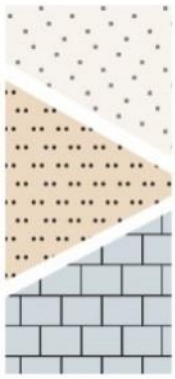

Bonanza Valley Groundwater Management Area Plan

October, 2016

Minnesota Department of Natural Resources
Ecological and Water Resources Division

MNDNR

Funding for this project was provided by the following:

The Clean Water Fund, which receives 33 percent of the sales tax revenue from the Clean Water, Land and Legacy Amendment, approved by voters in November 2008. The Clean Water Fund's purpose is to protect, enhance and restore water quality in lakes, rivers, streams and groundwater.

At least 5 percent of the money is targeted for the protection of drinking water sources. The Legislature allocates funds for water quality work and drinking water protection based on recommendations from the Clean Water Council.

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October 3, 2016

Bonanza Valley Groundwater Management Area: Designation and Plan

Minnesota is rich in water resources. With more than 10,000 lakes, thousands of miles of rivers and streams, and many thousands of acres of wetlands, it might be natural to think that our water is essentially unlimited. But in some parts of the state, the unseen, underground aquifers that make up our groundwater resources are under pressure to meet growing needs for domestic water supplies, irrigation, industrial and other uses. These groundwater resources also are interconnected with lakes, streams and wetlands that we value for commerce, recreation, and water supplies. Those surface waters also provide the habitat needed by many animals and plants. If we are not careful in how we use water, both economic development and ecosystems could be put at risk.

These concerns led the Minnesota Department of Natural Resources to explore a different approach to groundwater management in three areas around the state where trends suggest groundwater use might be or become unsustainable. After working with an advisory team of 27 people representing agriculture, local government, and other agencies since February 2014, the DNR is establishing the Bonanza Valley Groundwater Management Area, which is hereby designated to include all of the areas delineated in the plan accompanying this letter, including areas of Pope, Stearns, Kandiyohi, Douglas, Swift, Meeker and Todd counties. We have created this five-year plan to guide our work in this area to ensure that groundwater supplies remain adequate to meet human needs while protecting lakes, streams and wetlands.

I believe this plan is a very positive step for Minnesota. It draws upon a wealth of technical expertise across a variety of sectors. It has been informed and improved by extensive input and feedback from major water users, local government, concerned citizens and other interests. The plan is comprehensive yet achievable. It lays out clear objectives and specific actions the DNR will take to ensure sustainable use of groundwater. It also acknowledges that DNR cannot be successful alone, and describes the important roles of water users and other agencies.

I want to thank the volunteers who served on the Project Advisory Team and the people who actively participated in meetings throughout the process. The many hours you dedicated are very much appreciated. This plan provides a good starting point, but working to maintain the Bonanza Valley water resources will require many more people, agencies and interests continuing to work together in the years to come. I'm confident that will happen, because Minnesotans have shown their commitment to natural resource conservation and stewardship.

Tom Landwehr
Commissioner

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1. Introduction

The Minnesota Department of Natural Resources (DNR) works with citizens to manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for sustainable commercial uses of natural resources. The DNR works to integrate and sustain a healthy environment, a sustainable economy, and livable communities. This strategy shares stewardship responsibility with citizens and partners to manage for multiple interests.

The DNR is responsible for managing the state's water resources to sustain healthy waterways, basins and groundwater resources. The DNR plays an important role in supporting sustainable groundwater use through its permit programs, information collection and analysis activities, law enforcement responsibilities, education, and technical assistance opportunities.

The DNR is one of several state and local agencies and organizations with responsibility to develop, protect and manage our water resources. The following briefly describes some of the key roles of state agencies in water:

- Board of Water and Soil Resources (BWSR): provides resources and technical assistance to local governments, manages conservation easements, and provides oversight to local water management entities.
- Department of Natural Resources: collects and analyzes information on water, regulates water use and riparian land use activities, manages public land, and oversees water supply plans.
- Department of Agriculture (MDA): responsible for fertilizer and pesticide regulation and management, including implementing the state Nitrogen Fertilizer and Pesticide Management Plans to protect groundwater; developing voluntary best management practices; monitoring groundwater in agricultural settings; product registration; and applicator training and licensing.
- Department of Health (MDH): ensures public drinking water systems protect sources and meet federal drinking water standards, regulates water well construction and sealing to protect groundwater, assesses drinking water contaminant risks to public health and licenses professions impacting drinking water.
- Pollution Control Agency (MPCA): develops water quality standards, monitors surface water and groundwater quality, and restricts discharges of pollutants through use of permits.
- Public Facilities Authority: manages municipal financing programs to help communities build and upgrade drinking water, wastewater and storm water infrastructure.

Groundwater is at risk of overuse and contamination throughout the state, and this risk is a more urgent issue in some specific areas of the state. To address concerns about long-term sustainable use of groundwater in these areas, the DNR is defining Groundwater Management Areas (GWMA) and developing management plans. The purpose of the GWMA Plan (Plan) is to guide DNR actions in managing the appropriation and use of groundwater within the GWMA over the five years following adoption of the Plan. The DNR will update the Plan as needed, to allow it to continue guiding sustainable groundwater use beyond the initial five years addressed in this first version of the Plan.

The GWMA represents a geographic area within which groundwater users share a distinct aquifer system or groundwater resource. Users include both those who are required to have appropriation permits and those who do not require permits to use groundwater.

Problem

As part of a statewide analysis of groundwater resources, the DNR identified the Bonanza Valley as an area of specific concern where groundwater resources are at risk of overuse and degraded quality. Multiple permit holders and other groundwater users are connected through their use of groundwater and their effect on water resources.

The DNR manages water resources to assure an adequate supply, largely through permitting and tracking water appropriation and use. The Water Appropriation Permit Program balances competing management objectives that include development and protection of Minnesota's water resources. Key challenges for the DNR in managing groundwater appropriations and use in the Bonanza Valley GWMA include the following:

- Demand: projected growth in water demand, particularly for agricultural irrigation
- Natural Resources: potential for negative effects on groundwater-dependent natural resources such as wetlands, lakes, and streams
- Conservation: a need for improved and expanded application of water conservation and improved water use efficiency
- Contamination: reduction in the availability of clean groundwater
- Information: gaps in the information needed to determine the sustainability of groundwater use

Purpose

The purpose of the GWMA Plan is to guide DNR actions in managing the appropriation and use of groundwater within the GWMA over the next five years. The following points help summarize the purpose of the GWMA Plan by identifying what it is and what it is not:

- The Plan directs the actions of the DNR and is not a plan for others to implement.
- The Plan establishes actions to guide the improvement of the DNR's appropriation permitting process, to ensure sustainable groundwater use.
- The Plan calls for the development of sustainability thresholds for groundwater use in the GWMA, where thresholds do not already exist.
- The Plan covers a five-year period, with the expectation that actions will be revised to continue the work beyond the initial five-year period.
- The Plan directs actions to improve communication for stakeholders within the GWMA.
- The Plan calls for regular review of progress by the Project Advisory Team of stakeholders.
- The Plan is not a comprehensive study of the area, but instead uses information from completed studies and suggests future studies to inform the plan and process. The Plan does not establish any new or broader regulatory authority. The actions proposed in the Plan are based on existing regulatory authority.
- The Plan itself is not an individual or a collective water supply plan for individual permit holders, industries, or municipalities.

The GWMA is intended to be in place for the long term, which will require updating and renewing the Plan after the first five-year implementation period. During the initial five-year implementation period, the Plan, actions and progress will be reviewed annually, evaluated, and revised with the help of the standing Project Advisory Team and stakeholders. The Plan identifies actions for the DNR to take, in collaboration with other agencies, organizations and individuals active in the GWMA. Those state agencies and organizations have an important role in supporting the DNR's actions in the Plan. The MPCA, MDH, MDA and BWSR have provided specific commitments and actions in support of the DNR's Bonanza Valley GWMA. Those commitments are included in Appendix A.

Many of the actions described in Section 5 will develop information, tools, and processes that will form the foundation for better decisions. The Plan does not establish or include a total allocation limit. Rather, it lays the path for determining sustainable thresholds, now and in the future, and managing appropriations to stay within the sustainability thresholds in a planned and transparent framework. Actions oriented toward all five Plan objectives are integral to this process.

Process

The Plan lays out a framework for addressing the groundwater management goal and objectives of the DNR Groundwater Management Program (Strategic Plan) in light of the particular challenges within the area. In order to gain insight into specific interests of the diverse groundwater users in the area, the DNR established a Project Advisory Team (PAT) to provide feedback and advice. DNR established an internal project team that drafted the plan, incorporating feedback from the PAT and other stakeholders.

The PAT was comprised of stakeholders from state agencies, county and city/township governments, a lake association, a watershed district, industry, and the federal government (Table 1-1). In response to legislative changes made in 2014 (Minn. Stat., sec. 103G.287, subd. 4), the DNR expanded the membership of the PAT during the planning process to increase the number of team members holding water appropriation permits.

The role of the PAT has been to provide advice and feedback on the process and the Plan during Plan development. DNR asked PAT members to be two-way conduits of information about the process and Plan to other stakeholders. The PAT was not established to achieve consensus on the Plan, and participation on the PAT does not imply consent of the Plan or specific elements of the Plan. For implementation of the Plan, the DNR will establish a new advisory team with a formal charter to match the needs of the GWMA going forward.

Twelve PAT meetings were held from February 2014 through March 2015. Following development of the draft Plan with input from the PAT, the DNR sought wider stakeholder review and comments.

At the end of the five-year initial implementation period, the DNR will conduct a comprehensive review of the process, actions and results of the GWMA Plan, determine future actions and, if needed, revise the Plan. The GWMA Project Advisory Team, formed following establishment of the GWMA, will be an important part of the comprehensive review.

Table 1-1 Project Advisory Team (PAT)

Name	Affiliation	Permit Holder in Bonanza Valley
Charles Ampe	Irrigator in Bonanza Valley	Yes
Jim Anderson	Irrigator in Bonanza Valley	Yes
Ron Cin	Amelia-Levin-Villard Lakes Association	No
Paul Fiedler	Irrigator in Bonanza Valley	Yes
Paul Gerde	Pope County commissioner	Yes *
Scott Glup	USFWS	No
Ron Halvorson	Irrigator in Bonanza Valley	Yes
Mark Hauck	DNR, EWR Central Region	Yes *
Earl Hauge	Irrigator in Bonanza Valley	Yes
Holly Kovarik	Pope County SWCD	Yes *
Robert Lange	Irrigator in Bonanza Valley	Yes
Dan Langseth	MDA	No
Maggie Leach	MPCA	Yes *
Jim Lundy	MDH	No
Ron Mergen	City of Paynesville	Yes
Aaron Meyer	Minnesota Rural Water Association	No
Greg Noland	Irrigator in Bonanza Valley	Yes
Tara Ostendorf	N. Fork Crow River Watershed District	No
Cliff Patrick	Irrigator in Bonanza Valley	Yes
David Perryman	City of Glenwood	Yes
Jon Reichman	Irrigator in Bonanza Valley	Yes

Name	Affiliation	Permit Holder in Bonanza Valley
James Solheid	City of New London	Yes
Michael Stamer	Irrigator in Bonanza Valley	Yes
Rick Reimer	Kandiyohi County SWCD	No
Dave Traut	Traut Well Drilling	No
Brad Wenz	Stearns County SWCD	No
Jerry Wright	Irrigators Association of MN	No

(*: Pope County has a general permit; DNR has a permit for Glenwood Fish Hatchery; Pope SWCD has a permit for Rosholt Research Farms; MPCA has a permit for pollution mitigation in Paynesville)

Plan Structure

The remainder of the Plan is divided into five additional sections.

SECTION 2 - DESCRIPTION OF THE BOUNDARY AND THE GWMA summarizes background information on groundwater connected natural resources, water use, and governance that were used to select the GWMA boundaries. The information also sets the stage for identifying groundwater management challenges in the area.

SECTION 3 - THE GOAL AND OBJECTIVES states the Plan goal and describes five objectives that the DNR will pursue to achieve the overall goal of long term, sustainable groundwater use in the GWMA. Together, the five objectives describe sustainable groundwater appropriation and use based on directives given in Minnesota Statutes.

SECTION 4 - STATUS OF THE GWMA in Terms of the Objectives provides additional information about conditions within the GWMA that relate specifically to the five objectives. This information includes a summary of current understanding of the status of each objective within the GWMA, discussion of gaps in knowledge or activities, and recommendations for how to fill those gaps.

SECTION 5 – DNR ACTIONS states the actions that DNR will take over the next five years toward achieving the five objectives. These actions address the highest priority needs identified from the evaluations described in Section 4.

SECTION 6 – Implementation Schedule provides a schedule for the DNR to perform the Plan actions as well as goals for achieving measureable outcomes. This section also describes the review and revision process for the Plan.

SECTION 7 - GLOSSARY of terms used in the Plan

SECTION 8 - REFERENCES

APPENDICES A-E - Appendices provide agency statements and additional information.

2. Description of the Boundary and the GWMA

Bonanza Valley – the place and its people

According to the 2010 census data, approximately 18,075 people live within or very close to the GWMA boundary. Eleven cities have a combined population of 7,861 and the remaining 10,214 people live in 37 rural townships across parts of the seven counties described above. The total 2010 population is 1,125 more people than in 1990.

The name “Bonanza Valley” was coined by local supporters of development and economic growth.

Land cover types in the Bonanza Valley Groundwater Management Area were determined via satellite data in 2013 from the USDA National Agricultural Statistics Service.

Table 2-1 Land cover types in Bonanza Valley GWMA

Land Cover Type	Percent of Area
Row Crops (mainly corn and beans)	33.6
Small Grains/Seeds (nine different types)	2.0
Other crops (beets, potatoes, dry beans and others)	1.9
Alfalfa/hay/pasture	34.5
Grasslands/prairie	1.4
Woodlands	9.7
Wetlands	12.3
Barren/idle	0.1
Developed	4.5

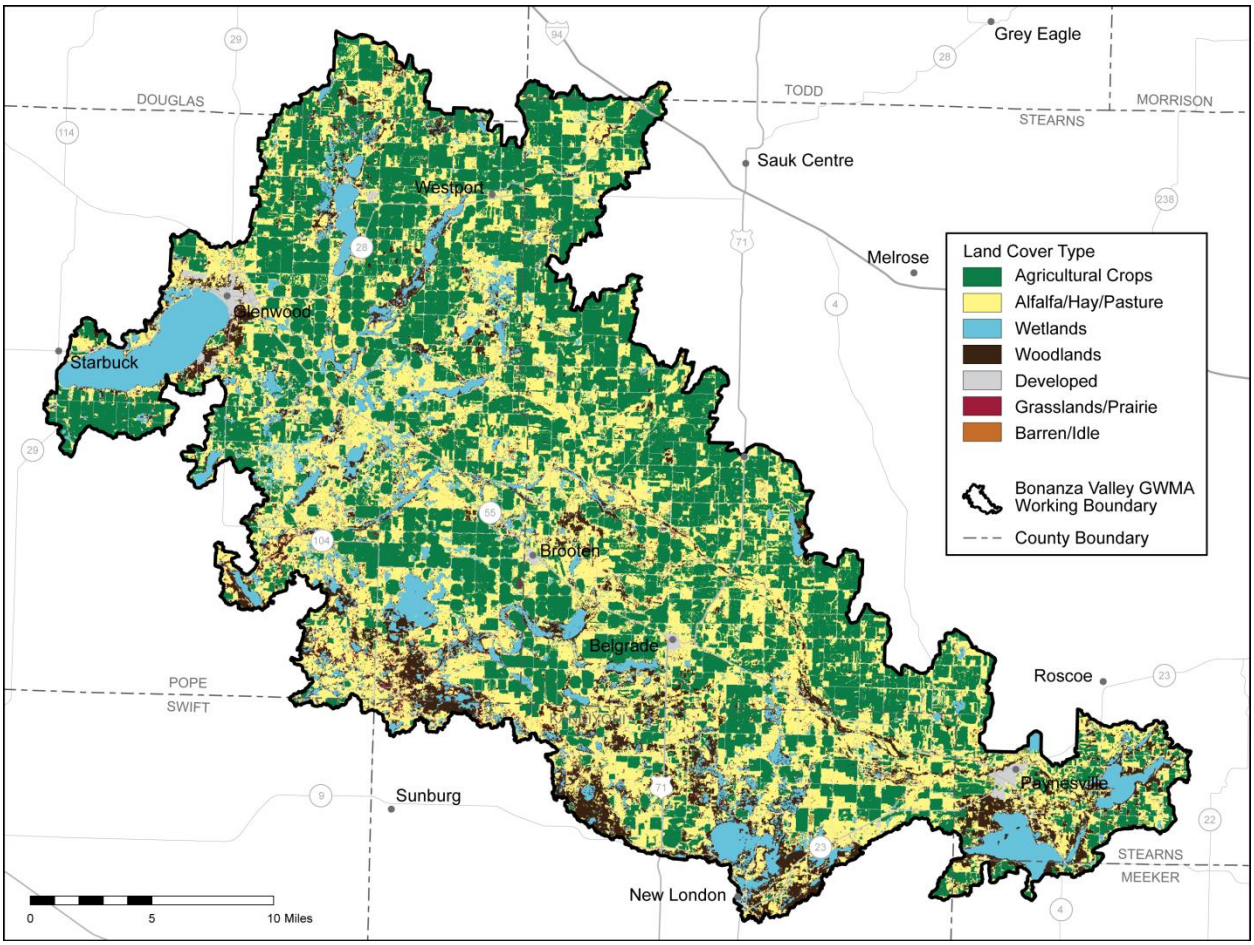

Figure 2-1 Land Cover Types in Bonanza Valley GWMA

A recently released study by the University of Minnesota Extension Office in Morris analyzed economic output from business sectors of various regions of the state for 2012. The Bonanza Valley GWMA boundary falls within three of these regions: west central, central and mid Minnesota. Among the largest business sectors in these regions are: manufacturing, professional and business services, agriculture, forestry fishing and hunting.

The Bonanza Valley is home to a wide variety of residents including rural homeowners, town dwellers, farmers, and waterfront homeowners.

Figure 1-2-2 Land cover types in the Bonanza Valley GWMA

The Bonanza Valley GWMA Boundary

A geographic area was defined within which to manage groundwater resources (Figure 2-2). The boundary for this GWMA was selected by using a composite of physical elements and water use patterns. Establishing a boundary allows us to identify and analyze factors that affect long-term water use and to identify specific actions that reduce the risk of unsustainable groundwater use.

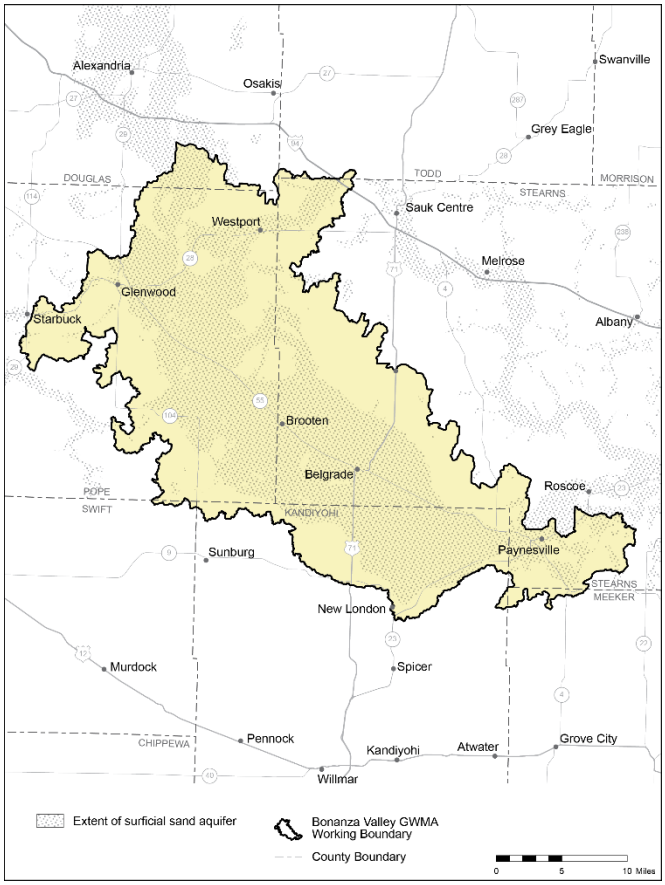

Figure 2-2 Boundary of the Bonanza Valley GWMA

Elements considered in selecting the boundary of the GWMA included the following:

- Water use
- Hydrogeology
- Watershed boundaries

The GWMA boundary contains water-dependent natural features, and the boundary overlays such features as governmental jurisdictions, other governance structures and planning units. The boundary selected for the Bonanza Valley GWMA includes parts of southern Douglas, eastern Pope, northeastern Kandiyohi, southwestern Stearns, northeastern Swift, southwestern Todd and northwestern Meeker counties. Major cities that are within the boundary include Glenwood, Westport, Brooten, Belgrade, and Paynesville. The cities of Starbuck and New London are partially within the boundary of the GWMA.

Watershed Boundaries

At the surface, the Bonanza Valley GWMA contains three surface watersheds (Figure 2-3) with water flowing in three directions: to the Sauk River watershed to the Northeast, the Chippewa River Watershed to the West and the Crow River Watershed to the Southeast. The proposed boundary for the Bonanza Valley GWMA is 447,005 acres, or 698 square miles.

The northern part of what is currently called Bonanza Valley is not a valley. It is mostly a highland area that includes glacial deposits of sand and gravel. Rain, snow and other precipitation are the major sources of water that replenishes lakes, rivers and groundwater in the Bonanza Valley GWMA. Water can leave the Bonanza Valley by way of rivers and streams, groundwater flow and evapotranspiration.

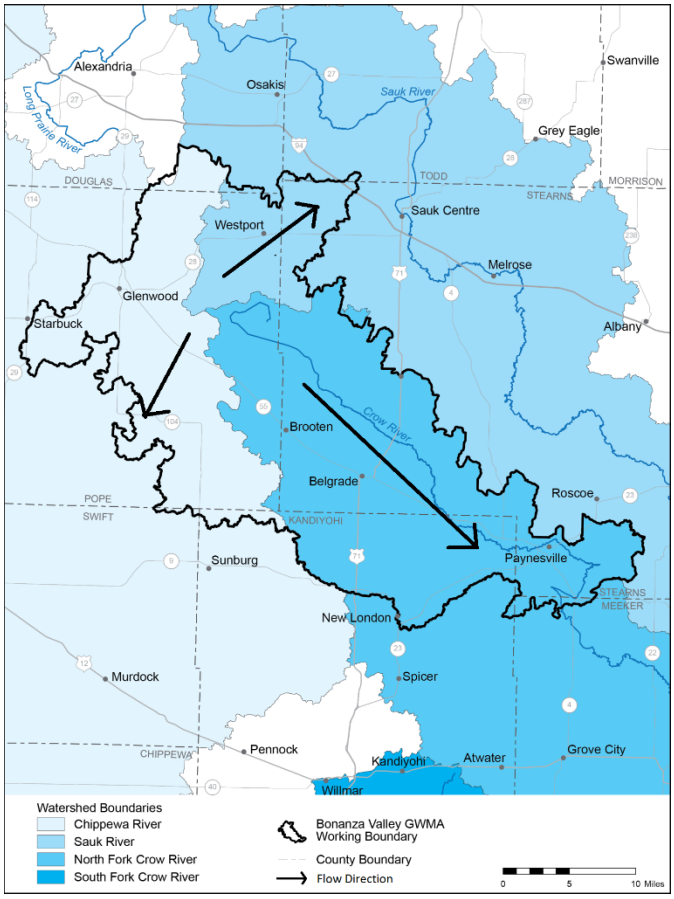

Figure 2-3 Watershed Boundary and flow Direction in Bonanza Valley GWMA

Hydrogeology

Hydrogeology defines the natural conditions and boundaries of the groundwater system. The current understanding of the system is that groundwater moves through the geologic system both laterally (side-to-side) and vertically (up and down). In three dimensions, the geologic formations found in Bonanza Valley form a complex groundwater system (Figure 2-4).

Underground, “groundwater divides” that are similar to watershed divides also exist. The locations of the groundwater divides in the Bonanza Valley area, where water flows in different directions underground, can be approximated using information such as the County Geologic Atlases for Pope and Stearns Counties. As more information is collected, the locations of these groundwater divides will be more accurately identified.

Two main aquifer types are found in the Bonanza Valley GWMA. The first are water table aquifers (Quaternary Water Table Aquifers, or QWTA), which are the uppermost aquifers. The second are buried aquifers (Quaternary Buried drift Artesian Aquifers, or QBAA), which are separated by more dense earth layers and found at various depths below the water table aquifer. The current understanding of the groundwater system in the Bonanza Valley indicates that groundwater flows between the water table and buried aquifers.

The sand plain outwash landscape that characterizes the Bonanza Valley GWMA is a geologic formation covering a large area that extends beyond the GWMA. This outwash formation was deposited by flowing water during ice melting at the end of the most recent glacial event, approximately 10,000 to 12,000 years ago.

Residence time testing results indicate that much of the water in the water table aquifer is less than 60 years old. The oldest known groundwater is sometimes called “vintage” and tends to be from the deeper formations in the buried aquifers. The vintage ages can vary from approximately 10,000 to 12,000 years old, corresponding with the melting of glacial ice. Vintage groundwater is the source of much of the high capacity groundwater supply in the Bonanza Valley area. This has been understood through various scientific studies that include analysis of climate, groundwater residence time and long-term water level measurement collected from observation wells. Zones where recent water mixes with vintage water have been identified in several mid drift buried aquifers and are described in the County Geologic Atlases for Pope and Stearns Counties. A County Geologic Atlas does not yet exists for Kandiyohi County.

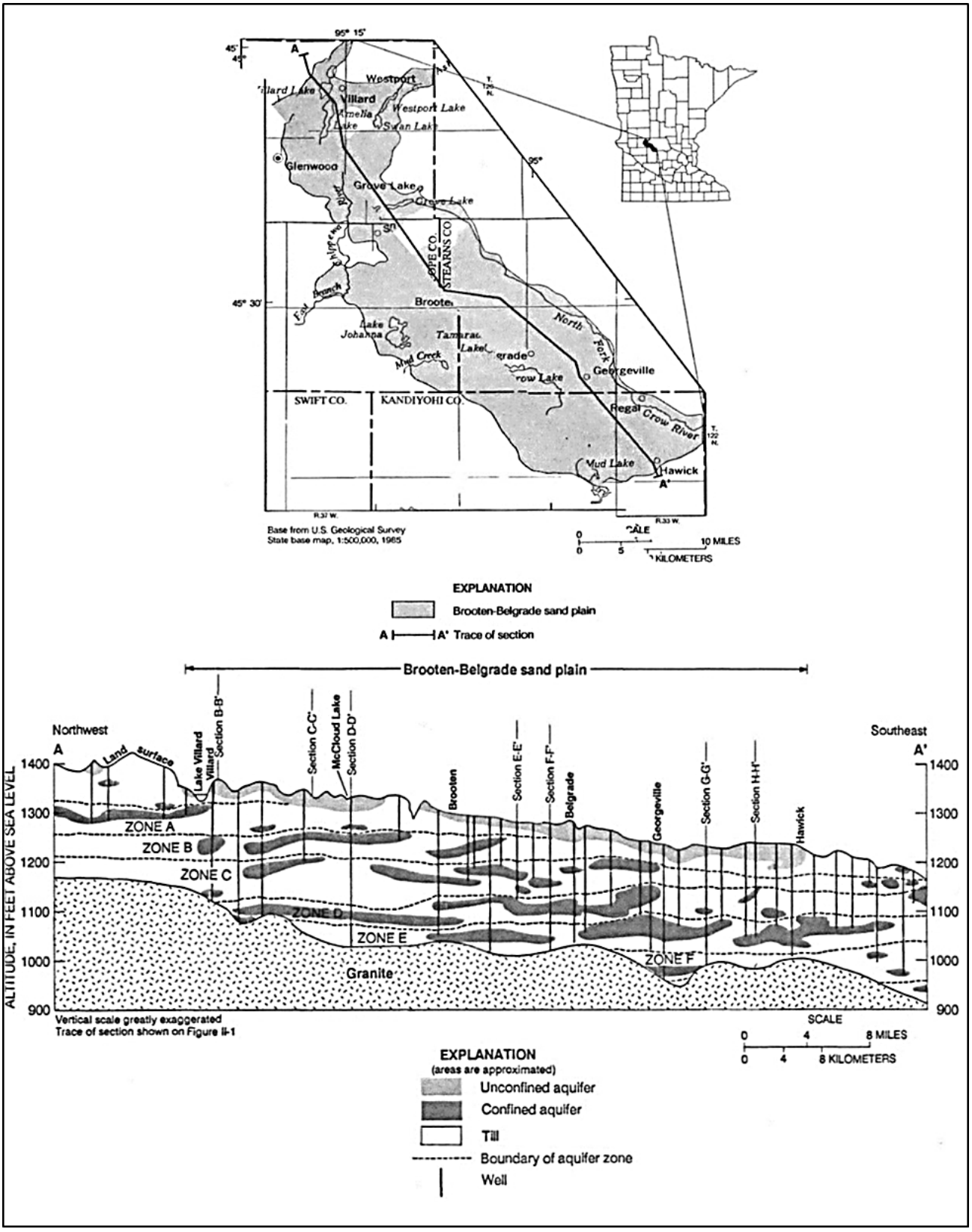

Figure 2-4 Geologic cross section courtesy of the U.S. Geological Survey - Geoff Delin, 1990.

Water Use

Bonanza Valley is an area of intensive groundwater use.

Over the past twenty-five years, permitted groundwater use in Bonanza Valley has nearly tripled. In contrast, the statewide increase in groundwater use was roughly one third (i.e., 175 percent increase in Bonanza Valley compared to 35 percent increase statewide – about five times the rate of increase in the Valley). .

The largest growth in groundwater demand has been for agricultural irrigation

The total land area in the sand and gravel aquifer area of Bonanza Valley is 239,765 acres. Areas of the sand and gravel aquifer for Stearns and Pope County have been studied and described by the Geologic Atlases for those counties. For Kandiyohi County the area of sand and gravel aquifer is very likely larger than the sand and gravel aquifer area shown on the figures throughout this plan. This is evident by the number of irrigation systems in operation that are outside of the Kandiyohi County mapped sand and gravel aquifer areas (Fig. 2-5). The development of a geologic atlas for Kandiyohi County would confirm the area of sand and gravel aquifers as well as revealing other aquifer characteristics.

Figure 2-6 describes water appropriation related land use in the sand and gravel aquifer of the Bonanza Valley as taken from the United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) 2013 land cover data. Irrigated acres were digitized by DNR staff from aerial photography and field visits during 2013 – 2014.

The USDA's NASS land cover data indicates 89,993 acres of agricultural land under cultivation in the Bonanza Valley GWMA sand and gravel aquifer area. As of May, 2015, 74,562 acres were under irrigation as reported to the DNR by water appropriation permit applicants and reflected in MPARS reporting system. This indicates that 15,431 acres of land under cultivation is not irrigated in the Bonanza Valley GWMA sand and gravel aquifer area.

The area that is developed/non upland is 36,955 acres. This developed/non upland is composed of the following land covers: developed land (pavement, cities, rural developments), wetlands (herbaceous and wooded wetlands, open water) and protected land (under ownership or conservation easement). This analysis does not include lakes.

The area that is upland but not crop land is 115,228 acres. This non-crop upland is composed of the following land covers: barren, deciduous forest, evergreen forest, fallow/idle cropland, grassland/prairie, mixed forest, other hay, pasture/grass, pasture/hay, shrub land, sod/grass seed, and woodland. See Appendix C for more information on this data analysis.

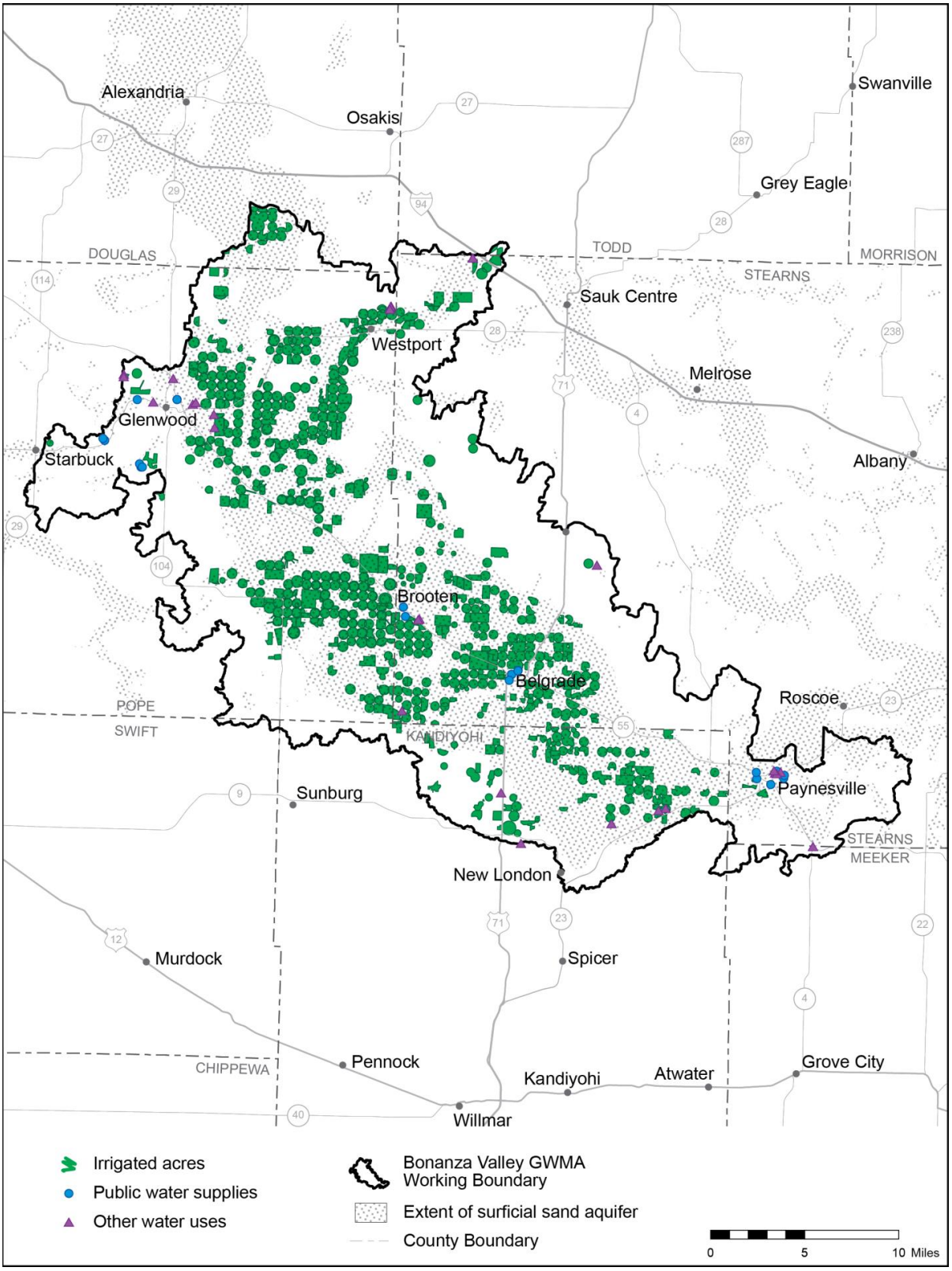

Figure 2-5 Permitted Water Use in Bonanza Valley GWMA, 2014

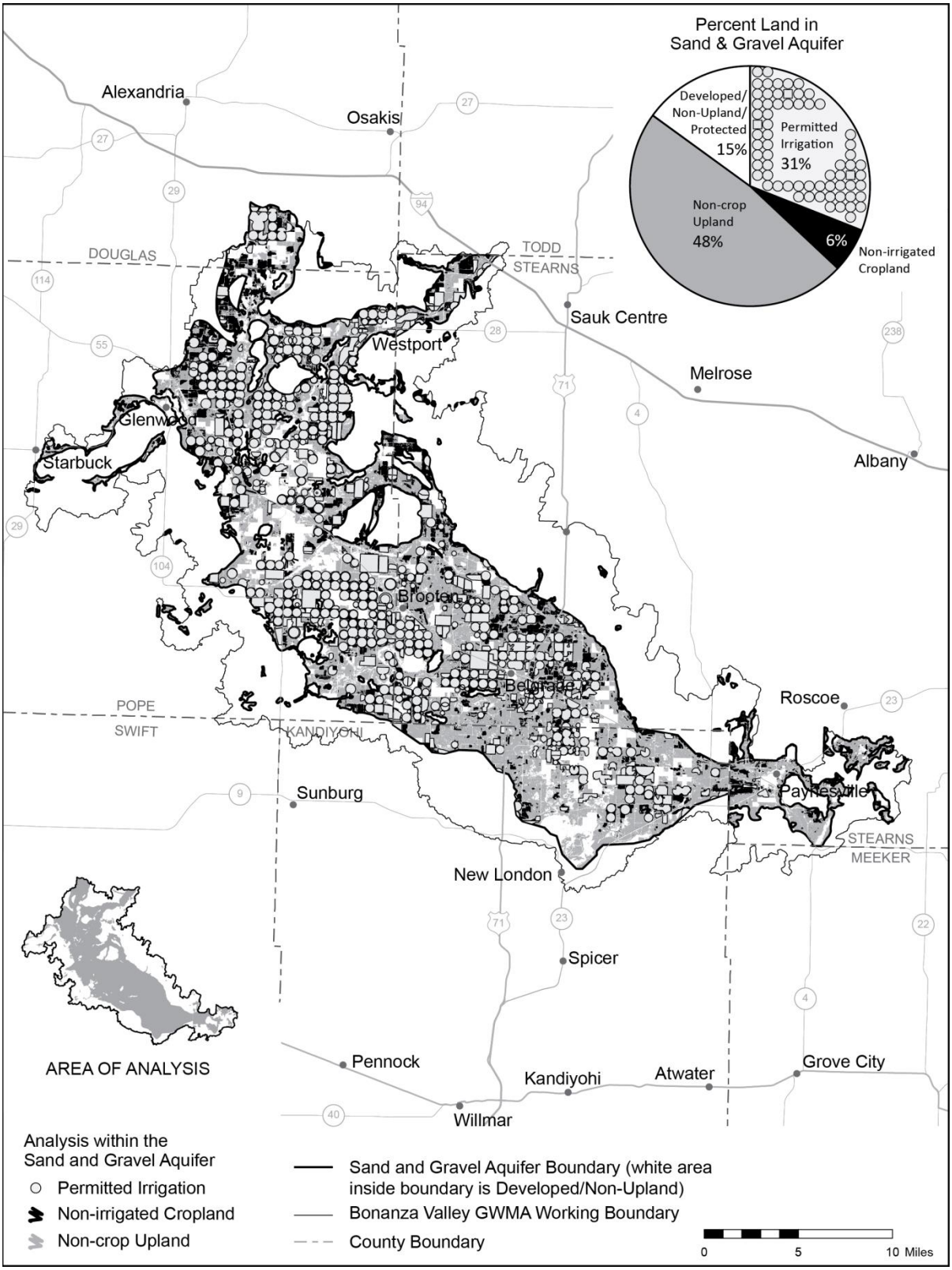

Figure 2-6 Water Appropriation Related to Land Use in the Sand and Gravel Aquifer, 2014

Groundwater appropriations and use

There were 624 active groundwater appropriation permits in the Bonanza Valley GWMA area as of September 2014. At that same time, there were an additional 367 inactive groundwater appropriation permits. Permittees are required to report their water use online through the Minnesota Permit and Reporting System (MPARS) by February 15 of each year.

Figure 2-7 presents groundwater use by economic sector over the past 10 years:

- 91.8 percent was used for irrigation and agricultural products processing (ag. products processing accounts for approx. 0.3% of the total use in this category)
- 3 percent was used for municipal water supply
- 2.3 percent was estimated for private domestic well use

2.9 percent was used for other permitted uses including, manufacturing, golf course irrigation, athletic field irrigation, aquaculture, pollution containment, livestock watering, dust control, dewatering, and sand and gravel washing.

Reported groundwater use in the Bonanza Valley reached an all-time high of 17.065 billion gallons in 2013. Of the reported permitted groundwater use in the Bonanza Valley in 2013, 95 percent was used for major crop irrigation. (Figures 2-8, 2-9, 2-10)

The source of the 17.065 billion gallons of water was the following:

- The water table aquifer; 41% (6.956 billion gallons),
- Buried aquifers; 42% (7.254 billion gallons),
- Surface waters and unknown aquifers; 17% (2.854 billion gallons)

Of the 74,562 acres under irrigation in the Bonanza Valley GWMA as reported by the MPARS system in May, 2015:

- 72,206 acres are reported as irrigated from groundwater wells,
- 1,346 are reported as irrigated from surface water sources and
- 1,010 acres are reported as irrigated from a combination of both groundwater wells and surface water sources.

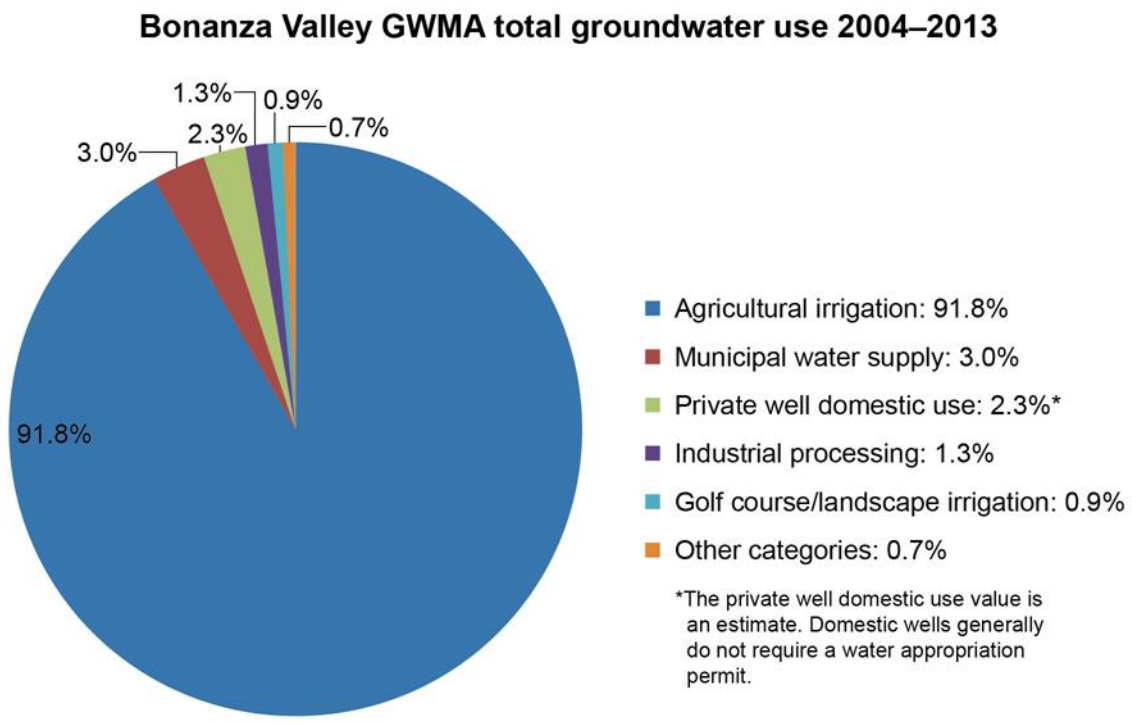

Figure 2-7 Percentage groundwater use by category 2004 – 2013

As of December 2013, the MDH's County Well Index (CWI) showed 5,724 wells on record for the Bonanza Valley, which includes all wells, even those that may no longer be in service. The number of wells for both domestic and irrigation purposes has steadily increased since water well records were required in 1974. The cumulative number of domestic wells installed in the Bonanza Valley is 3,527 and the cumulative number of wells installed for major crop irrigation is 1,211. The remaining wells are from other categories including commercial, monitoring, industrial, test wells and 18 other categories. Though older wells exist, the CWI well records include only wells constructed from about 1974 to present.

As of December 2014, there were 1,057 active DNR permitted wells in the Bonanza Valley on file with the DNR. An active well is a well boring that contributes to the amount of water allowed in the water appropriation permit. Some water appropriation permits may have multiple wells. There are 367 inactive groundwater appropriation permits on file.

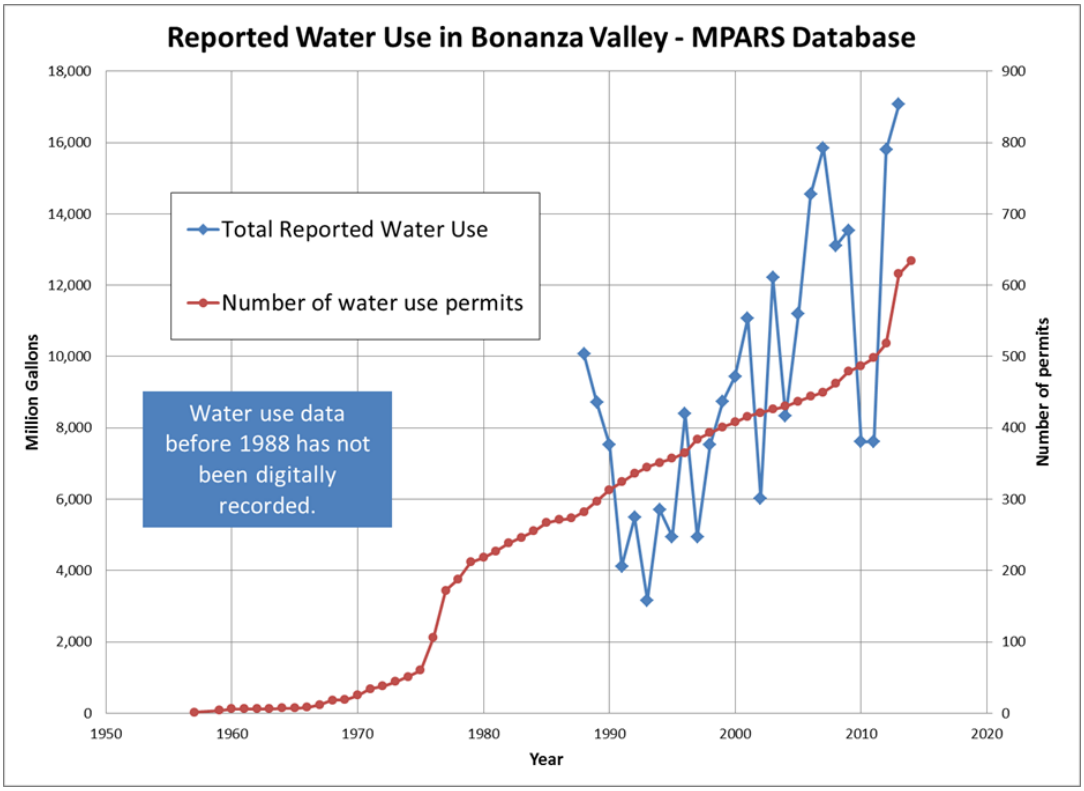

Figure 2-8 Reported Water Use (1988 – 2013) and Number of Permits in Bonanza Valley GWMA

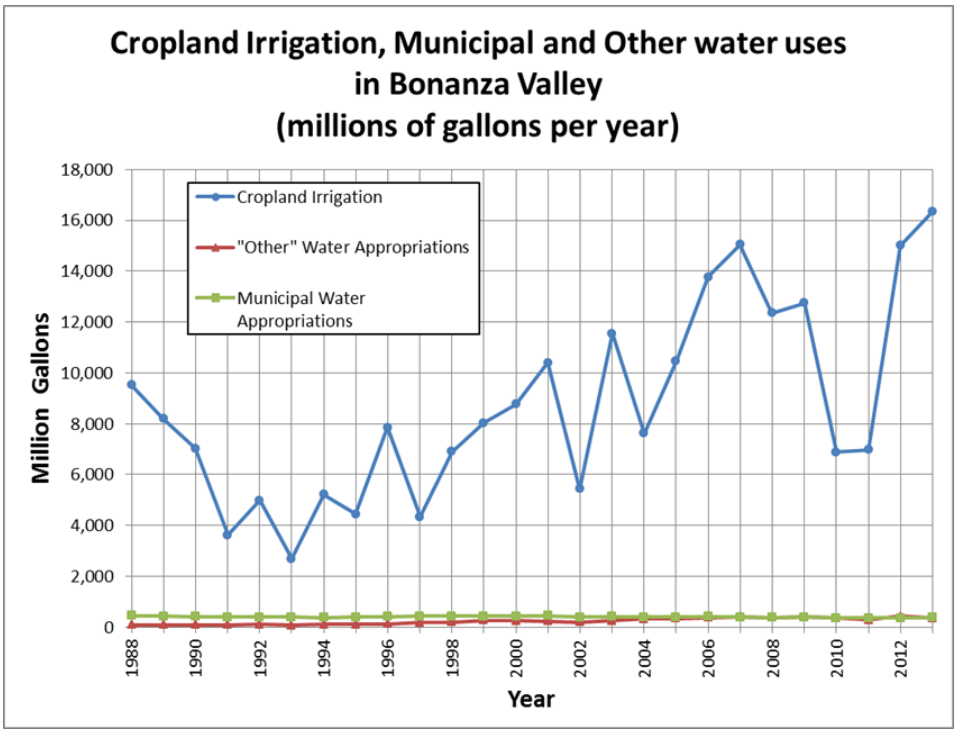

Figure 2-9 Water use by type of appropriation

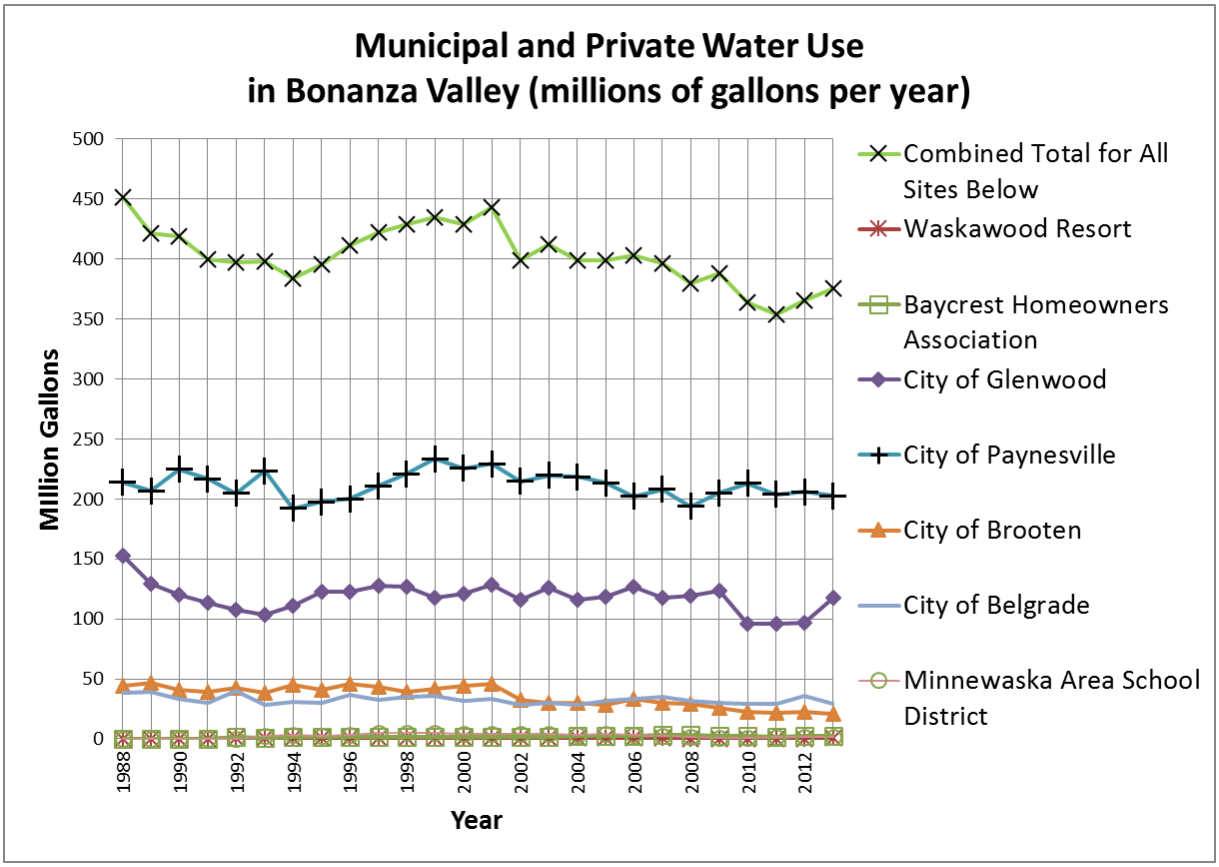

Figure 2-10 Water use by Municipal and Private Use type of appropriation from figure 2-8 above

Drinking Water

Minnesota State Statute (103G.265) sets priority uses for water. The highest priority use for water in the State of Minnesota is drinking water. Water used for drinking may or may not be associated with a water appropriation permit. Individual landowners who have a private well and withdraw less than 10,000 gallons per day or 1 million gallons per year are not typically required to apply for a water appropriation permit. Municipal and private use greater than 10,000 gallons per day or 1 million gallons per year are required to receive a permit. The source of municipal and private-use drinking water in the Bonanza Valley is from groundwater, typically from buried aquifers.

The responsibility for assuring safe municipal drinking water is shared between municipal water suppliers and the Minnesota Department of Health. Wellhead protection is a way for municipalities to prevent drinking water from becoming polluted by managing potential sources of contamination in the area that supplies water to a public well. More can be found on wellhead protection areas in section 4 of this plan, under water quality.

Water Dependent Natural Resources

The GWMA boundary includes unique ecological features, including surface waters that are directly connected to the hydrogeology of the GWMA (Figure 2-11). Groundwater appropriations can impact the health of these natural resources. The following features occur within the Bonanza Valley GWMA:

- Six designated calcareous fens in Kandiyohi and Pope counties
- Wetland complexes across the entire area
- Lakes that may be susceptible to changing aquifer levels
- One designated trout stream in Pope County
- One hundred one watercourses classified as public waters
- Twenty-five types of groundwater associated native plant communities
- Nine state and federally-listed threatened and endangered plant and animal species associated with groundwater

Rare Natural Features Associated with Groundwater in the Bonanza Valley Groundwater Management Area

Rare features (Figure 2-12 and 2-13) contribute to the health of the habitat and environment that surrounds us. Some even contribute directly to local economies in the form of recreation—including hunting/fishing, wildlife viewing, and camping. Rare features can include species of unique plants and animals as well as native plant communities (habitats).

There are six designated calcareous fens occurring in Kandiyohi and Pope Counties. Calcareous fens support four of the rare plants found in the Bonanza Valley GWMA. Calcareous fens are protected from degradation under Minnesota statute.

There are 16 native plant community types that are closely associated with groundwater-related habitats such as fens and marshes (Table 2-2). They range from wooded to grassland communities such as tamarack swamps, cattail marshes and sedge meadows. Half of these plant community types are considered imperiled or critically imperiled. Seven of the 25 native plant community types closely or often associated with groundwater in the Bonanza Valley are considered abundant. (Table 2-3) There are 26 species of birds, fish, mussels and plants that are either endangered, threatened, special concern or are a state listed “Species In Greatest Conservation Need,” that are dependent on habitats with groundwater or groundwater seepage areas in the Bonanza Valley Groundwater Management Area (Table 2-4).

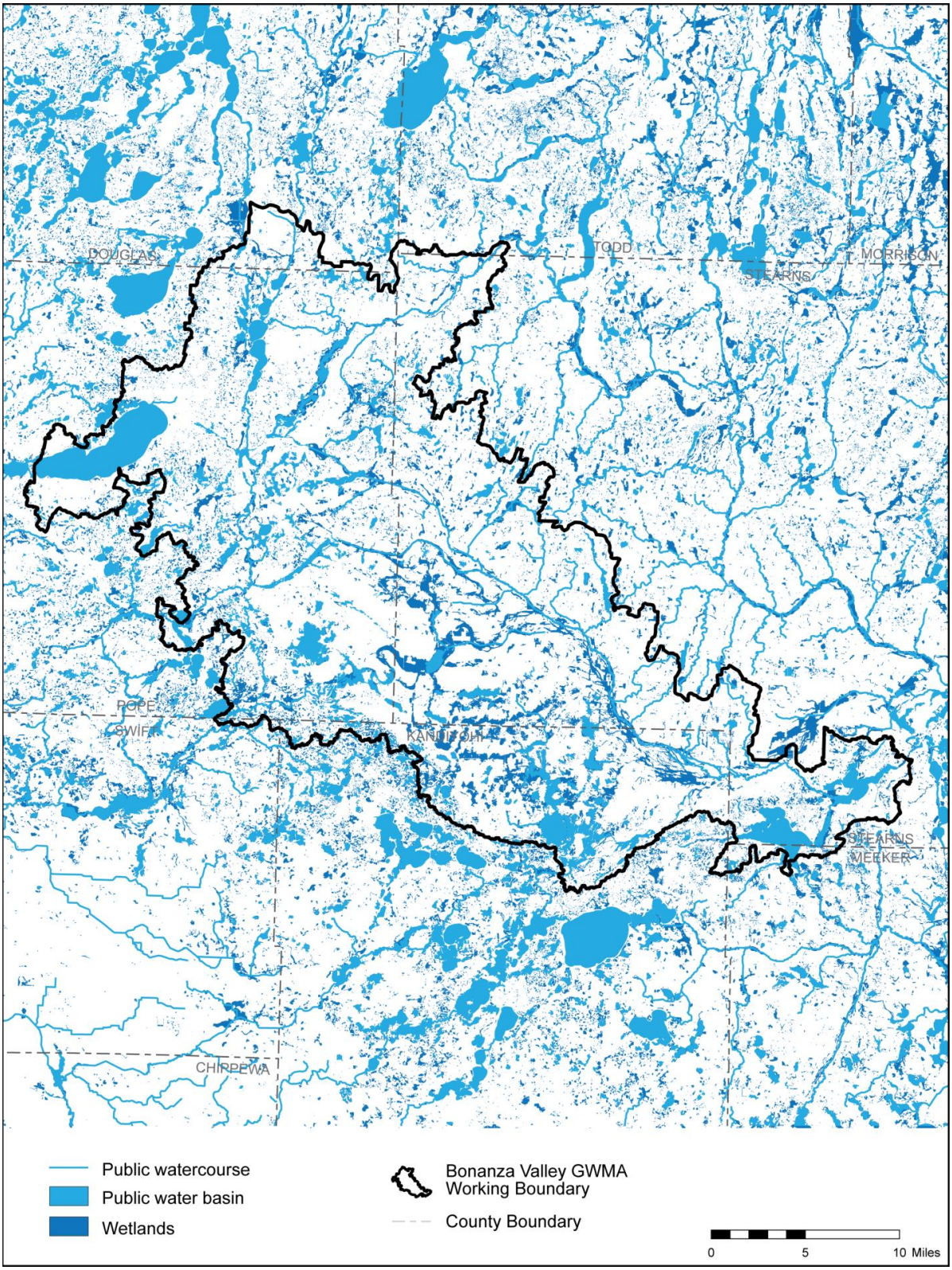

Figure 2-11 Public Waters and Wetlands

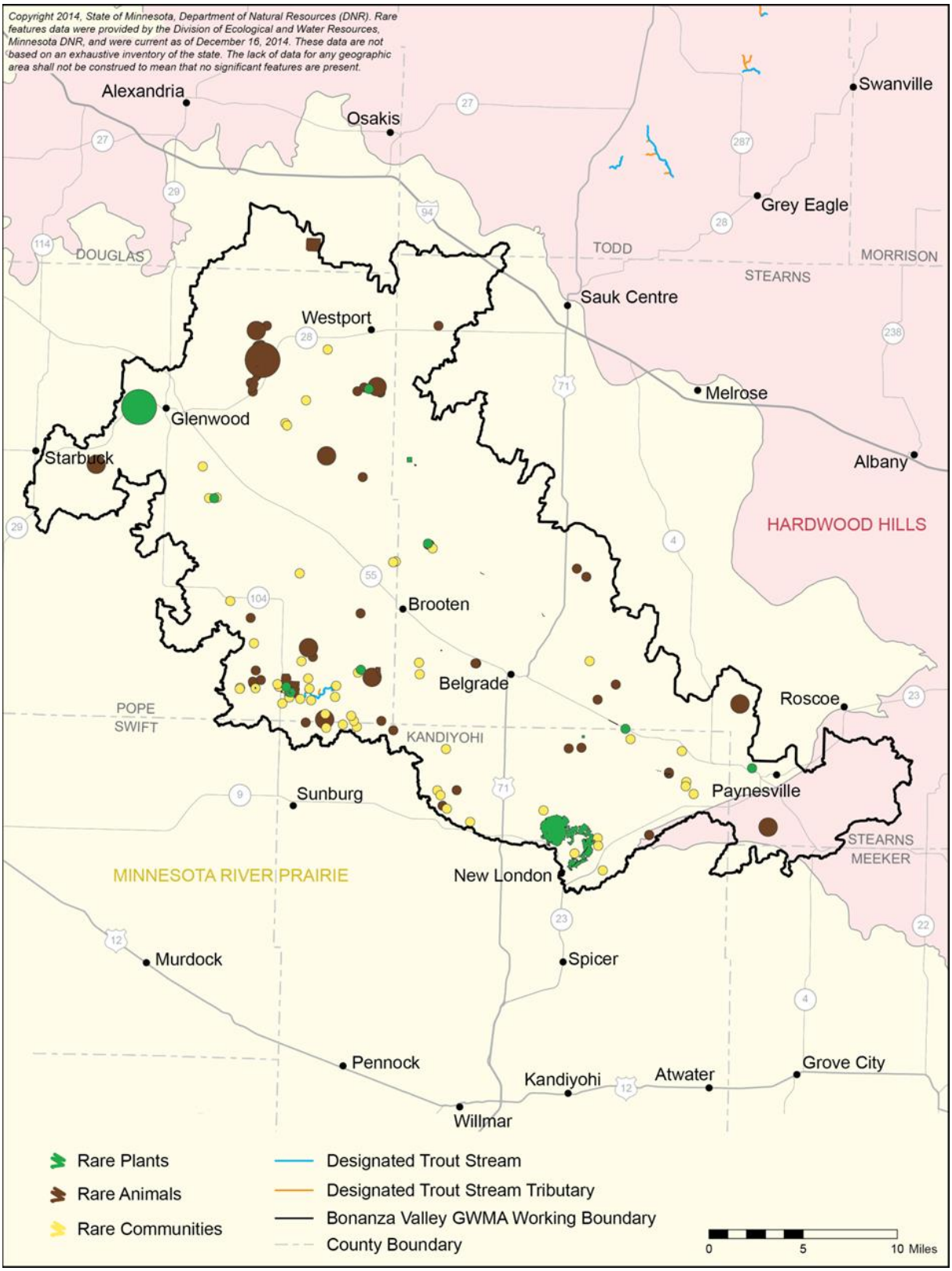

Figure 2-12 Rare plants, animals and native plant communities and a trout stream within the working boundary of the proposed Bonanza Valley GWMA

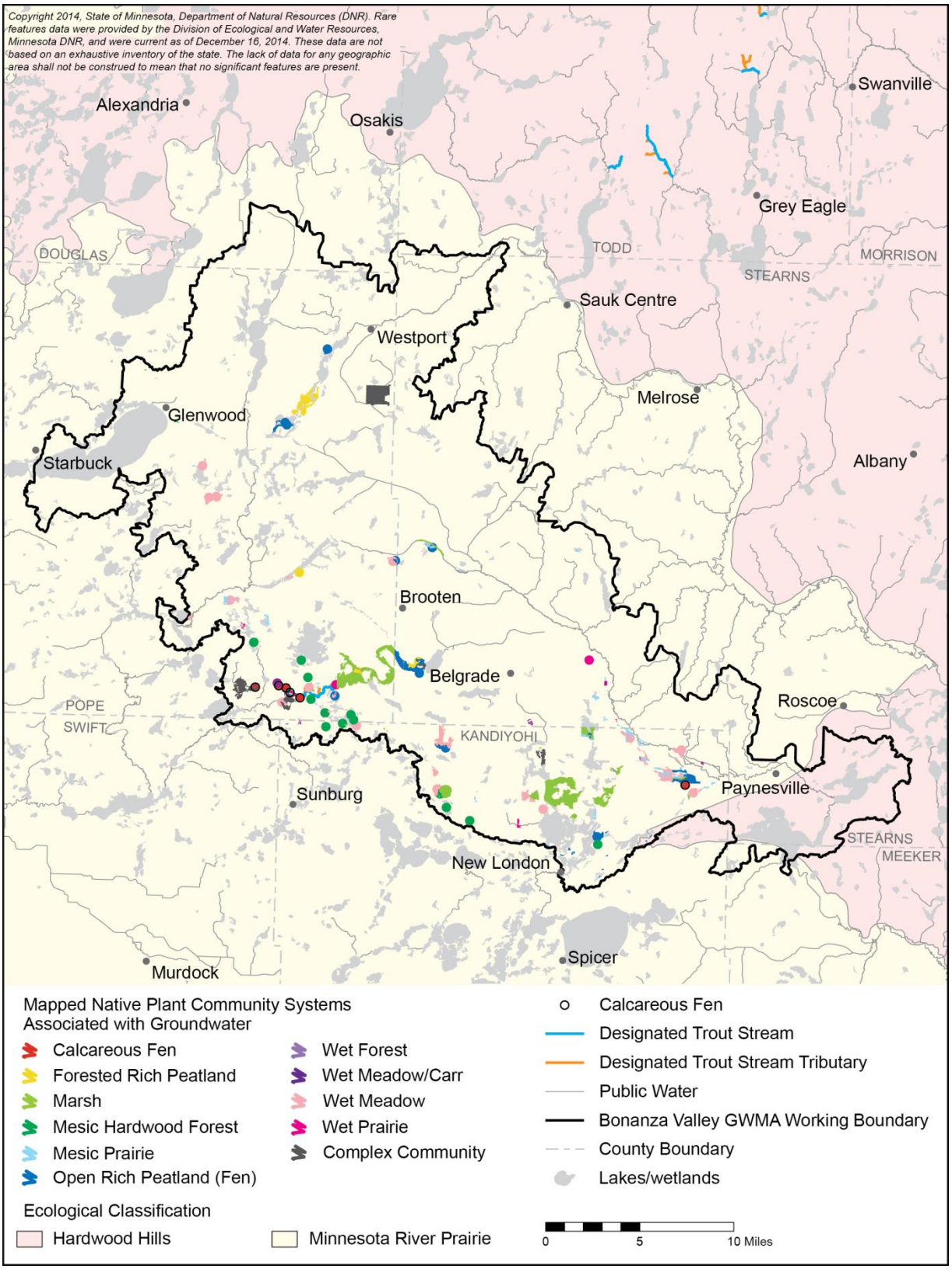

Figure 2-13 Designated trout streams and native plant communities associated with groundwater

Table 2-2 Native plant communities closely associated with groundwater

Native Plant Community Code	Native Plant Community System	Native Plant Community Type	Conservation Status Rank	Associated with Seepage* areas?
MRp83a	Marsh	Prairie Mixed Cattail Marsh (Sedge) Type	S1 = critically imperiled	
MRp83b	Marsh	Prairie Mixed Cattail Marsh	S1	
MRp93c	Marsh	Prairie Bulrush-Arrowhead Marsh	S1	
OPp93c	Calcareous Fen	Calcareous Fen (Southeastern) Type	S1	Yes
WPs54a	Wet Prairie	Wet Seepage Prairie (Southern) Type	S1	Yes
MRn83a	Marsh	Cattail Sedge Marsh (Northern)	S2= imperiled	
MRn83b	Marsh	Cattail Marsh (Northern)	S2	
OPp93b	Calcareous Fen	Calcareous Fen (Southwestern) Type	S2	Yes
FPs63a	Forested Rich Peatland	Tamarack Swamp (Southern) Type	S2S3	
OPp91	Open Rich Peatland (Fen)	Prairie Rich Fen	S3= vulnerable to extirpation	
OPp91a	Open Rich Peatland (Fen)	Rich Fen (Mineral Soil) Type	S3	
OPp91c	Open Rich Peatland (Fen)	Rich Fen (Prairie Seepage) Type	S3	Yes
WMs83a	Wet Meadow/Carr	Seepage Meadow/Carr	S3	Yes
WMs83a1	Wet Meadow/Carr	Seepage Meadow/Carr—Tussock Sedge Subtype	S3	Yes
OPn92a	Open Rich Peatland (Fen)	Graminoid Rich Fen (Basin)	S4= apparently secure	
OPn92b	Open Rich Peatland (Fen)	Graminoid-Sphagnum Rich Fen	S4	

Table 2-3 Native plant communities often **associated with groundwater**

Native Plant Community Code	Native Plant Community System	Native Plant Community Name	Conservation Status Rank	Associated with Seepage* Areas?
UPs23a	Mesic Prairie	Mesic Prairie (Southern) Type	S2 = imperiled	
WPs54b	Wet Prairie	Wet Prairie (Southern) Type	S2	
MHs49a	Wet-Mesic Hardwood Forest	Elm - Basswood - Black Ash - (Hackberry) Forest Type	S3 = vulnerable to extirpation	
WMp73a	Wet Meadow/Carr	Prairie Wet Meadow/Carr	S3	
WMn82b2	Wet Meadow	Sedge Meadow; Tussock Sedge Subtype	S4= apparently secure	
WMn82b	Wet Meadow	Sedge Meadow Type	S4S5	
WFs55a	Wet Forest	Lowland Aspen Forest	S4	
WMn82a	Wet Meadow	Willow - Dogwood Shrub Swamp Type	S5 = secure, common, widespread, abundant	
WMn82b1	Wet Meadow	Sedge Meadow, Bluejoint Subtype	S5	

*Seepage refers to communities that have groundwater discharge/upwelling as opposed to communities that have perched groundwater situations

Groundwater connections to wildlife species are many and often complex. Wildlife groups as diverse as birds, bats, spiders, snakes, turtles, frogs, toads, fishes, and snails all contain species that require some form of surface water body to complete their life cycles and persist on the landscape. If groundwater fluctuations or depletions affect a significant number of surface water features in this area, important wildlife habitats may be impacted or lost.

Table 2-4 Rare Species Associated with Groundwater

Scientific Name	Common Name	Listing Status*	General Habitat Type
Rare Plants			
Aquatic Plants			
Eleocharis coloradoensis	Dwarf Spike-rush	SPC	Shores of prairie lakes with intact shoreline
Eleocharis quinqueflora	Few-flowered Spike-rush	SPC	Sparsely vegetated wet habitats
Najas marina	Sea naiad	SPC	Alkaline lakes
Rhynchospora capillacea	Hair-like Beak-rush	THR	Calcareous fens; spring fens
Ruppia cirrhosa	Widgeon-grass	SPC	Alkaline lakes
Scleria verticillata	Whorled nut-rush	THR	Calcareous fens
Triglochin palustris	Marsh arrow-grass	Watch list	Marshes
Terrestrial Plants			
Cypripedium candidum	Small white lady slipper	SPC	Calcareous seeps, wet prairie
Carex sterilis	Sterile sedge	THR	Calcareous fens, spring fens
Rare Animals			
Rare Mussels			
Lasmigona compressa	Creek heelsplitter	SPC, SGCN	Small rivers/streams
Rare Fish			
Etheostoma microperca	Least darter	SPC, SGCN	Clear freshwater streams/lakes
Notropis anogenus	Pugnose shiner	THR, SGCN	Glacial lakes/streams
Rare Insects			
Aflexia rubranura	Red-tailed prairie leafhopper	SPC, SGCN	Dry to wet mesic prairies. Prairie dropseed (*Sporobolus heterolepis*) is its host plant
Oarisma poweshiek	Poweshiek skipperling	State END; Fed END, SGCN	Wet to Dry native prairie
Speyeria idalia	Regal Fritillary	SPC, SGCN	Upland and wet prairie
Rare Amphibians			
Necturus maculosus	Mudpuppy	SPC, SGCN	
Rare Birds			
Ammodramus henslowii	Henslow's Sparrow	END, SGCN	Grasslands
Botaurus lentiginosus	American Bittern	Watch List, SGCN	Marshes/ wetlands

Buteo lineatus	Red-shouldered Hawk	SPC, SGCN	Mature deciduous forest w/ wetland openings
Grus canadensis	Sandhill Crane	Watch list	Grasslands/ wet meadows
Haliaeetus leucocephalus	Bald Eagle	Bald Eagle and Golden Eagle Protection Act (Federal), SGCN	Forested to wet areas; throughout
Limosa fedoa	Marbled Godwit	SPC, SGCN	Native grasslands adjacent to wetlands
Pelecanus erythrorhynchos	American White Pelican Colony	SPC, SGCN	Large, shallow lakes
Podiceps auritis	Horned Grebe	END, SGCN	Marshes/lakes
Phalaropus tricolor	Wilson's phalarope	THR, SGCN	Wet prairie/ sedge-dominated wetlands
Sterna forsteri	Forster's Tern Colony	SPC, SGCN	Marsh Complex

*END = Endangered; THR = Threatened; SPC = Special Concern; Watchlist = Species the DNR is tracking because they are in suspected decline; SGCN= Species of Greatest Conservation Need

Lakes, Streams and Wetlands

The Bonanza Valley area has a high density of surface water features like lakes, streams and wetlands. Water levels and/or chemistries of many of these areas are strongly influenced by groundwater, or have at least some hydraulic connection to the regional groundwater system. Many lakes, streams and wetlands, therefore, may be affected by changes in water table elevations.

There are 100 public waters courses and 316 public water basins within the Bonanza Valley GWMA (Figure 2-9)**.** All public waters are protected. Most public water basins and wetlands are small, very shallow and susceptible to fluctuations in groundwater levels. These areas provide critical habitat for a variety of economically and environmentally valuable native species, such as waterfowl, game fish, pollinators and water/air cleaning plants.

Lakes and Wetlands

Healthy shallow lakes and wetlands are important for native game fish to overwinter and sustain populations. In those basins, with flowage connections to rivers and tributaries, populations of northern pike (*Esox lucius*), common carp (*Cyprinus carpio*), black bullheads (*Ameiurus melas*), and minnow species (*Pimephales spp.*) can be supported. However, relatively few game fish have been captured in

the limited stream surveys and analyses (Indices of Biological Indicators) sampling completed throughout the GWMA, indicating habitat and connectivity deficiencies.

In general terms, streams in the upper reaches of the watersheds in the GWMA have few deep pools to provide oxygenated, cooler water for most native riverine game fish during summer months. Smaller tributaries may have intermittent or no flow during late summer months. These limiting conditions are made worse for fish populations by silt loading and nutrient enrichment.

The Bonanza Valley is also on the edge of what is called the Prairie Pothole Region that extends into South Dakota, North Dakota, western Minnesota and southern Canada. This area contains wetlands that are key resting, feeding and breeding areas for migratory waterfowl, shorebirds, wading birds and many songbirds. Existing data shows that many of these species groups have declining population trends in Minnesota.

The Minnesota Prairie Conservation Plan has identified the Glacial Lakes and Moraines area as one of 29 areas with a high concentration of remaining native prairie. The Glacial Lakes and Moraines area overlaps with the Bonanza Valley GWMA along its southwest border with a portion extending though the cities of Regal and Belgrade. The Minnesota Prairie Conservation Plan proposes permanent protection, restoration, enhancement of native prairie as well as incorporating grasslands into “working lands.”

There are a large number of lakes and wetlands connected to the regional groundwater system and potentially vulnerable to impacts from groundwater depletion. These include a number of features near areas of relatively intensive groundwater use. Though groundwater depletion may affect upland plant communities, the wetland native plant communities and wetland types that are associated with groundwater (Table 2-2 and 2-3) are more at risk.

Lake and wetland water levels in the Bonanza Valley are influenced by climate and the changes within the shallow groundwater system. As an example, the recent DNR Fisheries Management Plan for Lake Johanna in the Bonanza Valley GWMA has analyzed the complexities of this type of relationship. The Bonanza Valley area will require additional study to fully evaluate these relationships.

The DNR gathers and reports the water elevation through its Lakes Database. The Lakes Database network does not include all lake level monitoring activities in which the DNR is involved. Examples include measuring wetland water levels in select Waterfowl Production Areas and Wildlife Management Areas, and monitoring as a condition of a water appropriation permit.

Bonanza Valley contains headwater areas for several well-known lakes such as Amelia, Levin, Minnewaska, Monongalia, Nest, Long, Green and Koronis. Water quality and quantity of lakes, rivers and wetlands are influenced by the water that flows into them; both surface water and groundwater. The opportunity to influence the quality of water in lakes, rivers and wetlands is greatest in headwaters areas, as there are smaller land areas that collect water and fewer opportunities for that water to encounter contamination sources. Additionally, these “headwaters” provide important flows during

periods of no runoff, which are referred to as “base flows.” Base flows are important in two respects, as they:

- provide high quality groundwater, which is typically lower in nutrients and has cooler temperatures than surface runoff, and
- help sustain water levels during extended dry climate conditions and during droughts.

Several lakes, rivers and streams in the area have been identified as “impaired” by the Minnesota Pollution Control Agency through the Watershed Restoration and Protection Strategies Program (WRAPS). Reduced base flow caused by groundwater pumping has the potential to exacerbate the severity of known water quality impairments. It is unknown if this is the case in the Bonanza Valley.

Streams

The flow of water in the streams of the Bonanza Valley have been measured by the DNR since 2009 . New monitoring stations are being installed to continue to improve the information available for water management decisions. Stream flows are being measured in the North Fork of the Crow River, Chippewa River and Ashley Creek, representing each major watershed in the Bonanza Valley. Water flows in streams can be increased mostly through surface water runoff and groundwater seepage through the river channel. Water flows in streams can be decreased through evaporation, groundwater seepage through the river channel when groundwater levels decline, and direct pumping.

The DNR has authority to designate trout streams, which provides increased protection from alterations and appropriations. In addition, the Minnesota Pollution Control Agency (MPCA) maintains higher water quality standards for cold water streams to protect these sensitive systems.

One designated trout stream, Mud Creek, is found within the boundary in Pope County.

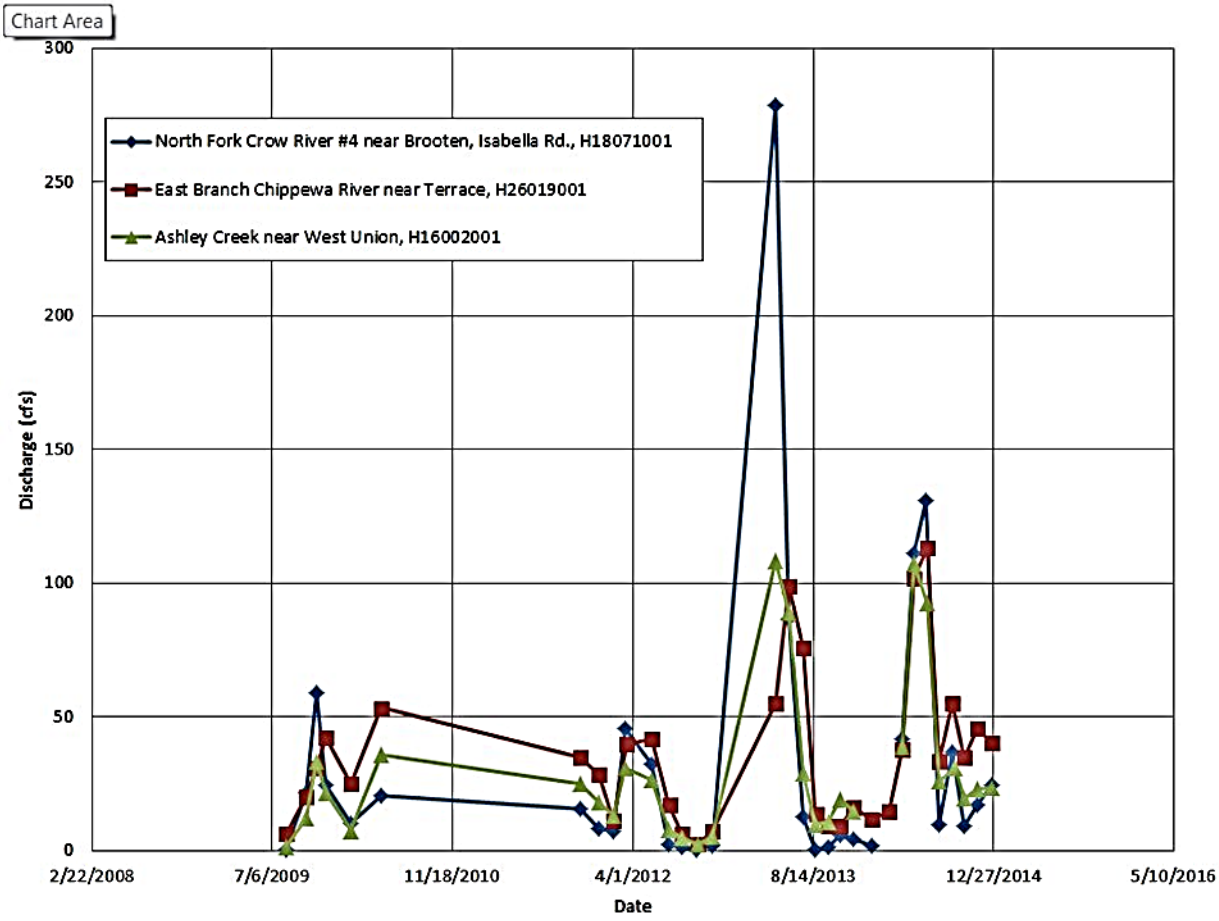

Figure 2-14 Stream flow results 2009 – 2014 on three water courses in the Bonanza Valley

Water Quality

Water quality can affect the availability and cost of groundwater in the GWMA. Contaminated groundwater may not be available for use by individuals, industry or cities unless it undergoes treatment. Consumers may have to use deeper aquifers or rely on surface water sources. Contaminated groundwater also presents a risk to the connected ecosystems (lakes, streams and wetlands), impacting the species that live there and the people who use these water bodies to live, work, and recreate.

Minnesota Statute 103G.287 directs the DNR to consider the effects of water quality in water appropriations. Management activities in the Bonanza Valley GWMA will require continued coordination between the existing state agencies that are responsible for groundwater and surface water quality, including: Minnesota Department of Agriculture (MDA), the Minnesota Department of Health (MDH), the Minnesota Pollution Control Agency (MPCA), Board of Water and Soil Resources (BWSR) and the DNR.

Jurisdictions, governance and planning

Cities, counties, watershed districts and other local units of government play a critical role in planning and managing for long-term water supply and water sustainability. Implementation of practices to improve water quality and quantity are heavily dependent upon local plans such as comprehensive local water management plans, watershed district plans, county comprehensive plans and city comprehensive plans. These plans are authorized by Minnesota Statute.

The Bonanza Valley GWMA encompasses parts of:

- 7 counties
- 35 townships
- 12 cities
- 3 watershed districts
- 7 Minnesota House of Representative Districts
- 5 Minnesota Senate Districts
- 7 Soil and Water Conservation Districts

Local water governance in the area of the Bonanza Valley is guided by cities, counties and watershed districts. The watershed districts define their boundaries on surface watershed boundaries. The boundaries of the Bonanza Valley GWMA also follow surface watershed boundaries.

Comprehensive local water management entails the adoption and implementation of local water management plans that are based on local priorities. Counties, with their planning and land-use authorities, are uniquely positioned to link many land-use decisions with local goals for surface and groundwater protection and management. BWSR has oversight responsibilities to ensure that local water plans are prepared and coordinated with existing local and state efforts and that plans are implemented effectively. All parts of Minnesota have state-approved and locally adopted plans in place. Counties that contain the majority of the Bonanza Valley are Pope, Stearns and Kandiyohi.

State of Minnesota jurisdiction for the Bonanza Valley GWMA is guided, in part, by Minnesota Statutes, section 103G.287, which states, “The commissioner may designate groundwater management areas and limit total annual water appropriations and uses within a designated area to ensure sustainable use of groundwater that protects ecosystems, water quality, and the ability of future generations to meet their own needs. Water appropriations and uses within a designated management area must be consistent with a plan approved by the commissioner that addresses water conservation requirements and water allocation priorities established in section 103G.261.”

3. The Goal and Objectives

Section 3 describes the goal and objectives for groundwater management, including supporting statutes and rules. The goal for the GWMA expresses a future desired condition for the area.

The goal for the GWMA is:

> *In the Bonanza Valley Groundwater Management Area, the use of groundwater will be sustainable and therefore will not harm ecosystems, water quality, or the ability of present and future generations to meet their needs.*

The goal is drawn directly from the Minnesota Statutes for groundwater appropriations, Minn. Stat., sec. 103G.287, subd. 3, 4 and 5. These statutes describe protection of groundwater supplies, designation of groundwater management areas, and a standard of sustainability.

Groundwater use is defined as sustainable if that use:

- Does not harm aquifers and ecosystems
- Does not negatively impact surface waters
- Is reasonable, efficient and meets water conservation requirements
- Does not degrade water quality
- Does not create unresolved well interferences or water use conflicts

To attain the goal for the GWMA, this Plan sets five management objectives that define how these statutory requirements can be met. All of the management objectives must be achieved simultaneously to ensure sustainability of groundwater use.

These objectives are:

I. *Groundwater use in the GWMA does not harm aquifers and ecosystems, and does not negatively impact surface waters.*
II. *Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.*
III. *Groundwater use in the GWMA does not degrade water quality.*
IV. *Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.*
V. *All groundwater users in the GWMA have the necessary permits to use groundwater.*

The remainder of Section 3 describes each of the objectives in more detail.

Objective I. Groundwater use in the GWMA does not harm aquifers and ecosystems, and does not negatively impact surface waters.

Groundwater and surface waters together make up a connected hydrologic system that is affected by climate, geology and soils, land use and land cover, water use, and water quality changes. Therefore, impacts to aquifers, ecosystems, and surface waters resulting from water appropriations are related under this objective.

Aquifer Sustainability

The first part of this objective deals with preventing harm to aquifers. The purpose is to ensure that groundwater continues to be available for use in the future, while protecting ecosystems and surface waters (described below). Groundwater use always reduces aquifer storage unless there is an equivalent increase in recharge through surface-water infiltration. Limits on appropriations can help ensure aquifer sustainability.

In Minnesota Rules, parts 6115.0630 and 6115.0670, the concept of *safe yield* is used as the measure of limits on allowable groundwater use. The concept looks at the impact that water withdrawals from an aquifer have on aquifer water quality, levels, and pressure (sometimes referred to as 'heads'). It does not address potential impacts to other resources such as surface waters. Safe yield is defined separately for water-table aquifers and for artesian (confined) aquifers (see Section 7 for glossary of terms).

For buried aquifers, a water elevation level in an observation well (obwell) may be set as a threshold for aquifer protection that ensures compliance with safe yield (Figure 3-1). To protect the aquifer from being drawn down too far, 25 percent of the 'available' head (water height above the top of the aquifer, before pumping) must remain in an observation well. A warning threshold of 50 percent of the available head may be established to allow time for contingency plans to be put in effect if water levels decline.

For water-table aquifers, safe yield is a total-use rate that does not exceed the long-term average recharge rate (Minn. Rules, part 6115.0630). In short, output (pumping) for the aquifer does not exceed input (recharge) over the long term. Again, this does not account for impacts to surface waters, which are addressed in the next section. Pumping from buried aquifers typically causes water from the water-table aquifer to flow down into the artesian aquifers. Therefore, safe yield should be determined based on both direct and indirect withdrawals from water-table aquifers.

Water levels that have stabilized to a pattern of variations above the threshold indicate compliance with safe yield. Understanding pumping history and measured water levels is important when evaluating compliance with safe yield. Declining water levels that remain above the threshold are expected in some situations, even while use remains within the safe yield. This occurs if pumping rates gradually increase over time, the system has not come into equilibrium with recent pumping rates, or natural fluctuations create a temporary downward trend.

In most circumstances limits on groundwater pumping will be defined by the protection of surface-water resources and dependent ecosystems or by preventing water use conflicts rather than by safe yield for water-table aquifers.

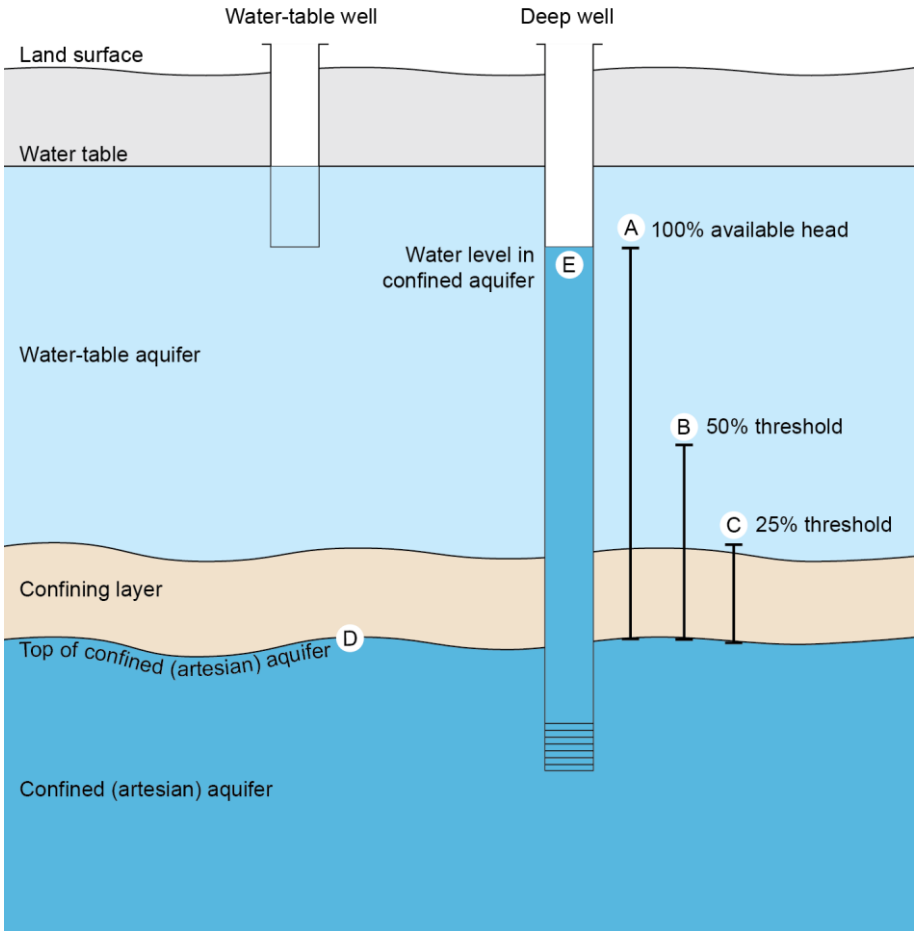

Figure 3-1 Safe yield thresholds for artesian (confined) aquifers

The available head (A) is the distance between the top of the confined aquifer (D) and the water level (E) in the deep well. The 50-percent threshold (B) is halfway between these same points; the 25-percent threshold (C) is one-fourth of the way. Water levels in a confined aquifer must not stabilize below the 25-percent safe yield threshold.

Ecosystems and Surface Waters

The second part of Objective I deals with harm to ecosystems and negative impacts to surface waters when groundwater is overused. The groundwater system is part of the water cycle, eventually destined to discharge to surface waters such as rivers, lakes, wetlands, or springs. Taking groundwater from water table and most artesian aquifers diverts water from surface waters or wetlands. Overuse of groundwater can significantly alter surface water features and the biological communities, recreation, and other uses that those waters support.

Surface water appropriations are governed by Minn. Stat., sec. 103G.285. Groundwater appropriations are governed by Minn. Stat., sec. 103G.287. Groundwater appropriations may also be subject to additional limits based on their surface water impacts as follows (Minn. Stat, sec. 103G.287, subd. 2):

> *Groundwater appropriations that will have negative impacts to surface waters are subject to applicable provisions in section 103G.285.*

Surface-water pumping (appropriation) has a direct and immediate effect on flow or water level in the surface water features from which the water is withdrawn. The same is not true for groundwater appropriations. Determining whether groundwater appropriations have negative impacts to surface waters is complex. Generally, the effect on connected surface water features is both delayed and spread out or 'flattened' in time and is typically distributed among multiple water features.

Several Minnesota statutes and rules exist that may be used to determine impacts to surface waters:

1. Appropriations from lakes listed in Bulletin 25[1] are limited to a total annual volume of water amounting to 1/2 acre-foot per acre of water basin (6 inches over the surface area of the water body) (Minn. Stat., sec. 103G.285, subd. 3). Statute also calls for the setting of protective elevations that consider aquatic vegetation, fish and wildlife, recreation, existing uses, and slope of the littoral zone.
2. Appropriations taken directly from surface water bodies are limited according to the requirements establishing and enforcing *protected flows* for streams and rivers or *protective elevations* for lakes and wetlands (Minn. Stat., sec. 103G.285). These are intended to accommodate the range of needs and uses of water bodies. For surface-water appropriations, consumptive appropriations may not be made from watercourses during periods of specified low flows (i.e. protected flows) or from lakes and wetlands when water levels are below the protective elevation (Minn. Stat., sec. 103G.285, subd. 2 and 3).
3. Minnesota Statutes protect trout streams from water appropriations (Minn. Stat., sec. 103G.285, subd. 5) because they are particularly dependent on steady flow, stable cold water temperatures, and sufficient oxygen levels. These conditions depend on a steady supply of groundwater from springs or diffuse seepage. The goal is to limit stream depletion due to groundwater pumping.

[1] DNR Staff, 1968. An Inventory of Minnesota Lakes. Division of Water, Soils and Minerals, Minnesota Conservation Department. Bulletin 25, 498 p.

4. Calcareous fens are a rare type of peat-forming, groundwater-dependent wetland that are also protected in statute (Minn. Stat., sec. 103G.223) because they host rare plants and are sensitive to impacts. Calcareous fens are very dependent on upwelling groundwater to maintain their unique chemical and physical characteristics. To meet the statutory requirement, the goal is to limit depletion of water moving to the fen as a result of groundwater pumping.
5. Public water wetlands may not be drained unless replaced (Minn. Stat., sec. 103G.221), and temporary drawdown is only allowed if certain conditions are met, including: improving navigation and recreational uses, improving fish or wildlife habitat, exposing sediments in order to remove nutrients or contaminants, to alleviating flooding of agricultural land or allowing mining of metals (Minn. Rules, part 6115.0270).

The 2015 Minnesota Legislature directed the DNR (Laws of Minnesota 2015, First Special Session, chapter 4, article 4, section 143) to take the following actions concerning sustainability thresholds: "the commissioner of natural resources shall consult with interested stakeholders and submit a report to the Legislative Water Commission and the chairs and ranking minority members of the house of representatives and senate committees and divisions with jurisdiction over the environment and natural resources policy and finance on recommendations for statutory or rule definitions and thresholds for negative impacts to surface waters as described in Minnesota Statutes, sections 103G.285 and 103G.287, subdivision 2. Stakeholders must include but are not limited to agricultural interests; environmental interests; businesses; community water suppliers; state, federal, and local agencies; universities; and other interested stakeholders."

In January 2016, the DNR submitted a report entitled: "Report to the Minnesota State Legislature: Definitions and Thresholds for Negative Impacts to Surface Waters." The DNR will use the approach described in this report to determine if negative impacts to streams, lakes, or wetlands are occurring due to groundwater appropriation within the GWMA. (The report is available on the DNR website. The executive summary of the report provides a succinct description of the approach, and it is included in this plan as Appendix E.)

Section 5 of the GWMA Plan provides a set of actions to meet Objective I.

Objective II. Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.

Water conservation is a key component of ensuring sustainability, and an important goal within the GWMA. Efficient use increases the water available for current and future uses and can help reduce stress on the water resource. Explicit conditions may be placed on appropriation permits that require conservation practices appropriate to a specific use. As Minnesota's population has increased, so has the use of groundwater and the amount of water flowing through public water supply systems (Figures 3-2 and 3-3).Conservation Requirements for Municipal Systems

Minnesota Statute, sec. 103G.291 requires public water suppliers serving more than 1,000 people to implement demand reduction measures by January 1, 2015. The cities of Glenwood and Paynesville are the only municipalities within the GWMA that serve over 1,000 people (Figure 3-4).

The measures must include a rate structure or outline a program that achieves demand reduction. Minnesota Statute, sec. 103G.291 also requires public water suppliers to adopt and enforce water-use restrictions when the governor declares a critical water deficiency. The restrictions must limit watering lawns, washing vehicles, irrigating golf courses and parks, and other nonessential uses.

Cropland Irrigation

New water use permit applications for agricultural irrigation include a check box to indicate if a soil and water conservation plan has been approved by the local SWCD.

Other Water Uses

Water conservation conditions may be placed on appropriation permits other than those for municipal water supply where reasonable use can be quantified, for example:

- The amount of water reasonably needed for a particular agricultural situation (soil types, climate, and crop type)
- Specific goals for water use for golf course operations in the GWMA
- Water use goals for specific industries

Non-permitted water users across the GWMA should also practice water conservation. The DNR supports conservation requirements for private and non-permitted use established through local jurisdictions such as watershed districts and municipal governments.

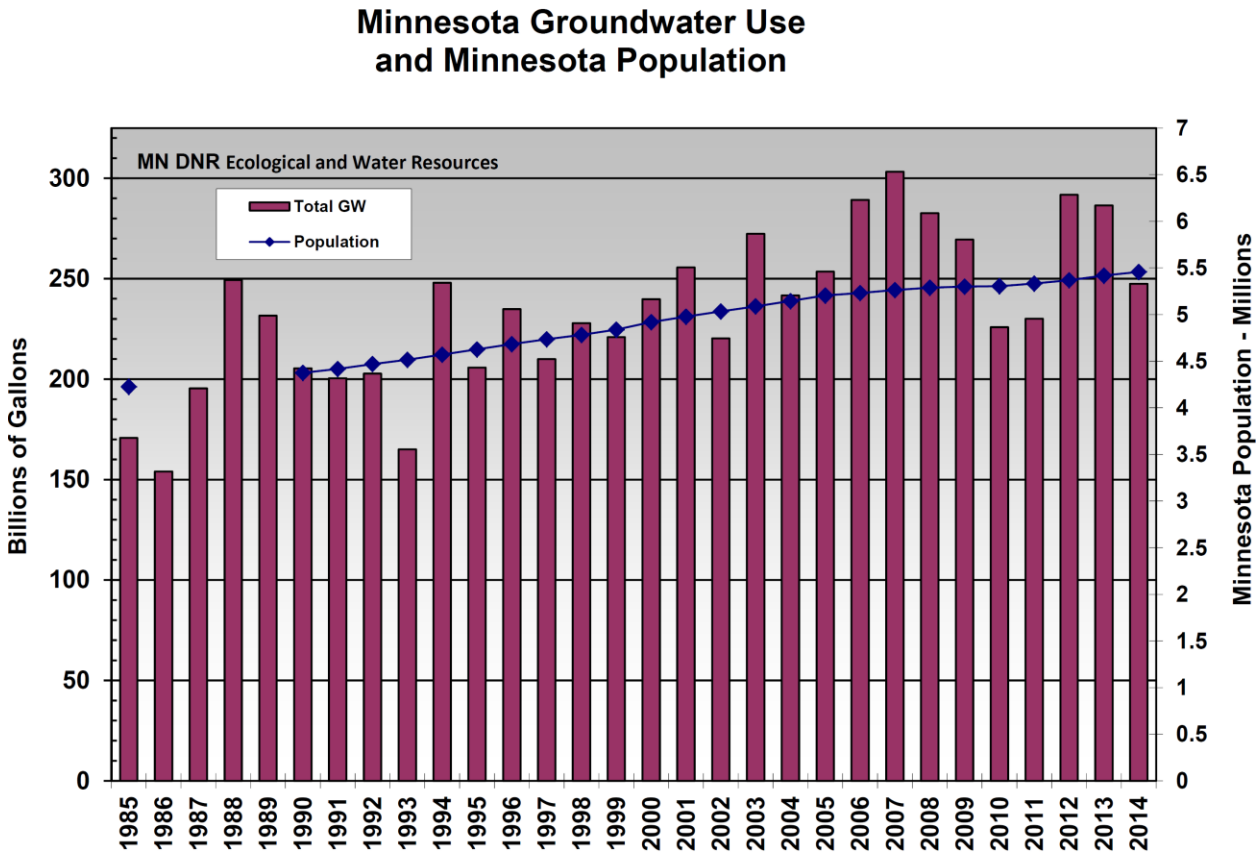

Figure 3-2 Minnesota Reported Groundwater Use and Minnesota Population

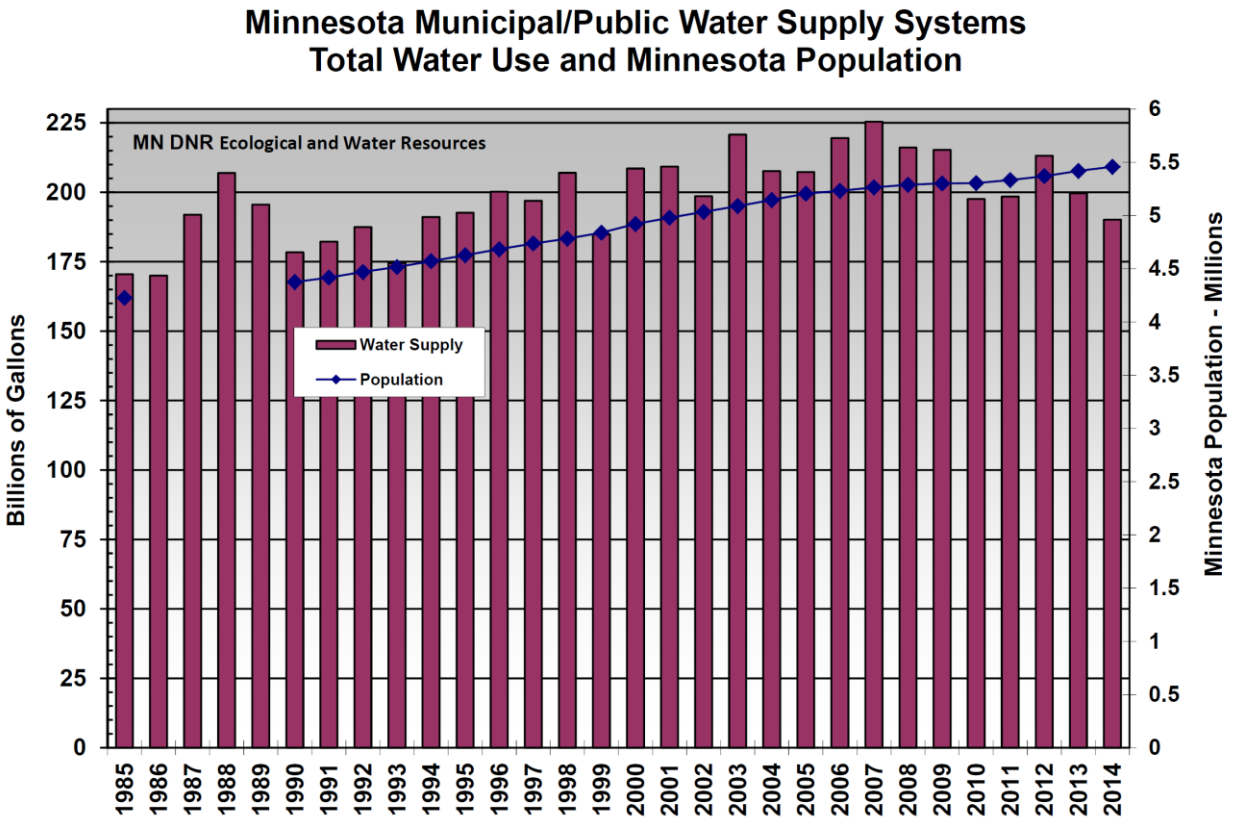

Figure 3-3 Minnesota Municipal / Public Water Supply Systems Total Water Use and Minnesota Population

Section 5 of the GWMA Plan provides a set of actions to meet Objective II.

Objective III. Groundwater use in the GWMA does not degrade water quality.

Pumping groundwater does not directly degrade the quality of the water in the aquifer in most circumstances. However, some pumping can cause water levels in wells to fall below the top of a buried aquifer (See Figure 3-1), resulting in conversion to a water-table condition. In some circumstances, this can lead to changes in water chemistry and degradation of water quality. Compliance with safe yield for buried aquifers prevents this situation from occurring as described under Objective I.

The effects of groundwater pumping on existing contamination must be considered when evaluating groundwater appropriation permits. Groundwater pumping can cause existing groundwater pollution to move or spread. Changes in groundwater levels and pressures can increase the movement of pollutants between aquifers or increase the spreading of pollutants within the same aquifer.

In some cases, pollution containment wells are used to limit movement of contaminated groundwater into less or uncontaminated areas of the aquifers. The MPCA, in cooperation with the responsible parties, determines duration and volume of pumping to contain pollution plumes and limit the movement or spreading of groundwater contamination.

Finally, water quality considerations in surface-water features must be incorporated into groundwater appropriation thresholds for surface-waters. Changes to the amount of groundwater flow into surface-water features can affect water quality items such as temperatures, oxygen levels and contaminants such as nitrate-Nitrogen.

Section 5 of the GWMA Plan provides a set of actions to meet Objective III.

Objective IV. Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.

The DNR must also address competing demands for appropriations of water within the sustainable limits. The purpose of this objective is to manage water appropriations in accordance with the allocation priorities in Minn. Stat., sec. 103G.261. The first priorities for water allocation are domestic water use and use of surface water for power generation. Five other priority levels are given for other uses: all other consumption of less than 10,000 gallons per day, agricultural irrigation and processing, other power production, other consumption greater than 10,000 gallons per day, and non-essential uses.

A *well interference* problem occurs when groundwater appropriation causes the water level in public water supply well(s) or private, domestic well(s) to fall below the reach of those wells (Minn. Stat., sec. 103G.287 subd. 5 and Minn. Rules, part 6115.0730). According to Minn. Stat., sec. 103G.287, subd. 5, this applies to public water supply and private domestic wells constructed according to the state well code (Minn. Rules, part 4725). An interference complaint can only be valid for a domestic well if that well was constructed before appropriation permits allegedly causing the interference were issued and there are adequate water supplies available.

An interference problem may be resolved by modifying the affected well, replacing the well with a deeper well, replacing the well with an alternate water supply (e.g. connection to a public system), or modifying permitted pumping rates or schedules. Potential for well interference is considered when evaluating new water appropriation permits or amendment applications. The DNR follows procedures described in Minn. Rules, part 6115.0730 to mitigate potential interference that may be caused by new or increased appropriations and to respond to interference complaints.

A *water use conflict* occurs when water demands among existing and proposed users exceed the available waters. A water use conflict can only be resolved by limiting or restricting the rate, volume, and/or timing of water appropriations. The available waters must first be determined based on resource sustainability (Objectives I and II) before allocating the available waters among users. The DNR follows procedures described in Minn. Rules, part 6115.0740 to resolve water use conflicts (see Appendix C).

Section 5 of the GWMA Plan provides a set of actions to meet Objective IV.

Objective V. All groundwater users in the GWMA have the necessary permits to use groundwater

The purpose of this objective is to manage water appropriations in accordance with the allocation priorities in Minn. Stat., sec. 103G.261. Domestic water use is the first priority for allocation of waters.

> (1) first priority, domestic water supply, excluding industrial and commercial uses of municipal water supply, and use for power production that meets the contingency planning provisions of section 103G.285, subdivision 6;
>
> (2) second priority, a use of water that involves consumption of less than 10,000 gallons of water per day;
>
> (3) third priority, agricultural irrigation, and processing of agricultural products involving consumption in excess of 10,000 gallons per day;
>
> (4) fourth priority, power production in excess of the use provided for in the contingency plan developed under section 103G.285, subdivision 6;
>
> (5) fifth priority, uses, other than agricultural irrigation, processing of agricultural products, and power production, involving consumption in excess of 10,000 gallons per day; and
>
> (6) sixth priority, nonessential uses.

Objectives I, II, III and IV (above) can only be tracked and achieved with an effective permitting system. Permits provide key data on groundwater use and the means to limit use if necessary to meet sustainability objectives. To be in compliance with current state requirements, individuals and organizations must, at a minimum, do the following if requesting 10,000 gallons of water per day or one million gallons of water per year:

- Obtain a water appropriation permit
- Pay annual fees
- Report annual water use according to permit conditions

Each groundwater appropriation permit holder is required to report the volume of water use on an annual basis. The reported volume must be accurate to within 10%. The use of water flow meters for reporting volumes is required. However, the commissioner may approve alternate methods of measuring water volume. As a result, the use of timing devices has become a method for reporting annual water use.

Permit holders must also comply with special conditions placed on their permits that are designed to ensure sustainability and/or monitor resource conditions. Some permits may include special conditions such as groundwater-level monitoring from wells specifically constructed for that purpose.

The DNR commissioner can modify water appropriation permits in a manner consistent with Minnesota statute and rule. These modifications can be in response to water use conflicts as noted above or more broadly to assure permitted water use is sustainable. For more information, see appendix B.

Objective V is meant to emphasize the importance of permitting and permit compliance to meet the sustainability goals of the Bonanza Valley GWMA. Section 5 of the GWMA Plan provides a set of actions to meet Objective V.

4. Status of the GWMA in Terms of the Objectives

Groundwater use in the Bonanza Valley area is increasing, and is at risk of overuse and contamination. Long-term observation well data show increasing summer water level drawdowns of buried aquifers and other monitoring well data indicate increasing nitrate contamination of shallow water table aquifers. While the current data show that there is not an immediate crisis resulting from increased water use in the Bonanza Valley area, these trends are serious and are addressed in this plan.

This section describes our current understanding of the status of the Bonanza Valley GWMA with respect to the five objectives described in Section 3. Based on the five objectives, the definition of sustainability with respect to groundwater is that use:

- Does not harm aquifers and ecosystems
- Does not negatively impact surface waters
- Is reasonable, efficient and meets water conservation requirements
- Does not degrade water quality
- Does not create unresolved well interferences or water use conflicts

All of the sustainability objectives must be achieved to attain overall sustainability of groundwater use in the GWMA.

Status of Objective I. Aquifers, Ecosystems and Surface Waters

Objective I. Groundwater use in the GWMA will not harm aquifers and ecosystems, and will not negatively impact surface waters.

Groundwater, surface waters and groundwater-dependent ecosystems are interrelated. Groundwater levels fluctuate in response to a number of influences including climate, land use, and groundwater pumping. Managing for sustainable use of groundwater requires quantitative knowledge of the influences on groundwater and its connection to surface water.

Two types of information are needed to make water-appropriations permitting decisions that protect aquifers, surface water resources, and associated biological communities. First, acceptable levels of hydrological impacts must be determined for each type of feature. General considerations are discussed in Section 3, but site-specific thresholds may be needed for particular surface water features. Second, an estimate must be made of how and the degree to which existing or proposed water appropriations may change the hydrological regime. The projected or interpreted impacts may then be compared to the specific thresholds.

Climate Data and Trends

The main driver of groundwater recharge variations is climate. The climate in the Bonanza Valley GWMA is characterized by variable weather. The ‘normal’ condition is for substantial ups and downs in precipitation, evaporation, and other climatic factors that affect hydrology.

In addition to changes in the amount of annual precipitation, the timing, nature, and distribution of precipitation also is important. Recent trends include wetter springs and larger rain events over shorter periods.

Relatively small changes in precipitation over large areas can have a significant effect on groundwater recharge and groundwater levels. The current climate monitoring network may be inadequate for determining this important part of the water balance in the GWMA. The network should be evaluated and expanded to fill data gaps.

There are 13 locations in the proposed Bonanza Valley GWMA where precipitation is recorded through the DNR's MNGage system of volunteers. The information is reported monthly and coordinated by Soil and Water Conservation Districts. There are three automated stations that provide real-time climate data operated by local airports and the Minnesota Department of Transportation. These can be a good source of a wider range of weather information in the Bonanza Valley. There is one evaporation network site that provides real-time climate data operated at the Herman Rosholt Experimental Farm. The Community Collaborative Rain, Hail and Snow Network, or CoCoRaHS, is a network of volunteer weather observers in the United States and Canada that take daily readings of precipitation and report them to a central data store over the Internet. There are three CoCoRaHS sites in the Bonanza Valley (Figure 4-1).

Figure 4-1 Bonanza Valley Precipitation Monitoring

DNR stream gauging stations installed in 2015

were fitted with real-time weather data including precipitation, wind speed and relative humidity.

The Pope County SWCD hosts weather information on its website gathered from the Herman Rosholt Experimental Farm in the Bonanza Valley. The University of Minnesota has developed a method of improving irrigation water management, resulting in more effective use of water in above-ground irrigation systems using current weather conditions, like that hosted by the Pope County SWCD. It is called the Checkbook Method. More sites within the Bonanza Valley that record detailed weather conditions will provide more accurate information for irrigation decisions.

Based on regional climate data from the National Climatic Data Center (NOAA), the long-term average annual precipitation for the State of Minnesota is 25.98 inches (see Figure 4-2). Long-term average precipitation in west central Minnesota from 1895-2013 is 23.8 inches (Figure 4-3).

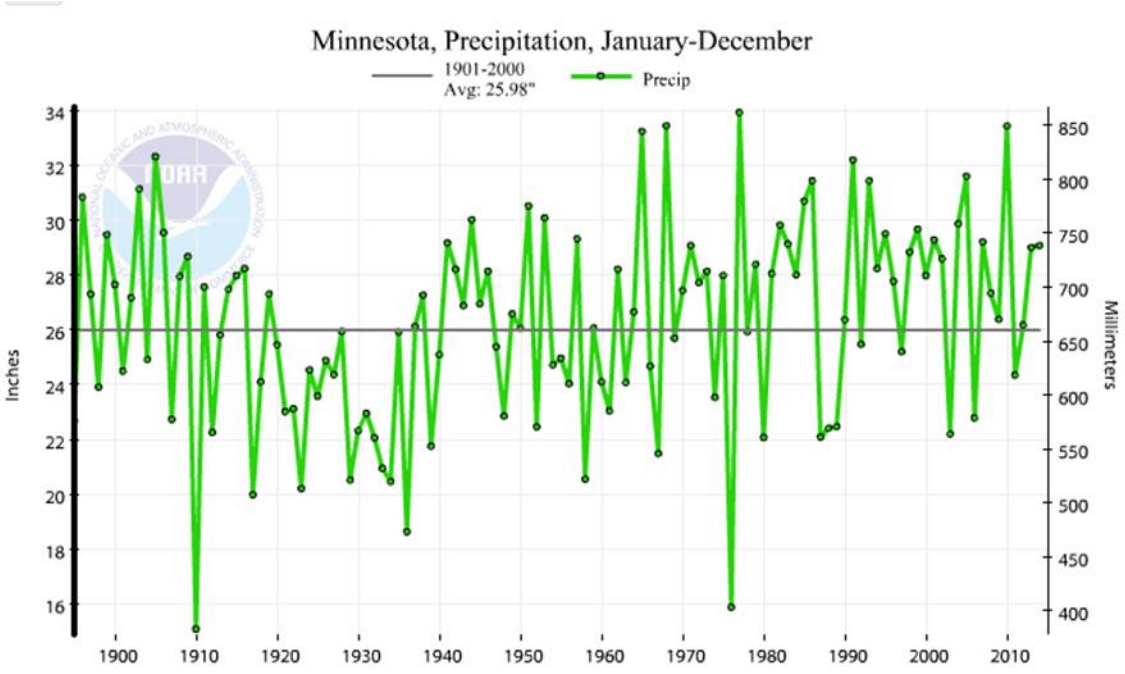

Figure 4-2 Example of historic precipitation patterns for the State of Minnesota

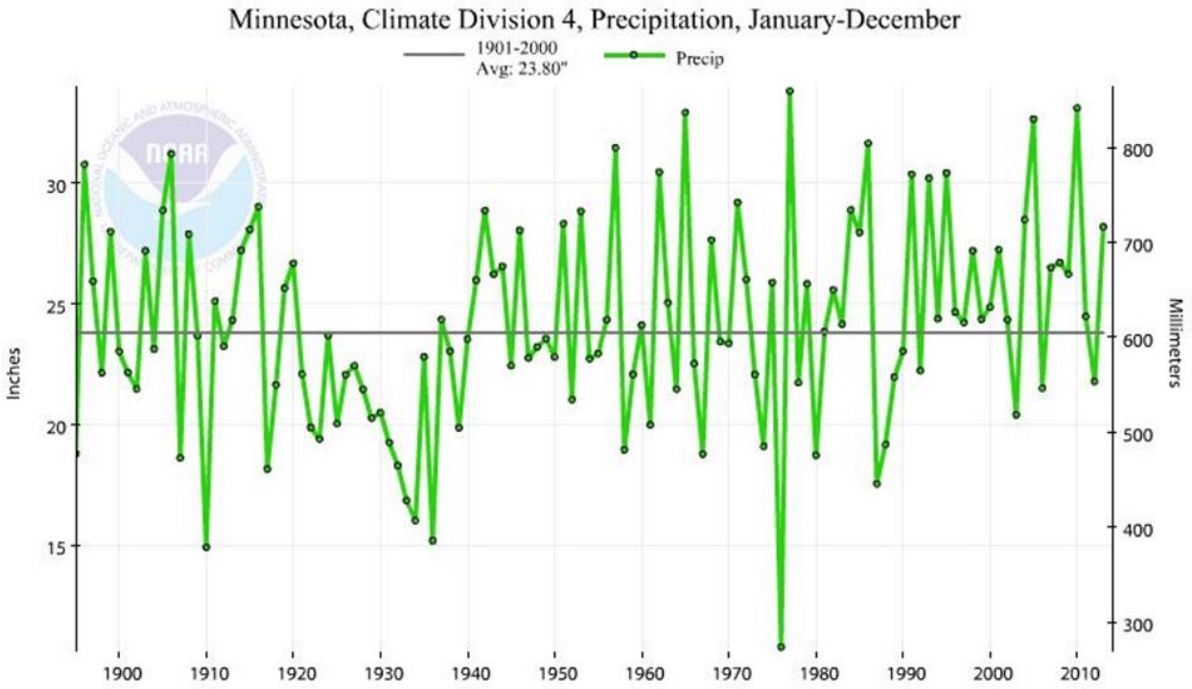

Figure 4-3 Example of historic precipitation patterns for west central Minnesota. Includes Yellow Medicine, Lac qui Parle, Chippewa, Swift, Pope, Stevens, Big Stone, Traverse, Grant, Douglas, Otter Tail and Wilkin counties

Groundwater Recharge

Aquifers are recharged with water from precipitation that moves downward through the soil. The amount of groundwater recharge is affected by the amount of:

- Precipitation
- Water held by the soil that does not contribute to recharge
- Precipitation that runs off, or is drained off the soil and into streams, lakes or wetlands
- Precipitation that evaporates directly from the soil or is taken up by plants and evaporated

The U.S. Geological Survey reports a mean annual potential for groundwater recharge in the Bonanza Valley GWMA in a range between 2 to 10 inches per year (Figure 4-4). The majority of the sand and gravel aquifer in the area is reported to have a potential annual recharge rate of between 6 to 10 inches per year.

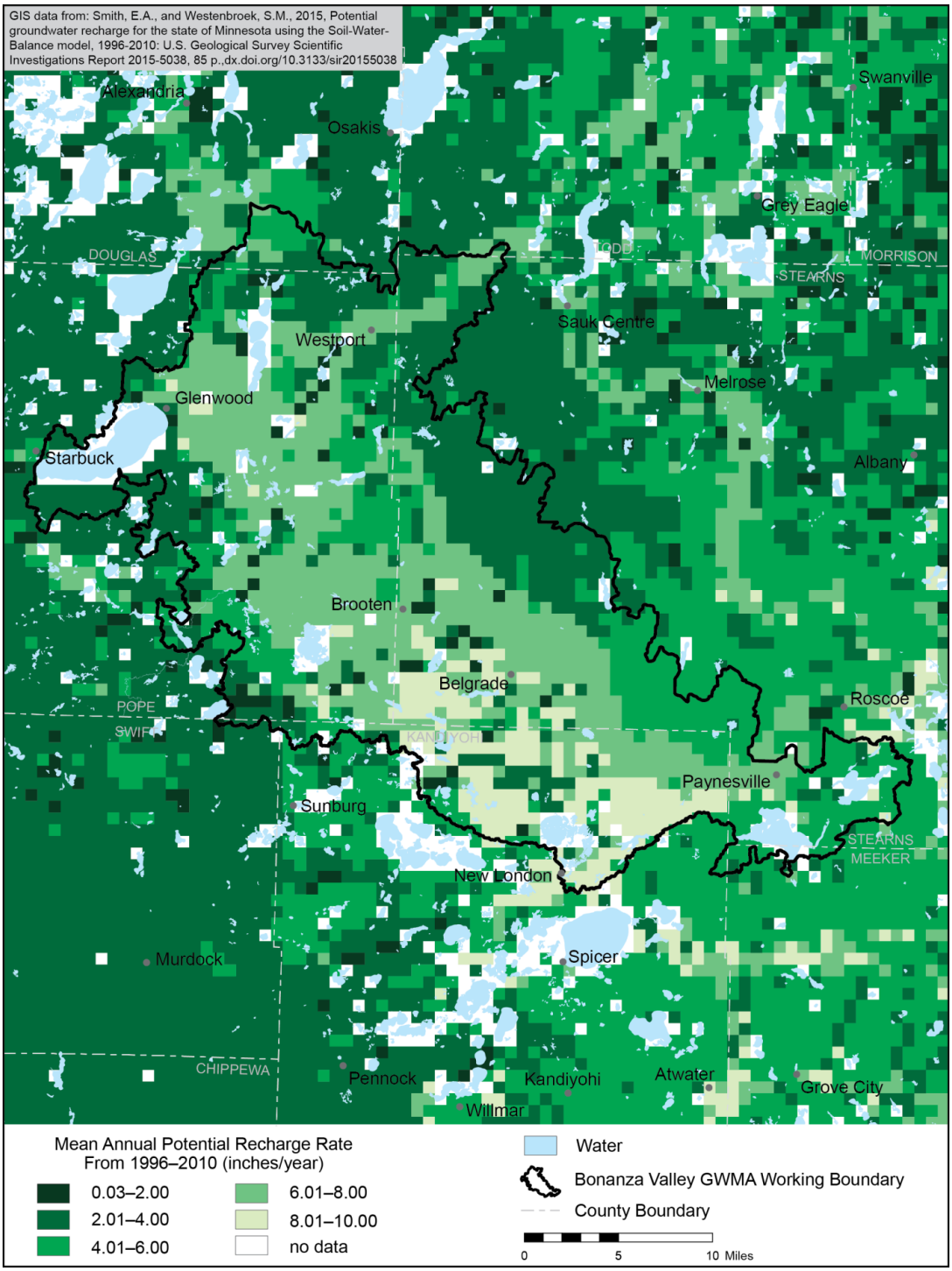

Figure 4-4 Groundwater recharge rates in Bonanza Valley GWMA

Groundwater-Level Data and Trends

Monitoring

Monitoring groundwater levels is an important element of groundwater management and ensuring compliance with safe yield. Monitored groundwater levels must be viewed in the context of natural climate fluctuations and groundwater pumping history.

Since 1944, the DNR has managed a statewide network of water-level observation wells (DNR obwells). Most of these are dedicated observation or monitoring wells. Water-level readings are available via the DNR webpage. There are 58 actively measured DNR obwells within the GWMA boundary area. Thirty-nine wells are constructed in the water table aquifer and 19 are constructed into buried aquifers (Figure 4-5). Three of these wells have been installed since fall of 2014.

Additional groundwater level monitoring wells are needed to improve the information available to make management decisions. When site conditions warrant, permit applicants are required to install monitoring wells and/or to conduct aquifer tests. To improve consistency in data and reduce costs to applicants for water appropriation permits, opportunities should be investigated to allow multiple permittees to utilize a common set of monitoring wells.

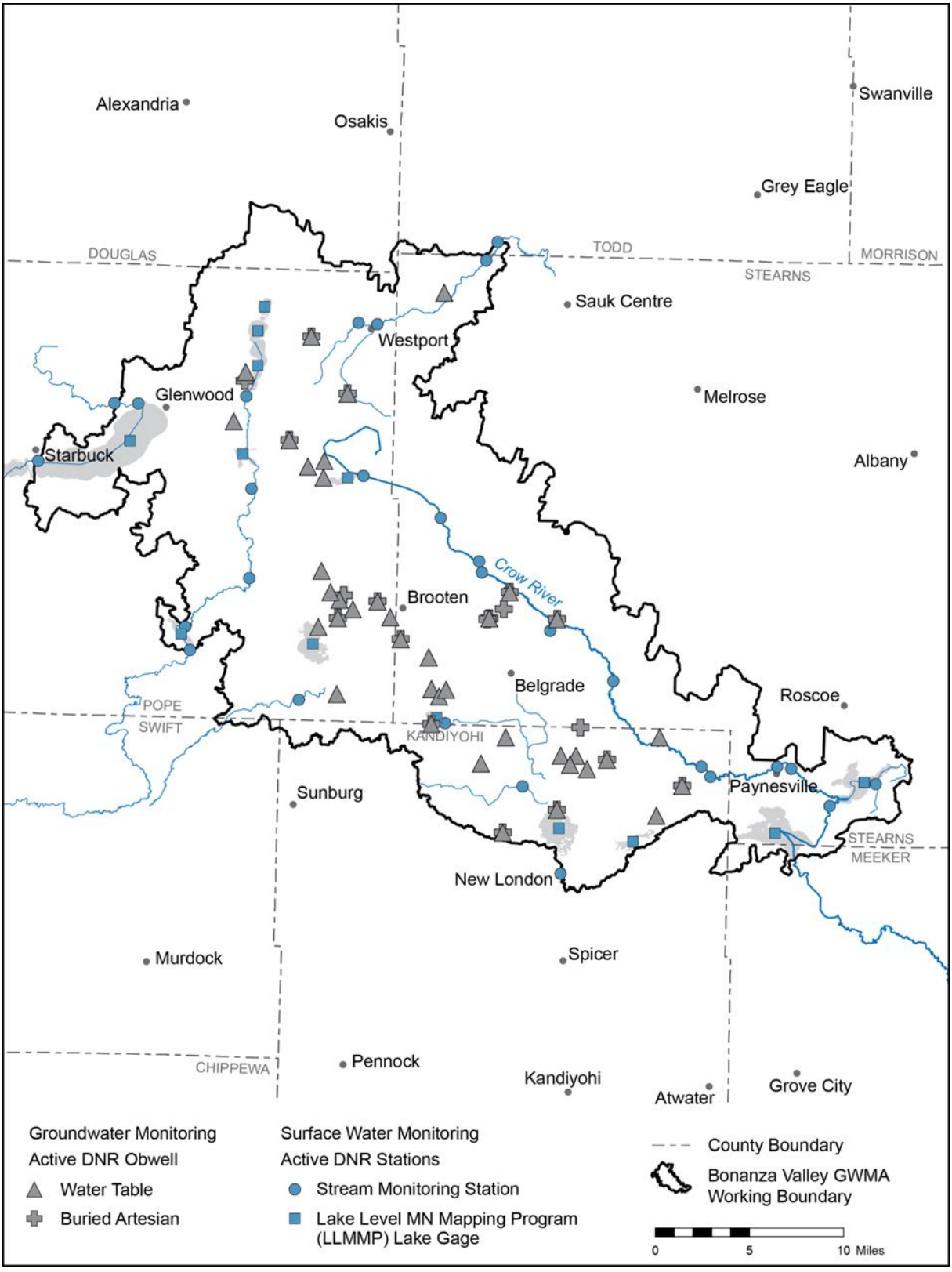

Figure 4-5 Active DNR observation wells and surface monitoring sites

DNR obwells 34001, 34002 have some of the longer water level records in Bonanza Valley (Figure 4-6). A hydrograph shows the water level or flow rate over time at a specific point or well, often showing seasonal changes and trends over time. Climate influences can be reflected, such as the drought of 1987-1990 or recharge periods, both of which can be seen in the buried aquifer hydrograph below for DNR obwells 61037 and 73037. (Figure 4-7).

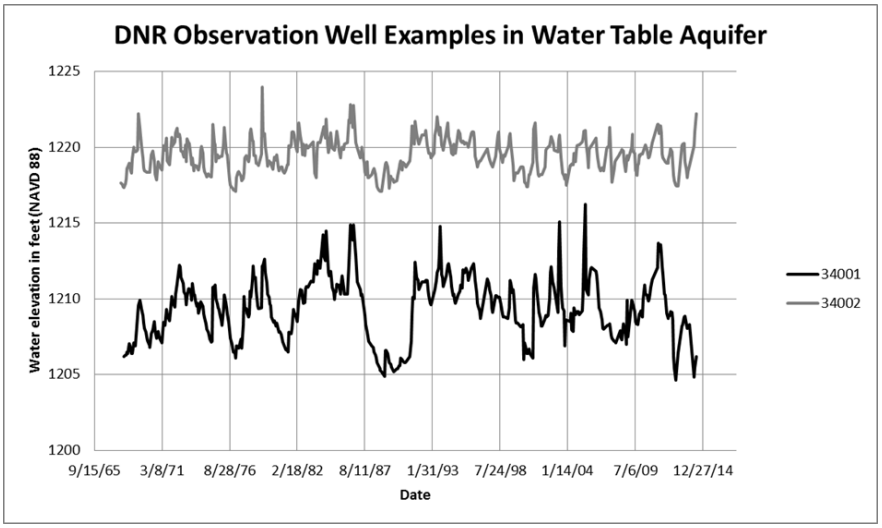

Figure 4-6 DNR **observation well hydrographs for water table aquifer**

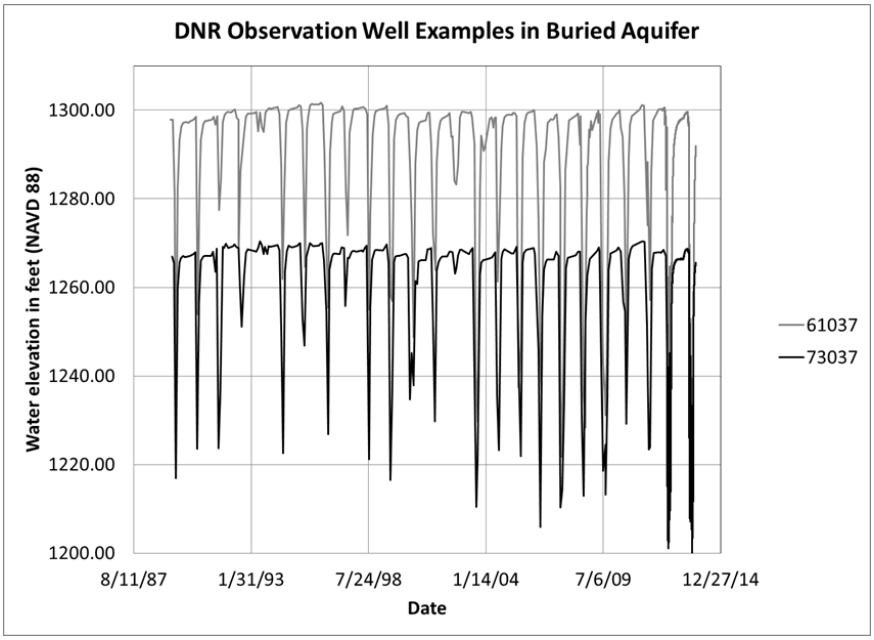

Figure 4-7 DNR observation well hydrograph for buried aquifer

Hydrograph analysis from the 16 DNR observation wells with established water level records in buried aquifers shows that four wells have been drawn down below the level of 50% of remaining head

pressure. Of those wells, there have been 30 times when water in the observation well has been drawn down below the 50% of remaining head pressure. A greater number of these drawdowns have occurred in recent years.

No DNR observation wells have been drawn down past the 25% of remaining head pressure.

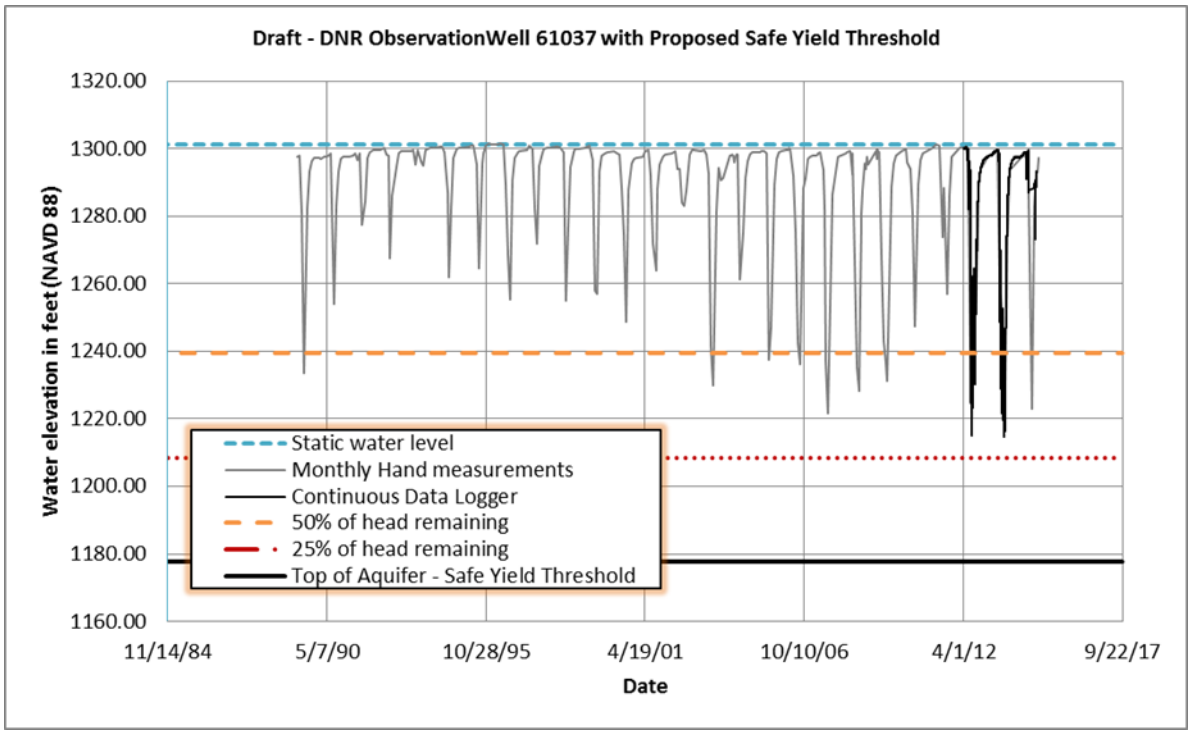

Figure 4-8 DNR observation well hydrograph for buried artesian aquifer

Using data for groundwater models

Groundwater levels are measured in groundwater level obwells. Observation well data is necessary to calibrate computer models that can be used to predict water levels in areas where no groundwater measurements exist. The more observation well data that can be applied to the computer model, the more accurate the model becomes.

A groundwater model was developed by the U.S. Geological Survey (USGS) during the late 1980s. Conditions have changed significantly since this model was completed, both in the number of wells and annual pumping volumes in the Bonanza Valley and in computer technology. Portions of this USGS model may serve as a useful framework and a starting point for a new and updated model.

Partnering for data

Permit holders have developed important local information to help understand groundwater pumping impacts on surface waters and wetlands through aquifer testing and water monitoring. The USGS is conducting a project to improve understanding of groundwater-lake interactions. The results of these studies will be useful for prioritizing evaluation of groundwater pumping impacts.

USFWS and the DNR are partnering to better understand the groundwater/surface water connection by monitoring water table aquifer relationships to water levels in the wetlands of Waterfowl Production Areas in the Bonanza Valley. Four new monitoring sites are being added to the one existing Waterfowl Production Area monitoring site.

Status of Objective II. Water Conservation

Objective II. Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.

Municipal Water Supply and Water Conservation

Public water supply systems serving more than 1,000 people must also have a water supply plan approved by the DNR. In the Bonanza Valley GWMA, the cities of Glenwood and Paynesville serve more than 1,000 people and must have a water supply plan (Minn. Stat., sec. 473.859). The plans lay out future challenges and options for a community's water supply and the community commits to certain water use and conservation goals.

Wastewater treatment facilities commonly place treated wastewater into rivers. However, the cities of Paynesville, Glenwood and Belgrade place treated wastewater on land through irrigation systems. This reduces the potential for pollution to rivers, lakes and wetlands, while increasing likelihood of groundwater recharge. Land application of municipal wastewater also reduces suspended solids, unwanted bacteria, phosphorus and reduction of nitrates through uptake of nitrogen from irrigated plants.

Agricultural Irrigation and Water Conservation

Permits for agricultural irrigation may include "conditions" as part of the permit, such as a requirement for the permittee to develop a conservation plan with help from the Soil and Water Conservation District. These conservation plans may include irrigation water conservation, as well as requirements to follow Best Management Practices for nitrogen management.

The actual adoption rate of cropland irrigation water conservation measures is not currently known. An irrigation system "roadside survey" of the Kandiyohi County portion of the Bonanza Valley GWMA was conducted by DNR staff in 2014 (Figure 4-9). The goal was to approximate the adoption of drop nozzles on irrigation equipment. Many irrigation management practices that conserve water are not readily visible, such as irrigation scheduling, variable frequency drives, soil moisture monitoring, low pressure conversion and precision irrigation. The use of drop nozzles on irrigation systems can easily be seen and is commonly used in conjunction with low pressure delivery of water. The larger droplets of water that are delivered closer to the ground reduces the amount of water lost to evaporation before reaching the crop or the ground. The roadside survey looked at 76 sites with irrigation systems that could be reviewed from the road:

- 33 center pivot irrigation systems had drop nozzles installed (43 percent)
- 44 center pivot irrigation systems had nozzles located on top of the pipe (57 percent)

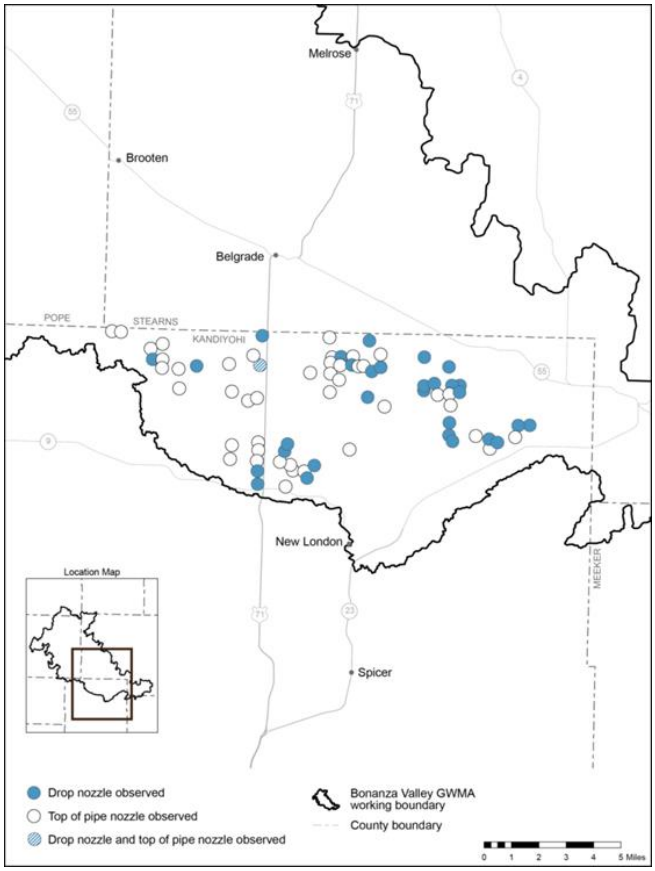

Figure 4-9 2014 roadside survey indicating the presence of drop nozzles on center pivot irrigation systems

Status of Objective III. Water Quality

Objective III. Groundwater use in the GWMA does not degrade water quality.

The quality of groundwater in the Bonanza Valley is very important. Nitrates, arsenic and other chemicals have been found in groundwater in the Bonanza Valley GWMA. In some areas, nitrate and arsenic have exceeded health risk limits for drinking water. Poor groundwater quality may limit the use of groundwater. The following section discusses water quality in the Bonanza Valley GWMA.

Water Quality

Water quality affects the availability and cost of groundwater in the GWMA. Where groundwater has been contaminated, it may not be available for use by individuals, industry or cities, unless it undergoes treatment. In areas of contaminated groundwater, people who need drinking water may have to use deeper aquifers or rely on water treatment systems to remove contaminants. Contaminated groundwater also presents a risk to the health of connected ecosystems (lakes, streams and wetlands).

Minnesota Statute 103G.287 directs the DNR to consider the effects of water quality in water appropriations. Management activities in the Bonanza Valley GWMA will require continued coordination between the existing state agencies that are responsible for groundwater and surface water quality, including: Minnesota Department of Agriculture (MDA), the Minnesota Department of Health (MDH), the Minnesota Pollution Control Agency (MPCA), Board of Water and Soil Resources (BWSR) and the DNR.

Drinking Water

In the Bonanza Valley GWMA, municipal drinking water sources that take water from deeper wells show little nitrate contamination. Drinking water taken from water table aquifers for public water suppliers or private domestic wells may be more vulnerable to contamination.

The Minnesota Department of Health (MDH) evaluated drinking water wells within the Bonanza Valley GWMA boundary and found:

- Maximum nitrate concentrations taken from 308 drinking water wells between Jan. 1, 2004, and Dec. 18, 2013, showed recorded nitrate concentrations ranging from “non-detect” to 22 mg/L. The health risk limit for nitrate is 10 mg/L. Arsenic, a common naturally-occurring contaminant in Quaternary Buried Artesian Aquifers in central Minnesota, was measured in 145 wells within a range of <0.05 ug/L to 38.8 ug/L. The arsenic Maximum Contamination Level is 10 ug/L.

While nitrate levels in the proposed GWMA’s deep, buried aquifers are low at present, data indicate that water can flow vertically to the deep aquifers and expose portions of the Bonanza Valley groundwater to contamination from the land surface. In addition, arsenic, a naturally occurring element in groundwater, is currently found in some of these deeper aquifers at levels that exceed the drinking water standard.

In the Bonanza Valley GWMA, movement of groundwater contaminants is recognized as a potential impact to drinking water, other groundwater uses and ecosystems. The Minnesota Department of Health has the authority to designate Special Well and Boring Construction Areas in the GWMA where groundwater contamination is a risk to drinking water. A Special Well and Boring Construction Area is sometimes also called a well advisory. It is a mechanism that provides for controls on the drilling or alteration of public and private water-supply wells, and can require monitoring wells in an area where groundwater contamination has, or may, result in risks to the public health. The purposes of a Special Well and Boring Construction Area are to inform the public of potential health risks in areas of groundwater contamination, provide for the construction of safe water supplies, and prevent the spread of contamination due to the improper drilling of wells or borings. The MDH has designated 17 sites in Minnesota as Special Well and Boring Construction Areas in Minnesota. At this time, there are no Special Well and Boring Construction Areas in the Bonanza Valley GWMA.

Wellhead protection is designed to protect public water supply wells. States are required to have wellhead protection programs under the provisions of the 1986 amendments to the federal Safe Drinking Water Act. A capture zone for the well (called the wellhead protection area) is designated and a plan is developed and implemented for managing potential contamination sources within the wellhead protection area. The Minnesota Department of Health (MDH) administers the state wellhead protection rule (Minnesota Rules, Chapter 4720.5100 - 4720.5590) that sets standards for wellhead protection planning. The Minnesota Department of Agriculture (MDA) is the lead state agency for addressing pesticides and nitrate from fertilizer in groundwater. As such, the MDH and the MDA share responsibilities in wellhead protection areas.

Wellhead Protection Areas (WHPA) can be thought of as the recharge area to a public well. This area is identified through groundwater flow modeling and hydrogeologic mapping. A licensed geologist or engineer will analyze the time it takes for water to travel to the well, the aquifer transmissivity, flow boundaries, daily volume of water pumped and the groundwater flow field. These boundaries often do not follow any recognizable landmarks. Drinking Water Supply Management Areas (DWSMA) are larger areas that encompass WHPAs and use landmarks such as roads and property lines to map the boundaries where land is to be protected and managed through the WHPA plan.

There are eight DWSMAs in, or partially in, the Bonanza Valley Groundwater Management Area. The vulnerability of these DWSMAs to human-induced contamination in the Bonanza Valley GWMA area varies from very low to high (see figure 4-10).

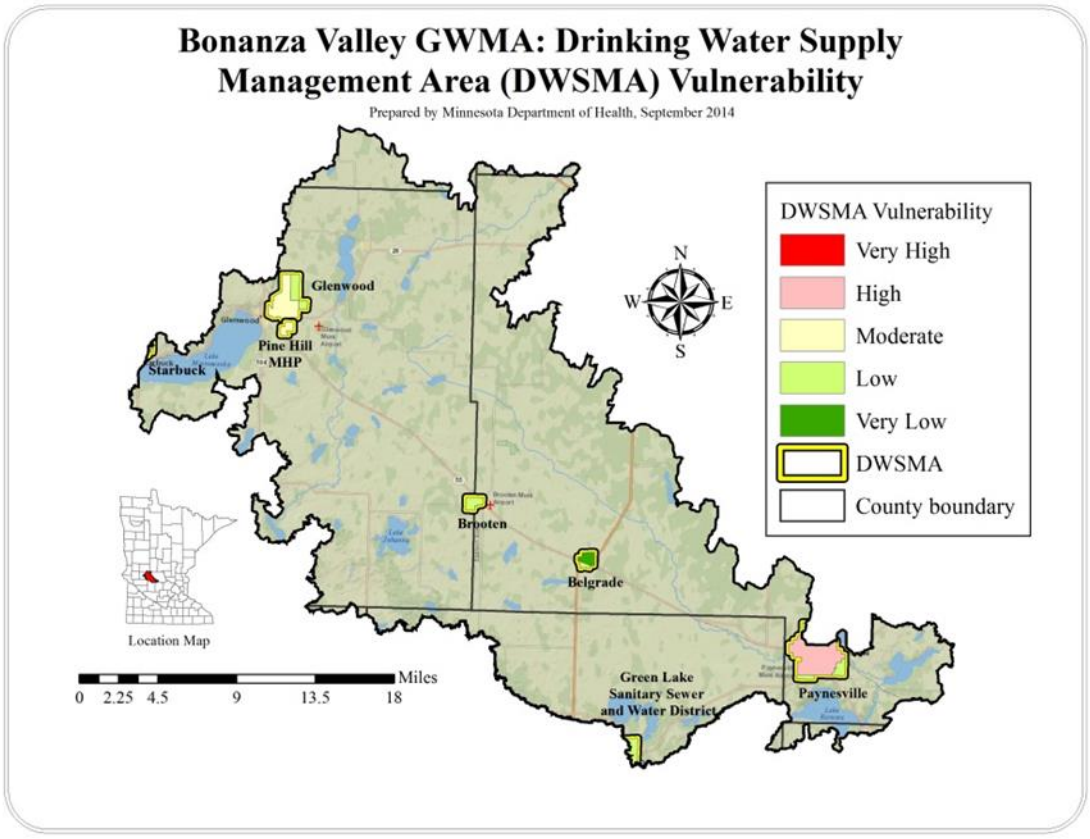

Figure 4-10 Drinking Water Supply Management Area (DWSMA) Vulnerability

Nitrates in Water Table Aquifer

The water quality in the water table aquifer (QWTA) in Bonanza Valley has been sampled regularly at 20 sites between 2000 and 2012 by the MDA (Figure 4-11). The results show 73 percent of the 421 samples taken had nitrate levels above 10 mg/l (ppm), the current Minnesota Health Risk Limit (HRL) for nitrate. Over time (2000–2010), the nitrate concentrations in the Bonanza Valley are increasing and the trend is statistically significant as described in the 2012 MDA report.

The 2015 Minnesota Nitrogen Fertilizer Management Plan is a blueprint for minimizing groundwater impacts from the use of nitrogen fertilizer. The plan states, “The primary goal of the plan is to involve the agricultural community in problem solving at the local level. We all need to work together to respond to and address localized concerns about unsafe levels of nitrate in groundwater.”

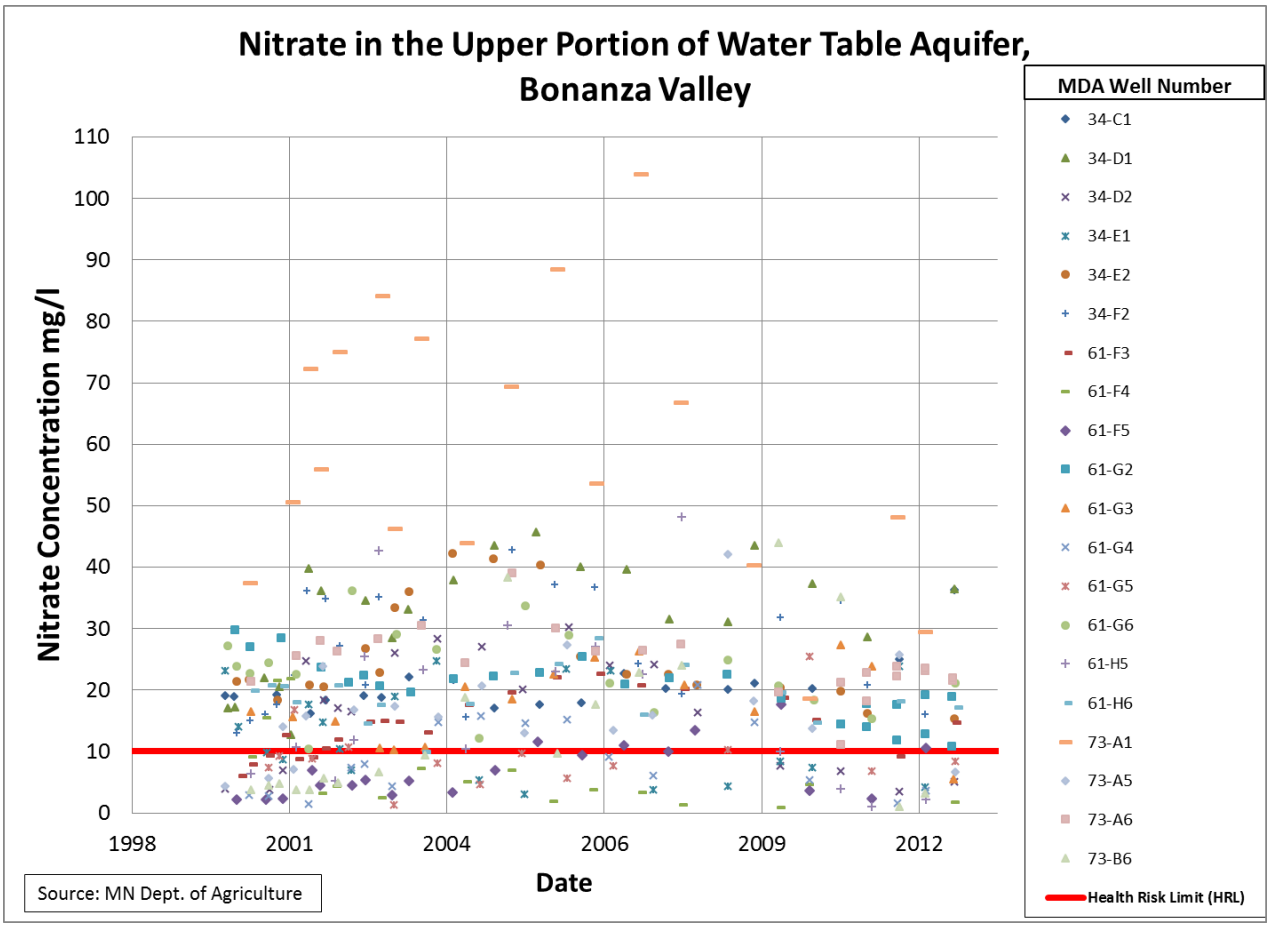

Figure 4-11 Reported nitrate concentrations in water table aquifer in Bonanza Valley GWMA

Groundwater Quality Affects Wetlands, Rivers and Lakes

Groundwater contamination can limit the availability of reliable drinking water. It can also degrade water quality in wetlands, rivers and lakes, harming the organisms that live in or depend upon these surface waters. Groundwater can be a significant source of water to wetlands, rivers and lakes. If contaminants are found in the groundwater, contaminants can be delivered to these surface water features. The estimated statewide nitrate contributions to wetlands, rivers and lakes during an average precipitation year are from the following:

- Cropland tile drainage (37 percent)
- Cropland groundwater (30 percent)
- Point sources (9 percent)
- Atmospheric deposition (9 percent)
- Forests (7 percent)
- Cropland runoff (5 percent)
- Septic systems (2 percent)
- Urban stormwater (1 percent)
- Feedlot runoff (<1 percent)

(Source: Nitrogen in Minnesota Surface Waters, MPCA 2013).

The water in some of the rivers, lakes and streams in the Bonanza Valley GWMA has been evaluated against federal and state standards as a part of the MPCA's Watershed Restoration and Protection Strategies (WRAPS) program to determine if these waterbodies are impaired under the terms of the Clean Water Act (Figure 4-12 and Table 4-1).

Beginning in 2007, the North Fork of the Crow River (NFCR) Watershed was monitored, the data assessed and strategies were developed to restore and protect the watershed's water bodies. The North Fork of the Crow River watershed is considered part of the source water protection area for the Twin Cities. Both the NFCR watershed Restoration and Protection Strategy and the Total Maximum Daily Load (TMDL) report were completed in December of 2014. The Sauk River Watershed Restoration and Protection Strategy report was released spring of 2015 and the Chippewa River Watershed Restoration and Protection Strategy report is still being developed.

The lakes currently listed as impaired by nutrients in the Bonanza Valley GWMA are Swenoda Lake, Levin Lake, Lake Johanna, Gilchrist Lake, Westport Lake and Rice Lake.

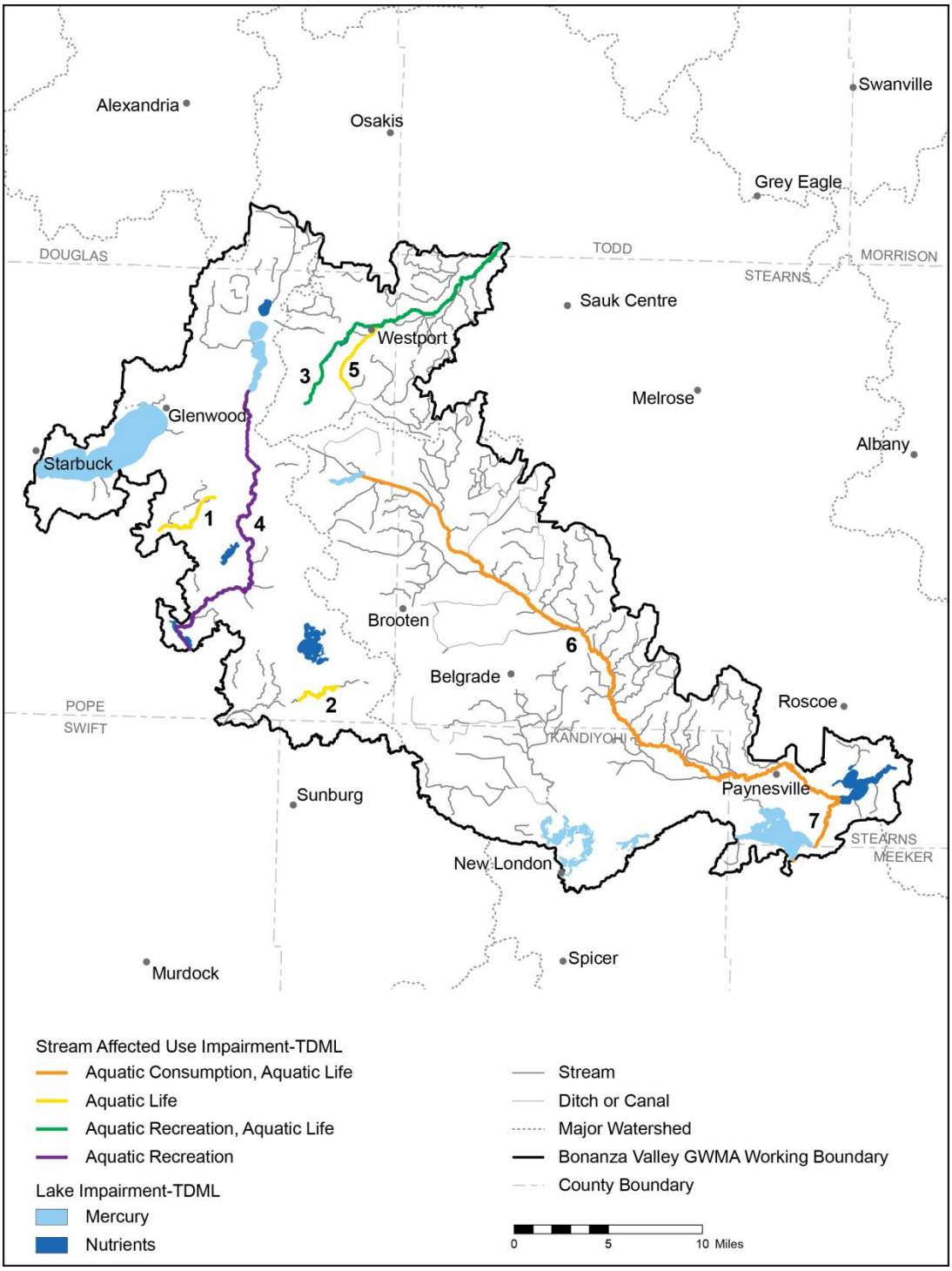

Figure 4-12 Reported impairments – Informs future Total Maximum Daily Load study. Data from Minnesota Pollution Control Agency. Numbered stream reaches correspond to Table 4-1.

Table 4-1 River Reach and Known Impairments – reach numbers correspond to Figure 4-12.

Stream Reach Number	Stream Reach Name	Description	Affected Use	Impairment Parameter	Watershed (HUC 8)	Major Basin
1	Unnamed creek	Headwaters to Lake Ben	• Aquatic Life	• Fish-IBI	Chippewa	Minnesota River
2	Mud Creek	T123 R36W S28, east line to T123 R36W S29, west line	• Aquatic Life	• Macroinvertebrate-IBI	Chippewa	Minnesota River
3	Ashley Creek	Headwaters to Sauk Lake	• Aquatic Recreation, • Aquatic Life	• Macroinvertebrate-IBI • Fish-IBI • Dissolved Oxygen • Bacteria (E.coli)	Sauk	Mississippi Headwaters
4	East Branch Chippewa River	Headwaters (Amelia Lake 61-0064-00) to Mud Creek	• Aquatic Recreation	• Bacteria (E.coli)	Chippewa	Minnesota River
5	County Ditch 6	Unnamed creek to Ashley Creek	• Aquatic Life	• Macroinvertebrate-IBI • Fish-IBI	Sauk	Mississippi Headwaters
6	North Fork Crow River	Headwaters (Grove Lk 61-0023-00) to Rice Lake	• Aquatic Consumption, • Aquatic Life	• Fish-IBI • Dissolved Oxygen • Mercury	North Fork Crow	Mississippi Headwaters
7	North Fork Crow River	Rice Lake to Lake Koronis	• Aquatic Consumption, • Aquatic Life	• Macroinvertebrate-IBI • Mercury	North Fork Crow	Mississippi Headwaters

Status of Objective IV. Well Interferences and Water Use Conflicts

Objective IV. Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.

Well Interferences

There have been 10 formal well interference complaints in the Bonanza Valley GWMA. Potential for well interference is considered when evaluating new water-appropriation permit or amendment applications. Seven of these have been filed since 2005.

Water Use Conflicts

Protection of groundwater-dependent surface water features and biological communities may require limiting water appropriations in some areas. It is possible that water use conflicts could arise from cumulative impacts of multiple users. Improved analysis methods and use of data for evaluating surface-water impacts could reveal water use conflicts not previously identified.

Status of Objective V. Permits

Objective V. All groundwater users in the GWMA have the necessary permits to use groundwater.

Compliance

There are no known groundwater users in the GWMA who require a permit and are not covered under an existing permit. It is possible, however, that there are unidentified groundwater uses that require a permit. A thorough audit of water wells has not been conducted for the GWMA. Beginning in July 2013, new wells requiring a water appropriation permit must receive preliminary approval from the DNR prior to construction. This helps the DNR monitor compliance.

While the DNR has not conducted a comprehensive well audit in the area, it did complete a 2012-13 compliance review to determine the presence of irrigation pivots without permits in the Bonanza Valley Area. There were 12 irrigation pivots in Kandiyohi County, 19 in Pope County and 21 in Stearns County that were operating irrigation systems without a water appropriation permit. Since that time, all unauthorized irrigation system operators have submitted an application or are in the process of resolving the unpermitted use.

DNR staff obtains compliance reports from the Minnesota Permitting and Reporting System (MPARS) electronic permits database. When pumping volume exceeds the appropriation permit amount, the DNR investigates and takes appropriate action regarding the overuse.

In general, compliance with permitted volumes is high in the Bonanza Valley GWMA. Special circumstances may lead to actual use exceeding permitted volume in a given year, such as waterline breaks, other system problems, or one-time uses. Permit holders may request an amendment to

increase their appropriation. The DNR will follow the established statute and rule processes for permit changes. For further information on water appropriation permit modifications, please see appendix B.

5. DNR Actions

Prior sections of the Bonanza Valley GWMA Plan have described the area; introduced the sustainability goals, objectives and sustainability thresholds for the area; and presented the DNR's current understanding of natural resources and appropriations with respect to the sustainability thresholds. Section 4 described some of the information and data gaps that need to be addressed to continue to manage groundwater sustainably. This section restates the sustainability goal for the GWMA, and introduces the specific actions by each objective that the DNR plans to take to meet the sustainability goal.

> *The GWMA Goal: In the Bonanza Valley Groundwater Management Area (GMWA), the ongoing use of groundwater will be sustainable, and therefore, will not harm ecosystems, water quality, or the ability of present and future generations to meet their needs.*

Objective I. Groundwater use in the GWMA does not harm aquifers and ecosystems, and does not negatively impact surface waters.

1. **DNR will improve monitoring of groundwater levels, basin water levels, stream flows, climate, groundwater-associated biological communities and water use within the GWMA to inform DNR permit decisions.**

    a. The DNR will continue to build a comprehensive hydrological and climate monitoring system for the GWMA. The DNR will coordinate with federal, state, and local agencies in these efforts. The following are some initial efforts that may be adjusted over time:
        i. Stream flow monitoring - in 2016, install six new water flow monitoring gauges. Two of the six will provide real-time data.
        ii. Wetland monitoring - in 2016, add four new wells in waterfowl production areas in partnership with the US Fish and Wildlife Service to the existing four sites.
        iii. Lake level monitoring – Add lake gauges as needed to the existing 15 gauges.
        iv. Groundwater Level Monitoring - By 2018, install up to 15 monitoring wells in close proximity to the stream gage sites to gather the data necessary to analyze the potential impact of groundwater pumping on surface waters and groundwater. These are in addition to the existing 49 groundwater level monitoring wells.
            i. Investigate whether there are opportunities to coordinate use of monitoring wells with multiple permittees.
        v. Identify additional climate monitoring requirements and add weather stations as needed to provide real time precipitation, temperature and wind speed for more precise evapotranspiration estimates.

i. Increase the number of citizens reporting precipitation and weather to the Minnesota Volunteer Precipitation Observing Program and the Community Collaborative Rain, Hail & Snow Network (real-time).

vi. Explore the potential impacts of tile drainage on hydrology in the GWMA.

i. Determine next steps in understanding potential impacts of tile drainage in the GWMA (the amount of tile drainage in the GWMA is unknown).

b. The DNR will continue to improve information on water use within the GWMA.

i. Evaluate the use of remote sensing (satellite) technologies to monitor water use.

ii. Explore if calibration techniques are necessary and would significantly improve the accuracy of reported water use data.

iii. Refine estimates of non-permitted groundwater use across the GWMA. Note that permits are not required for uses that are less than 10,000 gallons per day or 1 million gallons per year.

The DNR will develop and use the most appropriate methods and models to predict volumes, rates and water level impacts from groundwater appropriations as well as describe the current groundwater conditions and characterize the nature and extent of the primary aquifers and the relationship of surface water and groundwater.

c. Develop additional information on groundwater-associated biological communities to inform permit decisions.

2. The DNR will develop and apply sustainability thresholds for aquifers, ecosystems and surface waters in the GWMA[2].

a. The DNR will use safe yield for aquifers to determine limits to appropriation permits in the GWMA.[3]

b. The 2015 Minnesota Legislature directed the DNR (Laws of Minnesota 2015, First Special Session, chapter 4, article 4, section 143), to take the following actions concerning sustainability thresholds: “the commissioner of natural resources shall consult with interested stakeholders and submit a report to the Legislative Water Commission and the chairs and ranking minority members of the house of representatives and senate committees and divisions with jurisdiction over the environment and natural resources policy and finance on recommendations for

[2] Sustainability means that groundwater and surface water levels, water quality, and ecosystems are not harmed and that present and future generations will be able to meet their need for water.

[3] Safe yield for artesian conditions means the amount of groundwater that can be withdrawn without degrading water quality or causing a continual decline in groundwater levels that results in a change from artesian to water table condition. Safe yield for water table conditions means the amount of water that can be withdrawn without degrading the quality of the water in the aquifer and without allowing the long term average withdrawal to exceed the available long term average recharge to the aquifer system based on representative climatic conditions.

statutory or rule definitions and thresholds for negative impacts to surface waters as described in Minnesota Statutes, sections 103G.285 and 103G.287, subdivision 2. Stakeholders must include but are not limited to agricultural interests; environmental interests; businesses; community water suppliers; state, federal, and local agencies; universities; and other interested stakeholders." In January 2016, the DNR submitted a report entitled: "Report to the Minnesota State Legislature: Definitions and Thresholds for Negative Impacts to Surface Waters." The DNR will use the approach described in this report to determine if negative impacts to streams, lakes, or wetlands are occurring due to groundwater appropriation within the GWMA. (The report is available on the DNR website. The executive summary of the report provides a succinct description of the approach, and it is included in this plan as Appendix E.)

3. DNR groundwater appropriation permits will integrate sustainability limits, individual and cumulative permit analysis, and will include evaluation of existing permits within the GWMA.

a. The DNR will evaluate each new permit application individually, as well as in conjunction with other permits in the related aquifer systems to address issues associated with the cumulative impacts of appropriations across the aquifer.

b. The DNR will complete a review of all existing permits in the GWMA within 5 years and, if necessary, adjust permits to achieve sustainable groundwater use (the DNR will follow the established statute and rule processes for permit changes – see appendix B)[4].

c. Where needed, and in accordance with statutory requirements, the DNR will limit current and future appropriations.[5]

d. Improve communication tools that will allow the public to more clearly understand the permitting process, including modifying the language in the preliminary well notification letter.

4. The DNR will improve communication on the status of Objective I (aquifers, ecosystems, surface waters) in the GWMA.

a. The DNR will create a new GWMA reporting system that will be understandable by the public, and it will include results of data collection and analysis in the GWMA.

b. The DNR will hold at least two GWMA Advisory Team meetings per year. They will be open to the public.

c. The DNR will increase education and outreach to the public about sustainable use of groundwater in the GWMA.

[4,5] The DNR has not determined the detailed steps and timeline for how we will evaluate and implement any necessary changes to existing permits. However, we recognize that this is a vital component of GWMA planning, and we are committed to working with permittees as we develop that process.

d. The DNR will invite Kandiyohi County to participate in the County Geologic Atlas program.

5. The DNR will improve access to data collected and analyzed by other organizations in the GWMA.

a. The DNR will actively support and participate in the development of a more comprehensive and accessible data management system within the GWMA, including website improvements.

b. The DNR will support the activities of the Pope SWCD, Minnesota Department of Agriculture, and the University of Minnesota Extension Service at the Rosholt Experimental Farm, and will inform the public of their research results.

6. The DNR will ensure that community water supply plans include actions that must be taken if cumulative aquifer withdrawals exceed thresholds or if negative impacts on surface waters are occurring due to groundwater withdrawals in the GWMA.

7. The DNR will promote groundwater recharge in the GWMA, consistent with sound water quality management.

a. The DNR will work with other organizations and agencies including watershed districts, counties and local units of government to identify important groundwater recharge areas and opportunities to enhance recharge.

b. The DNR will support local government efforts to protect important groundwater recharge areas through zoning and land use planning.

c. The DNR will update the groundwater sensitivity maps for the GWMA within 5 years.

Objective II. Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.

1. **The DNR will ensure that groundwater users are complying with water conservation requirements in their water supply plans and permits.**

    a. The DNR will include water conservation requirements in appropriate permits as framed by statute, rule, and public water supply plans.

    b. The DNR will evaluate compliance with water conservation requirements on permits that include them. (The DNR will be in contact with permit holders as we do these reviews).

    c. When considering a permit transfer request or amendment request to increase appropriations in this GWMA, the DNR will evaluate a permit holder's performance in meeting conservation requirements in their permit and the conservation goals contained in applicable water supply plans.

    d. The DNR will partner with local units of government such as Soil and Water Conservation Districts (SWCDs) to assist in developing and complying with conservation requirements in water appropriation permits.

    e. The DNR will update the information it uses to develop water conservation requirements specific to each water use category.

2. **The DNR will improve communication about and promote the values of water conservation in the GWMA.**

    a. The DNR will promote lessons learned about water conservation from working farms, municipalities, industries, and other water users in the GWMA.

    b. The DNR will include descriptions and evaluations of water conservation practices in the GWMA in the new GWMA reporting system.

    c. The DNR will update its website to include links to organizations with water conservation information (e.g., SWCDs, United States Department of Agriculture, and the University of Minnesota Technical Assistance Program).

3. **The DNR will work with other organizations to promote appropriate water storage and aquifer recharge in the GWMA.**

4. **The DNR will promote the use of water conservation strategies such as re-use of water in community water supply planning in the GWMA.**

Objective III. Groundwater use in the GWMA does not degrade water quality.

1. **The DNR will include compliance with local, state, and federal water quality regulations as permit conditions.**

    a. The DNR will coordinate with local, state, and federal agencies to identify water quality regulations that apply to groundwater use and clarify how best to assure compliance.

2. **The DNR will ensure that permitted appropriations do not degrade water quality by moving known contaminants.**

    a. The DNR will work with the PCA, MDH and MDA to determine the most suitable methods to evaluate the risk of moving known contaminants for new and existing permits[6].

3. **The DNR will ensure that community water supply plans take into account contaminant management.**

4. **The DNR will improve communication about known contaminants and pollution management in the GWMA.**

    a. The DNR will use a new reporting system to describe and evaluate status of contamination and pollution plume management in the GWMA.
    b. The DNR will work with the MDA, MDH, MPCA and others to share data about water quality among agencies.
    c. The DNR will work with the MDA, MDH, MPCA and others to better interpret water quality data.

5. **The DNR will ensure the permitted appropriations do not increase known water quality contamination of a surface water feature.**

[6] The DNR has not determined the detailed steps and timeline for how we will evaluate and implement any necessary changes to existing permits. However, we recognize that this is a vital component of GWMA planning, and we are committed to working with permittees as we develop that process.

Objective IV. Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.

1. **The DNR will continue to review permit applications to identify and reduce the likelihood of well interferences and water use conflicts.**

2. **The DNR will resolve well interferences and water use conflicts applying the framework outlined in statute and rule.**

3. **The DNR will improve information on aquifer characteristics in the GWMA to improve its ability to identify and reduce the likelihood of interferences and conflicts prior to permit approval.**

4. **The DNR will increase education and awareness about resolving well interferences and water use conflicts.**

Objective V. All groundwater users in the GWMA have the necessary permits to use groundwater.

1. The DNR will improve its capacity to detect unpermitted groundwater use.

a. The DNR will complete periodic analysis to identify potential unpermitted groundwater use in the GWMA and take appropriate action.

b. The DNR will conduct follow-up reviews of preliminary well approval actions to determine compliance with permit requirements.

c. The DNR will provide updated information to well drillers and consultants on existing laws and the water appropriation permit application process as it is available.

d. The DNR will facilitate the public's ability to identify and report unpermitted use.

2. The DNR will ensure that permitted volumes reflect actual use and that actual use does not exceed permitted volumes.

a. The DNR will evaluate water use reports and will contact permit holders whose reports indicate inaccuracies.

b. The DNR will monitor water use and bring permittees into compliance whose reported use is higher than permitted.

c. The DNR will help permit holders adjust permitted volume to better match actual use and need, consistent with other plan objectives.

3. The DNR will ensure that water users comply with conditions on appropriation permits.

a. The DNR will help bring permit holders into compliance with their permit conditions.

b. The DNR will focus on permits that have been reviewed to address challenges of cumulative impacts and sustainability thresholds (Objective 1, action 3).

6. Implementation Schedule

Having considered input from the PAT and other interested parties, the DNR chose the actions described in Section 5 to address the most pressing challenges to meeting the five sustainability objectives around which the plan is organized. As stated in Section 1 (Introduction), the purpose of the GWMA plan is to guide DNR actions in managing the appropriation and use of groundwater within the GWMA over the next five years.

Many of the actions described in Section 5 develop information, tools, and processes that will form the foundation for better decision making. At its outset, the plan does not include a detailed description of sustainable groundwater use and limits throughout the GWMA. Rather, it lays the path for determining sustainable limits, both now and in the future, and then managing to those limits within a planned and transparent framework. Actions oriented toward all five plan objectives are integral to this process.

Table 6-1 provides details of the DNR's implementation plans for the GWMA. Table 6-1 is not a schedule, but provides information about who within the DNR is responsible for undertaking the actions identified in Section 5, and the general timeframes for implementation. Table 6-1 provides the following information:

- Action ID. The number of the action is taken directly from Section 5. The actions are listed under the Sustainability Objectives and in the order they are introduced in Section 5, and not according to the order of planned implementation.
- Action. The specific actions corresponding to the action IDs are described in this column. Highlighted rows introduce categories of actions that follow. Some actions are paraphrased from the actions presented in Section 5 to fit into Table 6-1. See the actions in Section 5 for the complete text of each action.
- Responsible Organization, Unit or Individual. The DNR division, section, unit or position primarily responsible for the implementation of the action is listed first and in bold type. Additional resources required to complete the action are listed, including organizations other than the DNR where appropriate.
- Existing or New Responsibilities. Plan actions are listed as either "New", "Existing" or "Existing but enhanced." New actions are considered actions that have not been taken previously by the DNR. Existing actions indicate the DNR has taken these actions previously and intends to continue. Existing but enhanced actions are those the DNR is currently taking but intends to enhance by adding additional resources or changing the approach.
- Plan Years(s). This column identifies when the actions will be implemented by plan year.
    - Plan Years 1 through 5 – These represent the calendar years following the authorization of the Bonanza Valley GWMA Plan that an action will be started or implemented. Plan Year 1 is the first 12-month period following authorization to proceed. Plan Year 2 is the following 12-month period.

  - Ongoing – The actions are ongoing, starting in plan year 1, or before, and continuing throughout the five-year timeframe of the Bonanza Valley GWMA Plan and beyond the five-year GWMA Plan.
  - Semi-Annually – Actions will take place twice a year, at approximately six month intervals. Where appropriate, the interval is specified by month.
  - Annually – Actions will take place once per year
- Dependencies/Notes. Where initiation of an action is dependent upon initiation or completion of another action, the dependency is noted.

Figure 6-1 presents the general timing for initiation or continuing work on the actions. DNR resource managers responsible for each of the actions will develop more detailed work plans as needed.

Table 6-1 Bonanza Valley GWMA Implementation

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
Objective I. Groundwater use in the GWMA does not harm aquifers and ecosystems, and does not negatively impact surface waters.					
I.1	The DNR will improve monitoring of groundwater levels, basin water levels, stream flows, climate; groundwater associated biological communities and water use within the GWMA to inform the DNR permit decisions.				
I.1.a	DNR will continue to build a comprehensive hydrological and climate monitoring system for the GWMA. DNR will coordinate with federal, state, and local agencies in these efforts.				
I.1.a.i	Stream flow monitoring - By 2016, install 6 new water flow monitoring gauges. Two of the six will provide 'Real time' data.	**EWR – Water Monitoring and Surveys Unit**, Watershed Districts, other LGUs	New	1-2	
I.1.a.ii	Wetland monitoring - By 2016, add 4 new wells in waterfowl production areas in partnership with the US Fish and Wildlife Service to the existing 4 sites.	**EWR – Water Monitoring and Surveys Unit** with input from Hydrogeology and Groundwater Unit.	Existing but enhance	1-2	
I.1.a.iii	Lake level monitoring – Add lake gauges as needed to the existing 15 gauges.	**EWR – Water Monitoring and Surveys Unit** with input from Hydrogeology and Groundwater Unit. Coordinate with Division of FAW.	Existing but enhance	Ongoing	
I.1.a.iv	Groundwater Level Monitoring - By 2018, install up to 15 monitoring wells in close proximity to the stream gage sites to gather the data necessary to analyze the potential impact of groundwater pumping on surface waters and groundwater. These are in addition to the existing 49 groundwater level monitoring wells.	**EWR – Water Monitoring and Surveys Unit** with input from Hydrogeology and Groundwater Unit	Existing but enhanced	1, Ongoing	
I.1.a.iv.i	Investigate whether there are opportunities to coordinate use of monitoring wells with multiple permittees	**EWR – Hydrogeology and Groundwater Unit** with input from Water Monitoring and Surveys Unit	New	2-3	

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
		Regional Appropriations staff, and Water Regulations Unit			
I.1.a.v	Identify additional climate monitoring requirements and add weather stations as needed to provide real time precipitation, temperature and wind speed for more precise evapotranspiration estimates	**EWR – Water Monitoring and Surveys Unit, State Climatology Office, University of Minnesota** with input from Hydrogeology and Groundwater Unit	New	2-3	
I.1.a.v.i	Increase the amount of citizen precipitation and weather reporting through recruitment to the Minnesota Volunteer Precipitation Observing Program and the Community Collaborative Rain, Hail & Snow Network (real-time)	**EWR – Water Monitoring and Surveys Unit - State Climatology Office** with input from Hydrogeology and Groundwater Unit	Existing	1-2	
I.1.a.vi	Explore the potential impacts of tile drainage on hydrology in Bonanza Valley GWMA.	**EWR – Water Monitoring and Surveys Unit , United States Geological Survey** with input from Hydrogeology and Groundwater Unit	New	2-3	
I.1.a.vi.i	Estimate the amount of tile drainage in Bonanza Valley GWMA	**EWR – Water Monitoring and Surveys Unit , United States Geological Survey** with input from Hydrogeology and Groundwater Unit	New	2-3	
I.1.a.vi.ii	Determine next steps in understanding potential impacts of tile drainage in Bonanza Valley GWMA	**EWR Regional Appropriations staff** supported by Hydrogeology and Groundwater Unit and Water Monitoring and Surveys Unit	New	3-4	
I.1.b	The DNR will continue to improve information on water use within the GWMA.				
I.1.b.i	Evaluate the use of remote sensing (satellite) technologies to monitor water use.	**EWR – Water Monitoring and Surveys Unit ,** with input from Idaho Dept. of Water Resources, Hydrogeology and Groundwater Unit	New	2-3	

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
I.1.b.ii	Explore if calibration techniques are necessary and would significantly improve the accuracy of reported water use data.	**EWR Regional Appropriations staff**, with input from EWR water regulations unit	Existing	2-3	
I.1.b.iii	Refine estimates of non-permitted groundwater use across the GWMA. Note: permits are not required for uses that are less than 10,000 gallons per day or 1 million gallons per year.	**EWR Water Regulations Unit**	New	1	
I.1.c	DNR will develop and use the most appropriate groundwater models and methods to predict volumes, rates and water level impacts from groundwater appropriations as well as describe the current groundwater conditions and characterize the nature and extent of the primary aquifers and the relationship of surface water and groundwater.	**EWR Hydrogeology and Groundwater Unit,** EWR Regional Appropriations staff.	New	Ongoing, 1-2	I.2.d.i,iv
I.1.d	Develop additional information on groundwater associated biological communities to inform permit decisions	**EWR – Regional Plant Ecologist**	New	1-2	
I.2	The DNR will develop and apply sustainability limits for aquifers, ecosystems and surface waters in the GWMA.				
I.2.a.	DNR will use safe yield for aquifers to determine limits to appropriation permits in the GWMA	**EWR Regional Appropriations staff**, Hydrogeology and Groundwater Unit	Existing but enhanced	Ongoing	I.1.c
I.2.b	The DNR will determine negative impacts to surface water features (streams, lakes, wetlands)using the approach that is described in the 2016 "Report to the Minnesota State Legislature: Definitions and Thresholds for Negative Impacts to Surface Waters."	**EWR Information, Monitoring and Assessment section** and Conservation Assistance and Regulation Section	Existing but enhanced	1	I.1.c

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
I.3	The DNR groundwater appropriation permits will integrate sustainability limits, individual and cumulative permit analysis, and will include evaluation of existing permits within the GWMA.				
I.3.a	Evaluate each new permit application individually, as well as in conjunction with other permits in the related aquifer systems to address issues associated with the cumulative impacts of appropriations across the aquifer	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit, Water Monitoring and Surveys Unit	Existing but enhanced	Ongoing	I.1.a,c; I.2.a,b,c
I.3.b	DNR will complete a review of all existing permits in the GWMA within 5 years, and if necessary adjust permits to achieve sustainable groundwater use (DNR will follow the established statute and rule processes for permit changes – see appendix B	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit,	New	2-5	I.1.a,c; I.2.a,b,c
I.3.c	Where needed, and in accordance with statutory requirements, DNR will limit current and future appropriations	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit, Water Monitoring and Surveys Unit	Existing but enhanced		I.1.a,c; I.2.a,b,c; I.3.a,b
I.3.c	Improve communication tools that will allow the public to more clearly understand the permitting process, including modifying the language in the preliminary well notification letter.	**EWR – Water Regulations Unit**, EWR Central Office and Web Team	Existing but enhanced	1-2	
I.4	The DNR will communicate the status of Objective I.				
I.4.a	Create a new GWMA reporting system that will be understandable by the public, and it will include results of data collection and analysis in the GWMA.	**EWR Central Office and Web Team**	New	2-5	I.1.f

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
I.4.b	Hold at least two GWMA Advisory Team meetings per year. They will be open to the public	**EWR – Central Office or Regional GWMA Implementation Staff**	New	Semi-annual	
I.4.c	Increase education and outreach to the public about sustainable use of groundwater in the GWMA	**EWR – Communications staff, Water Regulations Unit (Conservation Consultant), Hydrogeology and Groundwater Unit,** EWR Appropriations Staff and Web Team	Existing but enhanced	1-5	
I.4.d	DNR will invite Kandiyohi County to participate in the County Geologic Atlas program	**EWR – Hydrogeology and Groundwater Unit, Minnesota Geological Survey**	New	1-5	
I.5	The DNR will improve access to data collected and analyzed by other organizations in the GWMA.				
I.5.a	Support and participate in the development of a more comprehensive and accessible data management system within the GWMA, including website improvements	**EWR –Water Monitoring and Surveys Unit**, EWR Web Team, Hydrogeology and Groundwater Unit, MPCA, MDA	New	1-2	
I.5.b	Support the activities of the Pope SWCD, Minnesota Department of Agriculture, and the University of Minnesota Extension Service at the Rosholt Experimental Farm, and will inform the public of their research results	**EWR – Water Monitoring and Surveys Unit**, other organizations	New	1, Ongoing	
I.6	Ensure that community water supply plans include actions that must be taken if cumulative aquifer withdrawals exceed thresholds or if negative impacts on surface waters are occurring due to groundwater withdrawals in the GWMA	**EWR – Regional Appropriations staff,** Water Regulations Unit (Conservation Consultant), Hydrogeology and Groundwater Unit, Area Hydrologists	Existing but enhanced	2-4	I.1.a,c; I.2.a,b,c
I.7	The DNR will promote groundwater recharge in the GWMA, consistent with sound water quality management.				

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
I.7.a	Work with other organizations and agencies including watershed districts, counties and local units of government to identify important groundwater recharge areas and opportunities to enhance recharge	**EWR – Central Region Staff**, watershed districts, counties, other LGUs	Existing but enhanced	2-3	
I.7.b	Support local government efforts to protect important groundwater recharge areas through zoning and land use planning.	**EWR – Central Region staff – Land Use staff** and Regional Appropriations Staff	Existing but enhanced	Ongoing	1.7.a
I.7.c	Update groundwater sensitivity maps for the GWMA within 5 years	**EWR – Groundwater and Hydrogeology Unit**	New	3-4	I.4.e
Objective II. Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.					
II.1	The DNR will ensure that groundwater users are complying with water conservation requirements in their water supply plans and permits.				
II.1.a	Include water conservation requirements in appropriate permits as framed by statute, rule, and public water supply plans	**EWR – Regional Appropriations staff**, Water Regulations Unit	Existing but enhanced	Ongoing	II.1.a.i
II.1.b	Evaluate compliance with water conservation requirements on permits that include them. (DNR will be in contact with permit holders as we do these reviews).	**EWR – Regional Appropriations staff**, Water Regulations Unit	Existing but enhanced	2-5	I.3.b
II.1.c	When considering a permit transfer request or amendment request to increase appropriations in this GWMA, DNR will evaluate a permit holders' performance in meeting conservation requirements in their permit and the conservation goals	**EWR – Regional Appropriations staff**, Water Regulations Unit	Existing but enhanced	Ongoing	II.1.a

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
	contained in applicable water supply plans.				
II.1.d	Partner with local units of government such as Soil and Water Conservation Districts (SWCDs) to assist in developing and complying with conservation requirements in water appropriation permits	**EWR – Water Regulations Unit (Conservation Consultant)**	Existing but enhanced	2-5	
II.1.e	Update the information to develop water conservation requirements specific to each water use category	**EWR – Water Regulations Unit (Conservation Consultant)**	New	3-5	
II.2	The DNR will improve communication about and promote the values of water conservation in the GWMA.				
II.2.a	Promote lessons learned about water conservation from working farms, municipalities, industries, and other water users in the GWMA	**EWR – Conservation Consultant and Web Team,** Water Regulations Unit	New	1-5	I.4.a
II.2.b	Include descriptions and evaluations of water conservation practices in the GWMA in the new GWMA reporting system.	**EWR – Conservation Consultant and Web Team**	New	1-5	I.4.a
II.2.d	Update DNR website to include links to organizations with water conservation information	**EWR – Conservation Consultant and Web Team**	New	1-5	
II.3	Work with other organizations to promote appropriate water storage, and aquifer recharge in the GWMA	**EWR – Conservation Consultant,** Area Hydro and Regional Appropriations staff	Existing but enhanced	Ongoing	
II.4	Promote the use of water conservation strategies such as re-use of water in community water supply planning in the GWMA	**EWR –Conservation Consultant,** Regional Appropriations staff,	Existing but enhanced	2-4	In coordination with Water Supply Planning process; II1.a.i
Objective III. Groundwater use in the GWMA does not degrade water quality.					
III.1	The DNR will include compliance with local, state, and federal water quality regulations as permit conditions.				

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
III.1.a	Identify water quality regulations that apply to groundwater use and clarify how best to assure compliance	**EWR – Water Regulations Unit**, Regional Appropriations staff, federal, state, and local agencies	Existing but enhanced	Ongoing	
III.2	The DNR will ensure that permitted appropriations do not degrade water quality by moving known contaminants.				
III.2.a	DNR will work with PCA, MDH and MDA to determine the most suitable methods to evaluate the risk of moving known contaminants for new and existing permits.	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit, MPCA, MDH, MDA	Existing but enhanced	Ongoing	
III.3	Ensure that water supply plans take into account contaminant plume management	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit	Existing but enhanced	2-4	In coordination with Water Supply Planning process
III.4.a	Use the GWMA reporting system to describe the status of pollution plume management in the GWMA	**EWR – Communications staff,** and EWR Web Team, Hydrogeology and Groundwater Unit, MPCA	New	1, Ongoing	
III.4.b	Work with MDA, MDH, MPCA and others to share data about water quality among agencies	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit, MPCA, MDH, MDA	Existing but enhanced	2-3	
III.4.c	Work with MDA, MDH, MPCA and others to better interpret water quality data	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit, MPCA, MDH, MDA	Existing but enhanced	2-3	
III.5	DNR will ensure the permitted appropriations do not exacerbate known water quality contamination of a surface water feature	**EWR – Regional Appropriations staff**, Hydrogeology and Groundwater Unit, MPCA, MDH, MDA	New	2-3	
Objective IV. Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.					
IV.1	Continue to review permit applications to identify and reduce the likelihood of well interferences and water use conflicts	**EWR –, Hydrogeology and Groundwater Unit,** MPCA	Existing but enhanced	Ongoing	I.1,I.2

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
IV.2	Resolve well interferences and water use conflicts applying the framework outlined in statute and rule	**EWR – Regional Appropriations staff,** Water Regulations Unit	Existing	Ongoing	
IV.3	Improve information on aquifer characteristics in the GWMA to improve its ability to identify and reduce the likelihood of interferences and conflicts prior to permit approval	**EWR – Hydrogeology and Groundwater Unit,** Regional Appropriations staff	Existing but enhanced	1-5	I.1, I.4.e
IV.4	Increase education and awareness about resolving well interferences and water use conflicts	**EWR – Water Regulations Unit,** EWR Communications Staff, Regional Appropriations staff,	Existing but enhanced	1-5	
Objective V. All groundwater users in the GWMA have the necessary permits to use groundwater.					
V.1	The DNR will improve its capacity to detect unpermitted groundwater use.				
V.1.a	Complete a regular analysis to identify potential unpermitted groundwater use in the GWMA and take appropriate action.	**EWR – Regional Appropriations staff**	New	1-5, Ongoing	
V,1.c	The DNR will conduct follow-up reviews of preliminary well approval actions to determine compliance with permitting requirements.	**EWR – Regional Appropriations staff**	New	Ongoing	
V.1.b	Provide updated information to well drillers and consultants on existing laws and the water appropriation permit application process as it is available	**EWR – Water Regulations Unit,** Regional Appropriations staff.	Existing but enhanced	2-5	
V.1.d	Facilitate the public's ability to identify and report unpermitted use	**EWR – Water Regulations Unit**	New	2-5	
V.2	The DNR will ensure that permitted volumes reflect actual use and use does not exceed permitted volumes.				
V.2.a	Evaluate water use reports and will contact permit holders whose reports indicate inaccuracies	**EWR – Regional Appropriations staff,** Water Regulations Unit	Existing	Ongoing	

Action ID	Action	Responsible Organization, Unit or Individual (Primary in Bold)	Existing or New Responsi-bilities	Plan Year(s)	Dependencies /Notes
V.2.b	Monitor permitted versus reported use and bring permittees whose reported use is higher than permitted use into compliance	**EWR – Regional Appropriations staff,** Water Regulations Unit	Existing	Ongoing	
V.2.c.	Work will work with permit holders to adjust permitted volume to better match actual use and need, consistent with other plan objectives	**EWR – Regional Appropriations staff**	New	2-5	I.3.b
V.3	The DNR will ensure that water users comply with conditions on appropriation permits.				
V.3.a	Work with permit holders to bring them into compliance with their permit conditions	**EWR – Regional Appropriations staff**	Existing but enhanced	Ongoing	I.3

7. Glossary of Terms

Aquifer – any water-bearing bed or stratum of earth or rock capable of yielding groundwater in sufficient quantities that can be extracted (Minn. Rules, part 6115.0630, subp. 2)

Appropriating – withdrawal, removal, or transfer of water from its source regardless of how the water is used (Minn. Stat., sec. 103G.001, subd.4)

Artesian aquifer or confined aquifer – a water body or aquifer overlain by a layer of material of less permeability than the aquifer. The water is under sufficient pressure so that when it is penetrated by a well, the water will rise above the top of the aquifer. A flowing artesian condition exists when the water flow is at or above the land surface (Minn. Rules, part 6115.0630, subp. 4).

Basin – a depression capable of containing water which may be filled or partly filled with waters of the state. It may be a natural, altered, or artificial depression (Minn. Rules, part 6115.0630, subp. 5)

Buried Quaternary Aquifer – an aquifer composed of glacially associated sands and/or gravels, over which a confining layer of clay or till was deposited

Conservation rate – a water fee (rate) structure that encourages conservation and may include increasing block fees, seasonal rates, time of use rates, individualized goal rates, or excess use rates (Minn. Stat., sec. 103G.291, subd. 4(a))

Evapotranspiration – the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.

Demand reduction measures – actions that reduce water demand, water losses, peak water demands, and nonessential water uses. Demand reduction measures must include a conservation rate structure, or a uniform rate structure with a conservation program that achieves demand reduction (Minn. Stat., sec. 103G.291, subd. 4(a)).

Groundwater – subsurface water in the saturated zone. The saturated zone may contain water under atmospheric pressure (water table condition), or greater than atmospheric pressure (artesian condition) (Minn. Rule, part 6115.0630, subp. 11)

Native plant community – a group of plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms

Negative Impact – refers to the relationship of groundwater use to surface waters. See Minn. Stat., section 103G.287, subd. 2 which states “Groundwater appropriations that will have negative impacts to surface waters are subject to applicable provisions in section 103G.285” (this affects altered and natural watercourses, which includes trout streams and basins).

Nested Obwells – Two or more adjacent water-level observation wells completed in different aquifers, or different depths within the same aquifer. Used to determine vertical differences in groundwater levels or heads.

Normal (climate) – the average of a climate variable such as precipitation or temperature over a standard 30-year period (e.g. 1981–2010)

Obwell – a water-level observation well in the DNR network

Potential evaporation or free water surface evaporation – evaporation from a thin film of water having no appreciable heat storage (Farnsworth et al., 1982).

Protected flow – the amount of water required in the watercourse to accommodate instream needs such as water-based recreation, navigation, aesthetics, fish and wildlife habitat, water quality, and needs by downstream higher priority users located in reasonable proximity to the site of appropriation (Minn. Rules, part 6115.0630, subp. 12)

Protective elevation – the water level of the basin necessary to maintain fish and wildlife habitat, existing uses of the surface of the basin by the public and riparian landowners, and other values which must be preserved in the public interest (Minn. Rules, part 6115.0630, subp. 13)

Recharge – the addition of water to the groundwater system

Safe yield – *water table condition:* the amount of groundwater that can be withdrawn from an aquifer system without degrading the quality of water in the aquifer and without allowing the long term average withdrawal to exceed the available long term average recharge to the aquifer system based on representative climatic conditions (Minn. Rules, part 6115.0630, subp. 15)

artesian condition: the amount of groundwater that can be withdrawn from an aquifer system without degrading the quality of water in the aquifer and without the progressive decline in water pressures and levels to a degree that will result in a change from artesian condition to water table condition (Minn. Rules, part 6115.0630, subp. 15)

Transpiration – the process of transport of water from plant roots to above ground parts where it is released to the atmosphere as vapor

Till - unsorted material deposited directly by glacial ice and showing no stratification. Till is sometimes called boulder clay because it is composed of clay, boulders of intermediate sizes, or a mixture of these. Groundwater generally flows more slowly through these layers than sand and gravel.

Water table aquifer or unconfined aquifer – an aquifer where groundwater is under atmospheric pressure (Minn. Rules, part 6115.0630, subp. 17)

Water-use conflict – A situation where the available supply of waters of the state in a given area is limited to the extent that there are competing demands among existing and proposed users which exceed the reasonably available waters (Minn. Rules, part 6115.0740. subp. 1).

Well interference – A situation where an appropriation reduces water levels beyond the reach of public water supply and private domestic wells constructed according to Minn. Rules, part 4725 (Minn. Stat., sec. 103G.287, subd. 5; Minn. Rules, part 6115.0730).

8. References

Delin, G.N., 1990. Geohydrology and water quality of confined-drift aquifers in the Brooten-Belgrade area, west-central Minnesota: U.S. Geological Survey Water-Resources Investigations Report 88-4124, 138 p.

Delin, G. N., 1991. Simulation of effects of ground-water development on water levels in glacial drift aquifers in the Brooten-Belgrade area, west-central Minnesota. USGS Water Resource Investigation report number 88-4193, 66 p.

DNR Staff, 1968. An Inventory of Minnesota Lakes. Division of Water, Soils and Minerals, Minnesota Conservation Department, pg. 3-4.

DNR Staff, 2014. Draft Analysis for the Working Boundary of the Bonanza Valley GWMA. Minnesota Department of Natural Resources, 17 p.

Minnesota Department of Health Website. Nitrate-Nitrogen (Nitrate) Probability Maps and Reports.

Minnesota Department of Health Website. Wellhead Protection.

Minnesota Department of Natural Resources (2005). Field Guide to the Native Plant Communities of Minnesota: The Prairie Parkland and Tallgrass Aspen Parklands Provinces, Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program, MNDNR St. Paul, MN. 362 p.

Minnesota Department of Natural Resources Fisheries Management Plan: Lake Johanna, Pope County 2014-2025. Division of Fish & Wildlife, Section of Fisheries, Glenwood Area Headquarters. 30 p.

Minnesota Department of Natural Resources Website. Rare Species Guide: http://www.dnr.state.mn.us/rsg/index.html

Minnesota Department of Natural Resources Website. Native Plant Community Classification – NPC Conservation Ranks, 8 p.

Minnesota Pollution Control Agency, 2013. Executive Summary Nitrogen in Minnesota Surface Waters, MPCA and University of Minnesota and U.S. Geological Survey. Doc. # wq-s6-26i, 24 p.

Minnesota Pollution Control Agency Website. North Fork Crow River Watershed.

Minnesota State Demographic Center Website. Popular Census 2010 Datasets.

NatureServe Explore Website. About the Data - Data Types & Uses.

[1] Minn. Stat., 103G.271, Subd. 3.

NHIS (Natural Heritage Information System) 2015. Natural Heritage Information System Database. MNDNR, St. Paul. Heritage review conducted Feb. 2015, MNDNR, R4, New Ulm, MN http://www.dnr.state.mn.us/nhnrp/nhis.html

Nitrate/Nitrogen pollution MDA. Minnesota Department of Agriculture Summary of Groundwater Nitrate-Nitrogen Data. March 2012. MAU-12-100. Pesticide and Fertilizer Management Division (PFMD) Staff collaboration.

North American Bird Conservation Initiative, U.S. Committee, 2014. The State of the Birds 2014 Report. U.S. Department of Interior, Washington, D.C. 16 p.

Pryor, S. C., D. Scavia, C. Downer, M. Gaden, L. Iverson, R. Nordstrom, J. Patz, and G. P. Robertson, 2014: Ch. 18: Midwest. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 418-440. doi:10.7930/J0J1012N

Smith, E.A., and Westenbroek, S.M., 2015, Potential groundwater recharge for the State of Minnesota using the Soil-Water-Balance model, 1996–2010: U.S. Geological Survey Scientific Investigations Report 2015–5038, 85 p., http://dx.doi.org/10.3133/sir20155038

Tuck, B. and Pesch, R., 2015. Economic Composition of the West Central Region of Minnesota: Industries and Performance. University of Minnesota Extension Center for Community Vitality. 15 p.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation—Minnesota *U.S. Fish and Wildlife Service and U.S. Census Bureau*

Appendices

Appendix A

Minnesota Executive Agency Commitments to Bonanza Valley GWMA Plan

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Minnesota Department of Agriculture

The Minnesota Department of Agriculture (MDA) supports the Minnesota Department of Natural Resources (MDNR) led approach to managing groundwater through the development of Groundwater Management Areas (GWMA). The MDNR is the lead agency for managing groundwater appropriations consistent with statutory requirements for sustainability including providing for ecosystem needs. The MDA has statutory responsibilities and expertise in addressing agricultural contributions to water quality concerns. The MDA will provide support in our areas of responsibility and expertise to the MDNR and local communities in GWMAs.

Overview of the MDA Role

The MDA is the lead state agency for addressing pesticides and nitrate from fertilizer in groundwater. MDA also has related regulatory and non-regulatory responsibilities for pesticide and fertilizer management including storage, handling and cleanup of contaminated facilities. The primary statutory authority for these activities comes from the Groundwater Protection Act [MN Statutes (MS) Chapter 103H], the Pesticide Control Law (MS 18B), and the Fertilizer, Soil Amendment, and Plant Amendment Law (MS 18C). The MDA coordinates with University of Minnesota Extension, soil and water conservation districts, farmers, agronomists and other interested parties to promote and support the most current science based best management practices to reduce potential agricultural contaminants in groundwater and for irrigation management.

The MDA has developed a Pesticide Management Plan (PMP) and a Nitrogen Fertilizer Management Plan (NFMP) which outline a formal approach to addressing pesticide and nitrate contamination in groundwater. The MDA will provide assistance to the MDNR within GWMAs primarily through the implementation of the NFMP and the PMP. The MDA will provide technical support for evaluating levels of pesticide and nitrate contamination, identifying potential sources and protective actions for nitrate and pesticides in groundwater, and other related work within a GWMA. The MDA approach emphasizes review of existing data on local agricultural practices and identifying appropriate voluntary best management practices (BMPs) to ensure that the best available science is used for addressing local problems, and on working closely with local farmers, crop advisors, local government, other agencies, and other interested parties to address nitrate or pesticide issues.

Nitrogen Fertilizer

The Nitrogen Fertilizer Management Plan (NFMP) is the state's blueprint for prevention, evaluation and mitigation of the impacts of nitrogen fertilizer on groundwater. Within GWMAs, MDA will participate in issues related to nitrate in groundwater using the processes identified in the NFMP. This includes monitoring and assessment, development and implementation of BMPs, and other prevention and mitigation activities. Some specific activities are provided below.

Where nitrates in groundwater may be of concern within GWMAs, MDA assistance will be guided by the NFMP and could include:

- Conduct monitoring and assessment of groundwater for nitrates;
- Evaluate nitrate data;
- Engage with the agricultural community, U of M Extension and other local stakeholders to provide information and solicit feedback;
- Provide advice on appropriate nitrogen fertilizer BMPs and other practices;
- Survey of current adoption of BMPs and agricultural practices;
- Assist agricultural community through information and education activities such as farmer meetings, on farm demonstration, technical assistance on nitrogen management practices;
- Follow-up evaluation to determine BMP effectiveness and adoption; and,
- Evaluation of other practices that should be considered.

Pesticides

The Pesticide Management Plan (PMP) is the state's blueprint for prevention, evaluation and mitigation of occurrences of pesticides or pesticide breakdown products in groundwater and surface waters of the state. The PMP includes components promoting prevention, developing appropriate responses to the detection of pesticides or pesticide breakdown products in groundwater and surface waters, and providing responses to reduce or eliminate continued pesticide movement to groundwater and surface water.If pesticides in groundwater are a concern within GWMAs, the MDA will provide assistance using the processes identified in the PMP. This assistance may include:

- Collection and analysis of data on the presence of pesticides and pesticide degradates in groundwater;
- Evaluation of monitoring data for common detection determinations in groundwater;
- Evaluation of BMPs;
- Engaging the agricultural community, U of M Extension and other stakeholders in evaluating and implementing BMPs;
- Evaluating actions to mitigate the effects of specific pesticides in common detection for groundwater;
- Development of voluntary pesticide-specific BMPs; and,
- Evaluation of BMP use and effectiveness.

MDA Point Source Authority

In addition to non-point source activities shown above, MDA has responsibilities and regulatory authority for overseeing agriculture chemicals from point sources as directed in MS 18C (fertilizer

storage, handling, distribution, use and disposal), MS 18D (agricultural chemical liability) and MS 18E (agricultural chemical response and reimbursement). As provided in these statutes, MDA will exercise these authorities as needed to address potential point sources of contamination such as releases from bulk storage facilities within GWMAs.

Irrigation

MDA, in cooperation with the University of Minnesota Extension, will provide technical support for irrigation water management to reduce the potential for impacts from nitrogen fertilizer and pesticides to groundwater. MDA will promote current irrigation practices that use the best available science. This could include practices such as increasing water use efficiency, irrigation scheduling, fertigation, and other irrigation management practices.

Variation based on unique circumstances for each GWMA:

The above outlines the general approach of MDA involvement within GWMAs. This approach will be modified as appropriate to address the unique circumstances of each GWMA.

Minnesota Department of Health

Objective I. Groundwater use in the GWMA does not harm aquifers and ecosystems, and does not negatively impact surface waters.

1. MDH will act to implement the federal Safe Drinking Water Act by focusing on a 'source to tap' strategy of multiple protections to ensure the delivery of safe drinking water to all Minnesotans connected to a public water system.
2. MDH will enforce the Minnesota Well Code to ensure wells meet current construction and maintenance standards.
3. MDH will focus Wellhead Protection plan development and implementation efforts that protect drinking water resources and public health.
4. MDH will coordinate with state agency efforts to evaluate and improve local (e.g., LUGs, NGOs) capacity to manage groundwater and drinking water issues.
5. MDH will support and prioritize activities that protect both public and private groundwater resources that are used as a source of drinking water.

Objective II. Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.

1. MDH will focus Wellhead Protection plan development and implementation efforts to encourage sustainable land and water uses.
2. MDH will assist public water systems in identifying conservation activities when developing wellhead protection plans, especially activities that align with regional efforts within groundwater management areas.
3. MDH will continue to advise on stormwater infiltration practices in vulnerable wellhead protection areas.
4. Subject to legislative funding, MDH will conduct a thorough review of state rules, regulations, and policies relative to water reuse.
5. MDH will evaluate and encourage the adoption of conservation practices where multiple benefits can be achieved that conserve groundwater resources and improve the quality of drinking water in GWMAs.

Objective III. Groundwater use in the GWMA does not degrade water quality.

1. MDH will coordinate with state agency efforts to evaluate and improve local (e.g., LUGs, NGOs) capacity to manage groundwater and drinking water resources.
2. MDH will focus Wellhead Protection plan development and implementation efforts that encourage sustainable land uses and the adoption of conservation practices that result in reduced nutrient loss and other anthropogenic impacts that degrade drinking water quality and may impact human health.
3. MDH will assist public water systems in developing water monitoring networks, especially unconfined aquifer settings where drinking water sources are vulnerable.
4. MDH will promote the use of groundwater and land use modeling to demonstrate both the costs and benefits associated with changes in land use on both water quantity and quality.
5. MDH will coordinate with DNR, MPCA, MDA, USGS and others on monitoring, regulation, and prevention efforts for contaminants of emerging concern, including the development of health-based guidance, if appropriate.
6. MDH will coordinate with DNR and others to examine if regional aquifer management approaches might be of value to public water systems, local units of government, and other stakeholders concerned with drinking water protection.

Objective IV. Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.

1. MDH will share with DNR staff the data and groundwater models developed for wellhead protection purposes. These may assist in evaluation of hydraulic impacts of potential new high capacity wells that are located in close proximity to drinking water supply management areas.

Objective V. All groundwater users in the GWMA have the necessary permits to use groundwater.

1. MDH will assist the DNR technical staff with the coordination and evaluation of compliance issues/impacts on the public water systems.
2. MDH will coordinate with DNR on data exchange for new potential high-capacity wells in groundwater management areas.

Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency has reviewed the Bonanza Valley Groundwater Management Area Plan and determined that the agency can support the DNR's goals for the GWMA through the following actions organized by Plan objectives:

Objective I. Groundwater use in the GWMA does not harm aquifers and ecosystems, and does not negatively impact surface waters.

A. MPCA - Monitor the waters of the state within the GWMA to assess their quality, using a systematic intensive watershed approach to determine physical, chemical and biological integrity.
B. MPCA - Identify and investigate groundwater – surface water interactions
C. Work with local government units to promote and implement best management practices to protect surface and groundwater quality
D. MPCA – Support development of shared data system with DNR, MDH, MDA and other organizations

Objective II. Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.

A. MPCA - Identify and investigate groundwater – surface water interactions with in the GWMA
B. MPCA - Pollution Prevention and MnTAP consultations for water conservation
C. MPCA - Participate with other agencies to encourage water re-use where appropriate
D. MPCA – participate in development of new groundwater models to better understand flows, recharge rates and water balances within the GWMA.

Objective III. Groundwater use in the GWMA does not degrade water quality.

A. MPCA - Monitor the waters of the state to assess their quality, using a systematic intensive watershed approach to determine physical, chemical and biological integrity.
B. MPCA – continue to monitor statewide ambient well network as an early warning system identifying contaminant threats to shallow and vulnerable aquifers in GWMAs and elsewhere. MPCA will make data/results available to interested parties via EQuIS or MPCA website. MPCA will consider installing additional wells if in GWMAs if needed, in conjunction with partner agencies who oversee groundwater monitoring (MDA, MDNR, MDH).
C. MPCA - Minimize and regulate, with local partners pollutant discharges via permits, technical/financial assistance, and enforcement. E.g. septic systems, feedlots, spray irrigation permits, landfills.
D. MPCA (w/MDH, MDA, USGS) –adapt monitoring, prevention, regulation and remediation efforts for contaminants of new/emerging concern
E. MPCA - Work with local government units to promote and implement best management practices to protect surface and groundwater quality, including stormwater management

Objective IV. Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.

A. MPCA - Identify and investigate groundwater – surface water interactions
B. MPCA – help develop new groundwater models to better understand flows, recharge rates and water balances

Objective V. All groundwater users in the GWMA have the necessary permits to use groundwater.

1. MPCA – Support DNR efforts to identify all appropriate permit conditions related to MPCA regulatory authority.

Board of Water and Soil Resources

The Minnesota Board of Water and Soil Resources has reviewed the Bonanza Valley Groundwater Management Area Plan and determined that the agency can support the DNR's goals for the GWMA through the following actions, organized by Plan objectives:

DNR Objective I. Groundwater use in the GWMA does not harm aquifers and ecosystems, and does not negatively impact surface waters.

A. BWSR will encourage local government units (Counties, Watershed Districts, Soil and Water Conservation Districts and others) to consult with the DNR to obtain groundwater management information relevant to their plan updates.
B. BWSR will support local governments' efforts to incorporate groundwater management objectives in their plans and to incorporate groundwater protection provisions in their regulatory programs. BWSR will develop guidance to help these local governments to adopt plans, policies and actions that are consistent with DNR objectives for management and protection of groundwater resources.
C. BWSR will encourage the participation of Soil and Water Conservation District and Watershed Districts in the DNR Observation Well program.
D. Consistent with BWSR's responsibility to administer the Wetland Conservation Act (WCA), BWSR will:
    a. support DNR's effort to develop tools to better estimate the effects of groundwater withdrawals on the quantity, quality and biological diversity of wetlands, and
    b. as requested, on a case-by-case basis, review and comment on applications for groundwater withdrawals that have the potential to affect wetlands.
E. BWSR will attend future GWMA Advisory Team meetings to maintain communication with DNR and provide a link to LGUs.
F. BWSR will encourage Kandiyohi County to identify support for development of a County Geologic Atlas as a priority in future plans and to pursue the completion of the atlas.

DNR Objective II. Groundwater use in the GWMA is reasonable, efficient, and complies with water conservation requirements.

A. BWSR will continue to encourage the development of groundwater management activities (e.g., irrigation scheduling program and pivot uniformity tests) within their existing and future grant programs.
B. BWSR will support local units of government in their development of local plans to address groundwater protections.

DNR Objective III. Groundwater use in the GWMA does not degrade water quality.

A. BWSR will support local governments' efforts to incorporate groundwater management objectives in their plans and to incorporate groundwater protection provisions in their regulatory programs.
B. BWSR will encourage local governments to consult with the DNR to obtain groundwater management information relevant to their plan updates.

DNR Objective IV. Groundwater use in the GWMA does not create unresolved well interferences or water use conflicts.

This objective does not relate to BWSR programs and responsibilities.

DNR Objective V. All groundwater users in the GWMA have the necessary permits to use groundwater.

This objective does not relate to BWSR programs and responsibilities.

Appendix B

Process Summary: Preliminary Well Construction, Water Appropriation Permitting, Municipal Water Supply Plans, Permit Modification Procedures

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Well Construction – Preliminary Assessment

The following provides a high-level summary of steps for a water appropriations permit applicant and the DNR will take to obtain a preliminary assessment of proposed well.

1. Applicant logs into MPARS to obtain approval for a new well.
2. The Appropriation Hydrologist reviews the approval request.
3. The approval request may be sent to the Groundwater Specialist for review.
4. The approval request may be sent to management for review in very complex cases.
5. A letter is sent to the applicant that may describe the resources of concern in the area (if any) and whether the anticipated appropriation is likely to meet the applicable requirements for obtaining a permit to pump water.
6. The applicant may be informed of the need to gather additional information, conduct aquifer tests, or install observation wells before applying for a DNR Water Appropriation Permit.
7. The DNR may follow up to ascertain if the applicant constructed of the well.

Appropriation Permit Actions

The following provides a high-level summary of steps to obtain a water appropriations permit.

1. Applicant completes the preliminary assessment for well construction.
2. Applicant logs into MPARS to request a DNR Water Appropriation Permit or to amend an existing Water Appropriation Permit.
3. The DNR Appropriation Hydrologist reviews the request and may send the initial request to the Groundwater Specialist for review at this point.
4. Additional information may be requested from the applicant to form a complete application, or to provide enough information with which to make a sound decision. The applicant may be informed of the need to conduct an aquifer test.
5. Meetings may be held with the applicant.
6. The Appropriation Hydrologist will generate the invoice for the permit application fee, or amendment application fee and it will be sent to the applicant using MPARS.
7. The applicant uses MPARS to pay the invoice.
8. When the application is complete and the fee is paid the application is forwarded to the County, SWCD, Watershed District, other relevant parties and other DNR staff for review. They are allowed 30 days to review the proposal and submit comments to the DNR.

9. If concerns exist, the applicant will be notified of the concerns and allowed to address those concerns. DNR staff is available for discussion regarding any issues related to the permit application or natural resource concerns. Additional actions may need to be taken by the applicant to address the concerns. An aquifer test may need to be conducted by the applicant.
10. If the issues are addressed, the Appropriation Hydrologist will draft the Permit in MPARS. The appropriate conditions will be added to the permit to address the need for water level monitoring, or other actions, by the applicant.
11. A DNR representative will issue the DNR Appropriation Permit using MPARS.

High-Level Process for Community Public Water Supplies

The following provides a high-level summary of steps a municipal water appropriations permit applicant and the DNR will take to obtain a high capacity well permit within the scope of an approved water supply plan.

1. City develops local Water Supply Plan, receives DNR approval & city adopts (approved WSP identifies future water needs & source water(s))
2. City submits Well Construction Preliminary Assessment to DNR prior to drilling well
3. DNR provides site-specific WCPA information to city
4. City drills well (MDH notification)
5. City submits permit amendment or application
6. DNR & city coordinate with other agencies (MDH, MPCA, Met Council, watershed districts, counties) and engage in comment period
7. DNR determines if aquifer testing is needed; if so,
    a. City prepares and submits aquifer test plan; DNR must approve
    b. City conducts aquifer tests with monitoring (input from DNR)
    c. DNR reviews aquifer test results
8. DNR makes permit decision
9. Issued permits have applicable permit conditions

Water Appropriation Permit Modifications

Consistent with Minnesota Statute and Rule, the DNR Commissioner can modify water appropriation permits. However, statute and rule also protect the permit holder.

For instance, water appropriation permit holders are afforded due process through Minnesota Statute and Rule. If the permit holder does not agree with a permit decision, in many cases they may demand a contested case hearing.

Contested case hearings are used in many states as well as in federal matters. They are informal court proceedings governed by state law that can be used to protect rights, duties and privileges of the affected parties. The purpose of contested case hearings is to provide decision makers with the highest quality information available to render permit decisions, and to provide third party review of an appeal made to a state agency decision.

Modifications to water appropriation permits are described very specifically by Minnesota Statute and Rule:

- The DNR is prohibited from modifying or restricting the authorized amount of groundwater that is used for agricultural irrigation between May 1 and November 15, unless the DNR determines that the authorized amount of appropriation endangers a domestic water supply. [1] This is designed to provide some assurance of a water source to bring the crop through to harvest.
- Whenever a permit is proposed to be modified, there is an opportunity for the permit holder to demand a contested case hearing.
- From the initial decision whether to issue or deny a permit, to the proposed modification of an existing permit due to the establishment of a protected flow or protected elevation in a nearby surface water feature, the applicant or permit holder has the opportunity to a public hearing.[2]
- If there is a water use conflict, where there is limited water availability, resulting in the commissioner proposing adjustments to permits in an area that are competing for the same inadequate water source, the action is taken by the DNR only after the permit holders or applicants are notified and given the opportunity for a hearing. See Appendix C for more information.[3]
- Most terminations are subject to advanced notice and opportunity for a hearing. An exception would be, for example, when a permittee requests termination.[4]
- The public hearings that can be requested are conducted as contested case hearings under Minn. Stat. Chapter 14, and are conducted by the Office of Administrative Hearings.[5]
- Permits that authorize appropriation from surface water sources may be temporarily suspended as a result of periods of extremely low rainfall. This is defined as when the flows measured in their watersheds fall below a certain point, typically the Q90 flow. Applicants for surface water appropriations are required to have a feasible contingency plan for these situations or agree to withstand the results of not being able to appropriate water (after suspension).[6]

It should be extremely rare for a permit holder to face a permit modification without significant advance warning. However, if a permit modification is necessary and the permit holder or applicant disagrees with the permit decision, Minnesota Statute and Rules provide for a hearing.

If the DNR found the existing authorized water use in an area to be unsustainable, DNR would provide advanced notice and involve permit holders in finding a solution.

[1] Minn. Stat., 103G.271, Subd. 3.
[2] Minn. Rules, 6115.0670, Subp. 3.
[3] Minn. Rules, 6115.0740, Subp. 3.
[4] Minn. Rules, 6115.0750, Subp. 8.
[5] Minn. Stat., 103G.311
[6] Minn. Stat., 103G.285, Subd. 6.

Appendix C

Minnesota Rule Guiding Water Use Conflicts

MINNESOTA RULE 6115.0740 WATER USE CONFLICTS (link to Minnesota Reviser).

Subpart 1. **Conflict defined**.

For the purpose of these rules a conflict occurs where the available supply of waters of the state in a given area is limited to the extent that there are competing demands among existing and proposed users which exceed the reasonably available waters. Existing and proposed appropriations could in this situation endanger the supply of waters of the state so that the public health, safety, and welfare would be impaired.

Subp. 2. **Procedure**.

Whenever the total withdrawals and uses of ground or surface waters would exceed the available supply based on established resource protection limits, including protection elevations and protected flows for surface water and safe yields for groundwater, resulting in a conflict among proposed users and existing legal users the following shall apply:

A. In no case shall a permittee be considered to have established a right of use or appropriation by obtaining a permit.

B. The commissioner shall analyze and evaluate the following:

(1) the reasonableness for use of water by the proposed and existing users;

(2) the water use practices by the proposed and existing users to determine if the proposed and existing users are or would be using water in the most efficient manner in order to reduce the amount of water required;

(3) the possible alternative sources of water supply available to determine if there are feasible and practical means to provide water to satisfy the reasonable needs of proposed and existing users.

C. If conflicts can be resolved by modifying the appropriation of the proposed and existing users, the commissioner shall do so.

D. If conflicts cannot be resolved through modification of proposed and existing permits the commissioner shall base the decision regarding issuance of new applications and retention, modification, or termination of existing permits on the basis of existing priorities of use established by the legislature as follows:

(1) If the unresolved conflict involves users who are or would be in the same priority class, the commissioner shall require the proposed users and existing permitted users to develop and submit a plan which will provide for proportionate distribution of the limited water available among all users in the same priority class. The commissioner shall withhold consideration of new applications and shall, if the existing permitted appropriations endanger the supply of waters of the state, suspend or limit existing permits until a plan is approved by the commissioner.

The plan must include proposals for allocating the water which address the following: possible reduction in the amounts of appropriation so that each user would receive a proportionate amount of water for use; and possible restrictions in the timing of withdrawals so that each user would be allowed to withdraw a proportionate share of water for use over certain periods of time.

If the commissioner approves the proposed plan, new permits will be issued and existing permits will be amended in accordance with that plan.

If the commissioner determines that the proposed plan is not practical or reasonable, the commissioner shall develop a new plan or modify the proposed plan to provide proportionate share of water among the users involved. The commissioner shall issue new permits and amend existing permits based on that plan.

(2) If the unresolved conflict involves users who are or would be in a different priority class the available water supply shall be allocated to existing and proposed users based on the relative priority of use. Highest priority users shall be satisfied first. Any remaining available water supply shall be allocated to the next succeeding priority users, until no further water is available. Users in the same priority class shall be offered the same options as provided in subitem (1).

Subp. 3. **Notice and hearing**.

All actions by the commissioner shall be made after notice and opportunity for public hearing.

Statutory Authority: MS s 103G.315; 105.415

Published Electronically: June 11, 2008

Appendix D

Description of analysis supporting Bonanza Valley GWMA Plan Figure 2-6

Protocol for Development of Figure 2-6 "Water Appropriation Related to Land Use in the Sand and Gravel Aquifer, 2014"

Figure 2-6 was developed by DNR staff using ArcMap computer mapping program with the aim of evaluating the percentage of ag land, irrigated land, and land that could be converted to agriculture in the sand and gravel aquifer area of the Bonanza Valley GWMA. The following describes the steps taken to develop the map:

1. The first data inputs in the Bonanza Valley consist of the following map layers:
   - Bonanza Valley Boundary (DNR)
   - Sand and Gravel Aquifer Boundary (DNR Geologic Atlas and other DNR sources)
   - Digitized Irrigation (DNR field Staff from aerial photos and landowner contacts)
   - Publicly owned lands and other conservation lands "Protected Lands" (DNR and others)
   - Crops grown and locations – 2013, known as "Geo-referenced, crop specific land cover" - (United States Department of Agriculture (USDA) National Agricultural Statistic Service (NASS) 2013 Cropland Data Layer (retrieved from Quick Layers) http://www.nass.usda.gov/research/Cropland/sarsfaqs2.html)
2. The Surficial Sand and Gravel Aquifer layer was clipped to the Bonanza Valley Boundary.
3. Wetlands, rivers, streams, lakes, developed land and publicly owned (protected) land were removed from the base map (given a white color). These lands cannot be converted to cropland. Wetlands, rivers, streams, lakes and developed land were found in the 2013 NASS data referenced above. The following are "protected" lands:
   - United States Fish and Wildlife Service Waterfowl Protection Areas
   - United States Fish and Wildlife Service Wetland Management Districts
   - United States Fish and Wildlife Service Easements
   - The Nature Conservancy Preserves
   - State Wildlife Management Areas
   - State Aquatic Management Area Lands
   - State Scientific and Natural Areas
   - State Reinvest in Minnesota Easements
   - State Native Prairie Bank Easements
4. The Cropland Data Layer and Irrigated Acres Layer were clipped to the Surficial Sand and Gravel layer. This allows an evaluation of the land cover in only the sand and gravel aquifer area – which is the most likely to have existing irrigation systems and the highest likelihood of

installation of new irrigation systems.

The cropland data layer consists of the following categories:

- Ag Land
  - Alfalfa
  - Barley
  - Camelina
  - Canola
  - Clover/Wildflowers
  - Corn
  - Dry Beans
  - Flaxseed
  - Millet
  - Oats
  - Other Crops
  - Peas
  - Potatoes
  - Rye
  - Sorghum
  - Soybeans
  - Spring Wheat
  - Sugarbeets
  - Sunflower
  - Sweet Corn
  - Winter Wheat
- Non-Ag Upland
  - Barren
  - Deciduous Forest
  - Evergreen Forest
  - Fallow/Idle Cropland
  - Grassland Herbaceous
  - Mixed Forest
  - Other Hay
  - Pasture/Grass
  - Pasture/Hay
  - Shrubland
  - Sod/Grass Seed
  - Woodland
- Other
  - Developed/High Intensity
  - Developed/Low Intensity
  - Developed/Medium Intensity

- Developed/Open Space
- Herbaceous Wetlands
- Open Water
- Wetlands
- Woody Wetlands

5. Acres were calculated using the ArcMap “statistics tool” in the attribute tables.

Appendix E

Executive Summary of the Report to the Minnesota State Legislature: Definitions and Thresholds for Negative Impacts to Surface Waters

Background and purpose

This report was prepared in response to Laws 2015, chapter 4, article 4, which directed the Department of Natural Resources (DNR) to consult with interested stakeholders and develop recommendations for statutory or rule definitions and thresholds for negative impacts to surface waters.

The DNR is charged with *managing* water resources to assure an adequate and sustainable supply for multiple uses. Minnesota has a modified riparian water law system, in which landowners have the right to make reasonable use of the abutting surface waters or the groundwater beneath their land, as defined and regulated by the water appropriation permitting program. The water itself is a public trust resource, and the state grants the right to water beyond personal use – above 10,000 gallons per day or one million gallons per year – through water appropriation permits. In recent years, it has become increasingly clear that Minnesota's water resources, while abundant in many areas, are not unlimited. In some areas, increasing water withdrawals are using more groundwater than is naturally being recharged. In other areas, groundwater supplies are limited due to the underlying geology. Groundwater contamination is also a limiting factor in many areas.

The variability of Minnesota's climate and geography mean that rainfall is not always available in the quantities we need at the times when it is most needed. Increasing demands on both surface water and groundwater supplies can cause negative impacts to the ecosystems and riparian uses of streams, lakes, and wetlands. While water levels fluctuate naturally throughout the year and across multiple years, water appropriations can push low levels lower, significantly reducing stream flows and more frequently putting fish, wildlife, plant communities and riparian uses at risk.

This report examines the effects of groundwater use on rivers and streams, lakes, and wetlands. DNR's analysis and recommendations are based on the fact that surface water bodies go through seasonal and multi-year cycles of high and low water levels. The seasonal patterns, known as the seasonal hydrograph, are primary drivers in creating and maintaining the unique ecology and associated aquatic and riparian habitats of each water body. To preserve the seasonal hydrograph, protected flows must be established for streams, and protection elevations for lakes and some wetlands. These protection levels can then be translated into a quantity of water that can be sustainably withdrawn. Multi-year dry cycles and extreme droughts also serve important ecological functions, but may require a different approach to determining sustainable water use—e.g., water use that is ecologically sustainable under the normal seasonal hydrograph may need to be reduced during extreme drought.

This report was prepared with input from a broad range of stakeholders, as described in the Introduction and Appendix A. This report also incorporates and summarizes scientific studies, including

an examination of approaches used in other states and countries. The recommendations in this report represent the DNR's suggestions to further define and describe methods of determining protected flows and protection elevations. These recommendations are based on the DNR's assessment of available information, analytical tools and the practicality of applying them in Minnesota.

Recommendations

The recommendations in this report fall into three categories: 1) definitions to be added in statute; 2) integration of statutory provisions dealing with surface water and groundwater; and 3) approaches to determining the thresholds for streams, lakes, and wetlands.

Definitions

The following definitions are recommended to be added in statute:

- Negative impact to surface waters – in relation to water appropriations, a change in hydrology sufficient to cause ecosystem harm or alter riparian uses long-term.
- Ecosystem harm – in relation to water appropriations, to change the biological community and ecology in a manner that results in a less desirable and degraded condition.
- Sustainable diversion limit – in relation to water appropriations, a maximum amount of water that can be removed directly or indirectly from a surface water body in a defined geographic area on an annual basis without causing a negative impact to the surface water body.

Statutory changes

The DNR also recommends combining many of the provisions in section 103G.285, which deals with surface water appropriations, and 103G.287, which deals with groundwater, into a single "Water Appropriations" section. This revision would recognize the interconnected and interdependent nature of surface and groundwater resources while removing the circular references between the two sections of statute that make it difficult to identify and assess 'negative impacts.'

Approach to determining thresholds

A "threshold" is essentially the point at which negative impacts occur. Thresholds can be estimated based on data and scientific literature. Calculating thresholds at a statewide scale is not appropriate or practical, however, given the number of variables involved – e.g., which species or which riparian uses are negatively impacted. The diversity of Minnesota's surface water and groundwater resources, land use, and climatic factors would make a single number misleading and inappropriate for many locations and conditions. The precautionary principle would require that any such statewide threshold be set to be protective of the most vulnerable resource, thereby unnecessarily restricting water use in many areas. Therefore, the DNR proposes establishing specific thresholds for specific watercourses, water basins, watersheds, or hydrologic areas in those parts of the state where water use is at risk of causing negative impacts.

Streams: The DNR's research and a review of scientific literature indicate that a 20% change in hydrologic regime (relative to the August median base flow) will negatively affect the ecosystem, while a change less than 10% is not likely to be detectable. Setting a diversion limit of no more than 10% of the August median base flow will preserve the seasonal variability of the natural hydrology under all but the most extreme drought conditions. A 15% diversion limit would preserve much of the seasonal variability, but is not adequate to protect ecosystems during periods of drought. We recommend a 10% limit in most circumstances, but recognize a diversion limit of up to 15% may be appropriate in some areas where water uses are less dependent on a consistent supply.

Lakes: The DNR recommends an approach that establishes sustainable diversion limits for two categories of lakes.

Lakes connected to stream systems that outflow most of the time. For these lakes, the outflowing stream's diversion limit would be applied to the lake and a separate protection elevation for the lake would not be necessary.

Lakes with infrequent surface outflow. For these lakes, protection elevations specific to the lake could be established based on key considerations related to hydrology, ecology, and riparian uses. Water levels at and above the protection elevation are expected to maintain the characteristic hydrology, ecology, and riparian uses of the lake most of the time. Water levels below the protection elevation put one or more of the water body's resources or uses at risk. The protection elevation is used to establish the sustainable diversion limit.

Wetlands: Different types of wetlands have distinct and characteristic seasonal water levels that maintain their characteristic plant and animal communities. Most wetland types in Minnesota depend to some extent on groundwater for at least some part of the growing season. Some wetland types, such as fens, are highly connected to and dependent on groundwater, while others, such as floodplain forests, are more directly influenced by surface-water. However, as yet there is no systematic method for evaluating potential negative impacts on wetlands due to groundwater appropriations, due to limited wetland-related hydrologic data.

The DNR is proposing to establish a comprehensive wetland hydrology characterization and monitoring program statewide. An initial step in this process is to begin testing the feasibility of establishing target hydrographs for the various wetland types, with a particular focus on areas of the state experiencing a heavy demand for groundwater appropriation. A target hydrograph is a range of acceptable water levels throughout the year for each various wetland types, extending from "normal" levels to infrequent or rare low levels that stress the characteristic plant and animal communities. The target hydrograph would be used as a guide for developing allowable diversion limits throughout the growing season to maintain the characteristic hydrologic regime.

Impacts to wetlands are also regulated under other authorities, primarily the Minnesota Wetland Conservation Act and the Public Waters Permit Program. The DNR's goal under this approach would be to avoid wetland drainage that would trigger regulation under those programs.

Methodology

The DNR would focus its efforts to set thresholds for negative impacts primarily in those areas of the state where the intensity of groundwater use and/or scarcity of groundwater supplies is causing concern, such as the groundwater management areas or individual water bodies known to be negatively affected by groundwater use. In these areas, the DNR will implement the following steps:

1) establish negative impact thresholds for surface water bodies;
2) establish sustainable diversion limits that will maintain protected flows and protection elevations of those water bodies;
3) conduct groundwater modeling to determine the effects of groundwater withdrawals on the surface water bodies; and
4) assess to what degree individual groundwater withdrawals may need to be adjusted.

Applying this approach to water use permitting

Water users, whether they are public suppliers, agricultural irrigators, industry, businesses or golf courses, need reliability and predictability. Establishing negative impact thresholds and sustainable diversion limits should ultimately improve the predictability and consistency of water appropriation decisions. It should also reduce the need to modify permits during drought and thus allow water users to rely on a fixed quantity in most years, although extreme drought conditions extending over multiple years may still call for emergency water use restrictions.

Establishing negative impact thresholds and sustainable diversion limits is the first step in the process of allocating water resources among individual appropriators. Further discussion is needed as to how best to engage current and prospective water users in allocation decisions once we have determined the amount of available water in a given hydrologic area.

Minnesota's water appropriation statutes were formulated in an era when groundwater resources were viewed as essentially unlimited. Allocating water resources in an environment where those resources may in fact be limited calls for additional research and discussion. Our statutes and rules may need to be revised to provide better guidance. The DNR is currently researching potential models of water allocation systems used in other states and regions as part of this larger discussion.

Local governments also play a significant role in the water allocation process through their planning and land use controls, which help to determine the number and nature of residential, commercial, and industrial water users in a given community. In planning for future development, local governments should carefully consider the sustainability of their water supplies and the extent to which new water-intensive uses should be allowed or encouraged. A planning process that considers the needs of all water users, future needs, and opportunities for water conservation can help to sustainably manage existing and proposed water use.

Conclusions

- **Minnesota is in the "urgency room," not the "emergency room," in terms of water use management.**

- **The state's water management policies, statutes, and rules are strong and conceptually sound. However, the state's water management statutes could be improved by clarifying terminology and better recognizing the interconnected nature of surface water and groundwater.**
- **There is a strong scientific basis for maintaining the natural dynamic patterns of surface water bodies by establishing protected flows for individual streams, protection elevations for individual basins, and target hydrographs for wetlands.**
- **Over the next five years, the DNR intends to set protected flows, protection elevations, and target hydrographs for water bodies in places where demand for water may be exceeding sustainable supplies. The changes to statute recommended in this report would help support that work.**