPA SWAP guidance states:

> ... for the purposes of undertaking an inventory for significant potential contamination sources and determining susceptibility of the public water supply, the state can choose to segment delineated watershed area(s) into units (e.g., stream segments, buffer zones, sub watershed areas) for more cost effective analysis.

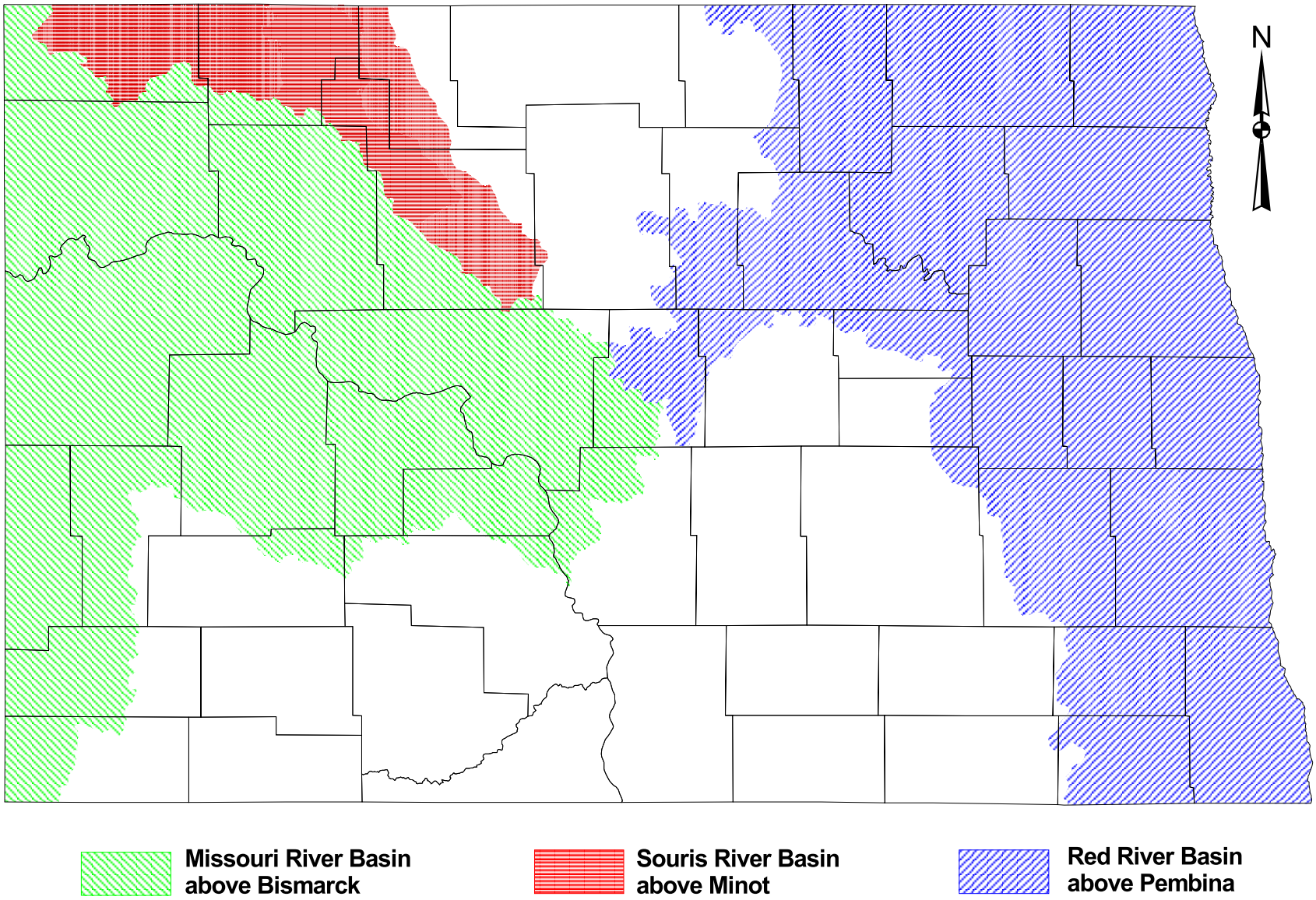


Figure 11. Watershed Delineation: Source Water Assessment Areas for the Entire State.

Based upon the above-referenced explanation and unique differences in the surface water systems in the state, the NDDH proposes to delineate rivers/streams and lakes/reservoirs utilizing separate methods. Delineation methods used to define surface water assessment areas in North Dakota are explained in 3.3.3.1 through 3.3.3.3.

3.3.3.1 Default Stream/River - Critical Zone Segments

The source water assessment primary delineation method for rivers and streams in North Dakota is referred to as the default stream/critical zone segment method. This method will be applied to stream/river systems from which limited or no applicable site-specific information is available. This method includes the identification of a stream stretch bounded on each side by a buffer or critical zone area (Figure 12). The assessment area for a stream segment using this method is defined as a fixed distance starting from the PWS intake and ending at a predetermined point upstream of the intake. For river/stream systems in North Dakota, this fixed distance will be a minimum delineated distance of 15 valley miles upstream of the intake structure. Other inputs into the main surface water supply, such as natural tributaries into the source water leading to the PWS intake structure or other points of diversion, will be delineated with a minimum distance of 15 valley miles as measured from the PWS intake structure.

As a general rule, assessment areas will be delineated using the 15 valley mile criteria as outlined in this chapter. However, in the event that manmade or natural diversions result in a site specific change in flow or residence time in a stream/river channel, the 15 valley mile criteria will be evaluated and modified, if necessary, to provide for the delineation of an appropriate source water assessment area.

The critical zone method is defined as a horizontal distance perpendicular from the bank full elevation stage. This horizontal distance will be a minimum of 1000 feet on both sides of the river/stream. A distance less than 1000 feet may be considered where the natural topography/geology, width of the alluvial aquifer system or proximity of contaminants of concern justify a decreased critical zone size. Figure 12 depicts the default stream/critical zone delineation method for surface waters with limited site-specific information.

3.3.3.2 Time of Travel

The second surface water delineation method for a stream/river system utilizes site-specific historical information for the stream/river. Data obtained from routine stream gaging completed by the USGS, provides long-term information on stream/river flow for the major surface water systems in North Dakota. This information provides year-round flow or velocity data. With a given stream velocity and a given response time,[24] an assessment area for a stream segment can be

[24] A response time for purposes of this document is defined as the time a surface water system owner has to respond to a reported contamination incident occurring at an upstream boundary as measured from the PWS intake.

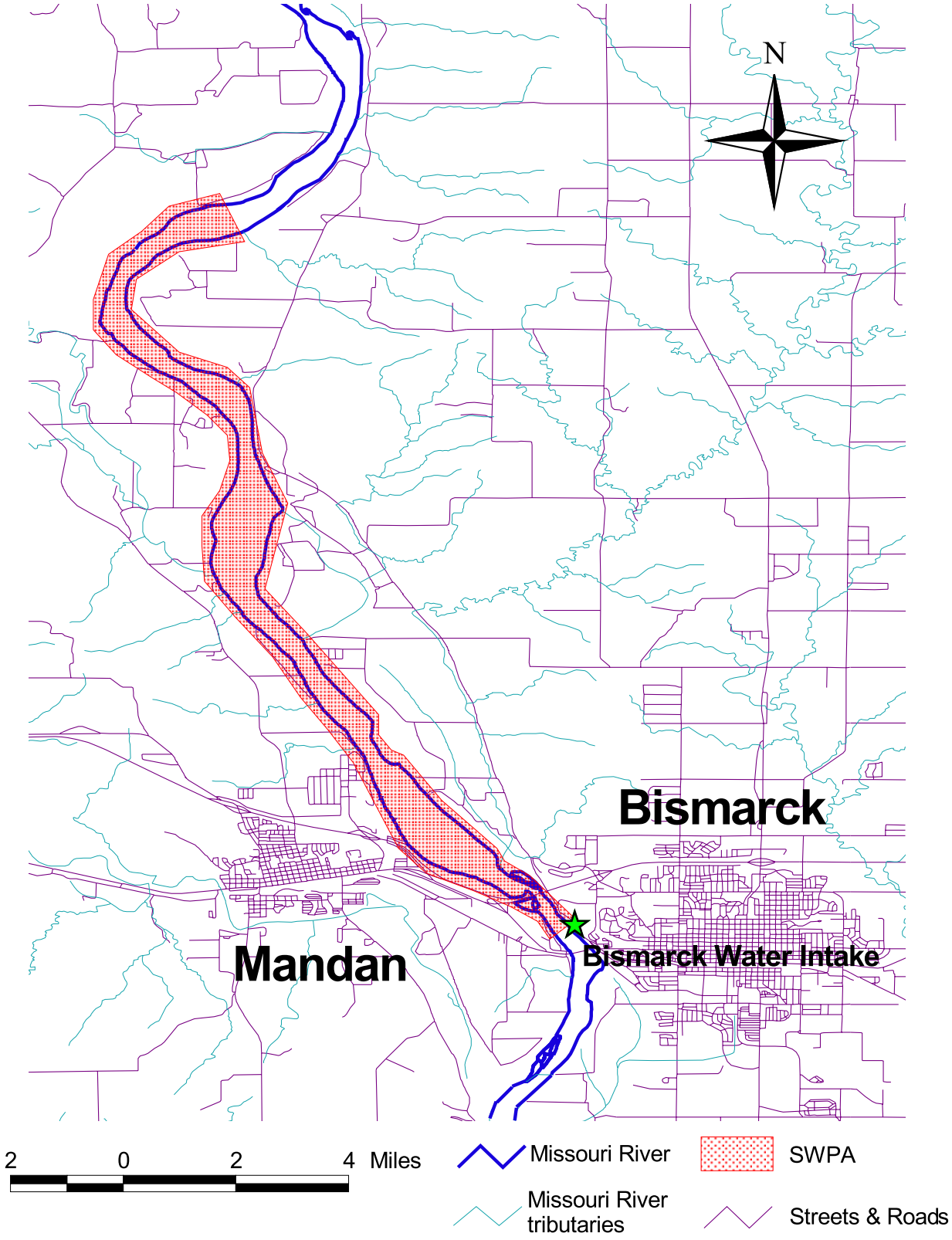


Figure 12. Arbitrary Stream/Critical Zone Segment (Example Only)

determined. To identify a source water delineation size, the NDDH will use streamline flow data consistent with the bank full stage at a specific stream gaging station.

The NDDH will use data collected from the gauging station, located immediately upstream of the PWS intake in combination with a 12-hour response time to define the upstream boundary of the critical assessment area.

The stream/river segment once defined will also have a critical zone of 1000 feet, measured from the bank full elevation, on both sides of the stream to the full length of the assessment area. A distance less than 1000 feet will be considered where natural topography/geology, width of the alluvial aquifer system, or proximity of contaminants of concern justify a decreased critical zone.

The surface water-based PWSs which will have an assessment area delineated by one of the above-mentioned methods are identified in Table 10.

Table 10.
Public Water Systems Drawing Source Water from Surface Waters

PWS Name	PWS City	Population	Source	PWS Type
Bismarck, City of	Bismarck	49,256	Missouri River	Community
Coal Creek Station	Underwood	486	Missouri River	NT NC
Coyote Station	Beulah	227	Missouri River	NT NC
Drayton, City of	Drayton	961	Red River	Community
Fargo, City of	Fargo	74,111	Sheyenne River	Community
Fargo, City of	Fargo	74,111	Red River	Community
Grafton, City of	Grafton	5,086	Park River	Community
Grafton, City of	Grafton	5,086	Red River	Community
Grand Forks, City of	Grand Forks	49,425	Red River	Community
Grand Forks, City of	Grand Forks	49,425	Red Lake River	Community
Leland Olds Station	Stanton	50	Missouri River	NT NC
Mandan, City of	Mandan	15,177	Missouri River	Community
Mayville, City of	Mayville	2,092	Goose River	Community
Minot, City of	Minot	34,544	Souris River	Community
Park River, City of	Park River	1,725	Homme Dam (Park River)	Community
Pembina, City of	Pembina	642	Red River	Community
Progold, Inc.	Wahpeton	65	Red River	NT NC
United Power Assoc.	Stanton	75	Missouri River	NT NC
Valley City, City of	Valley City	7,163	Sheyenne River	Community
Washburn, City of	Washburn	1,506	Missouri River	Community
Williston, City of	Williston	13,131	Missouri River	Community

T = Transient NT = Nontransient NC = Noncommunity

3.3.3.3 Surface Water from Natural Lakes or Man-Made Reservoirs

PWSs which utilize natural lakes or man made reservoirs in North Dakota are typically located in rural agricultural areas of the state. Due to the lack of point sources of contamination and the typically large volumes of water, a default critical zone of 1000 feet will be included around the entire water body as measured from the highest recorded water elevation established by the USGS. Distances less than 1000 feet will be considered where natural topography/geology, width of the alluvial aquifer system, or proximity of contaminants justify a decrease in the critical zone. This delineation method will only be applied to the Mulberry Creek Reservoir and Mt. Carmel Dam. Primary tributaries or streams which feed into these lakes have been identified by the NDDH NPS program, and will be included in the assessment.

An alternative delineation method will be implemented for Lake Sakakawea, which encompasses 368,231 acres with 1,600 miles of shoreline. The large size of Lake Sakakawea makes the delineation of the entire lake unmanageable when attempting to implement source water assessment provisions. To address PWSs which utilize this water resource, a 1000-foot critical zone as measured from the highest recorded lake elevation will be extended to a minimum distance of three miles on either side of the PWS intake structure. Due to the natural size of the lake, dilution expected to occur in the case of a catastrophic release of a contaminant into the lake, and state law which requires immediate reporting and corrective action be implemented in the event of a release, the defined assessment area is considered.

Those PWSs that will be addressed, using the natural lake/reservoir delineation method, are identified in Table 11.

Table 11:
Public Water Systems Drawing Source Water from Surface Waters

PWS Name	PWS City	Population	Source	PWS Type
Antelope Valley Station	Beulah	207	Lake Sakakawea	NT NC
Dakota Gasification Co.	Beulah	700	Lake Sakakawea	NT NC
Dickinson, City of	Dickinson	16,097	Lake Sakakawea	Community
Downstream Campground	Riverdale	280	Lake Sakakawea	NC
Garrison, City of	Garrison	1,530	Lake Sakakawea	Community
Garrison Power Plant	Riverdale	26	Lake Sakakawea	NT NC
Lake Sakakawea State Park	Pick City	300	Lake Sakakawea	NC
Langdon, City of	Langdon	2,241	Mulberry Creek Res. 2nd Line	Community
Langdon, City of	Langdon	2,241	Mulberry Creek Res. 1st Line	Community
Langdon, City of	Langdon	2,241	Mt. Carmel Dam	Community
Parshall, City of	Parshall	943	Lake Sakakawea	Community
Pick City, City of	Pick City	203	Lake Sakakawea	Community
Riverdale, City of	Riverdale	283	Lake Sakakawea	Community

T = Transient NT = Nontransient NC = Noncommunity

3.3.4 Source Water From Surface Water Delineation Strategy

Based upon the current status and number of PWS systems which utilize surface water in the state, source water assessment areas will be delineated using the following approach:

- A default stream/critical zone delineation method for a source water assessment area will be established for all community and noncommunity water supply systems which exhibit limited or no site-specific stream information. The minimum delineated area will be 15 valley miles upstream from the intake structure and 1000 feet measured perpendicular from the stream flow and the bank full stage elevation. A delineated area of less than 15 miles upstream of the intake structure may be allowed in cases where the natural flow of the stream has been altered by manmade structures, such as dams.

- A source water assessment area delineation utilizing the time of travel method will be implemented for community and noncommunity systems provided sufficient site-specific information is available.

- A critical zone of 1000 feet from the high water elevation will be delineated for areas around natural lakes or man made reservoirs.

- For systems which use water from Lake Sakakawea, a 1000-foot critical zone, as measured from the highest recorded lake elevation, will be extended a minimum distance of three miles to either side of the PWS intake.

3.4 Contaminants of Concern

Section 1453(a)(2)(B) of the SDWA Amendments of 1996 requires states to:

> Identify for contaminants regulated under this title for which monitoring is required under this title (or any unregulated contaminants selected by the state, in its discretion, which the state, for purposes of this subsection, has determined may present a threat to public health), to the extent practical, the origins within each delineated area of such contaminants to determine the susceptibility of the public water systems in the delineated area to such contaminants.

EPA's guidance mandates that the list of contaminants of concern include all raw water contaminants regulated under the SDWA for which an MCL is specified, contaminants regulated under the surface water treatment rule, and the microorganism *Cryptosporidium*.

The Department proposes:

- To consider contaminants of concern as those with identified SDWA MCLs, including those regulated under the SWTR (Table 12). Also included will be contaminants that are detected by the state ambient water quality monitoring programs (Section 2.1.4 and 2.1.3.2) and/or are regulated under the State Management Plan for Pesticides (Section 2.3.3) or SDWA if contaminants could potentially impact a source water intake.

The list of contaminants of concern will be evaluated once every three years, with the objective to identify “new” contaminants of concern or delete existing compounds which no longer pose a threat to PWS systems, as documented by existing environmental use or monitoring data.

3.5 Contaminant Source Inventory

The second element of a source water assessment is the completion of a contaminant source inventory. A contaminant source inventory identifies land use or facilities which have a significant potential to release a contaminant of concern. The EPA guidance defines a significant potential source of contamination as:

> ... any facility or activity that stores, uses, or produces, as a product or by-product, the contaminants of concern and has a sufficient likelihood of releasing such contaminants to the environment at levels that could contribute significantly to the concentration of these contaminants in the source waters of the public water supply(s) [emphasis added].

The NDDH has compiled a list of the types of potential contaminant sources (Table 13). It is important to note that ambient water quality monitoring, remedial response, and implementation of state regulatory programs have identified 11 different contaminant sources that have shown increased likelihood to impact water quality in North Dakota (Table 8). The potential sources are classified in one of four categories: farm, commercial/industrial, residential, and other (mostly municipal).

EPA's definition for a significant potential source allows exclusion of any source which does not have "a sufficient likelihood ..." of impacting the water resource. EPA's guidance translates this source-exclusion flexibility into thresholds for factors such as: amount produced, stored or used; likelihood of release at the source, including source mitigation plans; source location with respect to the PWS's intake structure; and others (undisclosed).

Table 12.
Contaminants of Concern for Source Water Assessments

PRIMARY INORGANIC CHEMICALS	VOLATILE ORGANIC CHEMICALS	PESTICIDES	OTHER SYNTHETIC ORGANIC CHEMICALS
Antimony	Benzene	Alachlor	Acrylamide
Arsenic	Carbon Tetrachloride	Atrazine	Benzo (a) pyrene
Asbestos	p-Dichlorobenzene	Carbofuran	Di (2-ethylhexyl) adipate
Barium	o-Dichlorobenzene	Chlordane	Di (2-ethylhexyl) phthalate
Beryllium	1,2-Dichloroethane	Dalapon	Epichlorohydrin
Cadmium	1,1-Dichloroethylene	Dibromochloropropane (DBCP)	Hexachlorobenzene
Chromium	cis-1,2-Dichloroethylene	Dinoseb	Hexachlorocyclopentadiene
Copper	trans-1,2-Dichloroethylene	Diquat	Polychlorinated biphenyls (PCBs)
Cyanide	Dichloromethane	Endothall	2,3,7,8-TCDD (Dioxin)
Fluoride	1,2-Dichloropropane	Endrin	Total Trihalomethanes
Lead	Ethlybenzene	Ethylene Dibromide (EDB)	
Mercury	Monochlorobenzene	Glyphosate	**RADIONUCLIDES**
Nickel	Styrene	Heptachlor	Combined Radium-226 and Radium-228
Nitrate	Tetrachloroethylene	Heptachlor Epoxide	Gross Alpha Particle Activity (including Radium-226, but excluding Radon and Uranium)
Nitrite	Toulene	Lindane	
Selenium	1,2,4-Trichlorobenzene	Methoxychlor	**MICROBIOLOGICAL**
Thallium	1,1,1-Trichloroethane	Oxamyl (Vydate)	Total Coliforms (including fecal coliforms and E. coli)
Total Nitrate and Nitrite	1,1,2-Trichloroethane	Pentachlorophenol	Cryptosporidium
	Trichloroethylene	Picloram	Giardia
	Vinyl Chloride	Simazine	
	Xylenes (total)	Toxaphene	
		2,4-D	
		2,4,5-TP Silvex	

Table 13.
Categories of Sources and Activities that may Impact Water Quality

FARM

feedlots
manure piles
ag chemical application/storage
fertilizer application/storage
grain bins for fumigation

COMMERCIAL/INDUSTRIAL

gas/service stations/auto repair
truck terminals
rust proofers
small engine repair
machine shops
auto body shops
auto/chemical supplies

dry cleaners
printers
metal platers
painters/finishers
furniture strippers
wood preservers
heat treaters/smelters
annealers/descalers
laundromats
car washes
beauty salons
medical/dental/veterinary offices
mortuaries/funeral homes
research laboratories
photo processors
painting supplies

junk/salvage yards
nurseries
grain elevators

oil pipelines/reserve pits
mines: coal/sand/gravel
coal gasification plants
concrete/asphalt/tar plants
fuel oil distributors
heating oil storage

food processors
slaughterhouses
meat packing plants

power plants
construction sites

monitoring wells
injection wells
oil wells
water supply wells
exploration wells
geothermal wells
abandoned wells
seismic shot holes

herbicide wholesalers/retailers
pesticide wholesalers/retailers
fertilizer wholesalers/retailers

RESIDENTIAL

septic tanks/drainfields
domestic wells
storage tanks

chemical storage
abandoned wells

PUBLIC WATER SYSTEM OWNER

storm sewer impoundment/discharge
sanitary sewer
lift stations
water/waste treatment
industrial waste disposal
landfills/dumps (active & inactive)
hazardous waste sites

salt/sand piles
snow cleanups
urban runoff

subdivisions
golf courses/parks
water supply wells

cemeteries
animal burial

roads
railroads
airports

Each threshold is a reflection of the risk that a release of a contaminant of concern could exceed a drinking water standard in the source water.[25]

A source water assessment contaminant inventory will:

- ➤ Exclude potential domestic sources (such as homes) from consideration as significant sources, since contaminants of concern are not kept for commercial purposes; and

- ➤ Include other sources within defined source water assessment areas where, (1) indicator contaminants of concern are detected without application of any other thresholds such as amount stored or used; and (2) where contaminants are released to soil or water.

- ➤ Outside the defined source water assessment area, but within the delineated boundary of the local watershed, only major point sources (i.e., RCRA facilities, power plants, large feedlots), which are considered significant potential sources of contamination will be identified.

An indicator contaminant of concern is defined as a chemical compound(s) detected as part of an ambient water quality or other state approved monitoring program. Industries or other activities which utilize an indicator contaminant will be identified in the contaminant source inventory. As an example, the detection of benzene in an ambient monitoring program would result in the inclusion of all commercial or industrial sources of benzene as part of the potential contaminant source inventory. This may include gasoline storage facilities, automotive garages, accidental spill sites, or other activities which have a history of utilizing benzene containing compounds. Typical household or domestic uses of an indicator contaminant of concern will be excluded from the inventory, unless it can be documented that special conditions (i.e., high density of household use) exists. These activities would be included regardless of their past regulatory compliance or permit record.

3.6 Contaminant Source Inventory Strategy

Completion of a contaminant source inventory for each PWS system in North Dakota will require the identification of significant water quality contaminant sources within each source water assessment area. To facilitate the completion of contaminant source inventories in a timely and consistent manner, the NDDH proposes the following strategy.

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[25] The language of this sentence does not end "at a PWS well or intake structure," which would be inconsistent with the provision of best beneficial use policy. The language "to exceed a drinking water standard" translates EPA's use of "contribute significantly" into a measurable quantity, regardless of location within a delineated source water protection area.

An initial contaminant source inventory will be completed utilizing available computer data files of facilities under state regulation or which identify land use. The data search will identify the location and type of facilities, or land use classification, within the delineated surface and ground water source water assessment areas, and will include, at a minimum, data obtained from:

Underground Storage Tank Database
Release or Spill Inventory Database
Confined Animal Feedlot Database
Underground Injection Control Database
National Discharge Pollution Elimination System Database
Water Appropriation Database
Toxics Release Inventory Database
Municipal Landfill Database
Oil and Gas Database
Above Ground Storage Tank Database
CERCLA/RCRA Project Information
Emergency Planning and Right-To-Know Act
Land Use, Soil Classification, and Zoning Maps

This inventory method is considered to meet the initial contaminant source inventory completion mandates identified in EPA guidance. This information will be provided to PWS owners to encourage future source water assessment efforts.

After the NDDH completes a contaminant source inventory, each community and noncommunity PWS can voluntarily complete a more detailed inventory. All PWS systems will be encouraged to augment their contaminant source inventory by:

1. Identifying all potential sources of contamination, as identified in Table 13. Contaminant source inventory forms will be provided by the NDDH to assist in the proper classification and location of potential sources of contamination.

2. Providing this information to the NDDH for inclusion into the PWS system source water assessment file.

Each PWS will be encouraged to update their contaminant source inventory annually, identifying changes in land use or potential contaminant sources. The NDDH will encourage each PWS to update their source inventories through Source Water Protection Newsletters, and direct mailing. Significant changes to a PWS contaminant source inventory or a detection of an indicator contaminant can result in the reevaluation of the susceptibility analysis.

3.7 Determination of PWS Susceptibility

The third element of a source water assessment is the determination of the susceptibility of the source water at a ground water well(s) or surface water intake structure to a contaminant of concern. For purposes of this document, susceptibility will be defined as:

> The likelihood of a drinking water contaminant occurring or being detected at the water intake structure.[26]

The EPA guidance indicates that Congress intended that source water assessments should include an analysis of potential threats to PWS from inventoried sources of contamination. It also mandates that a SWAP plan describe how susceptibility determinations will be: (1) an absolute measure of the potential for contamination of the PWS; (2) a relative comparison between sources within the source water assessment area of the PWS; or (3) some other method that provides for the protection and benefit of PWSs.

Certain physical events must occur in such a sequence that the source water of a PWS contains levels of a contaminant that would pose a concern for PWS operators and the public. First, a release of the contaminant of concern must occur. Second, the contaminant must follow a pathway between the place of release and the source water intake of the PWS. Third, the concentration of the contaminant in the source water at the PWS intake depends upon the quantity released, and ability to be attenuated, and the dilution and depletion of the contaminant along the pathway.

To provide a consistent analysis of potential contaminant threats to a PWS from inventoried sources, a site-specific susceptibility determination must be completed. The North Dakota susceptibility determination process will consider the following elements:

- ➤ The structural integrity of the source water intake.
- ➤ The environment governing the transport of contaminants to the intake structure.
- ➤ The results of the contaminant source inventory.

3.7.1 Source Water from Ground Water Susceptibility Determination

The susceptibility determinations for ground water will be implemented for all community and noncommunity PWSs after an appropriate delineation and contaminant source inventory has been completed. Each well will be evaluated for its relative potential to be adversely impacted by a contaminant of concern.

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[26] Water intake structure is defined to include both ground water wells or surface water intake structure.

The ground water susceptibility determination will include a two tiered approach. Tier I will address well intake integrity and the natural environment. Tier II will address the potential sources of contamination and their relationship to the susceptibility determination from Tier I.

Well integrity is determined by evaluating water well construction logs, results from sanitary surveys[27] conducted by the NDDH and routine bacteriological analysis. Table 14 identifies a water well integrity matrix designed to determine the general integrity of the well. Low integrity wells are identified if a YES answer follows one or more of the questions identified in the table. A high integrity well is determined if a NO answer follows all questions in Table 14.

Aquifer sensitivity determinations were completed as part of the North Dakota Geographic Targeting System (GTS) (Section 2.1.4). The GTS has prioritized all surficial aquifers in classifications of high, moderate, and low vulnerability based upon site-specific geological, hydrological, topographical, and appropriated use. A complete listing of the aquifer vulnerability determinations can be found in Appendix D.

Table 14.
Well Integrity Identification Matrix

	YES	NO
Chronic bacteriological violations*		
Constructed prior to 1971 or does not meet the construction requirements of NDAC 33-18**		
Identification of well structural or operational problems during sanitary survey conducted by state or local health agencies		

* A chronic bacteriological violation is defined as a confirmed bacteriological detection for a community or noncommunity system as defined by the monitoring requirements of the SDWA and which require the implementation of remedial measures (e.g., chlorination).

** North Dakota Water Well Construction and Water Well Pump Installation Article 33-18: Water well and pump installation rules established by the state to ensure the integrity of the well and protection of the public health.

Aquifer vulnerability and well integrity determinations will be incorporated into a Tier I matrix to determine the potential susceptibility of the well intake structure (Table 15).

[27] A sanitary survey completed by the NDDH, typically consist of an on-site review of the water source, facilities, equipment, operation, maintenance, and monitoring compliance of a PWS to evaluate the adequacy of the system, its sources and operations, and the distribution of safe drinking water.

TABLE 15
Groundwater Potential Vulnerability - Tier I Classification

Well Integrity	GTS High/Moderate Aquifer Vulnerability	GTS Low Aquifer Vulnerability
Low Integrity Well	High Potential Vulnerability	Moderate Potential Vulnerability
High Integrity Well	Moderate Potential Vulnerability	Low Potential Vulnerability

A detection of a contaminant of concern at a groundwater well will result in a default determination of a high potential vulnerability for the specific well.

The Tier II assessments will include the vulnerability determinations identified in the Tier I assessment and the sources of concern identified in the contaminant source inventory. The NDDH will have identified the potential sources of acute and chronic contamination within the source water assessment area (Sections 3.4 and 3.6). The NDDH will designate a PWS as vulnerability when a contaminant of concern has been released within a source water vulnerability area resulting in the contamination of the ground water resource. This will be determined by reviewing: (1) of regulated activities for compliance with applicable permit and operational standards, (2) emergency response or contaminant release files, and (3) monitoring reports.

High concern PSCs are defined as compounds with documented unauthorized or accidental release, storage or handling of which do not comply with applicable state/federal permits or regulations, or which have been detected in the source water supply during routine monitoring within a source water assessment area. Low concern PSCs are defined as compounds which are present within a source water assessment area, but have not been released to the environment, the storage or handling comply with applicable requirements, or have not been detected in the source water.

TABLE 16
Groundwater Resource
Probable Vulnerability - Tier II Classification

Tier I Classification	High Concern PSCs*	Low Concern PSCs
High Potential Vulnerability	Susceptible	Susceptible
Moderate Potential Vulnerability	Susceptible	Moderately Susceptible
Low Potential Vulnerability	Moderately Susceptible	Not Likely Susceptible

* Potential Sources of Contamination

** The term “not likely susceptible” recognizes that a zero risk of detectable contaminants in source water will not exist.

3.7.2 Source Water from Surface Water Susceptibility Determination

The NDAC Chapter 33-16-02 defines drinking water as “waters that are suitable for use as a source of water supply for drinking and culinary purposes, after treatment to a level approved by the Department.”

Under the auspices of the SDWA and 305(b) program of the federal Clean Water Act, the NDDH assesses the beneficial use of surface waters for drinking water. The NDDH uses chemical monitoring data when available, as well as citizen complaints on taste and odor. Assessments are conducted by comparing chemical concentration data to North Dakota’s water quality human health criteria for Class I, IA, and II rivers and streams. The NDDH water quality criteria is described briefly in Section 2.1.3.2.

The water quality human health criteria include two means of exposure: (1) ingestion of aquatic organisms; and (2) ingestion of drinking water. Therefore, surface waters having contaminant levels exceeding the criteria are considered “not fully supporting” a drinking water use designation.

More specifically, the beneficial use of drinking water is classified as follows:

> Fully Supporting - For each human health contaminant, more than 50 percent of the samples had concentrations lower than the water quality standard, and there are no drinking water complaints on record.
>
> Fully Supporting but Threatened - For each contaminant, more than 50 percent of the samples had concentrations lower than the water quality standard; however, taste and odor or treatment costs have been associated with pollutants.
>
> Partially Supporting - For at least one contaminant, more than 50 percent of the samples exceed the human health standard, and/or frequent taste and odor complaints are on record.
>
> Not Supporting - Drinking water supply closure has occurred within the last five years.

An indication of the degree to which a surface water system is susceptible to contamination in North Dakota will be based upon the ongoing surface water quality assessments identified in the 305(b) North Dakota Water Quality Assessment Report and individual contaminant source inventories (i.e., sanitary survey and routine water quality monitoring). It is important to note that the 305(b) water quality classifications identified above are an indicator of anthropomorphic and natural water quality impacts on a surface water system. The assessments provide an indication of the hydrologic sensitivity to such factors as land use,

nonpoint and point sources of contamination, and the natural variations in water quality associated with northern climates.

To aid in a surface water susceptibility determination, the source water 305(b) classifications identified above and the contaminant sources of concern are combined on Table 17. The NDDH will have identified potential sources of acute and chronic contamination within the source water assessment areas (Section 3.6).

TABLE 17
Surface Water Susceptibility - Classification

305(b) Class Determination	High Concern PSCs*	Low Concern PSCs
Fully Supporting	Moderately Susceptible	Moderately Susceptible
Fully Supporting but threatened	Moderately Susceptible	Moderately Susceptible
Partially Supporting	Susceptible	Moderately Susceptible
Not Supporting	Susceptible	Susceptible

* Potential Sources of Contamination

High concern PSCs are defined as compounds with documented unauthorized or accidental release, storage or handling of which do not comply with applicable state/federal permits or regulations, or which have been detected in the source water supply during routine monitoring within a source water assessment area. Low concern PSCs are defined as compounds which are present within a source water assessment area, but have not been released to the environment, the storage or handling comply with applicable requirements, or have not been detected in the source water.

Future susceptibility assessments may be conducted if additional contaminant sources are identified within a source water assessment area or if the original 305(b) classification used to determine a susceptibility classification is changed.

Note that a detection of a contaminant of concern at the surface water intake, or the identification of a surface water intake as having a low integrity intake during a sanitary survey, can result in a default classification of susceptible.

3.8 Source Water Assessment Plan Anticipated Outcome

The North Dakota SWAP plan is designed to provide a realistic assessment based upon the existing state/local regulatory structure, as well as site-specific conditions and use for all sizes of PWSs in the state. The North Dakota SWAP will be implemented initially by the NDDH for the protection and benefit of each PWS and is anticipated to result in the following:

- The establishment of a source water assessment plan for each community and noncommunity PWS in the state, based upon site-specific information and system use.

- Identify sources of contamination which have the greatest potential to adversely impact a drinking water source.

- Provide the necessary tools and information to all PWS owners to allow them the opportunity to address the contaminant issues of concern identified in their source water assessments. The hope is that each PWS will develop comprehensive water quality protection strategies consistent with their local conditions and protection goals.

The state recognizes that the completion of the North Dakota SWAP plan is the initial step in the source water assessment process. The NDDH will continue to encourage the establishment of comprehensive source water assessment plans by each PWS through the development and implementation of appropriate site-specific protection strategies.

Chapter 4. SWAP Plan Implementation

The successful implementation of the North Dakota SWAP plan is contingent upon many factors including, coordination between federal, state and local organizations, and the commitment of these organizations to utilize assessments when considering future water protection strategies. This chapter discusses how the SWAP plan will be implemented and promoted in the future by identifying: (1) Plan Implementation Schedule; (2) Stakeholder Coordination; (3) Project Implementation Resource Requirements; (4) SWAP plan reporting; and (5) SWAP plan updates.

4.1 SWAP Plan Implementation Schedule

The NDDH anticipates completion of all elements of the SWAP plan within the time restraints identified by Congress. Congress has identified two program plan completion dates, with the initial date identified as November 6, 2001 and an extended completion date of May 6, 2003. Because the NDDH will implement all elements of the SWAP plan using existing staff and technical resources, an extension to May 6, 2003 will be requested. This request is provided to allow for staff turnover, training and other unforseen contingencies which may delay complete implementation of the SWAP plan. The schedule for plan development, approval and implementation is outlined in Table 18.

Table 18
North Dakota SWAP Plan Completion Schedule

Program Activity	Completion Date
Plan Development	February 1999
Plan Submittal to EPA Region VIII	February 8, 1999
EPA Review and Approval	November 8, 1999
Plan Implementation of All Elements	November 6, 2001
Plan Implementation (Time Extension)	May 6, 2003

4.2 Lead State Agency Role and Stakeholder Coordination

The NDDH is the lead state agency responsible for the completion of all elements of PWS source water assessments. Source water delineations, contaminant source inventories and susceptibility analysis will be completed as described in the North Dakota SWAP plan. However, the NDDH will go beyond the initial completion of each source water assessment

by encouraging public involvement, and development of protection programs through an established notification process.

The role of the NDDH in the SWAP plan implementation will be:

- Initial completion of all elements of the approved SWAP plan for each PWS in the state;

- Prompt notification of all interested parties, including federal, state and local agencies, of the availability of completed source water assessments;

- Promote the development of each source water assessment into a water protection program. This may be accomplished through public notification or cooperative agreements with other federal, state or local agencies. An example is the execution of an existing cooperative agreement between the North Dakota Rural Water Association and the NDDH. The North Dakota Rural Water Association has agreed to assist specific PWS's in the development of appropriate water protection ordinances and plans.

4.2.1 Role of Supporting Federal, State and Local Organizations

The role of supporting federal, state and local organizations will be to assist in SWAP plan implementation through the collection of environmental data, technical review or local program involvement. These activities are typically conducted through the completion of each organization's legislatively assigned duties and responsibilities. These assigned responsibilities may complement the implementation of a source water assessment but were not initially established to accomplish this mission (e.g., water quantity determinations by the SWC).

Experience with the implementation of the North Dakota Wellhead Protection Program has indicated program support and use from the following organizations:

Organization	Assistance Provided
North Dakota SWC	Water quality and quantity data, technical review of specific source water assessment plans.
North Dakota Geological Survey	Technical review of specific source water assessments.

Organization	Assistance Provided
Environmental State Regulatory Programs	Utilization of completed source water assessments as statutorily required (e.g., landfill siting, drinking water program)
Natural Resource Conservation Service	Utilization of completed source water assessments as statutorily required (e.g., conservation reserve program)
EPA	Utilization of completed source water assessments as statutorily required (e.g., proposed underground injection control laws)
Local organizations and PWS owner	Utilization of source water assessments to enhance or promote local source water protection efforts.

Organizations or agencies not identified above will be encouraged to utilize or comment on each source water assessment. However, the NDDH acknowledges that support is provided voluntarily as a benefit to the implementation of the SWAP plan.

4.3 Project Implementation Resource Requirements

To implement the North Dakota SWAP, the NDDH proposes to utilize the existing expertise developed through the implementation of the North Dakota Wellhead Protection Program. The proposal for the NDDH to complete SWAP plan activities is justified by: (1) the NDDH has achieved over 85 percent participation in the Wellhead Protection Program; (2) a total of approximately 650 PWS's are identified; and (3) the NDDH has developed the experience and technical expertise to satisfactorily complete all assessments. The ability to implement the SWAP plan is divided into three areas which include human resources as well as technical and financial capacity.

4.3.1 Human Resources

The NDDH maintains a trained professional staff dedicated to the completion of PWS Wellhead Protection Programs. To complete the source water assessments as identified, the NDDH will continue to dedicate 2 to 3 full time employees directed to complete all elements of the SWAP plan. Based upon the number of PWS's, SWAP plan proposal, and the current level of effort established in the completion of individual Wellhead Protection programs, the NDDH considers this level of involvement adequate.

4.3.2 Technical Capacity

The NDDH maintains a professional staff trained in the use of approved Wellhead Protection Area modeling software and industry accepted GIS software packages. This technical expertise, coupled with the widespread knowledge and availability of data relating to the state's water resources identified in Chapter 2, is considered adequate to complete the SWAP plan as proposed.

4.3.3 Financial Capacity

The NDDH will rely on existing federal (e.g., Clean Water Act and SDWA) and state general funding to complete the SWAP plans. In addition, to assist in the completion of noncommunity PWS source water assessments, the NDDH will explore the potential to utilize the North Dakota Drinking Water Revolving Loan fund. This may be utilized to hire temporary employees to complete the noncommunity source water assessments.

4.4 SWAP Plan Reporting

Complete status of SWAP plan activities in North Dakota will be reported to EPA through existing reporting requirements. These include:

- Annual end of year water quality program status reports to EPA Region VIII,
- Biennial Source Water Assessment Status Report, formerly Wellhead Protection Program Status Report, to EPA Region VIII and EPA Headquarters,
- Identification of SWAP plan activities in 305(b) Water Quality Report to Congress.

Additional reporting of SWAP plan activities may be considered at the request of EPA.

4.5 SWAP Plan Updates

The need to modify or amend each source water assessment will be routinely evaluated by the NDDH, or local PWS. Evaluation of completed source water assessments will be completed by the NDDH under the following scenarios:

- Once every five years after the initial completion of the source water assessment or more frequently if;
- Water quality monitoring, as part of the SDWA or ambient monitoring program, identifies a new contaminant of concern; or

- Identification of a new activity in the contaminant source inventory which has the potential to impact water quality; or

- A change in the PWS configuration (e.g., new well or intake structure, or new water source); or

- A request by the PWS to evaluate the existing source water assessment for accuracy and completeness.

APPENDIX A

Public Participation and

Responsiveness

Summary

APPENDIX B

List of

PWSs

which Draw Water

from Surface Water Resources

PWSs
Drawing Source Water from Surface Waters.

PWS Name	PWS City	Population	Source	PWS Type
Antelope Valley Station	Beulah	207	Lake Sakakawea	NT NC
Bismarck, City of	Bismarck	49,256	Missouri River	Community
Coal Creek Station	Underwood	486	Missouri River	NT NC
Coyote Station	Beulah	227	Missouri River	NT NC
Dakota Gasification Co	Beulah	700	Lake Sakakawea	NT NC
Dickinson, City of	Dickinson	16,097	Lake Sakakawea	Community
Downstream Campground	Riverdale	280	Lake Sakakawea	T NC
Drayton, City of	Drayton	961	Red River	Community
Fargo, City of	Fargo	74,111	Sheyenne River	Community
Fargo, City of	Fargo	74,111	Red River	Community
Garrison, City of	Garrison	1,530	Lake Sakakawea	Community
Garrison Power Plant	Riverdale	26	Lake Sakakawea	NT NC
Grafton, City of	Grafton	5,086	Park River	Community
Grafton, City of	Grafton	5,086	Red River	Community
Grand Forks, City of	Grand Forks	49,425	Red River	Community
Grand Forks, City of	Grand Forks	49,425	Red Lake River	Community
Lake Sakakawea State Park	Pick City	300	Lake Sakakawea	T NC
Langdon, City of	Langdon	2,241	Mulberry Creek Res. 2nd Line	Community
Langdon, City of	Langdon	2,241	Mulberry Creek Res. 1st Line	Community
Langdon, City of	Langdon	2,241	Mt. Carmel Dam	Community
Leland Olds Station	Stanton	50	Missouri River	NT NC
Mandan, City of	Mandan	15,177	Missouri River	Community
Mayville, City of	Mayville	2,092	Goose River	Community
Minot, City of	Minot	34,544	Souris River	Community
Park River, City of	Park River	1,725	Homme Dam (Park River)	Community
Parshall, City of	Parshall	943	Lake Sakakawea	Community
Pembina, City of	Pembina	642	Red River	Community
Pick City, City of	Pick City	203	Lake Sakakawea	Community
Progold, Inc.	Wahpeton	65	Red River	NT NC
Riverdale, City of	Riverdale	283	Lake Sakakawea	Community
United Power Association	Stanton	75	Missouri River	NT NC

PWS Name	PWS City	Population	Source	PWS Type
Valley City, City of	Valley City	7,163	Sheyenne River	Community
Washburn, City of	Washburn	1,506	Missouri River	Community
Williston, City of	Williston	13,131	Missouri River	Community

T = Transient NT = Nontransient NC = Noncommunity

APPENDIX C

Lists of

PWSs

which Draw Water

from Ground Water Resources

Community PWSs
Which Draw Source Water from Ground Water.

PWS Name	PWS City	Population	100% Consecutive
Abercrombie, City of	Abercrombie	252	-
Agassiz Water Users, Inc.	Gilby	3,151	-
Alexander, City of	Alexander	216	-
All Seasons WUA-System I	Bottineau	753	-
All Seasons WUA-System II	Bottineau	300	-
All Seasons WUA-System III	Bottineau	1,137	-
All Seasons WUA-System IV	Bottineau	97	-
Amenia, City of	Amenia	82	Yes
Anamoose, City of	Anamoose	277	-
Aneta, City of	Aneta	314	Yes
Apple Valley Coop	Menoken	300	-
Argusville, City of	Argusville	161	Yes
Arthur, City of	Arthur	400	-
Arvilla Water Users Association	Arvilla	150	Yes
Ashley, City of	Ashley	1,052	-
Barnes Rural Water Users, Inc.	Valley City	3,291	-
Barney, City of	Barney	79	Yes
Battleground Addition	Minot	95	-
Beach, City of	Beach	1,205	-
Benedict, City of	Benedict	52	-
Berlin, City of	Berlin	32	Yes
Berthold, City of	Berthold	409	-
Beulah, City of	Beulah	3,363	-
Binford, City of	Binford	233	-
Bisbee, City of	Bisbee	227	-
Bottineau, City of	Bottineau	2,598	-
Bowbells, City of	Bowbells	498	-
Bowdon, City of	Bowdon	196	-

PWS Name	PWS City	Population	100% Consecutive
Bowman, City of	Bowman	1,741	-
Braddock, City of	Braddock	56	-
Brooktree Wells, Inc.	Harwood	54	-
Buffalo, City of	Buffalo	204	Yes
Burlington, City of	Burlington	995	-
Cando, City of	Cando	1,564	-
Carrington, City of	Carrington	2,267	-
Carson, City of	Carson	383	-
Cass Rural WU-Phase I	Kindred	2,722	-
Cass Rural WU-Phase II	Kindred	1,522	-
Cass Rural WU-Phase III	Kindred	1,606	-
Casselton, City of	Casselton	1,601	Yes
Cathay, City of	Cathay	54	-
Cavalier Air Force Station	Concrete	150	-
Cavalier, City of	Cavalier	1,508	Yes
Center North System	Center	413	-
Center South System	Center	413	-
Christine Water and Sewer	Christine	160	-
Cogswell, City of	Cogswell	184	-
Coleharbor, City of	Coleharbor	88	Yes
Colfax, City of	Colfax	80	Yes
Colony Trailer Park	Minot	100	-
Columbus, City of	Columbus	223	-
Cooperstown, City of	Cooperstown	1,247	-
Country Club Co-op	Bismarck	96	Yes
Crary, City of	Crary	145	-
Crosby, City of	Crosby	1,312	-
Dakota Adventist Academy	Bismarck	125	-
Dakota Water Users North	Finley	672	-
Dakota Water Users South	Finley	1,200	-
Davenport, City of	Davenport	218	Yes

PWS Name	PWS City	Population	100% Consecutive
Dazey, City of	Dazey	129	-
Deering, City of	Deering	99	-
Devils Lake , City of	Devils Lake	7,782	-
Dickey Rural Water Users Assoc.	Edgeley	45	-
Drake, City of	Drake	361	-
Dunseith, City of	Dunseith	723	-
Edgeley, City of	Edgeley	680	Yes
Elgin, City of	Elgin	765	-
Ellendale, City of	Ellendale	1,798	Yes
Elliott, City of	Elliott	32	-
Emerado, City of	Emerado	483	Yes
Enderlin, City of	Enderlin	997	-
Esmond, City of	Esmond	196	-
Fairmount, City of	Fairmount	427	-
Fessenden, City of	Fessenden	655	Yes
Fingal, City of	Fingal	138	-
Finley, City of	Finley	543	Yes
Flasher, City of	Flasher	317	-
Flaxton, City of	Flaxton	121	-
Forman, City of	Forman	586	-
Fortuna, City of	Fortuna	53	-
Fradets Orchard Water System	Horace	56	-
Fullerton, City of	Fullerton	94	Yes
Gackle, City of	Gackle	450	-
Galesburg, City of	Galesburg	161	-
Gardner, City of	Gardner	85	Yes
Glen Ullin, City of	Glen Ullin	927	-
Glenburn, City of	Glenburn	439	Yes
Glenfield, City of	Glenfield	118	-
Golva, City of	Golva	88	-
Goodrich, City of	Goodrich	192	-

PWS Name	PWS City	Population	100% Consecutive
Grand Forks-Traill WUA	Thompson	5,760	-
Grandin, City of	Grandin	213	Yes
Granville, City of	Granville	236	-
Grenora, City of	Grenora	261	-
Gwinner, City of	Gwinner	585	-
Hague, City of	Hague	109	-
Hankinson, City of	Hankinson	1,038	-
Hannaford, City of	Hannaford	204	-
Harvey, City of	Harvey	2,263	-
Harwood, City of	Harwood	590	-
Hatton, City of	Hatton	800	Yes
Havana - North System	Havana	33	-
Havana - South System	Havana	62	-
Hazelton, City of	Hazelton	240	-
Hazen, City of	Hazen	2,818	-
Hebron, City of	Hebron	888	-
Hettinger, City of	Hettinger	1,574	-
Hillsboro, City of	Hillsboro	1,488	-
Home on the Range for Boys	Sentinel Butte	65	-
Hope, City of	Hope	281	Yes
Horace, City of	Horace	662	-
Horseshoe Bend Addition	Horace	72	-
Hunter, City of	Hunter	341	Yes
Jamestown, City of	Jamestown	15,571	-
Jud, City of	Jud	84	-
Karlsruhe, City of	Karlsruhe	143	-
Kathryn, City of	Kathryn	72	-
Kenmare, City of	Kenmare	1,214	-
Kensal, City of	Kensal	191	-
Killdeer, City of	Killdeer	772	-
Kindred, City of	Kindred	569	Yes

PWS Name	PWS City	Population	100% Consecutive
Kulm, City of	Kulm	514	Yes
Lakota, City of	Lakota	898	-
LaMoure, City of	La Moure	970	-
Larimore, City of	Larimore	1,464	-
Leeds, City of	Leeds	542	-
Lehr, City of	Lehr	191	-
Lidgerwood, City of	Lidgerwood	799	-
Lignite, City of	Lignite	242	-
Lincoln, City of	Lincoln	1,132	-
Linton, City of	Linton	1,410	-
Lisbon, City of	Lisbon	2,177	-
Litchville, City of	Litchville	205	Yes
Ludden, City of	Ludden	41	-
Maddock, City of	Maddock	559	-
Makoti, City of	Makoti	154	-
Mantador, City of	Mantador	77	Yes
Mapleton, City of	Mapleton	682	Yes
Marmarth, City of	Marmarth	144	-
Maxbass, City of	Maxbass	123	-
McClusky, City of	Mc Clusky	492	Yes
McVille, City of	Mc Ville	559	-
Mclean-Sheridan Rural Water	Mc Clusky	1,176	-
Meadowbrook Park Road & Water, Inc.	West Fargo	80	-
Medina, City of	Medina	387	-
Medora, City of	Medora	101	-
Mercer, City of	Mercer	104	-
Michigan, City of	Michigan	413	-
Milnor, City of	Milnor	651	Yes
Milton, City of	Milton	133	Yes
Minnewaukan, City of	Minnewaukan	401	-
Minot Mobile Estates	Minot	105	-

PWS Name	PWS City	Population	100% Consecutive
Minto, City of	Minto	560	-
Mohall, City of	Mohall	931	-
Monango, City of	Monango	53	-
Montpelier, City of	Montpelier	82	Yes
Mooreton, City of	Mooreton	193	Yes
Mountain, City of	Mountain	134	Yes
Napoleon, City of	Napoleon	930	-
New Leipzig, City of	New Leipzig	326	-
New Rockford, City of	New Rockford	1,604	-
New Town, City of	New Town	1,388	-
Newburg, City of	Newburg	104	-
Nome, City of	Nome	67	-
Noonan, City of	Noonan	231	-
North Prairie RWU-System III	Minot	405	-
North Valley WUA-System II	Cavalier	2,860	-
North Valley WUA-System III	Cavalier	195	-
Oakes, City of	Oakes	1,775	-
Oberon, City of	Oberon	103	-
Oriska, City of	Oriska	103	Yes
Osnabrock, City of	Osnabrock	214	Yes
Oxbow, City of	Oxbow	100	-
Page, City of	Page	266	-
Pekin, City of	Pekin	101	-
Plaza, City of	Plaza	193	-
Portal, City of	Portal	192	-
Portland, City of	Portland	602	Yes
Powers Lake, City of	Powers Lake	408	-
Ramsey Rural Water & Sewer	Devils Lake	1,868	-
Ransom-Sargent Water Users, Inc.	Lisbon	169	Yes
Ray and Tioga Water System	Ray and Tioga	2,363	-
Reeder, City of	Reeder	252	-

PWS Name	PWS City	Population	100% Consecutive
Rhame, City of	Rhame	186	-
Riverdale Subdivision	Fargo	80	-
Robinson, City of	Robinson	87	-
Rock Lake, City of	Rock Lake	221	-
Rolette, City of	Rolette	623	-
Rolla, City of	Rolla	1,286	-
Ross, City of	Ross	61	-
Rugby, City of	Rugby	2,909	-
Rutland, City of	Rutland	212	Yes
Ryder, City of	Ryder	121	-
Sanborn, City of	Sanborn	164	Yes
Sawyer, City of	Sawyer	319	-
Scranton, City of	Scranton	294	-
Selfridge, City of	Selfridge	242	-
Selkirk Settlement	Fargo	50	-
Selz Water Users Association	Selz	45	-
Sentinel Butte, City of	Sentinel Butte	79	-
Sharon, City of	Sharon	119	-
Sheldon, City of	Sheldon	149	Yes
Sherwood, City of	Sherwood	286	-
Sheyenne, City of	Sheyenne	272	-
Sheyenne Mobile Home Park	Lisbon	43	-
Sibley, City of	Sibley	49	-
Sleepy Hollow Water Company	Horace	100	-
Solen, City of	Solen	92	-
Souris, City of	Souris	97	-
South Heart , City of	South Heart	322	-
Southeast Water Authority	Mantador	3,220	-
St. John, City of	St. John	368	Yes
St. Thomas, City of	St. Thomas	444	Yes
Stanley, City of	Stanley	1,371	Yes

PWS Name	PWS City	Population	100% Consecutive
Stanton, City of	Stanton	517	-
Steele, City of	Steele	762	-
Strasburg, City of	Strasburg	553	-
Streeter, City of	Streeter	161	-
Stutsman Rural Water Users, Inc.	Jamestown	3,000	-
Sykeston, City of	Sykeston	167	Yes
Talbott Trailer Court	Minot	60	-
Tolna, City of	Tolna	230	Yes
Tower City, City of	Tower City	233	Yes
Towner, City of	Towner	669	-
Traill County Water Users	Portland	2,200	-
Tri-county Water Users , Inc.	Petersburg	2,800	-
Turtle Lake, City of	Turtle Lake	681	Yes
Tuttle, City of	Tuttle	160	-
Underwood, City of	Underwood	976	-
Upham, City of	Upham	205	-
Upper Souris WUA-System I	Kenmare	1,308	-
Upper Souris WUA-System II	Kenmare	195	-
Velva, City of	Velva	968	-
Venturia, City of	Venturia	30	-
Verona, City of	Verona	103	Yes
Wahpeton, City of	Wahpeton	9,270	-
Walcott, City of	Walcott	178	-
Walhalla, City of	Walhalla	1,131	-
Walsh Water Users	Grafton	3,600	-
Warwick, City of	Warwick	80	-
Watford City, City of	Watford City	1,784	-
Wells County Rural Water	Fessenden	2,087	-
West Fargo, City of	West Fargo	12,287	-
West River Water and Sewer	Minot	400	Yes
Westhope, City of	Westhope	578	-

PWS Name	PWS City	Population	100% Consecutive
Wildrose, City of	Wildrose	193	-
Willow City, City of	Willow City	281	-
Wilton, City of	Wilton	728	-
Wimbledon, City of	Wimbledon	275	-
Wing, City of	Wing	208	-
Wishek, City of	Wishek	1,171	-
Woodworth, City of	Woodworth	97	-
Wyndmere, City of	Wyndmere	501	-
Zap, City of	Zap	287	-
Zeeland, City of	Zeeland	197	-

Noncommunity Water PWSs
Which Draw Source Water from Ground Water.

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Alexander Water Spring	Alexander	25	T/NC	-
All American Steakhouse Lounge	Maddock	50	T/NC	-
Alsen Curling Club Cafe	Alsen	50	T/NC	-
Ambrose C Well	Ambrose	75	T/NC	-
Amoco Petroleum Products Terminal	Jamestown	25	T/NC	-
Andrus Resort/little Missouri	Dunn Center	70	T/NC	-
Arnegard Ballpark	Arnegard	25	T/NC	-
Arnegard Cafe	Arnegard	75	T/NC	-
Asbury Camp Meeting Assoc.	Washburn	100	T/NC	-
Baker Boy Supply	Dickinson	100	NT/NC	-
Beach Well # 2	Dickinson	100	T/NC	-
Beaver Creek Rec Area	Linton	25	T/NC	-
Beaver Lake State Park	Burnstad	150	T/NC	-
Behms Truck Stop Cafe	Minot	100	T/NC	-
Beulah Bay Rec Area	Beulah	25	T/NC	-
Big Coulee Dam Rec Area	Bisbee	25	T/NC	-
Birchwood, Inc.	Bottineau	70	T/NC	-
Boat Ramp 74	Bottineau	100	T/NC	-
Border Central High School	Calvin	65	NT/NC	-
Bottineau Winter Park Ski Area	Bottineau	126	T/NC	Yes
Bowman Haley Marina	Bowman	25	T/NC	-
Brendle’s Travel Trailer Crt	Parshall	70	T/NC	-
Buffalo Trails Campground	Williston	80	T/NC	-
Burning Hills Amphitheater	Medora	900	T/NC	-
Butte Public School	Butte	97	NT/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Camel Hump Rest Area North	Dickinson	180	T/NC	-
Camel Hump Rest Area South	Dickinson	180	T/NC	-
Camp Bentley	Drake	100	T/NC	-
Cannonball Stage Station S H Site	Carson	25	T/NC	-
Carbury Recreation Area	Bottineau	25	T/NC	-
Carlson's Water Service	Kenmare	50	T/NC	-
Center Mine (BN)	Center	135	NT/NC	-
Clausen Springs Rec Complex	Kathryn	25	T/NC	-
Club 85 Bar	Fairfield	50	T/NC	-
C Recreation Center	Esmond	40	T/NC	-
Corrigidor Bar	Wolford	30	T/NC	-
Cottonwood Campground 6	Medora	90	T/NC	-
Cottonwood Park	Bismarck	250	T/NC	-
Cozy Corner Cafe	Balfour	200	T/NC	-
Crappie Creek North	Glen Ullin	25	T/NC	-
Crappie Creek Rec Area	Glen Ullin	25	T/NC	-
Crookston's Resort	Bottineau	50	T/NC	-
Cross Ranch State Park	Hensler	50	T/NC	-
Crossroads Cafe	Churchs Ferry	75	T/NC	-
Crossroads Restaurant	Killdeer	200	T/NC	-
Crystal Springs Baptist Camp	Medina	50	T/NC	-
Crystal Springs Rest Area	Crystal Springs	300	T/NC	-
Dakota Prairie Cafe	Butte	35	T/NC	-
Dakota's Bar and Diner	New England	40	T/NC	-
Dawn 2 Dusk Amoco	Minot	150	T/NC	-
Dawson Cafe	Dawson	30	T/NC	-
De Mores Chateau	Medora	110	T/NC	-
Deepwater Campground	Riverdale	25	T/NC	-
Deering Township Well	Deering	30	T/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Douglas Creek Rec Area	Riverdale	25	T/NC	-
Downstream Rec Area	Elgin	30	T/NC	-
Doyle Memorial State Park	Wishek	40	T/NC	-
Driscoll Cafe	Driscoll	60	T/NC	-
Driscoll Public School	Driscoll	75	NT/NC	-
Duane Jacques (Water Hauler)	Kramer	40	T/NC	-
Eagles Aerie 2968	Lisbon	125	T/NC	-
Elks Camp Grassick	Dawson	120	T/NC	-
Enderlin Golf Course	Enderlin	40	T/NC	-
Englevale Rural Water System	Englevale	40	T/NC	-
Exit 42 Campgrounds	Belfield	25	T/NC	-
Federal Beef Processors, Inc.	West Fargo	200	NT/NC	-
Finn Rest Area	Rolla	50	T/NC	-
Flying J Motel	Fargo	30	T/NC	-
Fordville Public School	Fordville	130	NT/NC	-
Fort Buford State Historic Site	Williston	25	T/NC	-
Fort Lincoln State Park	Mandan	500	T/NC	-
Fort Seward State Historic Site	Jamestown	25	T/NC	-
Fort Union Historic Site # 12	Williston	79	T/NC	-
Four Corners Cafe	Fairfield	40	T/NC	-
Frank’s Place	Bantry	25	T/NC	-
Freedom Mine	Beulah	220	NT/NC	-
Fryburg School	Fryburg	40	NT/NC	-
Garden Gate Golf Club	Dunseith	45	T/NC	-
Garden Valley School	Williston	55	NT/NC	-
Geneseo Bar & Cafe	Geneseo	25	T/NC	-
George's Gathering	Dunseith	100	T/NC	-
Glen Berg Water Hauler	Berthold	36	T/NC	-
Grahams Island	Devils Lake	100	T/NC	Yes
Grandview Motel	Williston	25	T/NC	-
Graner Park	Mandan	150	T/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Granite Springs Water Co	Minot	30	T/NC	-
Grassy Butte Elem. School	Grassy Butte	27	NT/NC	-
Group Camp Complex 71	Bottineau	100	T/NC	-
Hahns Bay Recreation Area	Bottineau	80	T/NC	-
Hannah Bar	Hannah	50	T/NC	-
Heart Butte F U Camp	Elgin	65	T/NC	-
Henry Topolski (Water Hauler)	Portal	25	T/NC	-
Home Plate Cafe	Fredonia	40	T/NC	-
Hunter's Lodge	Butte	30	T/NC	-
Hurdsfield Dairy King	Hurdsfield	200	T/NC	-
Indian Hills Resort	Garrison	25	T/NC	-
International Peace Gardens	Dunseith	25	T/NC	-
Jack's Bar	Maida	25	T/NC	-
Jeff's Water Service	Flaxton	350	T/NC	-
Johnson Corner School	Watford City	55	NT/NC	-
Kautzman Brothers Manufacturing	West Fargo	50	NT/NC	-
Kelvin Klinic Bar	Dunseith	40	T/NC	-
Kite Cafe	Michigan	48	T/NC	-
Knickerbocker Liquor Locker	Hickson	30	T/NC	-
Knife River Indian Village	Stanton	50	T/NC	Yes
Knights of Columbus Club	Dickinson	200	T/NC	-
KOA Campground - Jamestown	Jamestown	25	T/NC	-
KOA Campground	Minot	50	T/NC	-
Kojak's Bar	Leonard	50	T/NC	-
Ladish Malting Co.	Spiritwood	50	NT/NC	-
Lady Bird Restaurant	Leonard	40	T/NC	-
Lake Tschida-Residence	Glen Ullin	25	T/NC	-
Lake View Supper Club	Hankinson	50	T/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Lakeshore Estates	Beulah	25	T/NC	-
Lakeside Marina Campground	Jamestown	100	T/NC	-
LaMoure County Memorial Park	Grand Rapids	25	T/NC	-
Larson's Drive Inn	Larimore	30	T/NC	-
Leonard Cafe & Grocery	Leonard	50	T/NC	-
Lidgerwood Park	Lidgerwood	30	T/NC	-
Little Missouri State Prim. Park	Killdeer	25	T/NC	-
Little Yellowstone Park	Kathryn	25	T/NC	-
Long X Saloon	Grassy Butte	50	T/NC	-
Long X Trailer Court	Watford City	100	T/NC	-
Maid O Moon Shine Campground	Bottineau	100	T/NC	-
McKenzie Bar	Mc Kenzie	30	T/NC	-
McKenzie Ranger District	Watford City	25	T/NC	-
Medina Rest Area	Medina	300	T/NC	-
Medora Campground	Medora	60	T/NC	-
Medora Campground II	Medora	175	T/NC	-
Metigoshe Drive Inn	Bottineau	30	T/NC	-
Metigoshe Ministries-Center Site	Bottineau	25	T/NC	-
Metigoshe Ministries-Pelican Lake	Bottineau	150	T/NC	-
Minot Country Club	Minot	60	T/NC	-
Mouse River F U Camp	Velva	70	T/NC	-
MPC-Milton R. Young Station Well	Center	200	NT/NC	-
Mt. Carmel Recreation Area	Langdon	100	T/NC	Yes
Munich Cafe and Bowl	Munich	100	T/NC	-
Munich Public School	Munich	225	NT/NC	-
Napoleon Livestock Cafe	Napoleon	400	T/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
New Town Marina	New Town	30	T/NC	-
Nick and Helen's Bar	Clyde	50	T/NC	-
Noonan City Well 1 (Coffee)	Noonan	100	T/NC	-
North Central of Barnes	Rogers	300	NT/NC	-
North Side Trailer Area # 2	Glen Ullin	25	T/NC	-
Northern Plains Natural Gas	Zeeland	0	NT/NC	-
Northgate Port of Entry	Northgate	100	T/NC	-
Northshore Concessions	Glen Ullin	25	T/NC	-
Oakes Golf Club	Oakes	50	T/NC	-
Orluck Water Haulers	Makoti	25	T/NC	Yes
Orvin Loftsgard Water Hauler	Hoople	200	T/NC	-
Outpost Motel	Beach	25	T/NC	-
Painted Canyon Overlook #7	Medora	90	T/NC	-
Panger Rest Area	Williston	75	T/NC	-
Park River Bible Camp	Park River	50	T/NC	-
PDQ Club	Arnegard	50	T/NC	-
Peaceful Valley Picnic # 4	Medora	40	T/NC	-
Peaceful Valley Ranch # 2	Medora	25	T/NC	-
Pelican Lake Campground	Bottineau	40	T/NC	-
Pettibone Public School	Pettibone	100	NT/NC	-
Pilgrim Park	Bottineau	25	T/NC	-
Pinky’s Club	Killdeer	50	T/NC	-
Pioneer Park	Bismarck	30	T/NC	-
Pleasant Lake Rest Area	Rugby	1000	T/NC	-
Prairie Jr. High	Fairfield	25	NT/NC	-
Prairie School	Fairfield	60	NT/NC	-
Queen City Park Well # 5	Dickinson	50	T/NC	-
R-J Bar	Munich	30	T/NC	-
Rasmussen # 3	Medora	90	T/NC	-
Red Willow Bible Camp	Binford	29	T/NC	-
Red Willow Lake Resort	Binford	300	T/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Rimrock Rec Area	Glen Ullin	40	T/NC	-
Rimrock Rec at Highway 49	Glen Ullin	25	T/NC	-
Riverside Supper Club	Ludden	30	T/NC	-
Roma’s Pizza	Emerado	50	T/NC	-
Rough Rider Camper Park	Minot	25	T/NC	-
Round Prairie School	Williston	100	NT/NC	-
Rud’s Interstate Standard	New Salem	50	T/NC	-
Rugby Eagles Aerie # 3834	Rugby	100	T/NC	-
Rugby Golf Club	Rugby	25	T/NC	-
Sand Dune Saloon	Mc Leod	40	T/NC	-
Sandy Lake Recreation Area	Bottineau	40	T/NC	-
Sarles Bar	Sarles	25	T/NC	-
Schatz’s Point	Glen Ullin	25	T/NC	-
Schoolhouse Cafe	Grace City	25	T/NC	-
Senior Citizen Building	Powers Lake	55	T/NC	-
Shelver’s Grove	Devils Lake	100	T/NC	Yes
Sheyenne Lodge	Valley City	30	T/NC	-
Smokey’s Pressure System # 3	Jamestown	25	T/NC	-
South Patterson Well # 6	Dickinson	30	T/NC	-
Sportsman’s Bar	Spiritwood	30	T/NC	-
Springbrook Bar	Springbrook	25	T/NC	-
Squaw Creek Campground # 11	Watford City	67	T/NC	-
Stake Out	Lisbon	100	T/NC	-
Stockman's Cafe	Bismarck	25	T/NC	-
Stockmen's Livestock Cafe	Dickinson	30	T/NC	-
Strawberry Lake Campground	Bottineau	25	T/NC	-
Sully Creek State Park	Medora	25	T/NC	-
Sully’s Hill Natl Game Preserve	Fort Totten	200	T/NC	-
T RoosevelT/Natl Pk-North	Watford City	128	T/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Tappen Public School	Tappen	160	NT/NC	-
Tennis Court Well	Dickinson	75	T/NC	-
The Bar	Williston	50	T/NC	-
The Big D	Dawson	30	T/NC	-
The Big Opening	Fairview	80	T/NC	-
The Curve Nite Club	Mott	35	T/NC	-
The Food Barn	Powers Lake	50	T/NC	-
The Hideout	Killdeer	40	T/NC	-
The Office (McCanna)	McCanna	25	T/NC	-
Tioga Golf and Country Club	Tioga	65	T/NC	-
Tobacco Garden Recreation Area	Watford City	50	T/NC	-
Top's Motel	Sterling	25	T/NC	-
Top's Restaurant	Sterling	400	T/NC	-
Town & Country Grill	McHenry	50	T/NC	-
Towner State Nursery	Towner	45	T/NC	-
Traynor Park	New Town	25	T/NC	-
Triangle Y Camp	Garrison	100	T/NC	-
Turtle Mountain Lodge	Bottineau	125	T/NC	-
Turtle River State Park	Arvilla	100	T/NC	Yes
Two Way Inn & Bar	Stanley	40	T/NC	-
U-Serve	New Salem	250	T/NC	-
US Customs Service-Antler	Antler	27	T/NC	-
US Customs Service-Hannah	Hannah	25	T/NC	-
US Customs Service-Hansboro	Hansboro	25	T/NC	-
US Customs Service-Sarles	Sarles	25	T/NC	-
US Port of Entry - St. John	St. John	25	T/NC	-
Valley Inn Cafe	Carpio	150	T/NC	-
VFW Club	Zahl	50	T/NC	-
Voyager Cove Camp	Pick City	35	T/NC	-

PWS Name	PWS City	Population	PWS Type	100% Consecutive
Washegum Campground 72	Bottineau	100	T/NC	-
Watford City Eagles #3543	Watford City	50	T/NC	-
Watford City Golf Course	Watford City	35	T/NC	-
West Fargo Stockyards	West Fargo	100	T/NC	-
Wheel Inn Lounge	Balta	50	T/NC	-
Wishek Livestock Market Cafe	Wishek	25	T/NC	-
Wolford High School	Wolford	100	NT/NC	-
Woodland Resort	Devils Lake	25	T/NC	Yes
Writing Rock State Historic Site	Grenora	25	T/NC	-

APPENDIX D

North Dakota Geographic

Targeting System Scoring

NORTH DAKOTA GEOGRAPHIC TARGETING SYSTEM SCORING

Total Priority Ranking based on Vulnerability, Susceptibility, and Water Use

RANK	AQUIFER NAME	DRASTIC SCORE	PEST. DRASTIC SCORE	CHEM. USE SURROGATE ($/AC)	PERMITTED WATER USE (AC.FT./YR)	TOTAL MONITORING SCORE
1	ELK VALLEY	167	189 (HIGH)	112.90 (HIGH)	16413 (HIGH)	9 (HIGH)
2	OAKES	161	185 (HIGH)	75.00 (HIGH)	20974 (HIGH)	9 (HIGH)
3	SHEYENNE DELTA	153	182 (HIGH)	131.04 (HIGH)	17889 (HIGH)	9 (HIGH)
4	INKSTER	157	179 (HIGH)	112.90 (HIGH)	3587 (HIGH)	9 (HIGH)
5	ICELANDIC	140	177 (HIGH)	154.00 (HIGH)	1860 (HIGH)	9 (HIGH)
6	FORDVILLE	155	167 (HIGH)	144.71 (HIGH)	2703 (HIGH)	9 (HIGH)
7	GALESBURG/PAGE	144	163 (HIGH)	75.44 (HIGH)	15568 (HIGH)	9 (HIGH)
8	MISSOURI RIVER	159	190 (HIGH)	43.34 (MOD.)	1329 (HIGH)	8 (HIGH)
9	WARWICK	156	187 (HIGH)	46.78 (MOD.)	10124 (HIGH)	8 (HIGH)
10	JUANITA LAKE	169	186 (HIGH)	75.50 (HIGH)	1002 (MOD.)	8 (HIGH)
11	HANKINSON	149	185 (HIGH)	131.04 (HIGH)	1000 (MOD.)	8 (HIGH)
12	SAND PRAIRIE	159	181 (HIGH)	67.26 (HIGH)	1304 (MOD.)	8 (HIGH)
13	EDGELEY	172	181 (HIGH)	71.55 (HIGH)	801.7 (MOD.)	8 (HIGH)
14	MARSTONMOOR PLAIN	162	180 (HIGH)	45.00 (MOD.)	6682 (HIGH)	8 (HIGH)
15	MEDFORD	147	174 (HIGH)	128.81 (HIGH)	601.7 (MOD.)	8 (HIGH)
16	STRASBURG	160	169 (HIGH)	52.56 (MOD.)	1910 (HIGH)	8 (HIGH)
17	LAKE NETTIE AQ. SYSTEM	160	169 (HIGH)	40.24 (MOD.)	4981 (HIGH)	8 (HIGH)
18	JAMESTOWN	149	167 (HIGH)	58.68 (MOD.)	7810 (HIGH)	8 (HIGH)
19	WAGONSPORT	154	165 (HIGH)	41.91 (MOD.)	1221 (HIGH)	8 (HIGH)
20	MANFRED	142	165 (HIGH)	60.11 (HIGH)	200.0 (MOD.)	8 (HIGH)
21	BISMARCK	145	163 (HIGH)	41.91 (MOD.)	2301 (HIGH)	8 (HIGH)
22	MILNOR CHANNEL	134	156 (MOD.)	131.04 (HIGH)	8616 (HIGH)	8 (HIGH)
23	ENGLEVALE	130	155 (MOD.)	76.46 (HIGH)	20155 (HIGH)	8 (HIGH)
24	LAMOURE	126	149 (MOD.)	71.69 (HIGH)	8878 (HIGH)	8 (HIGH)
25	GUELPH	118	139 (MOD.)	71.69 (HIGH)	2074 (HIGH)	8 (HIGH)
26	CARRINGTON	109	130 (MOD.)	75.50 (HIGH)	7995 (HIGH)	8 (HIGH)
27	LAKE SOURIS	172	190 (HIGH)	37.66 (LOW)	1396 (HIGH)	7 (MOD.)
28	ROCKY RUN	165	187 (HIGH)	60.11 (HIGH)	0.0 (LOW)	7 (MOD.)
29	TOWER CITY	160	179 (HIGH)	123.67 (HIGH)	67.0 (LOW)	7 (MOD.)
30	JAMES RIVER	161	179 (HIGH)	75.50 (HIGH)	54.0 (LOW)	7 (MOD.)
31	HEIMDAL	161	179 (HIGH)	60.11 (HIGH)	0.0 (LOW)	7 (MOD.)
32	STONEY SLOUGH	155	174 (HIGH)	67.26 (HIGH)	0.0 (LOW)	7 (MOD.)
33	PIPESTEM CREEK	154	173 (HIGH)	60.11 (HIGH)	89.0 (LOW)	7 (MOD.)
34	RUSLAND	148	169 (HIGH)	60.11 (HIGH)	0.0 (LOW)	7 (MOD.)
35	MEDINA	161	169 (HIGH)	58.68 (MOD.)	400.0 (MOD.)	7 (MOD.)
36	SHELL VALLEY	146	168 (HIGH)	39.45 (LOW)	1825 (HIGH)	7 (MOD.)
37	SPRING CREEK AQ. SYSTEM	131	168 (HIGH)	53.82 (MOD.)	480.4 (MOD.)	7 (MOD.)
38	SEVEN MILE COULEE	148	167 (HIGH)	58.68 (MOD.)	540.0 (MOD.)	7 (MOD.)
39	TOKIO	157	166 (HIGH)	45.86 (MOD.)	712.0 (MOD.)	7 (MOD.)
40	BURNT CREEK	137	159 (MOD.)	41.91 (MOD.)	3339 (HIGH)	7 (MOD.)
41	STREETER OUTWASH	150	159 (MOD.)	55.91 (MOD.)	3143 (HIGH)	7 (MOD.)
42	HORSESHOE VALLEY	152	156 (MOD.)	40.85 (MOD.)	3929 (HIGH)	7 (MOD.)
43	PEMBINA RIVER	116	139 (MOD.)	154.07 (HIGH)	1011 (MOD.)	7 (MOD.)
44	APPLE CREEK-LOWER	114	137 (MOD.)	41.91 (MOD.)	2720 (HIGH)	7 (MOD.)
45	HILLSBORO	116	135 (MOD.)	127.32 (HIGH)	430.0 (MOD.)	7 (MOD.)
46	SPIRITWOOD AQ. SYSTEM	90	128 (LOW)	61.52 (HIGH)	33718 (HIGH)	7 (MOD.)
47	ELLENDALE	100	124 (LOW)	71.69 (HIGH)	1492 (HIGH)	7 (MOD.)
48	WEST FARGO	75	95 (LOW)	123.67 (HIGH)	5286 (HIGH)	7 (MOD.)
49	GOLDWIN	175	196 (HIGH)	58.68 (MOD.)	0.0 (LOW)	6 (MOD.)
50	DENBIGH	162	182 (HIGH)	37.66 (LOW)	776.0 (MOD.)	6 (MOD.)
51	PLAINVIEW	164	181 (HIGH)	58.68 (MOD.)	0.0 (LOW)	6 (MOD.)
52	KLOSE	164	181 (HIGH)	58.68 (MOD.)	0.0 (LOW)	6 (MOD.)
53	KILGORE	144	179 (HIGH)	41.30 (MOD.)	150.0 (LOW)	6 (MOD.)
54	SHEYENNE VILLAGE	158	177 (HIGH)	48.63 (MOD.)	100.0 (LOW)	6 (MOD.)
55	CHERRY LAKE	165	174 (HIGH)	48.63 (MOD.)	0.0 (LOW)	6 (MOD.)
56	BEAVER CREEK SOUTH	160	171 (HIGH)	53.82 (MOD.)	0.0 (LOW)	6 (MOD.)
			PEST.	CHEM. USE	PERMITTED	TOTAL

RANK	AQUIFER NAME	DRASTIC SCORE	DRASTIC SCORE	SURROGATE ($/AC)	WATER USE (AC.FT./YR)	MONITORING SCORE
57	MERCER	145	166 (HIGH)	40.85 (MOD.)	50.0 (LOW)	6 (MOD.)
58	RIVERDALE	155	165 (HIGH)	40.85 (MOD.)	0.0 (LOW)	6 (MOD.)
59	PAINTED WOODS CREEK	155	165 (HIGH)	41.91 (MOD.)	0.0 (LOW)	6 (MOD.)
60	HILLSBURG	155	165 (HIGH)	55.91 (MOD.)	0.0 (LOW)	6 (MOD.)
61	BURLINGTON	154	165 (HIGH)	39.58 (LOW)	547.8 (MOD.)	6 (MOD.)
62	NORTHWEST EDDY	156	163 (HIGH)	48.63 (MOD.)	120.0 (LOW)	6 (MOD.)
63	CENTRAL EDDY	134	162 (HIGH)	48.63 (MOD.)	0.0 (LOW)	6 (MOD.)
64	KARLSRUHE	140	160 (HIGH)	37.66 (LOW)	530.0 (MOD.)	6 (MOD.)
65	NAPOLEAN OUTWASH	150	159 (MOD.)	55.91 (MOD.)	613.5 (MOD.)	6 (MOD.)
66	SOUTH FESSENDEN	137	158 (MOD.)	60.11 (HIGH)	0.0 (LOW)	6 (MOD.)
67	ESMOND	134	156 (MOD.)	45.86 (MOD.)	863.0 (MOD.)	6 (MOD.)
68	RUSSEL LAKE	136	155 (MOD.)	75.50 (HIGH)	0.0 (LOW)	6 (MOD.)
69	BRAMPTON	117	152 (MOD.)	79.69 (HIGH)	0.0 (LOW)	6 (MOD.)
70	NORTH BURLEIGH	139	151 (MOD.)	41.91 (MOD.)	507.0 (MOD.)	6 (MOD.)
71	GLENCOE CHANNEL	128	149 (MOD.)	41.91 (MOD.)	1115 (MOD.)	6 (MOD.)
72	BRIGHTWOOD	128	147 (MOD.)	131.04 (HIGH)	0.0 (LOW)	6 (MOD.)
73	BANTEL	123	147 (MOD.)	123.67 (HIGH)	0.0 (LOW)	6 (MOD.)
74	PAINTED WOODS LAKE	133	145 (MOD.)	40.85 (MOD.)	1000 (MOD.)	6 (MOD.)
75	MADDOCK	123	144 (MOD.)	45.86 (MOD.)	624.0 (MOD.)	6 (MOD.)
76	SKJERMO LAKE	131	141 (MOD.)	32.45 (LOW)	4596 (HIGH)	6 (MOD.)
77	MINOT	120	139 (MOD.)	39.58 (LOW)	11370 (HIGH)	6 (MOD.)
78	KNIFE RIVER	131	137 (MOD.)	37.21 (LOW)	5170 (HIGH)	6 (MOD.)
79	MIDWAY	111	136 (MOD.)	56.68 (MOD.)	468.1 (MOD.)	6 (MOD.)
80	GLENVIEW	118	133 (MOD.)	41.91 (MOD.)	325.0 (MOD.)	6 (MOD.)
81	EDINBURG	109	132 (MOD.)	144.71 (HIGH)	64.0 (LOW)	6 (MOD.)
82	SQUARE BUTTE CREEK	126	130 (MOD.)	43.34 (MOD.)	354.0 (MOD.)	6 (MOD.)
83	MCVILLE	100	125 (LOW)	57.27 (MOD.)	1777 (HIGH)	6 (MOD.)
84	NEW ROCKFORD	97	118 (LOW)	49.81 (MOD.)	10912 (HIGH)	6 (MOD.)
85	NORTONVILLE	87	111 (LOW)	71.69 (HIGH)	587.5 (MOD.)	6 (MOD.)
86	MCKENZIE	88	109 (LOW)	41.91 (MOD.)	6065 (HIGH)	6 (MOD.)
87	ELLIOT	76	103 (LOW)	76.46 (HIGH)	974.2 (MOD.)	6 (MOD.)
88	WHITE SHIELD	72	98 (LOW)	40.85 (MOD.)	3537 (HIGH)	6 (MOD.)
89	FARGO	57	83 (LOW)	123.67 (HIGH)	245.0 (MOD.)	6 (MOD.)
90	WINONA	75	80 (LOW)	52.56 (MOD.)	1874 (HIGH)	6 (MOD.)
91	YELLOWSTONE-MISSOURI	143	178 (HIGH)	34.45 (LOW)	0.0 (LOW)	5 (MOD.)
92	VANG	162	174 (HIGH)	39.58 (LOW)	100.0 (LOW)	5 (MOD.)
93	VOLTAIRE	154	173 (HIGH)	37.66 (LOW)	0.0 (LOW)	5 (MOD.)
94	ROBINSON	143	165 (HIGH)	38.23 (LOW)	0.0 (LOW)	5 (MOD.)
95	TAPPEN	141	161 (HIGH)	38.23 (LOW)	0.0 (LOW)	5 (MOD.)
96	MARTIN AQ. SYSTEM	144	161 (HIGH)	38.65 (LOW)	100.0 (LOW)	5 (MOD.)
97	BUFFALO CREEK-UPPER	145	158 (MOD.)	58.68 (MOD.)	0.0 (LOW)	5 (MOD.)
98	STREETER CITY AQUIFER	144	157 (MOD.)	58.68 (MOD.)	0.0 (LOW)	5 (MOD.)
99	BEAVER LAKE CHANNEL	132	155 (MOD.)	55.91 (MOD.)	0.0 (LOW)	5 (MOD.)
100	DOUGLAS	138	153 (MOD.)	39.58 (LOW)	405.0 (MOD.)	5 (MOD.)
101	APPLE CREEK-UPPER	142	152 (MOD.)	41.91 (MOD.)	0.0 (LOW)	5 (MOD.)
102	WISHEK AQ. SYSTEM	140	151 (MOD.)	53.82 (MOD.)	0.0 (LOW)	5 (MOD.)
103	RANDOM CREEK	146	151 (MOD.)	41.91 (MOD.)	0.0 (LOW)	5 (MOD.)
104	TURTLE LAKE	126	151 (MOD.)	40.85 (MOD.)	0.0 (LOW)	5 (MOD.)
105	MCINTOSH	120	148 (MOD.)	53.82 (MOD.)	0.0 (LOW)	5 (MOD.)
106	FORT MANDAN	137	148 (MOD.)	40.85 (MOD.)	0.0 (LOW)	5 (MOD.)
107	LITTLE KNIFE RIVER VALLEY	141	146 (MOD.)	28.74 (LOW)	399.0 (MOD.)	5 (MOD.)
108	DRY LAKE	124	145 (MOD.)	53.82 (MOD.)	0.0 (LOW)	5 (MOD.)
109	CATTAIL	140	145 (MOD.)	52.56 (MOD.)	190.0 (LOW)	5 (MOD.)
110	BRADDOCK	124	141 (MOD.)	52.56 (MOD.)	0.0 (LOW)	5 (MOD.)
111	BEAVER LAKE OUTWASH	124	139 (MOD.)	55.91 (MOD.)	0.0 (LOW)	5 (MOD.)
112	WILDROSE	116	137 (MOD.)	32.45 (LOW)	307.7 (MOD.)	5 (MOD.)
113	WOLF CREEK	110	135 (MOD.)	40.85 (MOD.)	0.0 (LOW)	5 (MOD.)
114	SIMS	123	134 (MOD.)	45.38 (MOD.)	0.0 (LOW)	5 (MOD.)
115	HEART RIVER	121	124 (LOW)	45.38 (MOD.)	253.7 (MOD.)	5 (MOD.)
116	WIMBLEDON	95	123 (LOW)	67.26 (HIGH)	0.0 (LOW)	5 (MOD.)
117	MUNICH	99	123 (LOW)	64.84 (HIGH)	0.0 (LOW)	5 (MOD.)
RANK	AQUIFER NAME	DRASTIC SCORE	PEST. DRASTIC SCORE	CHEM. USE SURROGATE ($/AC)	PERMITTED WATER USE (AC.FT./YR)	TOTAL MONITORING SCORE

RANK	AQUIFER NAME	DRASTIC SCORE	PEST. DRASTIC SCORE	CHEM. USE SURROGATE ($/AC)	PERMITTED WATER USE (AC.FT./YR)	TOTAL MONITORING SCORE
118	SUNDRE	101	122 (LOW)	39.58 (LOW)	7737 (HIGH)	5 (MOD.)
119	KIDDER CO. AQ. COMPLEX	91	120 (LOW)	38.23 (LOW)	16090 (HIGH)	5 (MOD.)
120	GARRISON	104	118 (LOW)	40.85 (MOD.)	710.0 (MOD.)	5 (MOD.)
121	SOO CHANNEL	105	117 (LOW)	41.91 (MOD.)	992.3 (MOD.)	5 (MOD.)
122	HOFFLUND	112	115 (LOW)	30.17 (LOW)	3274 (HIGH)	5 (MOD.)
123	PLEASANT LAKE	98	114 (LOW)	41.30 (MOD.)	766.0 (MOD.)	5 (MOD.)
124	PEMBINA DELTA	97	114 (LOW)	154.07 (HIGH)	0.0 (LOW)	5 (MOD.)
125	EMERADO	80	110 (LOW)	112.90 (HIGH)	0.0 (LOW)	5 (MOD.)
126	EASTMAN	86	110 (LOW)	75.50 (HIGH)	0.0 (LOW)	5 (MOD.)
127	BALD HILL CREEK	96	110 (LOW)	75.50 (HIGH)	0.0 (LOW)	5 (MOD.)
128	RAY	90	108 (LOW)	30.17 (LOW)	1271 (HIGH)	5 (MOD.)
129	LOST LAKE	83	106 (LOW)	40.24 (MOD.)	200.0 (MOD.)	5 (MOD.)
130	COLFAX	75	106 (LOW)	131.04 (HIGH)	122.0 (LOW)	5 (MOD.)
131	BELMONT	81	101 (LOW)	127.32 (HIGH)	15.0 (LOW)	5 (MOD.)
132	WINDSOR	82	97 (LOW)	58.68 (MOD.)	213.9 (MOD.)	5 (MOD.)
133	GWINNER	73	96 (LOW)	79.69 (HIGH)	0.0 (LOW)	5 (MOD.)
134	GRAND FORKS	72	94 (LOW)	112.90 (HIGH)	0.0 (LOW)	5 (MOD.)
135	FAIRMOUNT	68	94 (LOW)	131.04 (HIGH)	85.0 (LOW)	5 (MOD.)
136	ELM CREEK	85	92 (LOW)	45.38 (MOD.)	960.4 (MOD.)	5 (MOD.)
137	HAMILTON	66	90 (LOW)	154.07 (HIGH)	0.0 (LOW)	5 (MOD.)
138	THOMPSON	63	87 (LOW)	112.90 (HIGH)	0.0 (LOW)	5 (MOD.)
139	LONG LAKE	71	85 (LOW)	52.56 (MOD.)	981.6 (MOD.)	5 (MOD.)
140	WHITE EARTH RIVER VALLEY	157	157 (MOD.)	28.74 (LOW)	0.0 (LOW)	4 (LOW)
141	TOLGEN	138	153 (MOD.)	39.58 (LOW)	0.0 (LOW)	4 (LOW)
142	SHELL CREEK AQ. SYSTEM	135	150 (MOD.)	28.74 (LOW)	13.0 (LOW)	4 (LOW)
143	LIGNITE CITY AQUIFER	129	146 (MOD.)	28.73 (LOW)	100.0 (LOW)	4 (LOW)
144	EAST FORK SHELL CREEK	127	145 (MOD.)	28.74 (LOW)	0.0 (LOW)	4 (LOW)
145	ROLLA	119	144 (MOD.)	39.45 (LOW)	0.0 (LOW)	4 (LOW)
146	RYDER	119	141 (MOD.)	39.58 (LOW)	73.9 (LOW)	4 (LOW)
147	SOURIS VALLEY	114	139 (MOD.)	37.66 (LOW)	0.0 (LOW)	4 (LOW)
148	CANNONBALL RIVER VALLEY	128	138 (MOD.)	37.08 (LOW)	0.0 (LOW)	4 (LOW)
149	NORTH HILL	111	133 (MOD.)	39.58 (LOW)	0.0 (LOW)	4 (LOW)
150	TRENTON	112	130 (MOD.)	30.17 (LOW)	165.9 (LOW)	4 (LOW)
151	CUT BANK CREEK	94	130 (MOD.)	37.66 (LOW)	0.0 (LOW)	4 (LOW)
152	NAPOLEAN BURIED VALLEY	114	126 (LOW)	55.91 (MOD.)	0.0 (LOW)	4 (LOW)
153	STRAWBERRY LAKE	113	123 (LOW)	40.85 (MOD.)	0.0 (LOW)	4 (LOW)
154	COURTENAY	100	123 (LOW)	58.68 (MOD.)	0.0 (LOW)	4 (LOW)
155	SNAKE CREEK	98	120 (LOW)	40.85 (MOD.)	118.5 (LOW)	4 (LOW)
156	DEER LAKE	98	120 (LOW)	58.68 (MOD.)	0.0 (LOW)	4 (LOW)
157	TOBACCO GARDEN	111	119 (LOW)	34.45 (LOW)	404.0 (MOD.)	4 (LOW)
158	ROSEFIELD	86	114 (LOW)	48.63 (MOD.)	0.0 (LOW)	4 (LOW)
159	CHARBONNEAU	97	112 (LOW)	34.45 (LOW)	253.0 (MOD.)	4 (LOW)
160	LITTLE HEART	103	110 (LOW)	45.38 (MOD.)	0.0 (LOW)	4 (LOW)
161	KILLDEER	96	109 (LOW)	25.57 (LOW)	299.9 (MOD.)	4 (LOW)
162	HOMER	86	109 (LOW)	58.68 (MOD.)	0.0 (LOW)	4 (LOW)
163	GOODMAN CREEK	97	109 (LOW)	37.21 (LOW)	203.8 (MOD.)	4 (LOW)
164	COLUMBUS	86	109 (LOW)	28.73 (LOW)	358.2 (MOD.)	4 (LOW)
165	ZEELAND	92	108 (LOW)	53.82 (MOD.)	0.0 (LOW)	4 (LOW)
166	WELLER SLOUGH	81	105 (LOW)	40.85 (MOD.)	0.0 (LOW)	4 (LOW)
167	SYDNEY	81	105 (LOW)	58.68 (MOD.)	0.0 (LOW)	4 (LOW)
168	ANTELOPE CREEK	96	104 (LOW)	37.21 (LOW)	561.0 (MOD.)	4 (LOW)
169	NEW TOWN	88	103 (LOW)	28.74 (LOW)	609.0 (MOD.)	4 (LOW)
170	LEEDS	75	103 (LOW)	45.86 (MOD.)	0.0 (LOW)	4 (LOW)
171	MOUNT MORIAH	77	102 (LOW)	58.68 (MOD.)	0.0 (LOW)	4 (LOW)
172	STARKWEATHER	74	101 (LOW)	52.97 (MOD.)	0.0 (LOW)	4 (LOW)
173	ERIC LAKE	88	101 (LOW)	56.68 (MOD.)	0.0 (LOW)	4 (LOW)
174	ST. JAMES	93	100 (LOW)	45.38 (MOD.)	0.0 (LOW)	4 (LOW)
175	STREETER BURIED VALLEY	82	97 (LOW)	55.91 (MOD.)	0.0 (LOW)	4 (LOW)
176	YELLOWSTONE BURIED CHANNEL	82	97 (LOW)	32.45 (LOW)	405.0 (MOD.)	4 (LOW)
177	WING CHANNEL	75	93 (LOW)	41.91 (MOD.)	79.0 (LOW)	4 (LOW)
178	LITTLE MISSOURI RIVER	124	126 (LOW)	34.45 (LOW)	0.0 (LOW)	3 (LOW)

179	CHERRY CREEK	115	126	(LOW)	34.45	(LOW)	0.0	(LOW)	3	(LOW)
180	CEDAR CREEK VALLEY	121	126	(LOW)	37.08	(LOW)	0.0	(LOW)	3	(LOW)
181	KENMARE(?)	110	119	(LOW)	28.73	(LOW)	0.0	(LOW)	3	(LOW)
182	GRENORA	97	111	(LOW)	32.45	(LOW)	180.4	(LOW)	3	(LOW)
183	RYDER RIDGE	85	110	(LOW)	39.58	(LOW)	0.0	(LOW)	3	(LOW)
184	HIDDENWOOD LAKE	85	110	(LOW)	39.58	(LOW)	0.0	(LOW)	3	(LOW)
185	BUTTE	81	105	(LOW)	37.66	(LOW)	0.0	(LOW)	3	(LOW)
186	NE MISSOURI BURIED CHANNEL	93	103	(LOW)	32.45	(LOW)	25.0	(LOW)	3	(LOW)
187	GLENBURN	78	102	(LOW)	39.53	(LOW)	110.0	(LOW)	3	(LOW)
188	SHIELDS	91	102	(LOW)	17.83	(LOW)	0.0	(LOW)	3	(LOW)
189	BEAVER CREEK	89	99	(LOW)	17.83	(LOW)	0.0	(LOW)	3	(LOW)
190	WEST WILDROSE	82	97	(LOW)	32.45	(LOW)	190.5	(LOW)	3	(LOW)
191	HORSE NOSE BUTTE	80	95	(LOW)	25.57	(LOW)	0.0	(LOW)	3	(LOW)
192	BATTLE CREEK	83	95	(LOW)	17.83	(LOW)	0.0	(LOW)	3	(LOW)
193	BENNIE PEER	69	76	(LOW)	34.45	(LOW)	0.0	(LOW)	3	(LOW)

APPENDIX E

Examples of Contaminant Source Inventory Forms for Surface and Ground Water Source Water Assessment Areas