Demand for Drinking Water

Aquifers and Water-Bearing Characteristics

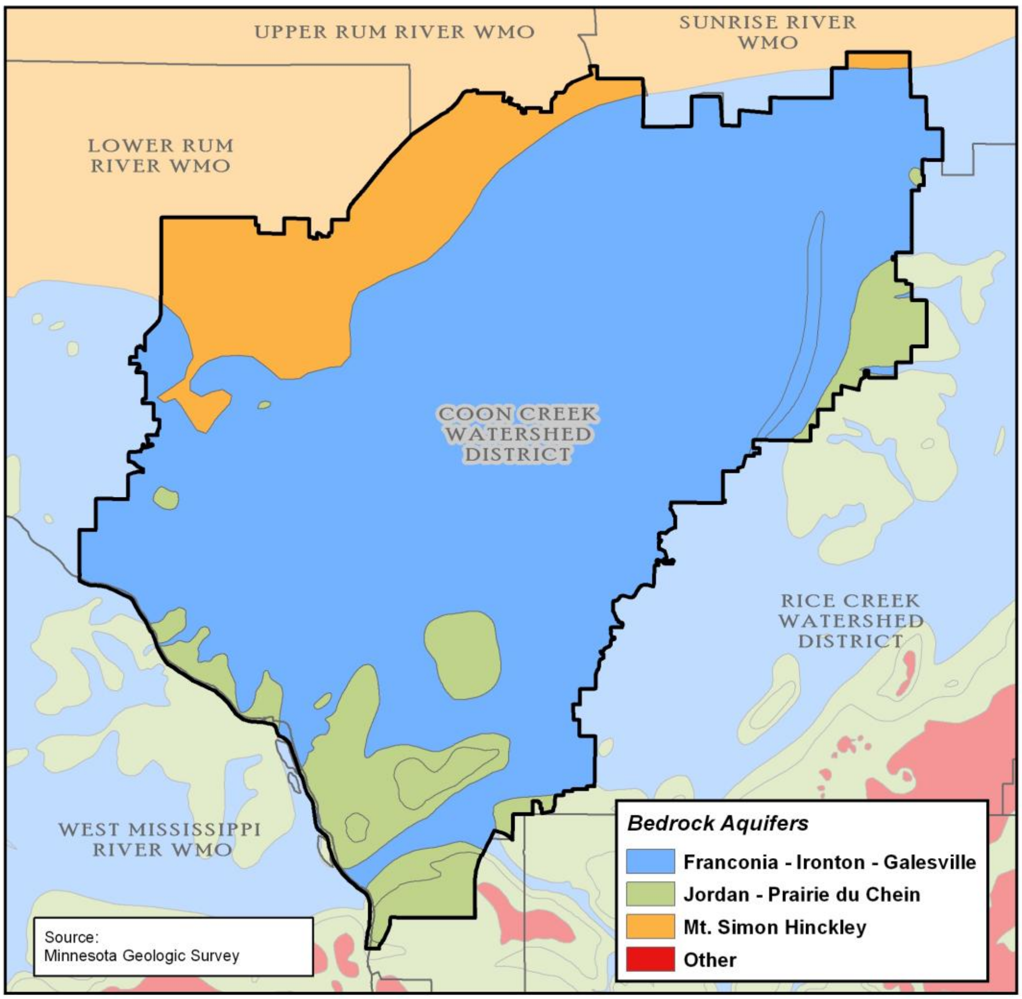
Four aquifers are considered to be capable of supplying substantial quantities of drinking water

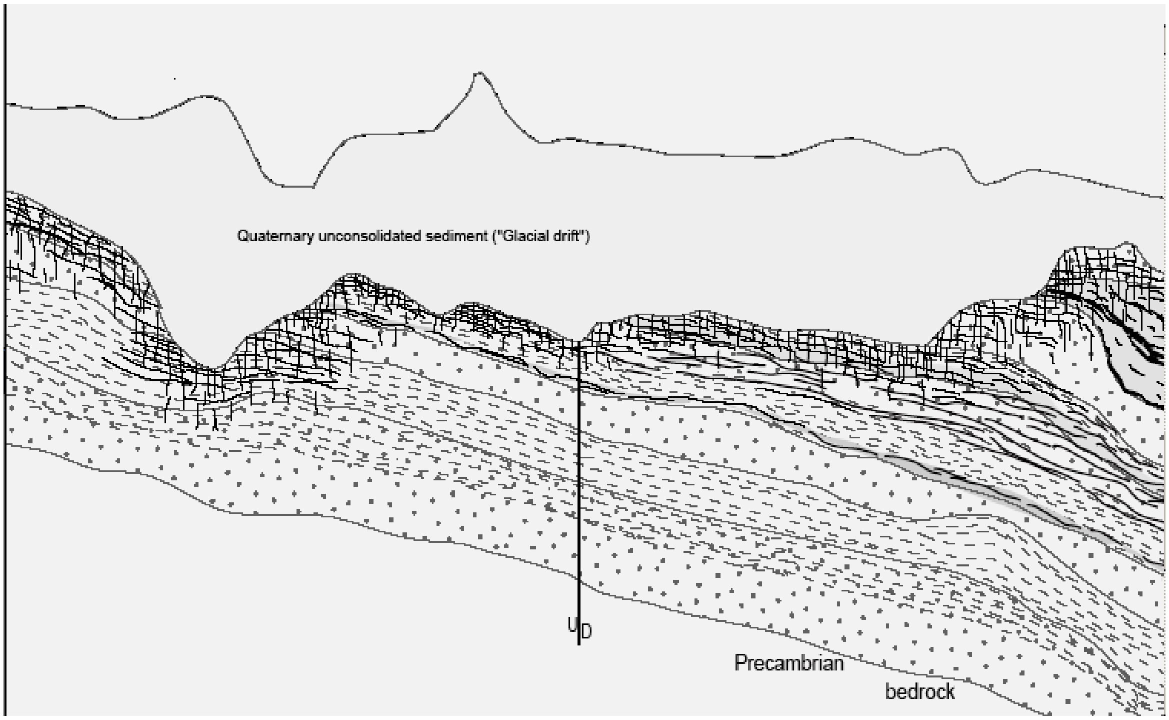
1. Drift
2. Jordan - Prairies Du Chien
3. Franconia- Ironton-Galesville
4. Mt Simon Hinckley

Drinking Water Availability

The watershed is fortunate to have a relative abundance of available groundwater. However, productive aquifers are not evenly distributed across the watershed

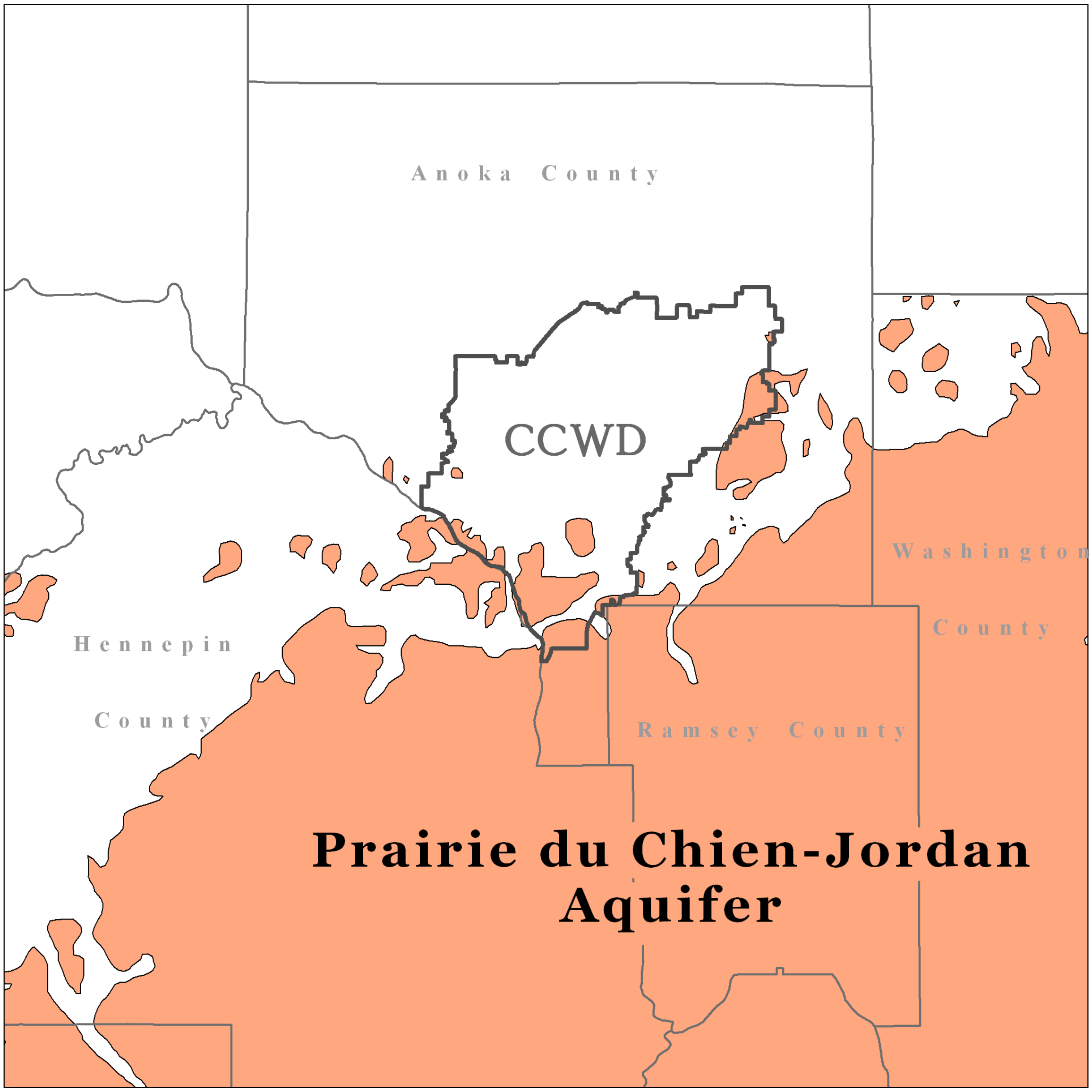
Distribution of bedrock aquifers within Coon Creek Watershed





Drift In addition to its own water supply potential, the Anoka Sand Plain Aquifer is important with regard to underlying aquifers. Underlying sand stone units form part of the northwestern flank of the Twin Cities artesian basin, from which large quantities of water are withdrawn. Direct hydraulic connection between the surficial bedrock aquifers occurs in some areas. Although the red-brown sandy till in much of the area forms the lower boundary of the surficial aquifer, it may be sufficiently permeable to permit a significant amount of vertical leakage to other aquifers below.

Jordan-Prairie Du Chien The Jordan Aquifer, in conjunction with the Prairie Du Chien, is the most heavily used water bearing and supply aquifer. The aquifer supplies approximately 80 percent of the groundwater used in the metropolitan area. The aquifer is 100 to 300 feet thick, is readily accessible, and can yield nearly 3,000 gallon per minute. The quality of the water is generally quite good, though hard, containing high amounts of dissolved minerals.



Franconia-Ironton-Galesville Aquifer

The Ironton-Galesville aquifer subcrops over approximately 2,400 acres of the watershed in Andover and Ham Lake. This aquifer has a transmisivity of 500 to 1500 feet squared per day in this region. It varies between 0 to 100 feet in thickness with an average thickness of 70 feet. The flow is from north to the south. Water yields in this aquifer range from 100 to 500 gallons per minute. Wells are commonly completed through to the underlying Mount Simon Hinckley.

Mount Simon-Hinckley Aquifer

The Mount Simon-Hinckley is the deepest aquifer in the watershed. The aquifer is typically viewed as a supplemental source of water to the Jordan. Well yields generally range from 200 to 700 gpm. This aquifer has been known to yield as much as 2,000 gpm. As with the Jordan, water in the Mt. Simon-

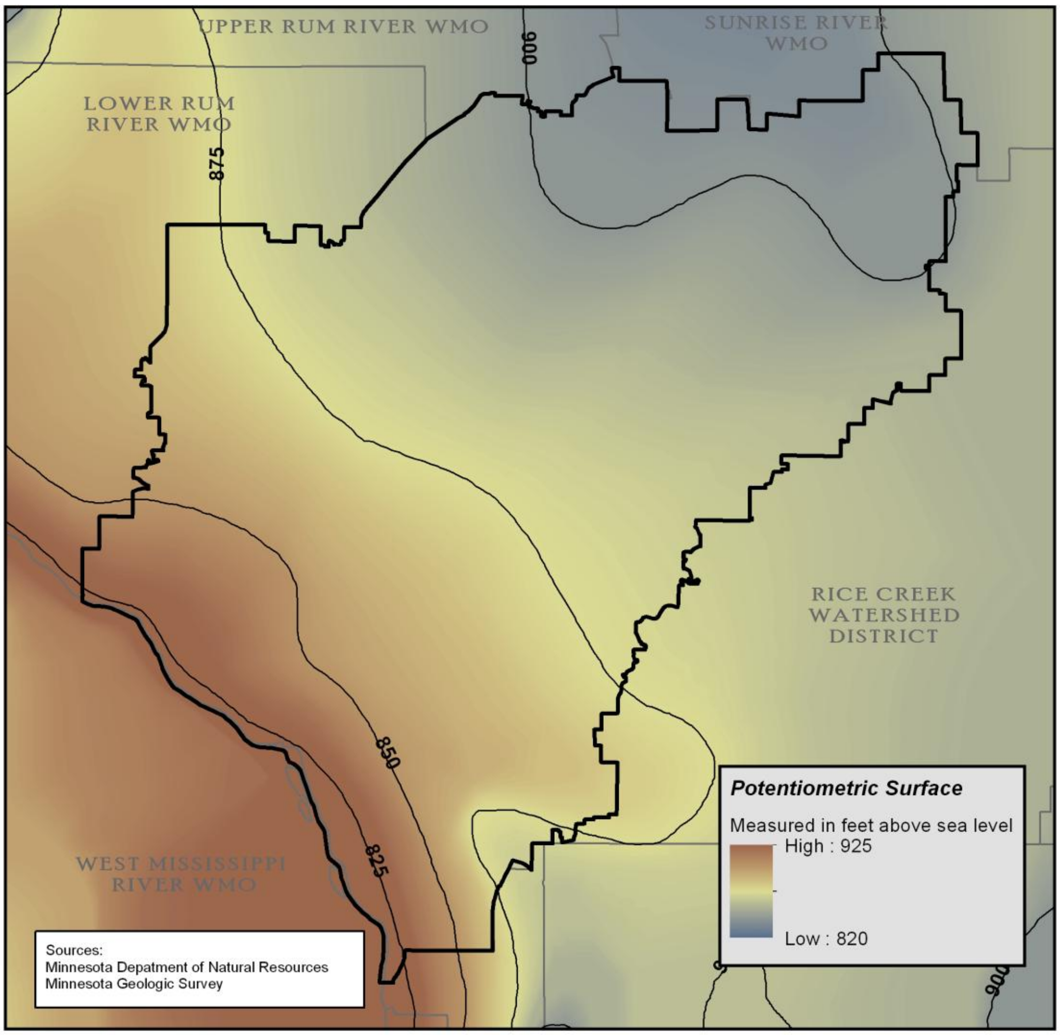
Hinckley is clean and hard, with locally high levels of iron and manganese.

The depth of this aquifer and its isolation by the Eau Claire formation confining layer has so far protected this aquifer from contamination. This aquifer is recharged to the north where the aquifer is the first bedrock encountered under glacial drift. The remaining recharge occurs through seepage downward through the confining Eau Claire sandstone unit.

Groundwater Availability and the Capacity to Provide Drinking Water

The watershed is fortunate to have a relative abundance of available groundwater. However, productive aquifers are not evenly distributed across the watershed

Potentiometric Surface

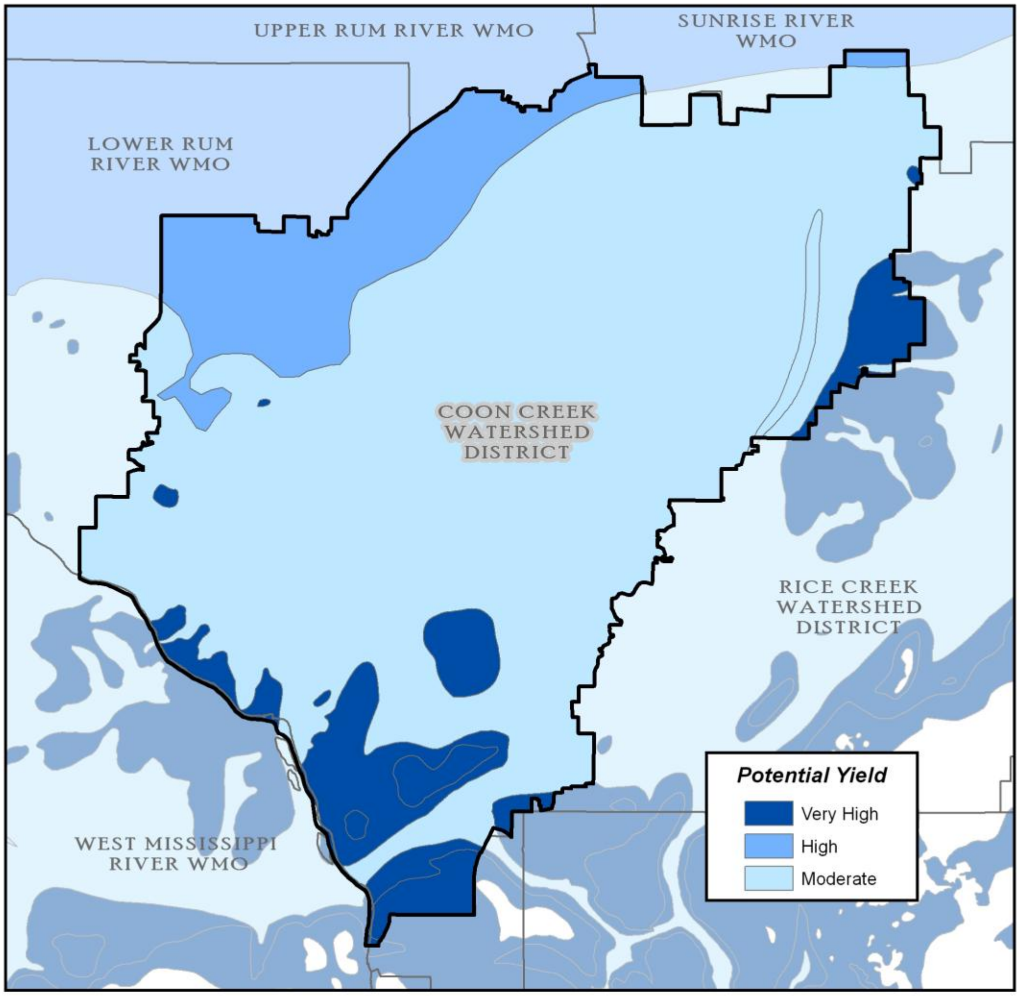


Water Yield

Water Source	Potential Yield	Yield (gpm)	Specific Yield (%)	Thickness (ft)
Drift	Varies		25%	150-250
Prairie Du Chien-Jordan	Very High	3,000	27%	180-325
Franconia-Ironton-Galesville	High to Moderate	100-500	20%	195-225
Mt. Simon-Hinckley	Very High	200-700	27%	145-165

Specific Yield is the quantity of water which a unit volume of aquifer, after being saturated, will yield by gravity; it is expressed either as a ratio or as a percentage of the volume of the aquifer; specific yield is a measure of the water available to wells.

Potential Yield of Bedrock Aquifers



Groundwater Quality

Precipitation that recharges the District groundwater supply percolates through the ground cover and enters the porous, chemically inert groundwater reservoir. The investigation of groundwater quality and its connection with land uses and surface water quality was the objective of the Clean Water Partnership study, conducted by ACD and the MPCA. The following table presents results from that study.

Quality of Shallow Groundwater

	Back ground	Peat	Residential	Urban

pH	-	7.39	7.92	7.91
Cl (ppm)	1.34	41.68	33.9	29.56
Fe(ppm)	24.19	4.26	0.51	0.25
K (ppm)	1.81	2.02	1.84	1.24
Na (ppm)	2.18	6.48	19.23	35.71
NO_2(ppm)	0.01	<0.01	<0.01	0.27
NO_3 (ppm)	0.01	<0.01	<0.01	12.25
TP (ppm)	0.64	0.21	0.04	0.03

*Data from CWP, 1997. Values represent mean concentrations from downstream sites.

Quality of Deep Groundwater

	Back ground	Peat	Residential	Urban
pH		7.84	8.01	8.2
Cl (ppm)	4.75	0.83	51.8	0.67
Fe(ppm)	3.19	2.39	0.73	0.44
K (ppm)	26.72	1.33	1.69	0.97
Na (ppm)	68.48	7.34	23.55	3.1
NO_2(ppm)	0.01	0.83	<0.01	<0.01
NO_3 (ppm)	0.01	<0.01	1.18	<0.01
TP (ppm)	0.7	0.36	0.16	0.15

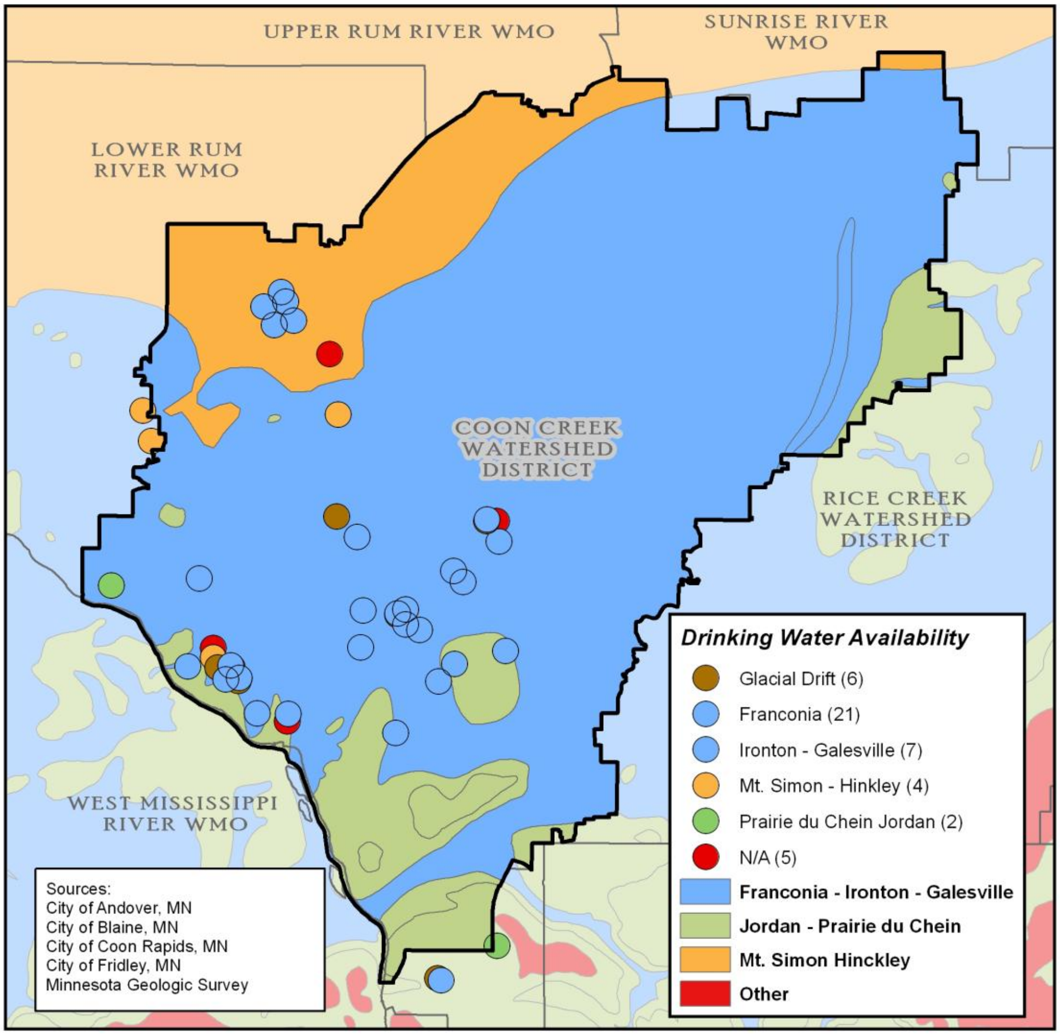
*Data from CWP, 1997. Values represent mean concentrations from downstream sites.

Current Provision of Drinking Water

Groundwater

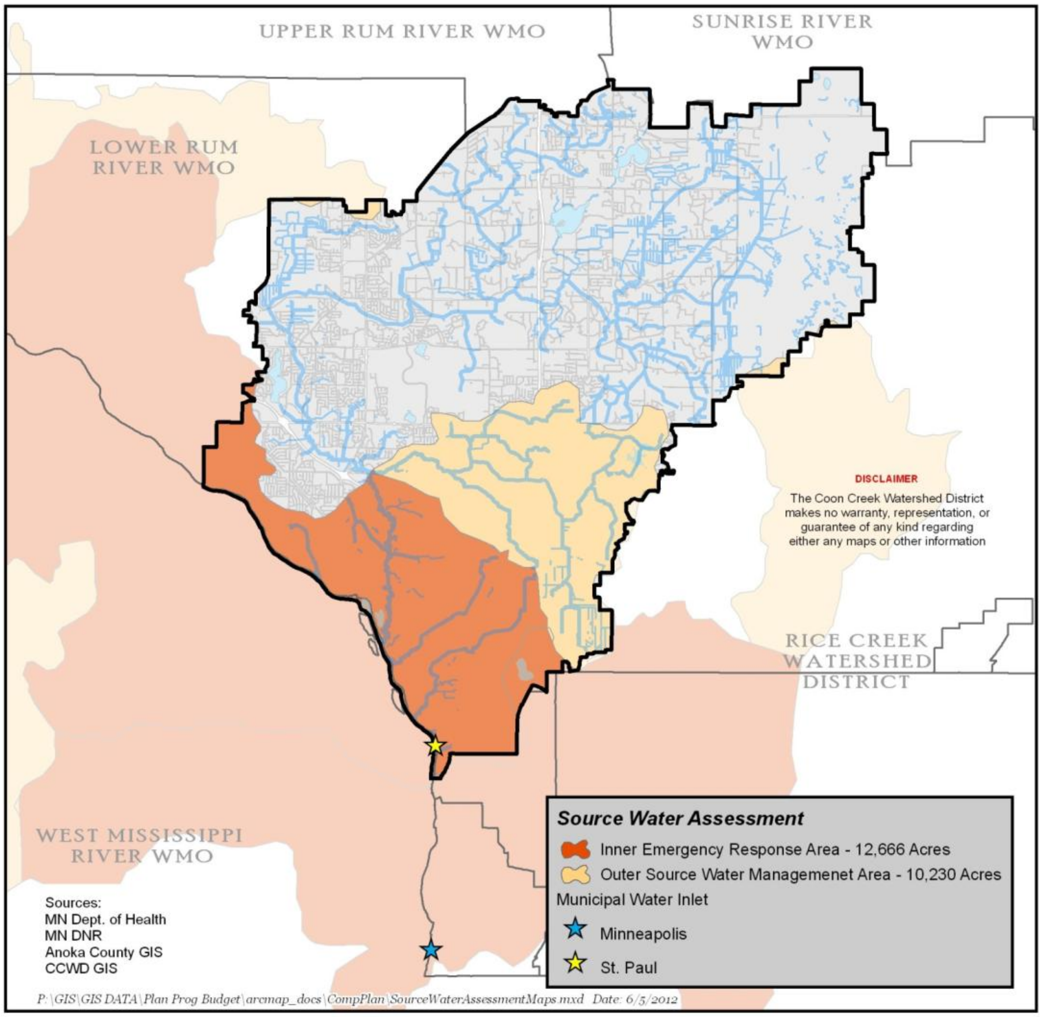
Water Source	Number of Wells	Current Use (MGD)	Percent of Current Use
Drift	8	7,750	12%
Prairie Du Chien-Jordan	8	7,775	13%
Franconia-Ironton-Galesville	37	39,910	62%
Mt. Simon-Hinckley	10	8,625	13%

Well distribution



Mississippi River

The Coon Creek watershed is directly upstream from the water intakes for both Minneapolis and St. Paul. The St Paul intake are within the District boundary



Value of Drinking Water

The factors that contribute to and affect the aggregate demand for drinking water within the Coon Creek Watershed are:

Population

	2000	2010	2020	Pct Chg
Andover	17,450	21,188	27,188	28%
Blaine	46,845	60,643	71,943	19%
Columbus	479	508	623	23%
Coon Rapids	62,295	65,700	66,000	0%
Fridley	27,449	27,000	26,900	0%
Ham Lake	11,782	15,017	16,686	11%
Spring Lake Park	7,090	6,710	6,710	0%
Total	173,390	196,766	216,050	10%

Projected Average Daily Water Use (mgd)

	2004	2010	2020	Change
Municipal	20.730	23.486	24.577	5%
Private	3.045	3.095	3.116	1%
Non-Municipal	2.757	2.709	2.709	0%
Total	26.532	29.290	30.402	4%

Metropolitan Council 2007

Service Preferences

Reflects the preferences expressed in a survey of citizens, City Engineers and water resource professional conducted in April and May of 2011.

In April and May 2011 29 citizens, engineers from the seven cities within the watershed and water resource professionals who are members of the ‘planning advisory committee’ were administered a paired comparison survey of the beneficial uses of and the demands on water resources.

Drinking water was ranked the most important and most valuable use of water by all three groups

	Citizens	City Engineers	Water Professionals	National
Drinking water	**1**	**1**	**1**	**1**
Water Quality	2	2	2	2
Flood Control	2	2	3	5
Groundwater Recharge	4	4	4	7
Storm Protection	6	5	6	6
Drainage	5	8	7	8
Aquatic life and recreation	**8**	**8**	**5**	**9**
Hunting and Fishing	**8**	**8**	**9**	**10**
Irrigation	9	9	10	4
Livestock and wildlife watering	10	10	8	11
Aesthetics	11	11	11	12
Industrial use and cooling	13	13	12	3

Cost to Use

At present the cost of using groundwater is low.

Costs are simply the financial outlay involved with well-drilling, placing the pump and the operating and maintenance costs of pumping and distributing the water.

The economic cost, however, is significantly larger. Groundwater appropriated from the sources utilized within the watershed are non-renewable within the practical time frames of municipal and private use. The current arrangement of pricing rewards over appropriation and waste of a non-renewable resource through block pricing, where the marginal price decreases as the volume of water utilized increases. The result is in essence mining of the resource, making water unavailable for other uses in both the short and long term.

Available Substitutes

The Cities of Coon Rapids and Fridley do have a natural substitute for potable groundwater in the form of the Mississippi river.

While the capital investment would be substantial, the river provides an alaternate supply once the water is pumped and treated

Ease of Adopting Substitutes

Adopting substitutes for groundwater would probably be difficult. In addition to the size of the initial capital investment, the demands and regulations on the Mississippi river would require the cities to commence actions with significant lead time to ensure uninterrupted service.

Marginal Value of Drinking Water At present the marginal value of each gallon or acre feet of water appropriated within the watershed is low.

Groundwater is a common-pool resource i.e., while one entity's use of groundwater may preclude another's, it is very difficult to effectively exclude individuals from using it. This applies to consumptive as well as non-consumptive uses.

Risks and Impairments to Drinking Water and Water Supplies

An adequate water supply is a necessity for any home or city. The source must provide quality water at a constant and dependable rate. Groundwater supplies 100 per cent of public drinking water within the watershed for both domestic use and livestock and wildlife watering.

Risks of disruptions to drinking water differ from site to site and are associated with the exposure and vulnerability of the water supply.

Uncertainty in meeting the projected demand in an area generally corresponds to:

- Areas lacking in productive aquifers
- Groundwater/surface water interdependence
- High susceptibility to contamination

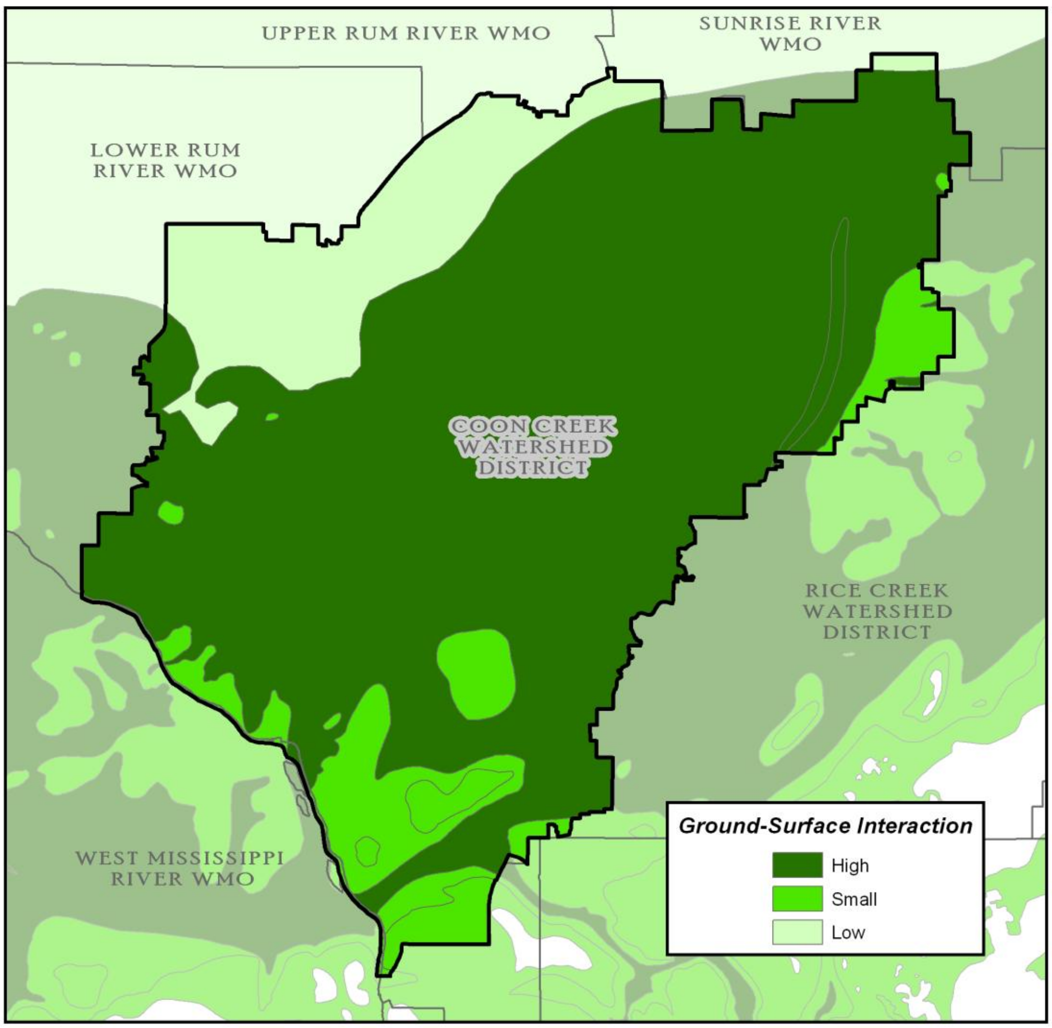
Climate Change The Coon Creek watershed has experienced an increase in temperature over the past two decades. Increasing temperatures have a direct impact on water resources and cause a decline in water supply availability and higher drought risk; changes in precipitation and precipitation patterns; decrease in snow pack, runoff, and streamflow and increased evapotranspiration. Warmer temperatures also increase water demand due to warmer temperatures and population growth coupled with the afore-mentioned impacts, adequate water supplies for future uses and generations remain uncertain.

Areas Lacking In Productive Aquifers The watershed is fortunate to have a relative abundance of available groundwater. However, productive aquifers are not evenly distributed across the watershed

Groundwater/ Surface Water Interaction The fresh groundwater in the unconsolidated formations of the watershed is derived largely from precipitation over the outcrop areas (Helegesen 1977). Rainfall lost to evapotranspiration has been estimated at 79 percent (Corrigan 1991). An additional 16 percent is lost to overland flow, leaving 5 percent for recharge. (Enviroscience 1983, USGS 1985)

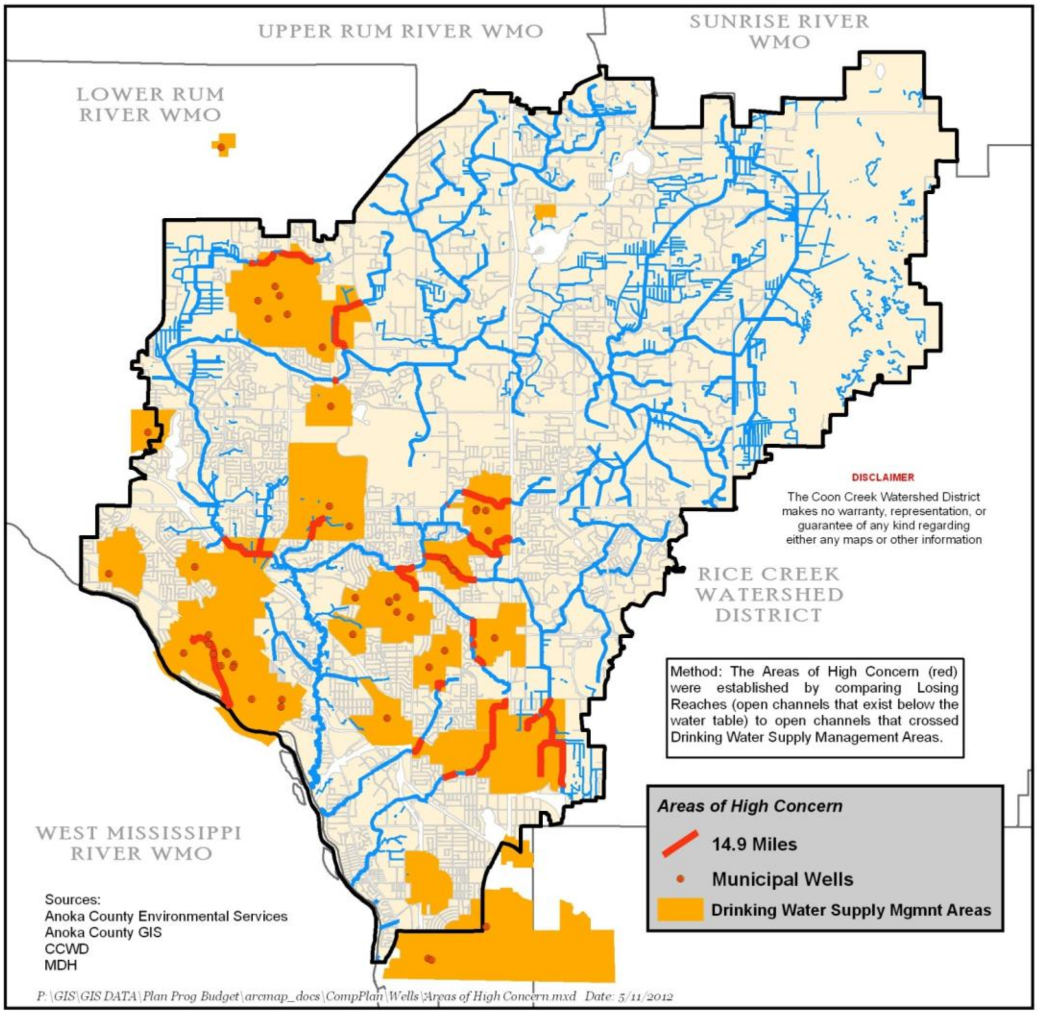
Since rainfall averages 30 inches per year in the watershed, approximately 1.5 inches per year (23.9 mgy) is potentially available to recharge the surficial groundwater reservoir.

Water Source	Ground x Surface interaction
Drift	Very High
Franconia-Ironton- Galesville	High
Prairie Du Chien-Jordan	Small
Mt. Simon- Hinckley	Low



Surface Water Effects on Water Supplies

Areas where the drainage system of Coon Creek are losing reaches within drinking water supply management areas is shown below. These ditch segments are potentially concentrating and transmitting surface pollutants to drinking water.

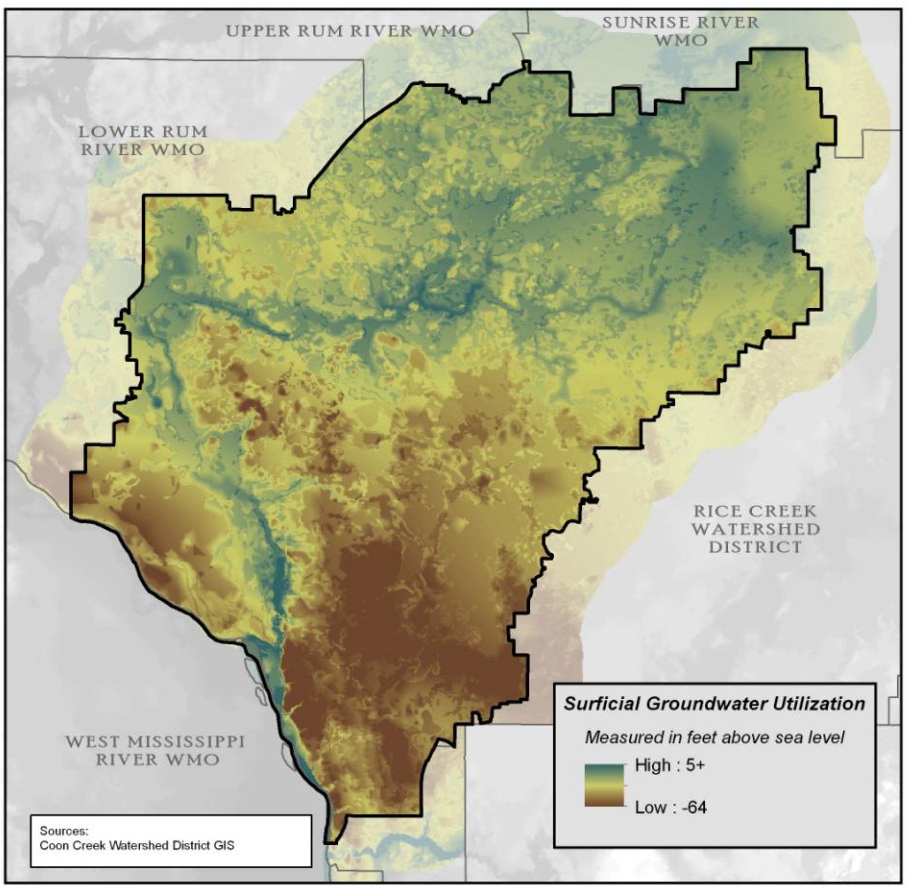


Groundwater Recharge/Over Appropriation

The ultimate source feeding groundwater is precipitation. Actual aquifer recharge rates are not well quantified within the watershed which leads to uncertainty in assessing sustainable withdraws.

Over appropriation is the result of removing water at a rate and or volume faster than the aquifer can supply. In cases where a water source takes 100 of years to recharge, appropriations are an irreversible withdrawal.

Water Source	Horizontal Conductivity (K)(ft/d)	Horizontal Migration	Vertical Migration
Drift-Local Water Table	1.61-137.14	Impeded by small pore space of clays	Low-Limited by low permability of underlying clays
Prairie Du Chein-Jordan	1-40	Due to joints, fractures and solution cavities	
Franconia-Ironton-Galesville	7-11	Due to pores and bedded plane fractures	
Mt. Simon-Hinkley	5	Medium to coarse grained quartzose sand stone embedded with pebbles overlaying shale and mudstone	



Susceptibility to Contamination

The surface, unconsolidated sands can hold a vast quantity of water. Significant pollution sources, actual or potential, include

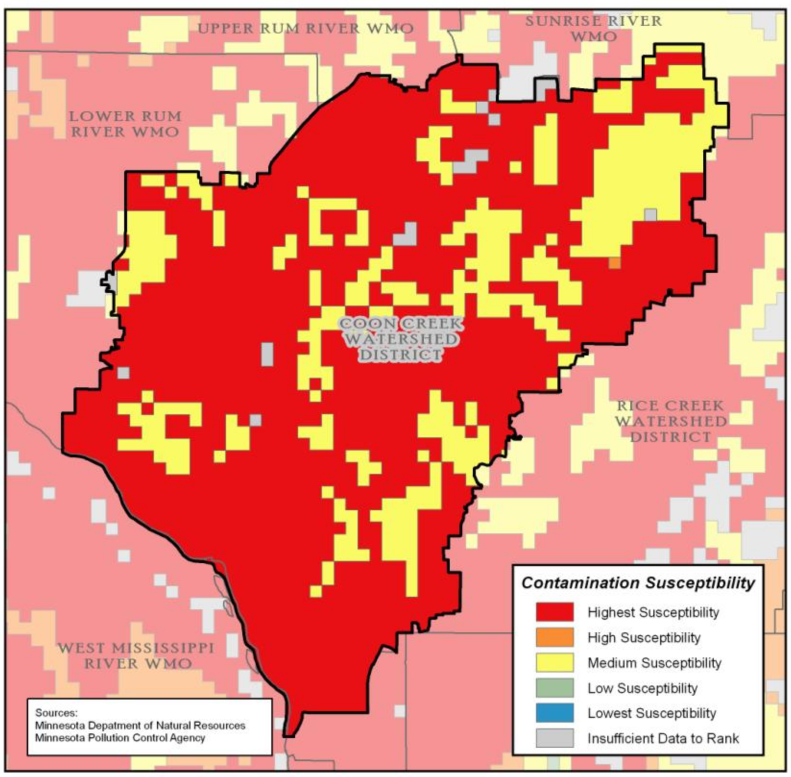
- septic tanks
- landfills
- chemical spills and dumping
- chemical storage leaks
- Highway deicing
- Agricultural chemicals.

These sources may have immediate local impacts and may also pose long-term, cumulative threats.

Pollutants detected in groundwater that could be harmful to humans or animals should they rise to inappropriate levels include:

- Bacteria
- Chloride,
- Nitrate, and
- Crop protection chemicals

It is estimated that 60,000 people reside in the unsewered portions of the watershed, producing 4.5 mgd of sewage and 6.6 million gallons per year of septage (septic tank pumpage).



Water Source	Vulnerability
Drift	Very High
Franconia-Ironton- Galesville	High
Prairie Du Chien-Jordan	Moderately Low
Mt. Simon- Hinckley	Low

Well Interference Well interference occurs when high capacity wells influence other wells causing reduced productivity or limitations on the ability to withdraw/appropriate water from a given aquifer.

Expected Service Level

Most of the watershed has adequate water supplies to meet the current and projected demand for drinking water. Work done by the Metropolitan Council indicates that supplies within the City of Blaine to be “uncertain”.

Projected Demand for Drinking Water (MGD)

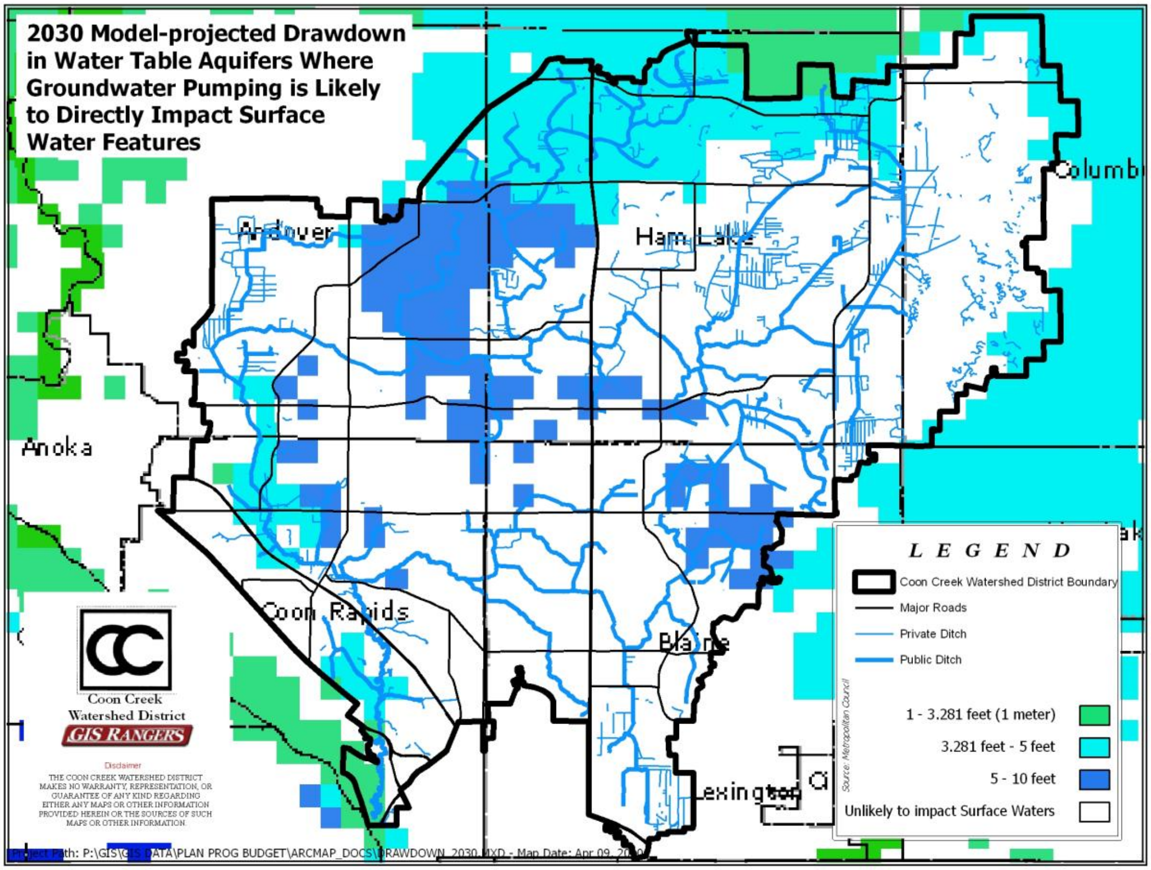
	2010	2020	Pct Chg
Andover	2.5-5.0	2.5-5.0	0%
Blaine	5.0-10.0	10.0-20.0	100%
Columbus	0.4-0.8	0.4-0.8	0%
Coon Rapids	5.0-10.0	5.0-10.0	0%
Fridley	2.5-5.0	2.5-5.0	0%
Ham Lake	1.5-2.5	1.5-2.5	0%
Spring Lake Park	0.4-0.8	0.4-0.8	0%
Total	17.3-34.1	22.3-44.1	29%

Externalities

Loss of Groundwater Driven Surface Water Features If surficial groundwater levels continue to fall between 2010 and 2020, surficial water features, such as

a. Lakes (decline of 50% surface area)
b. Wetlands (8,375 acres)
c. Base Flow

will be difficult to protect and sustain in the areas shown below:


2030 Model-projected Drawdown in Water Table Aquifers Where Groundwater Pumping is Likely to Directly Impact Surface Water Features
Andover
Ham Lake
Anoka
Coon Rapids
Blaine
Lexington
LEGEND
Coon Creek Watershed District Boundary
Major Roads
Private Ditch
Public Ditch
1 - 3.281 feet (1 meter)
3.281 feet - 5 feet
5 - 10 feet
Unlikely to impact Surface Waters
Source: Metropolitan Council
Coon Creek Watershed District
GIS RANGERS
Disclaimer
THE COON CREEK WATERSHED DISTRICT MAKES NO WARRANTY, REPRESENTATION, OR GUARANTEE OF ANY KIND REGARDING EITHER ANY MAPS OR OTHER INFORMATION PROVIDED HEREIN OR THE SOURCES OF SUCH MAPS OR OTHER INFORMATION.

Blaine "Uncertainty"

The Met Council study indicates that the 'uncertainty in meeting the projected demand in an area generally corresponds to:

- Areas lacking in productive aquifers
- Groundwater/surface water interdependence
- High susceptibility to contamination

Potential Impacts on Surface Water Contribute to Drinking Water Uncertainty in Certain Areas

If the Metropolitan Council projections are correct, the watershed will experience a loss of almost 52% (8,400 acres) of surficial water and related land resources by 2030.

The District estimates that there will be an additional impact (either through conversion of wetland type or lower lake levels) to an additional 2,000 acres (approx 12%)

Drinking Water Management Needs

To protect groundwater in the well head area, there are many Best Management Practices to choose from. Start with proper siting and locations of wells and potential contaminants such as manure storages, fertilizer, fuel and pesticide storages, septic systems and maintenance shops. Proper maintenance of these facilities and management of the nutrients, pesticides and fuels will help reduce groundwater contamination. Wells need managing too - they may require repair, upgrading, replacement or proper abandonment.

Integrate Drinking Water into Existing Water Management Program

To manage Watershed District water resources for multiple-uses by balancing present and future resource use with domestic water supply needs

1. Identify minor sub-watersheds providing water within the drinking water supply Management Area as defined in the City's well-head protection plan or 1 year travel time of municipal and other public wells and water supplies during land management planning.

2. Develop prescriptions on a case-by-case basis to ensure desired multiple-use outputs while recognizing domestic water supply needs.

3. Determine increased costs to cities and homeowners associations of any unusually restrictive practices required to meet state-approved Best Management Practices for protection of drinking water; identify any revenue losses from applying such restrictions.

Support Anoka County Geologic Atlas

Anoka County, The WMOs within the county and several cities have contributed money for the development of a geologic atlas for the County. The District needs to continue to support the development of this Atlas and encourage digitizing the data associated with the Atlas.

Show Municipal Water Supply Areas as Special Management Areas

Show municipal water supply areas as 'special management areas' in the Comprehensive plan when management intensity and timing differs from other areas. Watershed plans shall include:

1. A statement of objectives for managing the water resources on and flowing from the watershed. Include quality, quantity, and timing criteria for the water resource.
2. Guidelines for protection, management, use, and development, together with coordinating requirements for other uses and activities within the watershed.
3. Guidelines for monitoring uses, activities, and water quality characteristics that may be affected by watershed management activities.
4. An assessment of the contribution that should be made by the water-user toward management efforts, including such activities as operating a water-quality monitoring system and patrols needed to enforce any use restrictions.

Notices of Restrictions

1. Inform the public of use restrictions imposed on municipal water supply and reasons for restrictions.
2. Include use restriction clauses in all permits, or other documents authorizing use within the watershed.
3. Designate restricted municipal water supply areas on maps prepared for public use.

Conservation Water Fees

Extensive water use for public water supply, irrigated agriculture, and periodic droughts has led to a significant decline in surficial aquifer levels in some areas of the watershed, and lowered lake and wetland levels and spring discharges throughout the Anoka Sand Plain.

Water conservation is seen as the most important action we can take to sustain our water supplies, meet future needs, and reduce demands on the District's fragile water-dependent ecosystems such as lakes, streams, and wetlands.

The District will work with cities to develop strategies and implementation plans. A significant opportunity exists here to work with and educate decision makers on the need and benefits for water harvesting and reuse.

Currently, the State of Minnesota, Metropolitan Council and some cities encourage public water suppliers to implement such water conservation measures as:

- adoption of local irrigation and landscaping ordinances,
- leak detection,
- public education, and
- conservation-based water rates.

A focus on conservation-based rates (also referred to as "conservation rates," "conservation-oriented rates," or "demand management pricing") is needed. Below, are criteria used to design and evaluate conservation-based rates, consider alternative rate structures, and some of the challenges posed by conservation-oriented rates for utility companies.

Conservation-oriented water rates are aimed at stimulating water use efficiency and conservation through economic incentives, specifically through water price signals. American Water Works Association suggested four criteria to design and evaluate a conservation water rate structure. Three of the criteria are discussed here:

1. The structural form of the rate;
2. The proportion of utility costs that is recovered through fixed versus commodity charges; and
3. Effective communication of the price signal through consumer billing.
4. The fourth suggested criterion is relevant only for public-sector utilities and is not listed here: the extent to which the cost of the utility service is covered through user fees as opposed to other sources, such as taxes or general funds transfer

Increase Groundwater Recharge

Groundwater recharge plays a critical role in the hydrology of the surficial aquifer of the watershed and is strongly encouraged by MPCA.

Recharge is a long-established and effective water management tool that allows renewable surface water supplies to be stored underground now for recovery later during periods of reduced water supply.

The District's Recharge/Infiltration Program and standard was established with the principal goal of protecting the economy and welfare of the District by managing the reliability of its most valuable resource …water. The water management benefits of recharge are numerous and include the following:

- Encourages the use of renewable water supplies instead of continued over-reliance on finite groundwater supplies;
- Mitigate impacts of groundwater overdraft including subsidence and increased power costs for pumping water from greater depths;
- Firms the District's water supply by providing a "reserve" of water that may be recovered during prolonged drought;
- Water stored underground eliminates the need to construct costly surface reservoirs that are prone to excessive evaporation;
- Provides an alternative mechanism to deliver water through recharge and recovery instead of constructing costly water treatment plants and distribution facilities;
- The quality of recharged surface water is improved by filtration through underlying sediments in a process known as soil aquifer treatment.

Decrease Waste of Groundwater

Timed residential and commercial irrigation units often run when it is raining or when soil and plant conditions do need additional water. The result of waste of a resource that is in essence non-renewable.

Drip or trickle irrigation technology plus mulching is very water efficient combination: only the root zone of growing crop is watered and the mulch reduces evaporation.

Estimate Groundwater Storage and Supply within the Watershed

Water stored underground eliminates the need to construct costly surface reservoirs that are prone to excessive evaporation. However the amount of water stored is unknown. The approximate capacity needs to be known for rational public service and facilities planning

Support Proper Abandonment of Unused Wells

Unused wells are safety hazard and pose a risk to groundwater quality. They should be properly plugged and sealed.