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1. Master Water Supply Plan Overview

Introduction

The Twin Cities seven-county metropolitan area is home to over half of Minnesota's population. Securing safe and plentiful drinking water for them, while protecting the region's diverse water resources, requires coordinated, interdisciplinary and ongoing effort. Balancing the region's many competing needs of the region's many users is a challenge.

Population growth and expanding development are increasing demands on our water supplies in the region. Coordinated planning by local communities, the Metropolitan Council, and state partners will help meet our future water supply needs.

The Metropolitan Council Environmental Services division provides wastewater services and integrated planning to ensure sustainable water quality and water supply for the region. The role of the Metropolitan Council in water supply planning is to:

1. Work with regional partners to develop a regional plan
2. Maintain a database of technical info
3. Provide assistance to communities in developing their local water supply plans
4. Identify approaches for emerging issues

The region's Master Water Supply Plan provides communities in the region with planning assistance – including guidance and tools - for water supply, so that they can take the most proactive, cost effective approach to long term planning and permitting to ensure plentiful, safe, and affordable water that supports the prosperity and livability of the region for future generations.

The Metropolitan Council is not a water supplier and has no intent to take over local water supply systems. The regional planning process has been designed and applied to ensure local water suppliers have control of and responsibility for their water supply systems.

This chapter discusses the need for and benefits of regional water supply planning and provides a summary of the Master Plan, including what it means for local plans to reflect this Master Plan. Subsequent chapters provide details about the goal, water use, sources, issues, desired outcomes, implementation strategies, and roles and responsibilities.

Rationale for regional water supply planning

The Twin Cities metropolitan area is endowed with a relative abundance of high-quality ground and surface water, which supports over half of Minnesota's population and a thriving economy. Three major rivers, vast underground aquifers, and 950 lakes make us the envy of urban areas the world over.

The Metropolitan Council recognizes the responsibility and authority of local water suppliers to provide water. A regional perspective is also important, because the effects of local water supply decisions don't stop at community boundaries – there are cumulative effects on water supply sources and connected resources.

The Metropolitan Council forecasts that the region will add about 800,000 residents over the next 25 years. A pressing concern is the impact that future development might have on the reliability and availability of the region's water supplies.

The region's water supplies are not limitless, and activities within the region can affect water quality and quantity. Regional water supply planning can help to address issues such as regional and subregional groundwater declines, localized water shortages, contamination, and negative impacts on surface waters and help the region prepare for events such as drought. For example, in parts of the region, groundwater levels are declining. In some areas, it has lowered lake and wetland levels and impacted waterways and this has the potential to affect many more with increasing demands on our groundwater resources.

The development of this plan is not motivated by widespread water shortages or crises. Rather, this plan is a response to the recognized benefits of developing and maintaining a plan that supports current and future populations without adverse impact to natural and economic resources.

Water is livability

Water is vital to the region's present and future quality of life. It is key to our image of who we are as Minnesotans and what we want for our children.

Quality of life surveys repeatedly identify water-related features – parks, trails, beaches, etc. – as the region's most attractive features. Seventy-eight (78%) of the 2012 Residents Survey respondents considered water supply and water quality monitoring to be very important Council programs and responsibilities.

Water is prosperity

Water is vital to the region's present and future prosperity. Every sector of the region's economy is influenced by water – agriculture, manufacturing, mining, travel and lodging, and services. When critical water demands are met, health and economic impacts are avoided.

Minnesota ranks ninth in the number of Fortune 500 companies per capita by state (and third in the number of Fortune 500 *headquarters* per capita, after Washington DC and Connecticut), and those companies rely on stable water supplies. Four of them are the largest customers of a public water supply. Three of the metro area's Fortune 500 companies each have water permits to use more than 1 billion gallons of water a year. .

Benefits of the metropolitan area water supply planning process

With the Master Plan, communities are better able to take the most proactive, cost effective approach to long term planning and permitting to ensure plentiful, safe, and affordable water for future generations.

The Master Plan recognizes local control and responsibility for water supply systems; the plan supports this work by providing planning assistance to connect growth planning coordinated by the Metropolitan Council with water supply permitting conducted by the Minnesota Department of Natural Resources.

Benefits of the Master Plan include:

Regional perspective informs local planning. Water does not follow political boundaries, and water use decisions can have impacts that extend across multiple jurisdictions. The Master Water Supply Plan provides a perspective and tools to help develop and implement local plans that support sustainable water supplies across the region.

Better data, better analyses. The specific water supply sources and associated regional and local issues identified in this plan are supported by analyses based on the best available regionally consistent data and tools, such as the DNR water use database and regional groundwater flow model

(Metro Model 3). This regional approach to water supply assessment objectively highlights potential problem areas and thus reduces the likelihood that water supply problems will develop "under the radar".

Clearer and more consistent guidance for the permitting and approval process. The regional and local issues identified in this plan were assessed in close cooperation with the Minnesota Department of Natural Resources (DNR), and issues relevant to each community are outlined in the community's water supply profile in Appendix 1. When a community's local water supply plan reflects this Master Plan and the local plan is approved then, as long as requested water appropriation permit actions are consistent with the local plan, permits are more likely to be granted.

Economies of scale. This plan helps communities realize economies of scale in multiple ways. With a focus on working with partners to develop tools and other resources, costs associated with resource assessment may be reduced or eliminated; publicly available and regionally consistent data is provided as part of this plan. Additional resources, including Metro Model 3 and the Conservation Toolbox, are also provided. As development expands and demand increases, opportunities for interjurisdictional partnerships will, too. Continuous updating of technical analyses will identify such opportunities for cooperation to supply water in both the short and long term.

Mandate for Water Supply Planning from Minnesota Legislature

Public Water Supply Plans

A water supply plan is required for all communities within the metropolitan area with a municipal water supply system, as a required element of the local comprehensive plan (Minn. Stat., Sec. 103G.291).

A water supply plan template has been jointly developed by the Minnesota Department of Natural Resources and the Metropolitan Council. Completing the template fulfills multiple statutory obligations including:

- Minn. Stat., Sec. 103G.291 to complete a water supply plan including demand reduction
- Minn. Stat., Sec. 473.859 to address water supply in local comprehensive plans
- Minn. Administrative Rules 4720.5280 to address contingency planning for water supply interruption

Communities without public water supplies do not need to prepare a water supply plan, but should include information about plans to protect private water supplies in appropriate sections of the local comprehensive plan.

Communities and utility boards adopt the water supply plan, if one is required, along with the local comprehensive plan.

Comprehensive Plan Content

Under the Metropolitan Land Planning Act (Minn. Stat., Sec. 473.859), local governments must review and update their local comprehensive plans every 10 years, including an implementation program that describes public programs, fiscal devices, and other specific actions to be taken to implement the comprehensive plans. The implementation plan shall contain at least the following parts:

1. A description of official controls, addressing at least the matters of zoning, subdivision, **water supply** and private sewer systems, and a schedule for the preparation, adoption, and administration of such controls;

2. A capital improvement program for transportation, sewers, parks, **water supply**, and open space facilities; and
3. A housing implementation program, including official controls to implement the housing element of the land use plan, which will provide sufficient existing and new housing to meet the local unit's share of the metropolitan area need for low and moderate income housing. (Minn. Stat. 473.859, subd. 4)

Water Supply Planning Activities and Advisory Committee

The Metropolitan Council has provided technical assistance and planning studies to support community water supply planning for several decades, but it wasn't until 2005 that the Minnesota Legislature specifically directed the Metropolitan Council, under Minn. Stat., Sec. 473.1565, to:

> "carry out planning activities addressing the water supply needs of the metropolitan area,"…[including] development and maintenance of technical information; recommendations for clarifying roles, streamlining decision-making and approval processes, and funding; and the development of a Twin Cities Metropolitan Area Master Water Supply Plan... that:
>
> - Provides guidance for local water supply systems and future regional investments;
> - Emphasizes conservation, interjurisdictional cooperation, and long-term sustainability; and
> - Addresses the reliability, security, and cost-effectiveness of the metropolitan area water supply system and its local and subregional components."

The same legislation also created a Metropolitan Area Water Supply Advisory Committee (MAWSAC) representing state agencies, counties, municipalities, and utilities. Members were appointed by the Governor, and the membership is defined in statute. MAWSAC members provide guidance to local water supply planning efforts in accordance with the Master Water Supply Plan.

The Metropolitan Council is also guided by a variety of local stakeholders through several sub-regional water supply work groups established to provide input on the scope and results of sub-regional water supply studies.

Developing and Updating the Master Water Supply Plan

The Metropolitan Council strives for collaboration, integration, and accountability in all its work. These guiding principles have shaped how the Master Water Supply Plan was developed and updated.

The process for developing the 2010 Master Plan began in 2006 with a series of public meetings and workshops, guided by the Metropolitan Area Water Supply Advisory Committee. Public meetings were held regularly throughout the process to get input from city planning and utility staff, elected officials, and other interested people. Progress reports were provided to the Minnesota Legislature in 2007, and a formal public review period occurred in 2009. The Master Plan was approved by the Metropolitan Council in March 2010, and the DNR Commissioner approved the plan in July 2010.

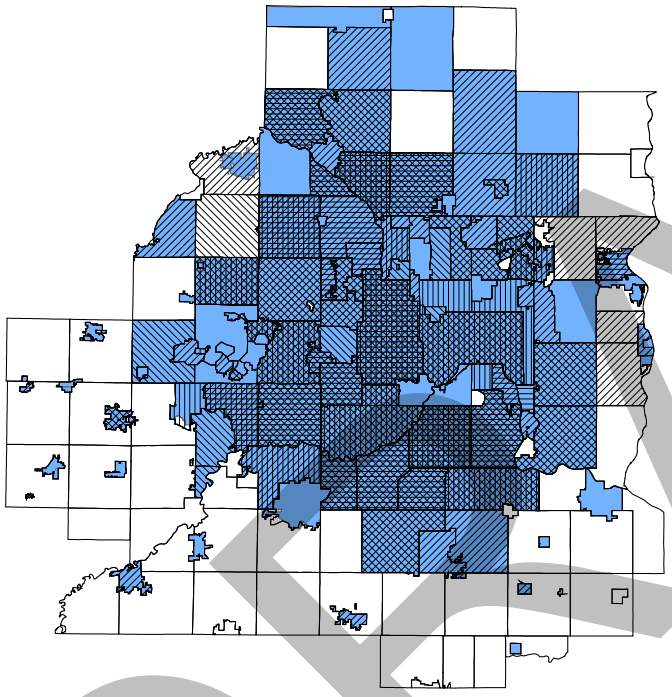
After completing the Master Water Supply Plan in 2010, the Council partnered with state agencies, private consultants and communities to complete several technical and outreach projects that strengthen regional and local water supply planning efforts, including better integration of water supply planning and local comprehensive planning.

The 2015 update of the Master Water Supply Plan incorporates new technical information and feedback from many stakeholders, and it reflects changes to the regional development framework, *Thrive MSP 2040,* and the *Water Resources Policy Plan*. Stakeholders were engaged through:

- Metropolitan Area Water Supply Advisory Committee presentations and discussion
- Community Technical Work Group presentations and discussion
- Public meetings (over 170 attendees representing more than 70 communities)
- Ad hoc community meetings (45 attendees representing over 32 communities)
- One-on-one discussions, including data sharing, between Council staff and community planning and utility staff (90 public water suppliers)
- Information shared on the Council's website
- Formal public review period and process

Overall, the communities participating in Master Plan outreach serve over 85% of the metropolitan area's population.

Figure 1. Communities engaged in Master Water Supply Plan outreach events and one-on-one discussions. Blue communities are partially or wholly served by a public water supply system.



Legend

- Community Boundary
- Attended Ad Hoc Meeting for Water Supply Planning Q/A or Provided Community Water Demand and/or Model Input Information
- Attended Spring 2014 Kick-off Meeting for Master Plan Update
- Attended Summer 2014 Meeting for Elected Official Discussion of Master Plan Update
- Attended Winter 2014 Technical Preview of Master Plan Content
- Served by Public Water Supply

How the Master Plan Guides Local Water Supply Planning

The Master Water Supply Plan provides communities in the region with planning assistance for water supply in a way that:

- Recognizes local control and responsibility for owning, maintaining and operating water systems

- Is developed in cooperation and consultation with municipal water suppliers, regional stakeholders and state agencies
- Is approved by the Commissioner of the Minnesota Department of Natural Resources
- Protects critical habitat and water resources over the long term
- Meets regional needs for a reliable, secure water supply
- Highlights the benefits of integrated planning for stormwater, wastewater and water supply
- Emphasizes and supports conservation and interjurisdictional cooperation
- Provides clear guidance by identifying key challenges/issues/considerations in the region and available approaches without dictating solutions

Guidance is provided in this Master Water Supply Plan (Appendix 1) and in the Local Planning Handbook so that communities can take the most proactive, cost effective approach to long term planning and permitting to ensure plentiful, safe and affordable water that supports the prosperity and livability of the region for future generations.

Local Water Supply Plan Considerations

A local water supply plan template has been jointly developed by the Minnesota Department of Natural Resources (DNR) and the Metropolitan Council (Council) to meet the water supply requirements of both agencies. In addition, completing the template fulfills the requirements by the Minnesota Department of Health to address contingency planning for water supply interruption in source water protection plans.

Appendix 1 may be helpful for completing the local water supply plan template. Appendix 1 contains community water supply profiles that summarize community-specific information about water use, potential water supply issues, and strategies.

Completing Parts 1-4 of the local water supply plan template and submitting it as part of the local comprehensive plans is the way community plans reflect the Council's water supply-related policies and the Master Water Supply Plan. Figure 2 illustrates the process for the Council and DNR review of the local water supply plan.

The following local water supply plan content addresses key elements of this Master Plan, which the Council's review of the local water supply plan will focus on:

Extended water demand projections

Extended water demand projections (through 2040 and estimated for full build-out) should be included in Part 4 of the local water supply plan template. These projections should be consistent with the population forecasts in the community's systems statement. Assumptions of water conservation impacts on demand projections are supported by information provided in part 3 (Conservation Plan) of the local water supply plan template.

Potential water supply issues

The discussion of resource sustainability in Part 1-E of the local water supply plan template should acknowledge the potential water supply issues identified on the community water supply profile in Appendix 2 of the Master Water Supply Plan. While the information in each water supply profile is generally based on regional analyses, it provides a useful starting place for local planning and can be verified and/or refined with more local analyses.

Monitoring and ongoing evaluation

Part 1-E of the local water supply plan should include information about existing and planned resource monitoring and evaluation needed to evaluate the local effects of community water use and to provide

early warning of unidentified or developing water supply issues. Metropolitan Council recognizes the value of monitoring and ongoing evaluation to reduce uncertainty about regional water supply sustainability; the Council will provide technical guidance upon request for this part of the local water supply plan. However, the DNR and the community are the primary partners responsible for developing the details of the monitoring and evaluation plan.

Water conservation

Water conservation practices can effectively reduce the demand placed upon groundwater and surface water sources as well as municipal water supply systems. Part 3 of the local water supply plan should provide a detailed water conservation plan, which may also inform extended water demand projections. Metropolitan Council will provide technical guidance and tools such as the Conservation Toolbox to assist in the development of this portion of the local water supply plan. However, the DNR and the community are the primary partners responsible for developing the details of the monitoring and evaluation plan.

Proposed approaches to meet extended water demand projections

Building on the information provided in Part 2-F of the local water supply plan template, Part 4 of the local water supply plan template should include describe:

- The adequacy of the existing water supply system to meet demand through 2040.
- Proposed approaches to meet water demand through 2040, if the current system is inadequate to do so, in a way that considers the potential issues identified for the community within Appendix 1 of the Master Plan and by local monitoring and evaluation.

Proposed approaches may include:

- Using new (currently not in use) approaches with a lower likelihood of causing well interference, aquifer or surface water impacts, or added treatment costs due to contamination. Potential approaches include expanded conservation, interconnections with neighbors, groundwater, surface water, reclaimed stormwater, and reclaimed wastewater.
- Continuing to use existing groundwater or surface water sources, supported by monitoring and evaluation to provide warning of developing problems and a plan for back-up should limitations occur.

In some cases, a multi-community approach may be warranted. The DNR and Metropolitan Council will provide planning assistance and technical information to support development of multi-community water supply management plans, where appropriate.

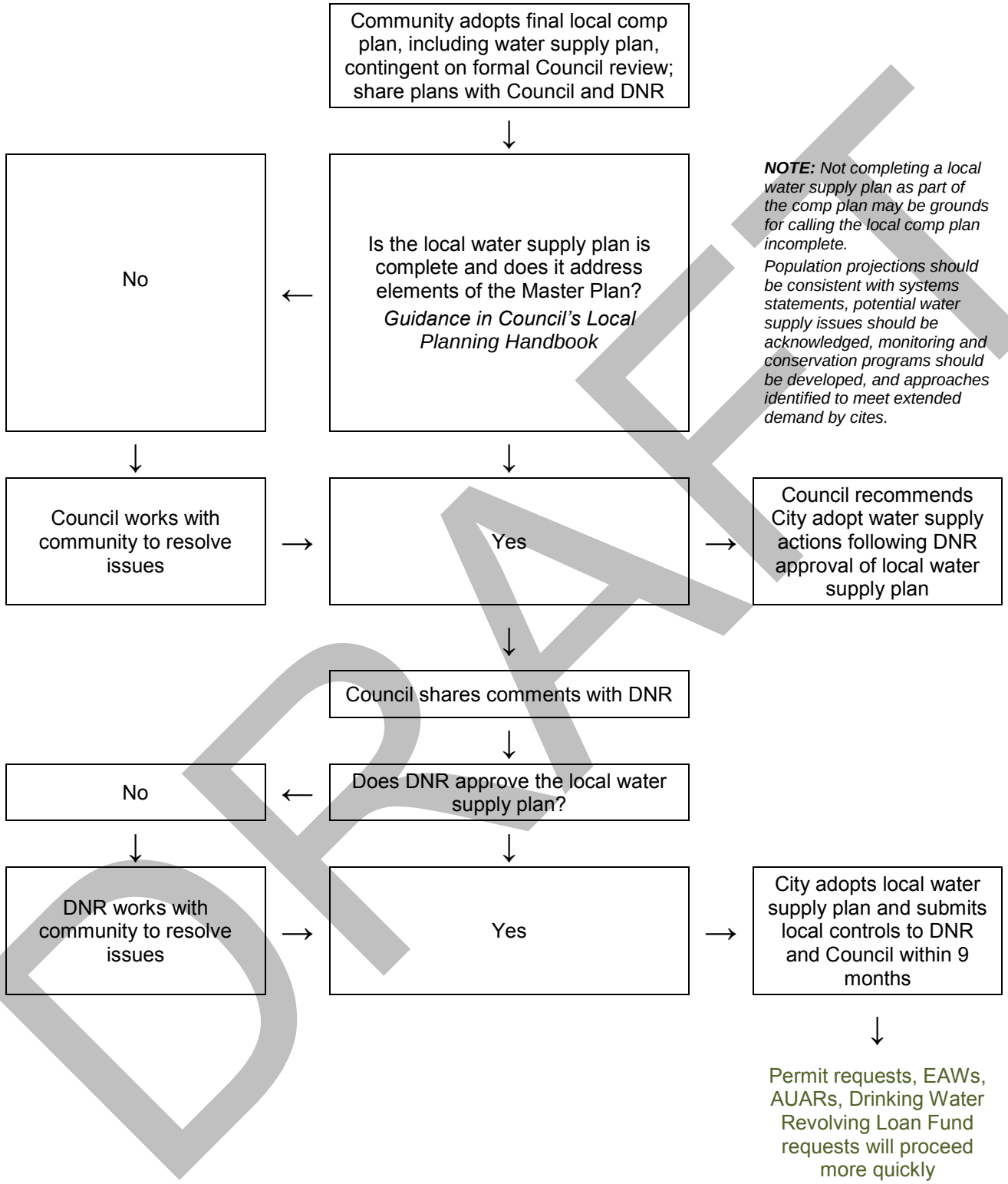
Metropolitan Council will also help support the work outlined in the local water supply plan template through public outreach to increase knowledge by the general public about water supply issues, partnering on technical studies, promoting and supporting water conservation, investigating reuse of treated wastewater, and supporting investments in water supply. Results from these efforts will be incorporated into regional analyses and in future updates to the Master Plan.

More detailed guidance on how local plans can incorporate water supply considerations is provided in the Metropolitan Council's *Local Planning Handbook*.

Review Process

Metropolitan Council and DNR cooperate in the process to review local water supply plans. Figure 2 shows the decision process review of water supply plans, including the benefits of completing and approving a local water supply plan.

Figure 2. Decision diagram of Metropolitan Council's review process, including coordination with DNR.



Updating the Master Water Supply Plan

The Master Water Supply Plan is updated regularly to reflect the best available information. Updates of the Master Plan will incorporate new technical analyses to provide the most up-to-date information about the region's water supplies, emerging issues, and water supply alternatives; and they will reflect new regional policies and system growth projections.

The Master Plan may be updated if and when the following triggers occur:

Triggers

- 10-year updates of The Metropolitan Council's *Thrive MSP 2040*
- Legislative actions mandate significant changes in Metropolitan Council or partners' roles or responsibilities
- New technical analyses that identify a change in our current understanding of water supply issues or approaches/alternatives identified in Master Plan community profiles

Scope and Process

Following 10-year updates of the *Thrive MSP 2040* and prior to update of the *Water Resources Policy Plan*, the Master Water Supply Plan will be updated as follows:

A. MAWSAC will be consulted for guidance about the scope and schedule for the plan update
B. Local stakeholders will be asked to provide input about the format, content, regional water supply issues and challenges, and technical analyses
C. Draft plan will be reviewed by MAWSAC and others and approved by Met Council for a formal public review, including a public notice and hearing
D. Public feedback will be incorporated and the final plan will be adopted by Met Council and approved by DNR

Other triggers may lead to ad hoc updates to the technical information and guidance in the Master Plan appendices, such as the community water supply profiles. The update process for appendices is:

A. Review by a technical advisory committee and communities impacted by the change
B. Updated community water supply profiles will be posted on the website, along with technical reports describing the technical project in question
C. Paper profiles will be mailed to impacted communities

Changes to the Master Water Supply Plan during the 2015 Update

The 2010 Master Water Supply Plan was updated in 2015 to integrate with Thrive MSP 2040, the region's 30-year comprehensive plan. The update also incorporates new technical information.

What is new

Most notably, the update incorporates new data and information that has been collected since 2010 and is available on the Council website:

- New Metropolitan Council population forecasts
- Metropolitan Council analysis of groundwater and surface water relationships
- Minnesota Geological Survey mapping of the vulnerability of bedrock aquifers to flow through glacial sediments
- Aquifer tests by the Minnesota Department of Health based on data collected through community source water protection programs since 2009

- New surface water and groundwater level monitoring data from the Minnesota Department of Natural Resources
- Water supply alternative feasibility assessments conducted by Metropolitan Council in partnership with communities
- Updated regional groundwater flow model (Metro Model 3)

The update also includes revision to satisfy Governor Dayton's 2014 Executive Order to implement plain language and compliance with the Americans with Disabilities Act.

What stays the same

The core of the 2010 Master Water Supply Plan remains the same, including:

- The rationale for regional water supply planning
- Goal
- Guiding principles
- Key water supply sources and challenges
- Statutory roles and responsibilities of the Metropolitan Council and partners

Changes between the 2010 and 2015 versions of the Master Plan

Chapter 1 of the updated plan contains the information provided in Chapter 1 of the original plan, including the rationale and history of regional water supply planning, the legislative mandate, and a summary of benefits of metropolitan area water supply planning process to partners and stakeholders.

Chapter 2 of the updated plan contains the information provided in Chapter 2 of the original plan, including the goal and guiding principles. The updated chapter also provides an overview of water supply policies in the updated *Water Resources Policy Plan*.

Chapter 3 of the updated plan contains the water use information provided in Chapter 3 of the original plan (which both discussed use and sources), but updated to reflect more recent information and more detail about water conservation.

Chapter 4 of the updated plan contains the water source information provided in Chapter 3 of the original plan (which discussed both use and sources), updated to include more information about wastewater and stormwater reuse.

Chapter 5 of the updated plan contains the water supply issue information provided in Chapter 5 of the original plan, updated to include the results of new groundwater flow model scenarios.

Chapter 6 of the updated plan contains information about the outcomes to be achieved through implementation of the Master Water Supply Plan. This is new content.

Chapter 7 of the updated plan contains information about specific implementation strategies that the Metropolitan Council will implement. This corresponds to Chapter 6 of the original plan, although more detail is provided and strategies are more closely aligned with the Metropolitan Council's updated *Water Resource Policy Plan* policies.

Chapter 8 of the updated plan contains information about the roles and responsibilities for water supply planning in the region. This chapter expands on the information provided in Chapter 4 of the original plan.

2. Water Supply Goal for Region

Introduction

This chapter discusses the goal, guiding principles and vision of the Master Water Supply Plan. These elements are expressed through Metropolitan Council's water supply policies and implementation strategies in the *Water Resources Policy Plan,* with this Master Plan providing more detail.

This information shapes the approaches recommended for supplying the water uses outlined in Chapter 3. Implementation of these policies will help the region achieve the outcomes discussed in Chapter 6. Chapter 7, Implementation Strategies, provides more detail about roles and responsibilities, milestones, and possible funding sources.

Goal: A Sustainable Water Supply Now and in the Future

The Master Plan has a single overarching goal: The region's water supply is sustainable now and in the future.

The premise of sustainability as the foundation of water supply planning is recognized in Minnesota statute. There has been, however, much discussion surrounding the meaning of "sustainable use."

Minnesota Statutes, Section 4A.07 define sustainable development for local government as:

> "…development that maintains or enhances economic opportunity and community well-being while protecting and restoring the natural environment upon which people and economies depend. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs."

Minnesota Statutes, Section 103G.287 provides the following definition of sustainable water use:

> "…water use is sustainable when the use does not harm ecosystems, degrade water quality, or compromise the ability of future generations to meet their own needs."

Considering the statutory definitions above, the region's water supply is sustainable when water users maximize their use of existing water supply infrastructure investments within the sustainable limits of available sources and use water in a way that:

- Is efficient and conserves water
- Maintains aquifer levels consistent with safe yield conditions defined in Minnesota Statutes
- Maintains surface water by managing withdrawals, including diversions of groundwater that supports them, to maintain protected flows and elevations
- Minimizes impacts to groundwater flow directions in areas where groundwater contamination has, or may, result in risks to the public health
- Recognizes uncertainty and seeks to minimize risk

Evaluation of sustainability considers a wide variety of information, and Chapter 5 provides more detail. While this Master Plan incorporates the best regional information available in 2015, insights may change over time as new technical information becomes available and policies change.

Guiding principles

Sustainable water supply planning must consider the links between surface water and groundwater, water quality and quantity, and water and land use. As these links are evaluated, both objective

technical information and subjective human values come into play. Water supply planning must be based on principles that strike a balance between technical information and human values. The following principles inform water-related decisions in the region:

1. Water supply planning is an integral component of long-term regional and local comprehensive planning.
2. An understanding of the region's long-term water supply availability and demand is necessary to identify a specific community's or sub-region's water sources.
3. All hydrologic system components, naturally occurring and man-made, must be carefully evaluated when making water infrastructure plans.
4. The quality of the region's water is a critical component of water supply planning.
5. Inter-jurisdictional cooperation is a viable option for managing short-term water supply disruptions and sustainably meeting long-term water supply needs.
6. Regional and local cost-effectiveness and fair cost-sharing are considered when identifying water supply options.
7. Wise use of water supplies is critical to ensuring adequate supplies for future generations.

Policies

The Master Water Supply Plan provides information and guidance to support the implementation of the Council's water supply-related policies, found in the *Water Resources Policy Plan*, guided by the principles above:

Policy on Sustainable Water Supplies. While recognizing local control and responsibility for owning, operating, and maintaining water supply systems, the Council will work with our partners to develop plans that meet regional needs for a reliable water supply that protects public health, critical habitat, and water resources over the long-term.

Policy on Assessing and Protecting Regional Water Resources. The Council will continue to assess the condition of the region's lakes, rivers, streams, and aquifers to evaluate impacts on regional water resources and measure success in achieving regional water goals.

Policy on Water Conservation and Reuse. The Council will work with together with partners to identify emerging issues and challenges for the region and solutions that include the use of water conservation, wastewater and stormwater reuse, and low impact development practices in order to promote a more sustainable region.

Investment Policy. The Council will strive to maximize regional benefits from regional investments.

Vision for a sustainable balance of sources

With access to multiple water sources, the Twin Cities metropolitan area is relatively water rich. As a region, a strategic and combined use of all available water supply sources simultaneously supports the region's economy and the quality of life that is so highly valued. And a diverse set of water sources provides better flexibility – to better manage rapid growth, extreme weather conditions, and other risks.

Like an investment portfolio, the region needs a combination of water sources that:

- supports our growth objectives
- considers cost and time
- distributes risk by diversifying

This plan recognizes that, across most of the metropolitan area, groundwater is the principal water supply source. Public and private water providers and users have invested many millions of dollars in water supply infrastructure. The Metropolitan Council values these past investments and supports plans that leverage these existing investments in infrastructure within the regional and local sustainable limits of water sources.

Sustainable water supply management will maximize the region's use of existing water supply infrastructure investments – usually groundwater - within sustainable limits. Where demand exceeds the sustainable limits of existing sources, water conservation and other sources are available to support demand.

There is no single solution for ensuring a long term sustainable water supply across the metro area. There are generally six water supply approaches available across the region, and it is the community's responsibility to consider which combination works best for them:

1. Water conservation
2. Groundwater
3. Stormwater reuse
4. Surface water
5. Enhanced recharge
6. Reclaimed wastewater

Together, this robust combination of sources can provide more than enough water for our region's needs. In parts of the region, however, some sources may not be enough to meet planned demand. Strategies like water conservation can begin immediately and may eliminate the need for or buy time to consider additional options. Other strategies, like expanding surface water infrastructure, take longer to implement but can alleviate pressure on groundwater systems in areas with irreducible demand for potable water. Much like investing, a deliberate collection of water supply sources, programs, and infrastructure will provide us with the best short and long-term water supply options. Figure 3 illustrates the vision for regional water supply sustainability.

Figure 2. Vision for regional water supply sustainability. [BEING UPDATED BY COMMUNICATIONS]

The Council recognizes the responsibility and authority of local water suppliers to provide water. A regional perspective is also important, because the effects of local water supply decisions don't stop at community boundaries – there are cumulative effects on water supply sources and connected resources.

When available information indicates that cumulative effects will cause negative impacts in parts of the region, a regional or subregional – meaning collaborative – approach provides an opportunity to explore the full scope of potential issues and solutions, because no single entity has the capacity or the authority to do all the work alone.

A regionally sustainable combination of water supply approaches will maximize the use existing water supplies and system investments within the sustainable limits of the resource and use other approaches to meet demand above the amount sustainably available from those sources. Where infrastructure changes are needed – such as to address needs for increased treatment, reducing

impact on natural and recreational resources – all available options should be considered, with input from neighbors and other partners who may know of opportunities for added value and cost-sharing.

Appendix 5 provides some case studies of local examples of alternative approaches to water supply, which move the region toward achieving our goal of sustainability.

While there are important benefits to long term planning, there is uncertainty about the future. Tools like regional groundwater flow modeling, discussed in Chapter 5, can be used to explore a range of possible future conditions. Regional modeling is a planning tool, not a regulatory tool, and it provides useful information to support regional planning and cooperation that ensures sustainability. Working collaboratively with the local providers to develop and share sound technical information and implementation tools will be the pathway to success in the area of sustainability.

3. Water Use Now and in the Future

Introduction

The region's water supplies have supported public health, economic development, parks and recreation in our region for generations. In short, our quality of life. Going forward, our region is expected to grow and change, with increasing demand for water.

This chapter discusses the region's current water use and how it is expected to change in the future. By 2040, it is estimated that the region will need about [JOHN EST] million gallons of water per day more than in 2010, if current water use practices continue. The need to ensure that the water use is sustainable for future generations, while protecting the environment and habitat, becomes increasingly important.

The comparison between water use and the information about available sources presented in Chapter 4 suggests that future water use should be matched to the best combination of sources available to sustainably meet demand.

Water Use Priorities Defined by Minnesota Statute

Water is used for a wide range of purposes in the region – from drinking to construction dewatering. Should multiple users request water above the sustainable limits of the same source, the allocation of water is prioritized by who is using the water and for what purpose, according to the six categories listed below, in order of priority (2013 Minnesota Laws Chapter 103G.216):

(1) Domestic water supply, excluding industrial and commercial uses of municipal water supply, and use for power production that meets the contingency planning provisions
(2) Use of water that involves consumption of less than 10,000 gallons of water per day
(3) Agricultural irrigation, and processing of agricultural products involving consumption in excess of 10,000 gallons per day
(4) Power production in excess of the use provided for in the contingency plan
(5) Uses, other than agricultural irrigation, processing of agricultural products, and power production, involving consumption in excess of 10,000 gallons per day
(6) Nonessential uses

Sustainable water use means that all of the region's water needs are met, which – as demand grows and competition for limited resources increases – means uses will need to be more efficient and matched to the most appropriate sources. For example, nonessential non-potable uses such as car washes or boulevard irrigation or may be better supplied by treated stormwater than by groundwater treated to drinking water standards.

Users of Water Sources in the Region

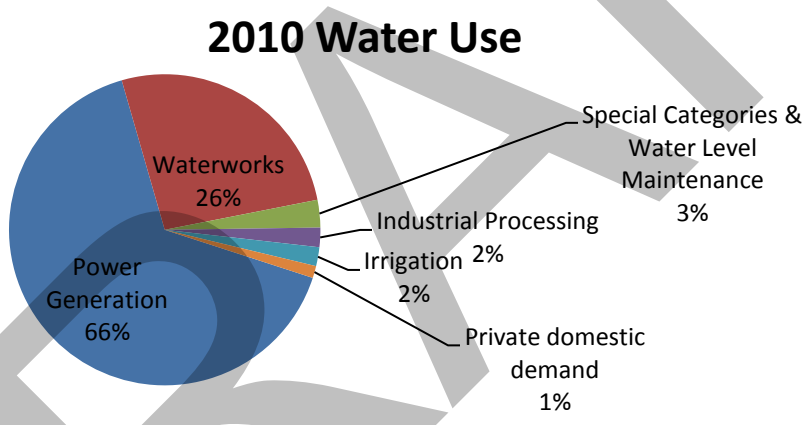
Metropolitan area water sources supply a diverse collection of water demands that, together, support the region's economic growth, public health, and overall quality of life.

In 2010 [TO BE UPDATED TO 2012], the metropolitan area used approximately 1,300 million gallons per day of surface water and groundwater. The biggest category of water use in the region is power generation (Figure 4). However, the metropolitan area power plants mostly use open-loop cooling systems where very little water is actually consumed; the rest is returned directly back to the surface water from which it came. That leaves waterworks (predominantly municipal), industrial processing, and irrigation as the three largest consumptive water uses, and most of this water is not returned back to its original source (Table #).

Table 1. Water demand in the Twin Cities metropolitan area.

Category	2010 Use [TO UPDATE]	Future Demand
Power Generation	304,500 MGY	Qualitative description
Waterworks	122,500 MGY	Qualitative description
Special Categories & Water Level Maintenance	13,300 MGY	Qualitative description
Industrial Processing	9,400 MGY	Qualitative description
Irrigation: Major Crop & Non Crop	9,100 MGY	Qualitative description
Private Water Supply (Domestic)	5,800 MGY	Qualitative description

Figure 4. Water consumed in the Twin Cities metropolitan area, 2010 [TO BE REVISED TO 2003-2012 AVERAGE].



Power Generation – Self Supplied

Power generation is the single largest water use in the metropolitan area, and production above what is identified in contingency plans is the fourth water use priority in the state.

In 2010 [UPDATE TO 2012], about 305 billion gallons of water were used by power plants in the metropolitan area. Most of the water used for power generation comes from surface water sources, but a small percentage comes from groundwater.

Because power generation is so dependent on surface water supply, drought response is a critical component of contingency planning. For example, the *System-wide Low-flow Management Plan for the Mississippi River above Saint Paul, Minnesota* helps ensure that "run-of-river" operations are maintained by hydropower operators during low flow to minimize artificial flow fluctuations resulting from power generations and to protect aquatic resources.

Although power generation is a large water demand, almost all of this water is used and then returned back to its original source. Consequently, power generation, although a large use, is not a primary focus of the Master Water Supply Plan.

Public Water Systems (Community: Municipal and Nonmunicipal)

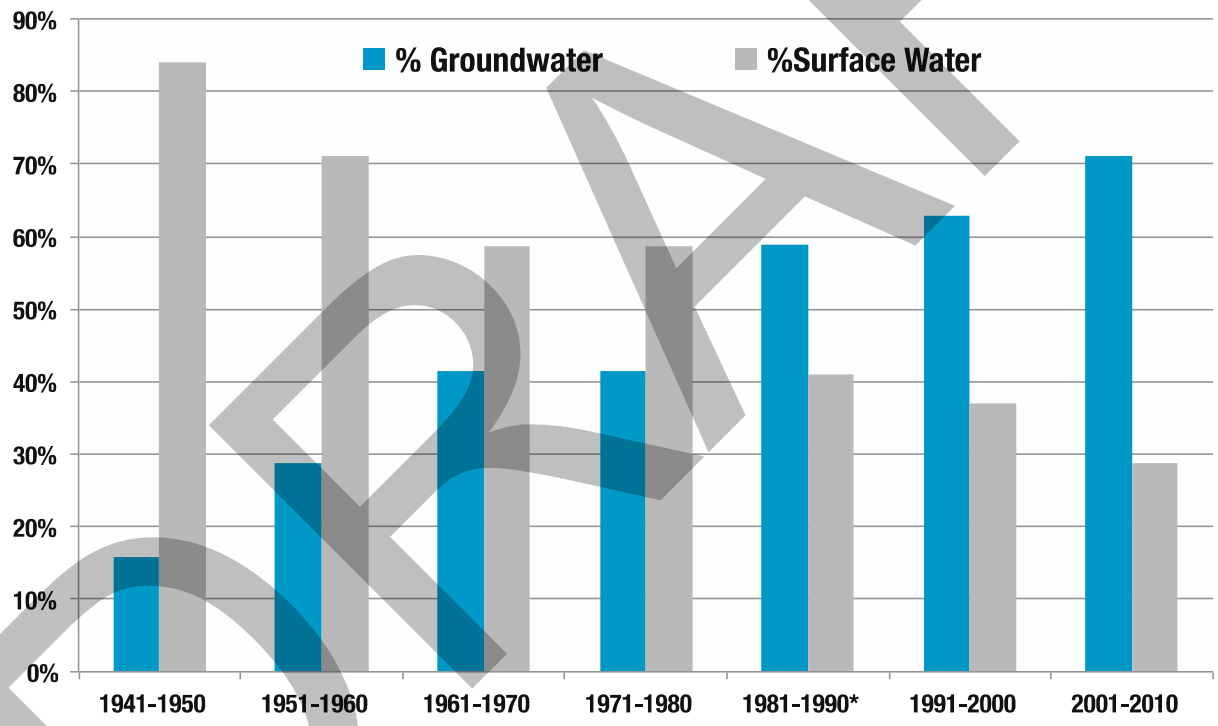
Public water supply is the second largest, and fastest growing, water demand in the metropolitan area. Over 100 separate public water suppliers provide the bulk of the region's drinking water and supports commerce and industry. A relatively small amount of public water supply is provided by commercial and institutional water works and private waterworks.

Municipal systems use the most water for a variety of purposes, which complicates the process of setting water use priorities for emergency planning. Water use for domestic purposes is first priority, but other municipal use is usually fifth or sixth priority.

In 2010 [TO BE UPDATED TO 2012 DATA BEFORE PUBLICATION], the region use an average of 335 million gallons per day for municipal purposes including residential, industrial and commercial uses. This is equivalent to about 115 gallons per person per day.

Today, most of the water used by public water suppliers comes from groundwater, although this hasn't always been the case.

Figure 5. Shift in use of water sources over decades, Twin Cities metropolitan area, 1941-2010.



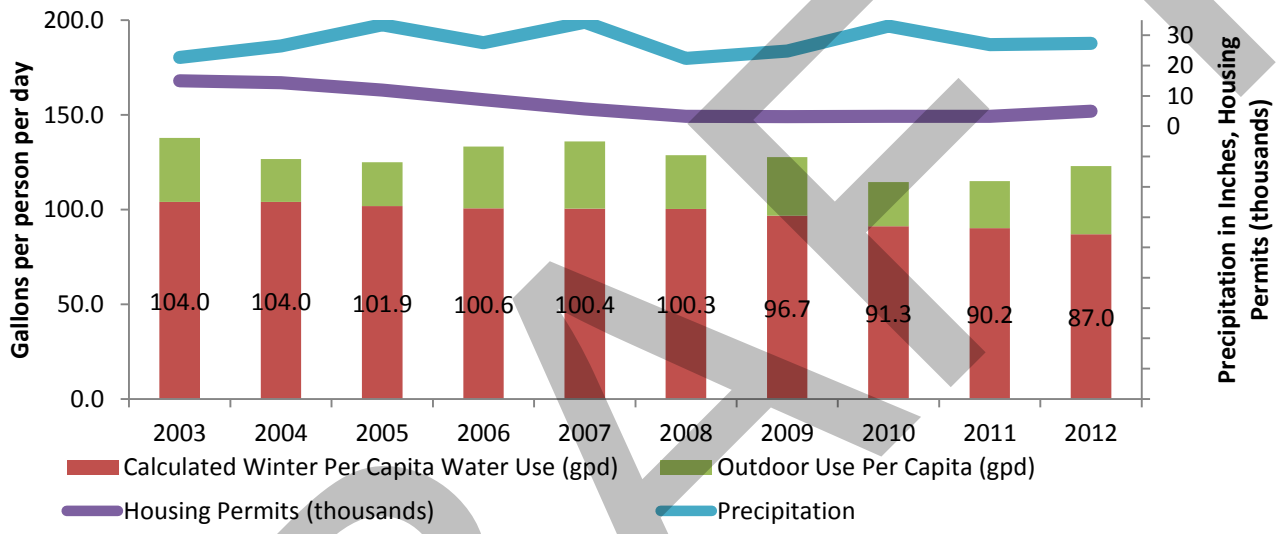
Like private domestic wells, groundwater is a preferred source for public supply across most of the region, due to widespread availability and relatively good water quality and low treatment costs. However, in some locations, higher pumping rates raise the risk of impacting neighboring wells and groundwater-supported surface water features.

Over the course of a year, most water is used indoors for household purposes and by commerce and industry. During summer months, however, a significant amount of water is used outdoors. In 2010 [TO BE UPDATED TO MOST RECENT DATA BEFORE PUBLICATION], the region used twice as much water during the summer (July) that in winter (February). The extra water was mostly used outdoors for seasonal businesses and lawn irrigation.

In the summer, Minneapolis Water Works is the region's largest public water supplier, because the City of Bloomington meets summer peak demand using water purchased from Minneapolis. In the winter, however, Saint Paul Regional Water Services is the region's largest public water supplier.

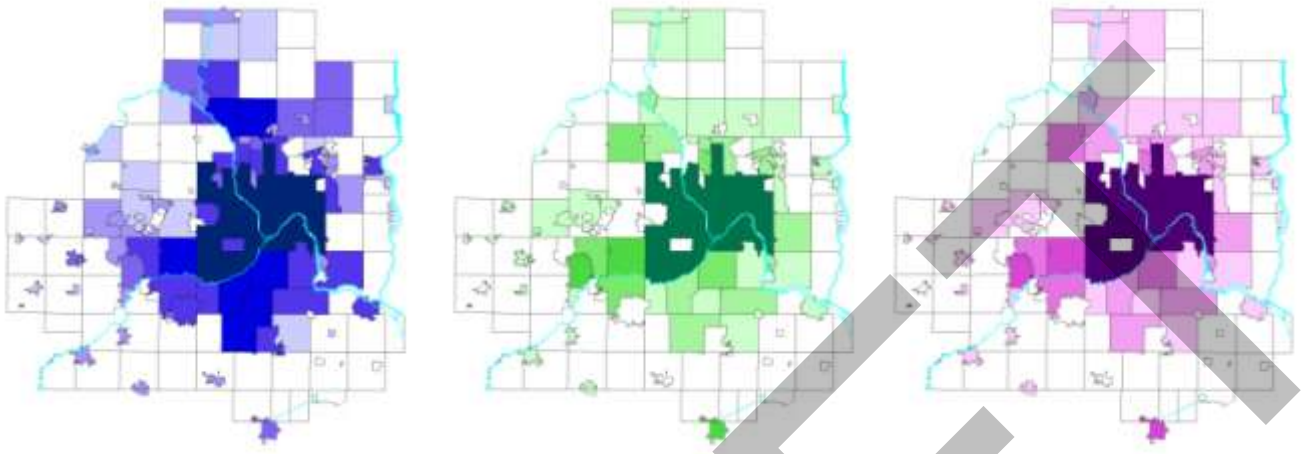
Figure 6 illustrates average yearly indoor (red) and outdoor (green) water use per person in the metro area. Over time, the amount of water used per person for indoor purposes has gone down. More efficient indoor appliances as well as economic conditions may be contributing to this trend. Outdoor water use, however, does not seem to show the same trend. Growth patterns, weather, economic conditions, and technological changes are factors that can affect outdoor water use but in ways that are difficult to predict.

Figure 6. Winter (indoor) and outdoor per capita water use, Twin Cities metropolitan area, 2003-2012.



Water demand varies between communities based on community size, land use and other factors. A 2014 survey of public water suppliers identified only two – Minneapolis Water Works and Saint Paul Regional Water Services – that averaged more than 60 million gallons per day from 1988 to 2012. About half of the region's public water suppliers (52%) averaged less than one million gallons per day (CITATION FOR WATER RATE STUDY IN BIBLIO). The three maps in Figure 8 illustrate the relative volumes of water provided by public water suppliers for residential (blue), industrial (green) and commercial (purple) uses in metro area communities. On average in the metro area, residential water use is 70%, commercial is 20% and industrial is 5% of municipal supplies. Municipal water use in all three categories is most intense in the urban core and generally diminishes outward from Minneapolis and Saint Paul. High water use, particularly residential, can be seen along major transportation corridors like Interstate Highways 94 and 35.

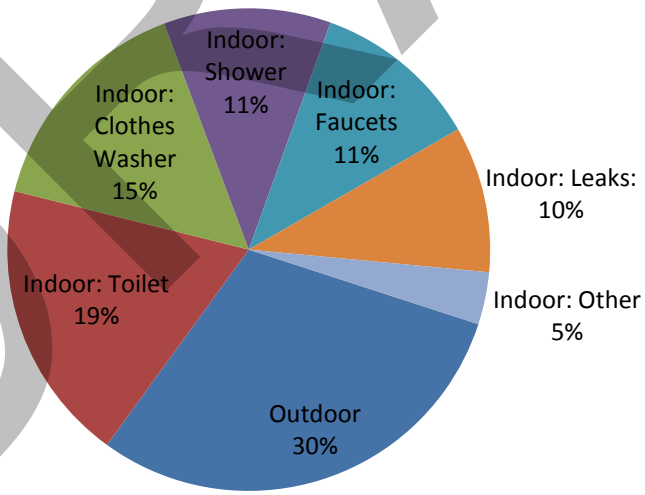
Figure 7. Relative volumes of water used by metro area communities in 2011 for residential (blue), industrial (green) and commercial (purple) uses.



Residential

Residential water use is the largest category of municipal water use in the metropolitan area, and is the highest priority water use. In 2011, approximately 70% of municipal water was used by residents for drinking and cooking, bathrooms and laundry, and for outdoor uses like lawn watering. In 2010, metropolitan area residents each used an average of about 60 gallons per day for residential purposes. However, this amount varies from community to community and from summer to winter. In some communities, summer water use is more than three times that of winter water use, while other communities use water more evenly throughout the year. As a region, approximately 30% of residential water is used outdoors, mostly for irrigation.

Figure 8. Estimate percent of residential water consumption by type of use, metro area, 2010.



While domestic water use is the State's first priority, this is generally assumed to mean indoor use. Outdoor water use is considered nonessential use and the first to be curtailed during an emergency,

although enforcement is challenging because this use is distributed among so many people and locations.

Commercial

Commercial water use is the second largest category of municipal water use in the region, but is the state's fifth-priority water use if emergencies arise. This means that, during an emergency, these uses may be curtailed per local emergency response plans.

In 2011, about 20% of municipal water was used for a variety of businesses. The amount of water used to support commerce varies from community to community. In some communities, such as New Brighton and Shakopee, almost half of the municipal water supply supports commercial, industrial, and institutional customers. Others, such as Birchwood Village and Centerville, report very little commercial or other nonresidential water use.

Industrial

Industry is the third largest category of public water supplies. Like commercial use, this is a fifth-priority use and subject to restriction in an emergency.

In 2011, approximately 5% of municipal water use supported industry. However, industrial water demand varies greatly from community to community. In some communities such as South St. Paul, almost a third of the municipal water supply is used by industrial customers. In others, none is used for industrial purposes.

Some industries, however, have their own water appropriations and wells and do not rely upon the municipal systems. That use is discussed later in this chapter.

Special Categories & Water Level Maintenance – Self Supplied

Water supplies are used for many other purposes, as well. In 2011, approximately 25 MGD were used for water level maintenance – some at long term quarry dewatering sites and some at short-term construction projects. An additional 12 MGD were used for special categories including pollution containment (9 MGD), sewage treatment (2 MGD), and snow and ice making (0.5 MGD).

These are generally fifth- and sixth-priority uses, and they are likely to the first curtailed during drought or other water use conflict.

Industrial Processing – Self Supplied

After municipal demand, private industry uses the most amount of water. Purposes include agricultural processing, petroleum processing, metal and non-metallic processing, sand and gravel washing and other similar uses. This use is the fifth priority water use in the state.

In 2011, the average daily industrial water use in the metropolitan area was approximately # million gallons per day. The top three uses were for petroleum chemical processing, agricultural processing, and industrial process cooling water.

Private industrial water use is distributed among approximately 200 permittees and ranges from less than a hundred to approximately 2 million gallons per day.

Irrigation – Self Supplied

Water is used for irrigation on major crops, golf courses, nurseries, and landscape/athletic fields; the amount varies from year to year depending on weather, and approximately 30 MGD were used for irrigation in 2011. About two-thirds of irrigation is for major crops (19 MGD in 2011). Eight MGD were

used in 2011 for golf course irrigation, and approximately 2 MGD each for landscape/athletic fields and for nurseries. Agricultural demand for major crop irrigation is the third-priority water use in the state.

Currently, there are approximately 57,500 irrigated acres in the region. Agricultural water use is seasonal, so although annual totals are not as high as industrial water use, summer seasonal use is very large, particularly in rural areas with sandy soils such as Dakota County.

DNR reports that water is used for major crop irrigation by over 400 permittees in the Twin Cities metropolitan area. Reported use ranges from a daily average of 200 gallons to over 2 million gallons.

Small Private Water Supply (Domestic)

Minnesota statutes establish domestic water use as the highest priority of the state's water when supplies are limited (Minn. Stat., Sec. 103G.261).

Slightly less than 10% of the region's population draws their drinking water from tens of thousands of private wells. While water use data is limited, the amount of water supplied by private domestic wells can be estimated by assuming that the population of the seven-county metro area that is not served by public water supply systems uses an average of 75 gallons per person per day. The result is an estimate of approximately 16 million gallons per day supplied by private domestic wells.

The most commonly used source of water for domestic private supplies is groundwater; it is more widespread and usually safe to drink with minimal or no treatment. Private well owners are responsible for testing water quality, taking action to prevent contamination at the wellhead or intake, and planning for back-up supplies in case of emergency. The Minnesota Department of Health (MDH) is an important resource in these efforts.

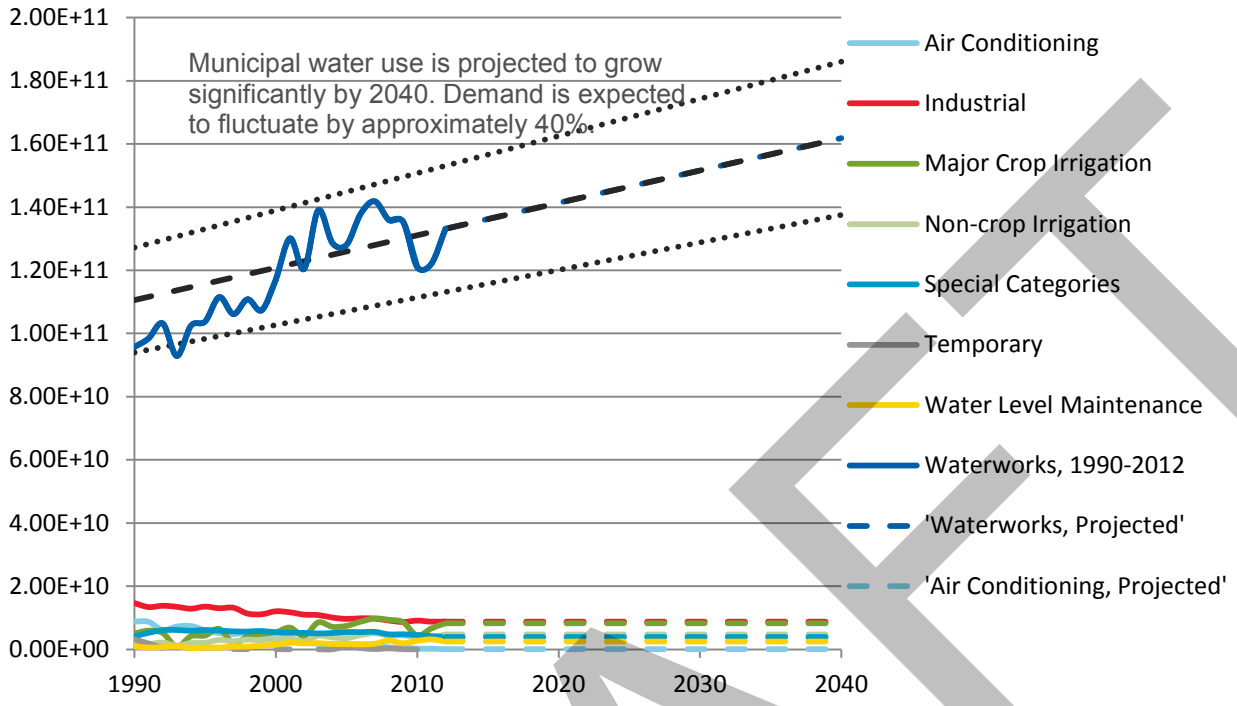
Domestic well owners who have problems obtaining water and believe the situation is due the operation of a high-capacity well that pumps more than 10,000 gallons per day or one million gallons per year can submit a well interference complaint to the Minnesota Department of Natural Resources (DNR) for investigation. Procedures for resolving well interferences are defined by *Minnesota Rules 6115.0730*. However, before DNR will investigate a well interference complaint, the well owner must have the well inspected by a licensed well driller to determine if the water supply problems are related to the condition of the domestic well.

Water use is growing - future water use

The amount of water used has changed over time, but municipal water use is the largest and has grown faster than any other water use category in the metro area. The other water use categories show various historical trends, although the quantities are not large compared to public supply.

As the region's population and economy continue to grow, regional water use is expected to grow as well. While water demand projections are not precise, simplifying assumptions can be made to estimate a reasonable range for future water demand.

Figure 9. Projected trends for the largest water consumption categories in the Twin Cities metropolitan area.

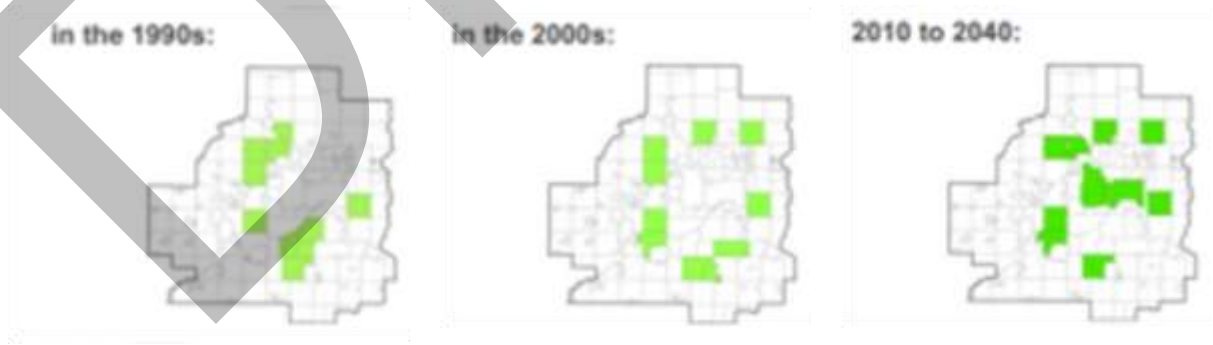


Municipal Water Demand

Based on population projections in the Metropolitan Council's 2040 regional development framework, *Thrive MSP 2040,* the region's population is expected to increase by approximately 30% percent above the 2010 figure, to approximately 3.6 million. During this same period, municipal water demand is expected to increase by approximately 50% between 2010 and 2040 and account for the majority of the increase in total regional water demand. Figure 10 highlights the top ten growing cities by decade.

75% of the population future growth is expected to occur in communities with public water supply systems supplied by groundwater; 11% in communities where public water supply systems supply surface water; 12% in communities with a groundwater-surface water mix (Saint Paul Regional Water Services, Edina and Bloomington, and Burnsville and Savage); and 2% of future growth is expected to occur in communities supplied by individual wells.

Figure 10. Top ten growing cities by decade (to be adapted from housing policy plan)



The impact of this population growth on water supply was estimated using a per capita unit use calculation for each of the 128 municipal water utilities in the seven-county metropolitan area

(CITATION IN ANNOTATED BIBLIOGRAPHY). Future water demand projections are obtained by multiplying future population projections by the estimated per capita unit use:

(Projected Water Use) = **(Projected Population)** X **(Per Capita Water Use)**

Where communities provided local data, these data replaced Council estimates.

Given the variability in water use due to climatic, economic and other conditions, the Council recognizes that actual water use is likely to fluctuate around an average value by approximately 40%. This information is useful and appropriate for regional planning and modeling, but not for local water system capacity planning. For example, local water supply planning also considers peak demand in addition to average daily use. Therefore, these projections are not intended for local water system capacity planning purposes (CITATION IN ANNOTATED BIBLIOGRAPHY).

Industrial Processing & Commercial – Self Supplied

The region's total industrial and commercial water demand is expected to remain relatively constant, although the location of water use and the adoption of water conservation strategies are likely to change in ways that are difficult to predict. As more information is collected about water use by private industry and commerce, projections for future industrial water use may change. For example, the region could become more attractive for businesses moving from states facing future water shortages.

Irrigation – Self Supplied

Agricultural water demand is expected to remain relatively constant or to increase slightly in the Twin Cities metropolitan area. Some counties, such as Dakota County, are likely to continue experiencing higher agricultural irrigation rates relative to other counties. In general, expansion of agricultural irrigation systems is assumed to be offset by improved irrigation efficiency and conversion of agricultural land to other development.

Managing and Conserving Water

The population and economy of the metro area are growing and demands on municipal water systems continue to increase. The metro area has enough water in the short-term, but long-term projections predict potentially significant impacts to aquifers if water continues to be consumed at current or higher rates and using current sources.

A key factor in mitigating possible problems is for residents, businesses, water suppliers, and elected officials to work together to become more water efficient.

There are many opportunities for more efficient water use and conservation across the region, and the benefits of water conservation extend beyond the preservation of water sources and the ecosystems and recreational water features they support. For example, water conservation may also reduce energy and treatment chemical use and offset future infrastructure investments.

The value of water conservation was a common theme at public meetings and other outreach for this Master Plan. Some challenges that need to be overcome were also identified, including:

- Mitigating the impact of decreased water use on utility revenue
- Lack of funding for local education, incentive and enforcement activities
- Different conservation approaches for different users (e.g. residents, industries, agricultural irrigators)
- Building public support

- Need for subregional and regional coordination regarding conservation targets and implementation

Municipal supply

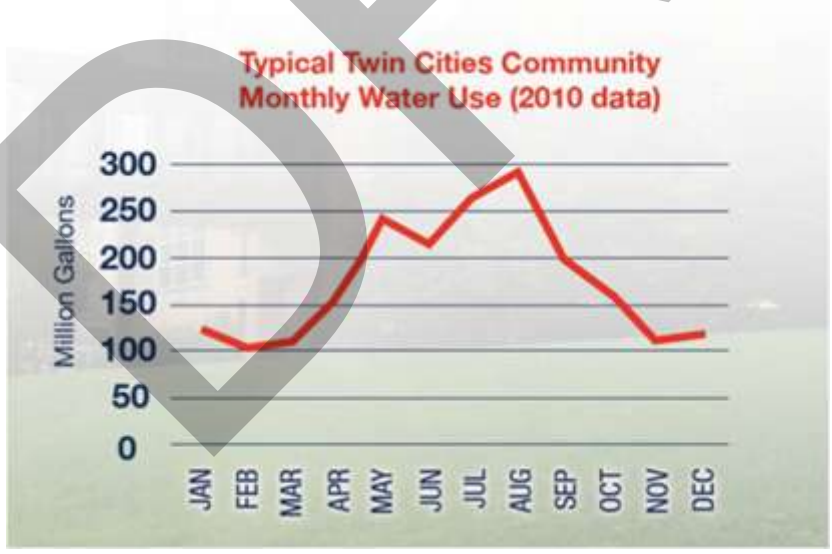
For public water suppliers, conserving water means educating customers, adopting inclined block rates with sufficiently high prices in upper tiers (which charge more per unit of water as water use increases), and enacting water conservation regulations. As of 2015 ___ communities have inclined block rates, ___ have conservation regulations, and ___ have education programs.

A recent National Geographic 'Water Currents' article noted that water efficiency may help avoid the expensive cost of adding new storage or treatment capacity. Every gallon saved is water that does not have to be pumped, treated, and delivered – and the saved water can then be reallocated to accommodate new growth or business need. In addition, water conservation may reduce the amount of wastewater that requires treatment (BIBLIOGRAPHY: National Geographic)

Setting measurable regional goals for water conservation is useful for implementation and evaluation purposes. For example, while a challenging goal, the region could reduce its total municipal (residential, commercial and industrial) per capita water use from 125 gallons to 90 gallons per day. This change means that the region's total 2040 water demand could be met with no regional increase in water use above 2010 amounts – existing water use could be managed to meet the region's needs. The Minnesota Department of Natural Resources, in partnership with the Metropolitan Council, already recommends a community goal for one part of the municipal demand: residential use of less than 75 gallons per person per day.

In most communities, reducing the growth in outdoor water use is perhaps the most valuable approach. Water systems are sized to meet maximum demand, so summer water use can drive substantial investments in infrastructure that is extraneous the rest of the year. In the metro area, a typical community will use up to 2.3 times more water in one summer month than during a winter month. And summer use is growing; between 1990 and 1994, the summer use was 1.6 times the winter use. The region could reduce its total water use by over 15% by simply returning to outdoor watering practices of this time period. This would conserve 16.8 billion gallons per year.

Figure 11. Seasonal municipal water use a typical metro area community, 2010 (FROM WATER CONSERVATION TOOLBOX).



Private industrial and commercial

A recent survey of private industrial water users by the Minnesota Technical Assistance Program indicates that the three biggest water supply concerns, as they related to industrial water-use processes, include: water discharge regulations, water use regulations, and incoming water quality (CITATION IN ANNOTATED BIBLIOGRAPHY).

The same survey indicated that approximately 40% of industrial groundwater users do not routinely monitor water use through separate processes; only total facility use is monitored. In this situation, water audits can identify a variety of opportunities for water and cost savings.

When industry and commerce do implement conservation, the benefits can be significant. For example, a small project with the Minnesota Technical Assistance Program in 2012 conducted 7 one-day site assessments that identified opportunities to save 71.9 million gallons per year. At three of those sites, changes identified through follow-up summer intern projects resulted in savings of 44 million gallons annually and savings of $360,000 per year (CITATIO IN ANNOTATED BIBLIOGRAPHY).

Agricultural

Agricultural water use is one of the largest water uses in Minnesota, including Dakota County in the metro area. Irrigation is a significant consumptive use of water that can adversely impact streamflows, groundwater availability, and natural ecosystems and the level at shich irrigation is sustainable is still unknown.

Irrigation management is a recommended best management practice in the Agricultural Best Management Practices Handbook for Minnesota. Along with optimizing available water supplies, irrigation management can support additional objectives such as decreasing non-point source pollution of surface and groundwater resources, and reducing energy use.

Conservation Toolbox

The Council has developed a free on-line conservation tool (Water Conservation Toolbox [HYPERLINK]) that residents, utilities, and communities can use to select an optimal mix of conservation measures that will maximize conservation in a way that makes economic sense for them.

The Conservation Toolbox includes a variety of information, including best management practices that target residential irrigation, information about sustainable conservation rate structures, and example ordinances that support water conservation.

4. Water Supply Sources

Introduction

The Twin Cities metropolitan area is fortunate to have relatively abundant water resources. The Mississippi River and the region's prolific aquifers provide residents with reliable water supplies, while its rivers and lakes serve commerce, support wildlife, and offer people a variety of recreational opportunities.

No single source supplies the region's water demand, as described in Chapter 3. Instead, a combination of sources provides the Twin Cities metropolitan area with water to meet its current and growing needs: groundwater, surface water, stormwater, and reclaimed wastewater.

This chapter describes the major water supply sources available to the region. The chapter also summarizes challenges and opportunities identified by the region's water supply managers and decision-makers. Plans to use these sources for current and future demand need to consider the issues presented in Chapter 5.

Supplementing Existing Sources with Additional Approaches

This plan recognizes that, across most of the metropolitan area, many communities rely on only one source of water. Local governments, businesses, public institutions, and private households have together invested many millions of dollars in the existing water supply infrastructure. The Metropolitan Council recognizes the value of these past investments and supports plans that leverage these existing community investments in infrastructure within the regional and local sustainable limits of water sources.

Where demand exceeds the sustainable limits of current sources, water conservation and a combination of other sources may be used to reduce demand for groundwater or augment groundwater to support demand.

Each community may consider which combination of water supply approaches work best for them. Some strategies, like water conservation, can begin immediately and eliminate the need for or buy time to consider additional options. Other strategies, like expanding surface water infrastructure, take longer to implement but can alleviate pressure on groundwater systems in areas with irreducible demand for potable water. Much like investing, a deliberate collection of water supply sources, programs, and infrastructure will provide us with the best short and long-term water supply options.

In some areas, expansion of surface water use to supply potable water has the dual benefit of reducing groundwater withdrawals and improving the suitability of reclaimed water for industrial and irrigation uses, by reducing the use of water softeners and resulting chloride concentrations in wastewater.

In other areas, addition of groundwater wells can provide a backup source of water to communities relying solely on surface water during extreme drought or contamination events.

Stormwater can be collected as precipitation runs off from impermeable surfaces, such as rooftops, and stored for future use. Like groundwater wells, stormwater reuse projects can be installed as development occurs, providing a local water source as local growth occurs. Stormwater is used as a relatively minor water supply throughout the region; it is most commonly used for irrigating turf areas. While still a minor source serving non-potable needs, this source is expected to grow.

Urban non-crop irrigators, such as golf courses, landscaping and athletic fields, may be especially well suited for using stormwater since they represent a significant water demand and water quality

requirements are less of a concern. Based on preliminary work done in Dakota County, it appears feasible that some volume of groundwater demand for these purposes could be offset with stormwater capture and use. In the northern portion of Dakota County, these uses totaled 257 million gallons in 2010, or just over one percent of annual non-winter runoff (CITATION IN ANNOTATED BIBLIOGRAPHY).

Reclaimed wastewater has potential for both recharging groundwater and reducing potable water demand by providing and alternate source for non-potable purposes such as industrial cooling, irrigation, and toilet flushing. Year round reuse of wastewater could include recharging groundwater, industrial cooling, and other non-potable use. Seasonal possibilities include irrigation of agricultural land, golf courses, parks, and lawns. Each type has water quality requirements that may require additional wastewater treatment before it is distributed and used.

There is no single solution for ensuring a long term sustainable water supply across the metro area, but all solutions are likely to include some combination of the sources discussed in this chapter.

Figure 12. Water cycle illustrating opportunities for integrated water resource planning.

Many opportunities exist throughout the hydrologic cycle to enhance and thereby expand available water supply. For example, stormwater best management practices may enhance aquifer recharge and provide reuse opportunities. (CITATIONS IN ANNOTATED BIBLIOGRAPHY FOR RECHARGE PROJECT).

Each of the region's water supply sources has unique benefits and obstacles. If managed together, however, they have the capacity to serve the region's water supply needs now and into the future.

The Council is committed to working with partners to protect, conserve, and utilize all sources of water in the region.

Water Supply Sources

The region has a diverse collection of water supply sources, as show on the map in Figure 13. They include surface water primarily supplied by the Mississippi River (blue), groundwater from a series of

aquifers distributed across the region (within the dashed line), reclaimed wastewater from several regional wastewater treatment facilities (squares), and stormwater across the entire area.

Figure 13. Water supply sources for potable and non-potable uses in the Twin Cities metropolitan area.

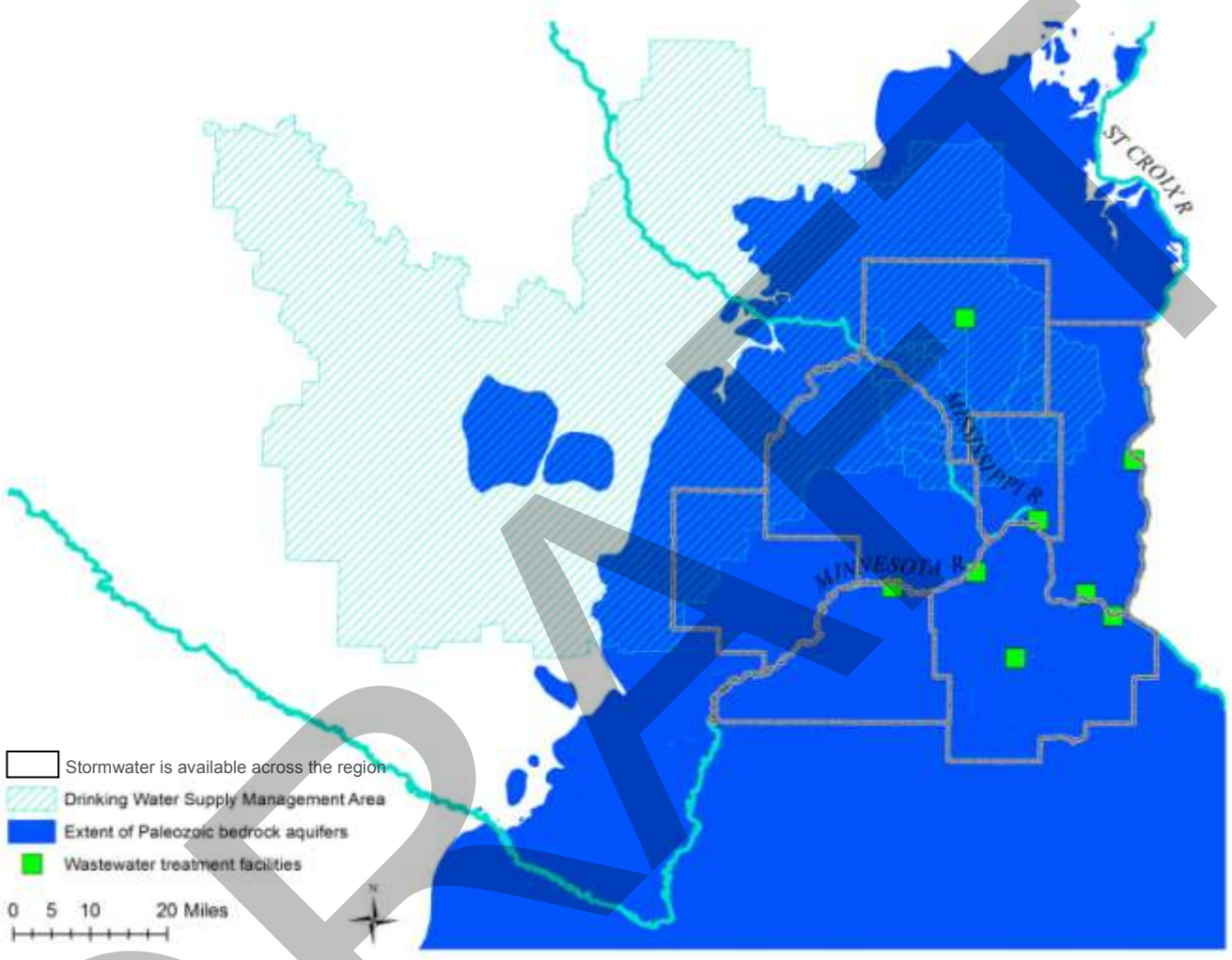


Table 1. Summary of water supply sources in the metro area, including average capacity, number of communities supplied and key management considerations.

Source & Management Considerations	Estimated Sustainable Amount Available from Sources & Infrastructure Currently in Use (Infrastructure exists or, in the case of stormwater, has current support for implementation)	Number of Communities Currently Supplied by This Source
Quaternary Aquifer • Challenging to identify the most productive sand and gravel layers • First aquifer to experience changes in recharge quantity and quality • Most likely of all aquifer to be connected to surface waters • Treatment needs for naturally and manmade contamination varies across region • Response to recharge may change as climate and land use changes • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	Being determined.	24
Prairie du Chien-Jordan Aquifer • Not available to some growing communities • As the most heavily used aquifer in parts of the region, greater likelihood of water use conflict • Connected to some protected surface waters • Treatment needs for naturally and manmade contamination varies across region • Response to recharge may change as climate and land use changes • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	Being determined	83
Tunnel City-Wonewoc Aquifer • Productivity varies greatly across the region and is highest where it is fractured or weathered • Connected to some protected surface waters • Treatment needs for naturally and manmade contamination varies across region • Low recharge rate in parts of the region, response to recharge may change with climate and land use • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	Being determined	30
Mt. Simon-Hinckley Aquifer • Use of this aquifer is restricted by Minnesota law • Very slow recharge rate, response to recharge may change as climate and land use changes • Significant groundwater mining has occurred historically • Treatment needs for naturally contamination varies across region • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	Being determined	35
Mississippi River • Coordination with Minneapolis Water Works and St. Paul Regional Water Services • Drought and related risk of water shortages • Vulnerability to contamination and related monitoring and treatment requirements • Limited ability to manage and protect water quality within the watershed • Limited access to source and related distribution costs • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	Max capacity of MWW & SPRWS?	__
Minnesota River • Drought and related risk of water shortages • Vulnerability to contamination and related monitoring and treatment requirements • Limited ability to manage and protect water quality within the watershed • Limited access to source and related distribution costs • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	0?	0?
St. Croix River • Drought and related risk of water shortages • Vulnerability to contamination and related monitoring and treatment requirements • Additional federal and state protections in place • Limited ability to manage and protect water quality within the watershed • Limited access to source and related distribution costs • Funding challenges may include project phasing opportunities, eligibility for funding sources,	Max capacity of Xcel & others?	0 – add Xcel?

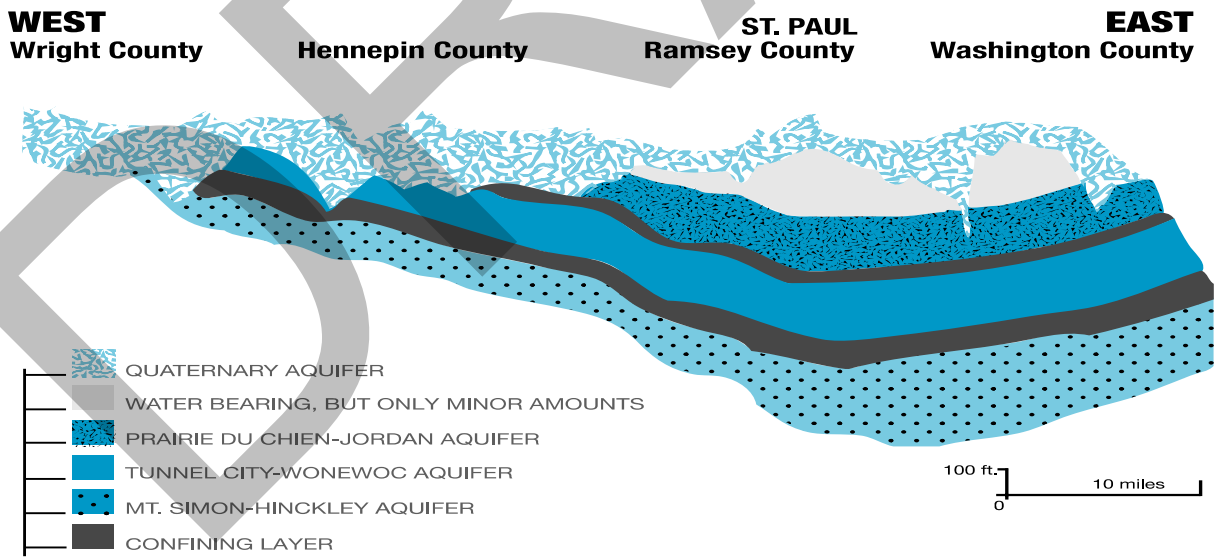
Source & Management Considerations	Estimated Sustainable Amount Available from Sources & Infrastructure Currently in Use (Infrastructure exists or, in the case of stormwater, has current support for implementation)	Number of Communities Currently Supplied by This Source
partnerships, etc		
Stormwater • Drought • Availability limited seasonally and by access to land for collection and storage • Vulnerability to contamination • Regulatory limits to protect public and environmental health • Water quality requirements for potential uses • Inconsistent watershed rules • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	Less than 100 MGD	All?
Reclaimed Wastewater • Seasonality of some non-potable demand • Geologic limitations on the effectiveness of reclaimed wastewater water as a source for enhanced aquifer recharge • Public acceptance • Regulatory limits to protect public and environmental health • Funding challenges may include project phasing opportunities, eligibility for funding sources, partnerships, etc	250 MGD	1 (East Bethel)

Limitations on Sources

Groundwater

Although there are several aquifers in the region, they are not equally distributed. For example, some communities in the western metro, such as Norwood Young America – do not have access to the productive Prairie du Chien-Jordan Aquifer. Figure 14 illustrates the aquifer layers and their curved shaped beneath the Twin Cities metropolitan area.

Figure 14. Geologic cross-section of aquifers service the metro area, from east to west across the northern metro.



The amount of groundwater that can be sustainably withdrawn depends on the amount of recharge available, the rock properties that control how easily water moves through the aquifer, and human-

imposed limits that have been established to protect public health, maintain ecosystem services, and reduce water use conflicts.

Recharge – the ultimate sources of water to the groundwater system – has been estimated by the Metropolitan Council, U.S. Geological Survey and Minnesota Pollution Control Agency. The range of these estimates suggest that 900 to 1,200 million gallons per day is the upper limit on the amount of groundwater available for all needs including baseflow to surface waters, drinking water, and to support industry and commerce (CITATION IN BIBLIOGRAPHY).

To understand what portion of potential recharge may be sustainably available from the groundwater system, regional groundwater flow modeling can also be used to explore approximately the limit (as an estimated range) on how much groundwater can be pumped without causing unacceptable conditions (Appendix 4). These conditions were incorporated into a regional groundwater model scenario that tests the sustainable capacity of aquifers in areas where high capacity wells already exist, under the assumptions that:

- Sustainable groundwater pumping should maintain aquifer levels consistent with safe yield conditions defined in Minnesota Statutes
- Sustainable groundwater pumping should maintain surface water by limiting withdrawals, including diversions of groundwater that supports them, to maintain protected flows and elevations
- Sustainable groundwater pumping should minimize impacts to groundwater flow directions in areas where groundwater contamination has, or may, result in risks to the public health

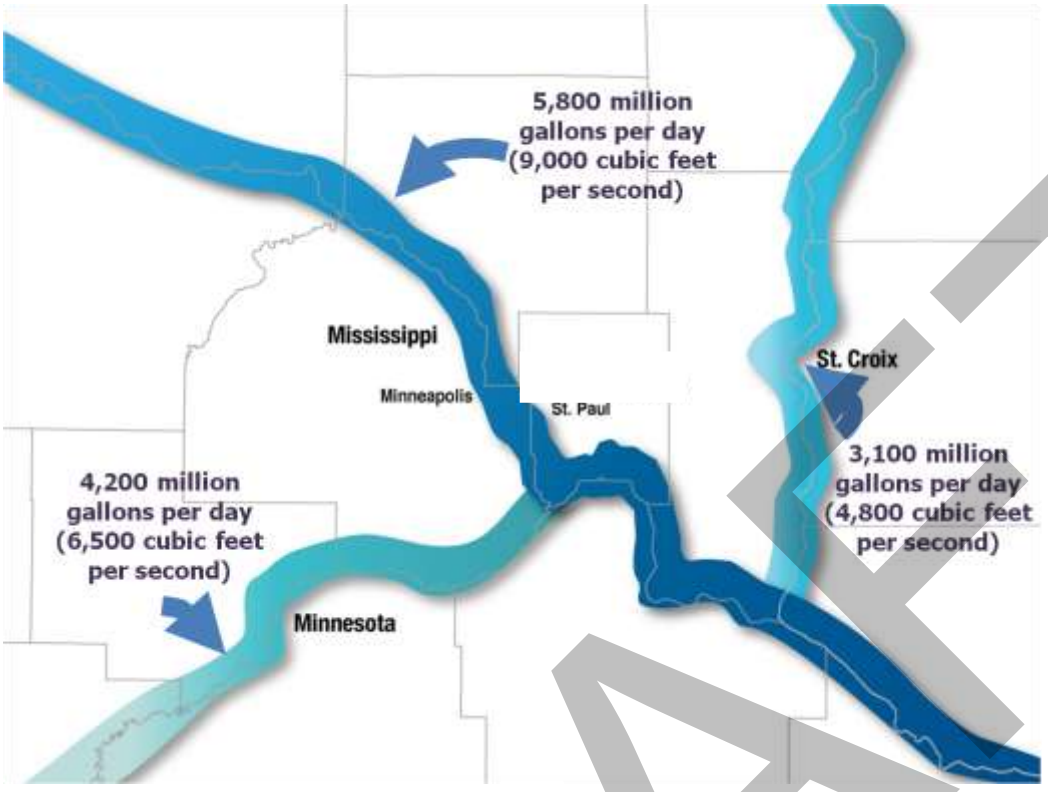
Results suggest that the region might sustainably withdraw approximately 400-500 million gallons of groundwater per day in areas where high capacity wells currently exist (Appendix 4). However, even when groundwater withdrawals are less than that, local limitations may still exist due to proximity of sensitive local features such as neighboring wells or a trout stream.

This calculation is an estimate of sustainable withdrawals, and can be used as a guide to regional water supply management. Additional data produced by expanded monitoring and aquifer analysis can be used to refine this estimate. The result is most sensitive to the factors used to define sustainable conditions. This type of modeling approach may be a useful tool to evaluate how changing definitions of sustainability affect our understanding of water supply availability. Chapter 7 includes a process to continue this type of evaluation in partnership with communities and other stakeholders.

Surface Water

The region's most visible water supply source is its surface water. Three major rivers, hundreds of streams and ditches, and thousands of lakes and wetlands provide varying amounts of water. This Master Water Supply Plan focuses primarily on one surface water source, the Mississippi River, but also provides information about two other large potential sources: the Minnesota River, and the Saint Croix River (Figure 16).

Figure 16. Metro area's three major rivers and average annual flow. [TO BE UPDATED TO ADD LOW-FLOW INFO]



Use of the Minnesota, Mississippi and Saint Croix rivers is limited by a variety of climatic, economic, water quality, regulatory, and ecological reasons.

For example, while average annual flow for the Minnesota, Mississippi and St. Croix rivers are 4,200; 9,000; and 3,100 MGD respectively, average August (low) flows are ___, ___, and ___ MGD.

Low flow in the Mississippi River is of particular concern and is included in the State Drought Plan, which includes a matrix of drought phase triggers. When flow is less than 2,000 cubic feet per second for five consecutive days, public water suppliers and other water users using the Mississippi River implement appropriate conservation measures. Should flow fall below 1,000 cubic feet per second for five consecutive days, all public water suppliers in the Twin Cities metro area implement mandatory water use reductions with the goal of reducing water use to January levels (CITATION IN BIBLIOGRAPHY).

Much discussion about these limits followed the 1988 drought (CITATION IN BIBLIOGRAPHY). Critical flow of the Mississippi River was determined to be a flow that supports basic needs for water supply, power and navigation; a minimum flow of 554 cubic feet per second is needed for these purposes (Metropolitan Council, 1990). Work done by the U.S. Geological Survey indicate that there is less than a 1% probability of flow on the Mississippi River falling below 600 cubic feet per second in any give year; the recurrence interval for flow less than 600 cubic feet per second is 100 years (CITATION IN BIBLIOGRAHY).

Stormwater

Currently, the State of Minnesota does not have a state-specific code applicable to stormwater harvesting and reuse. The MPCA has developed some guidelines for the use of reclaimed water, and

the Metropolitan Council has summarized these and other information in its *Stormwater Reuse Guide (CITATION IN BIBLIOGRAPHY)*.

Because of its direct tie to precipitation, stormwater is not consistently available for reuse, so storage is required to ensure water is available when needed. The amount of stormwater available at any given location is also a factor of the size and amount of impervious surface in the area contributing to the site.

More work is needed to evaluate the potential for stormwater reuse across the region, but a rough estimate can be made of the amount of stormwater available for reuse, based on some simplifying assumptions:

- A one acre parking lot generates 27,000 gallons of runoff during a 1" rainfall,
- An average of six 1" rainfall events occur on average in recent years, and
- 245,909 acres of impervious area exist in the metropolitan area.

Given those assumptions, approximately 100 million gallons per day of stormwater water could be available in the region. Stormwater reuse projects are not tracked consistently through the region, so it is uncertain how much stormwater reuse currently exists.

Reclaimed Wastewater

Opportunities to use reclaimed wastewater as a non-potable water source exist throughout the region. Reusing treated wastewater to supplement groundwater and surface water as sources of water to support regional growth, where economically feasible, will promote sustainability goals. Feasibility depends on site-specific factors. For instance, proximity to treatment plants, regulatory requirements, water quality needs, distribution system requirements, and the benefits of reuse from a total water perspective all contribute to feasibility. Reclaimed wastewater is one of the region's underutilized water supply sources.

The amount of reclaimed wastewater available for reuse is ultimately limited by the amount of wastewater produced and the number and size of wastewater treatment facilities. The Council currently operates eight wastewater treatment plants, with an average flow of 250 million gallons per day. The design capacity of these plants if 358 million gallons per day. Planned 2040 system capacity is 372 million gallons per day and long term (beyond 2040) is 500 million gallons per day.

The effluent quality and level of treatment varies among the existing wastewater treatment plants. Additional treatment would generally be needed to match reclaimed water quality requirements.

Cost is a key factor in evaluating the feasibility of wastewater reuse. In 2014, Metropolitan Council evaluated reclaimed water demand, water quality needs, and estimated costs in the Southeast Metro. Potential users included in a possible reuse scenario included Flint Hills Refinery, residential and commercial toilet flushing and irrigation in areas of growth between 2010 and 2040, and agricultural irrigation north of and east of the Empire Wastewater Treatment Plant. The treatment and distribution system incremental costs (above the the existing treatment) to provide reclaimed water ranged frm $5 to $10 per 1,000 gallons. Key factors driving costs are treatment requirements, distribution costs, and seasonality of use.

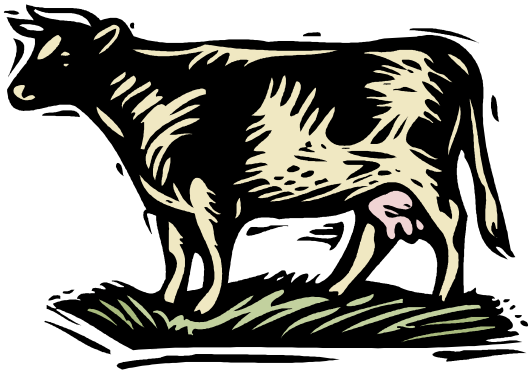
Estimated Amount of Water Available to the Metro Area

Considering that the metro area has access to water from several sources including stormwater, reclaimed wastewater, surface water and groundwater and based on our current understanding of water supply sustainability, the region can sustainably use about 1.2 billion gallons per day to meet

essential needs. In addition, another 5.5 billion gallons per day are available to meet non-essential needs, or those needs that could be cut back during emergencies such as drought.

Although the region generally has enough water to meet current and future demand from all available sources, each source is limited and is vulnerable to a variety of factors. The only single source capable of supplying the region's demand is surface water, which is also the most vulnerable to drought and contamination.

Figure 18. Comparison of historical and projected needs versus sustainable sources. [BEING UPDATED BY COMMUNICATIONS]



5. Key Water Supply Issues

Introduction

Sustainable water supply supports the region's prosperity and quality of life. The region has access to several water supply sources – the surface water, groundwater, and reused storm and wastewater that make up the region's "one water" - but each is limited. Our region is growing and our environment is changing. The region cannot take easy access to water for granted, and water supply planning should be done when there is time to develop workable solutions, not when a crisis threatens. Good planning now will keep our water supply safe and plentiful for generations to come.

This chapter discusses the water supply issues the region faces and how they vary across the region, including regulatory considerations, water use, conflicts and well interference, aquifer decline, surface water and ecosystem impacts, contamination, uncertainty in aquifer properties, reliability and funding.

Regional mapping, monitoring networks, and modeling are used to characterize the issues discussed in this chapter. This information should be refined with more locally-specific information, if available, to better evaluate potential issues. The information is also summarized for each community in Appendix 1, where it provides a useful starting place for local work to evaluate and manage water supply issues.

Issues Identified by Communities and Water Suppliers

Sustainable water use requires balancing among competing uses, including human and environmental uses. During the update of this Master Water Supply Plan, communities and water suppliers identified several key water supply management issues, including the following:

- Meeting complex regulatory requirements
- Balancing water supply sources between diverse public and private users, considering different water quality and quantity requirements
- Meeting customer expectations for rates, taste and odor, protection of public health
- Reducing vulnerability to drought and climate change, contamination, and changes in aquifer recharge and levels
- Funding for changes in water supply system operation, in a way that builds on past investments and addresses the high costs to build, operate and maintain new infrastructure
- Communicating with customers and the public about water supply; more public education is needed to raise awareness of how water supply systems work
- Identifying sustainable conditions and monitoring needed to evaluate them

These issues, and many others, are covered by the local public water suppliers, the Minnesota Department of Natural Resources, and the Minnesota Department of Health who work together to ensure that public water supplies meet or exceed all regulations and requirements.

Water Issues Change across the Region and Through Time

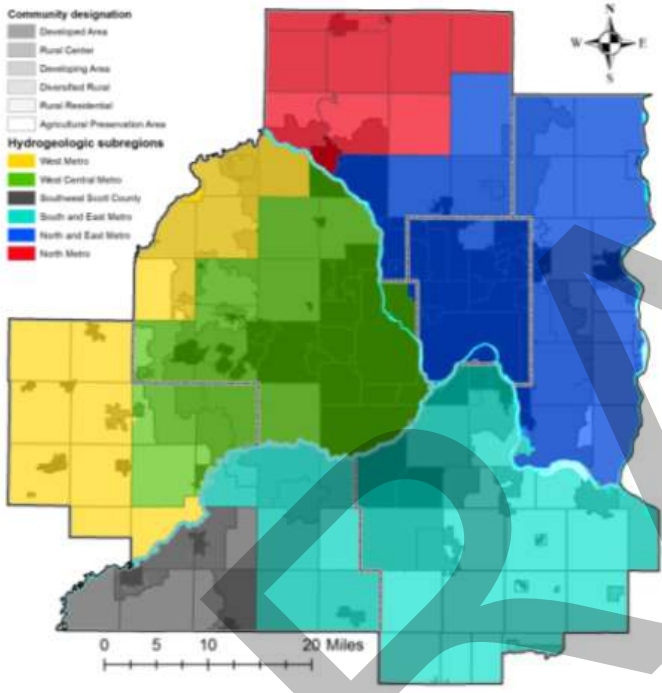
Water issues are different in different parts of the region, and they may vary over time. While water supplies – including a variety of aquifers and surface waters - are regionally abundant, they are not evenly distributed throughout the metropolitan area and may become limited over time due to hard-to-predict events like long term drought or contamination.

In addition, the state of public water supply systems varies greatly across the region. Some communities are fully served by aging water supply systems while others have just begun to develop public water supplies. Rural areas have different water supply and source water protection issues than their urban counterparts.

Our major rivers – the Minnesota, Mississippi, and St. Croix - transect the region, but most communities do not have direct access to these sources. The groundwater in the metropolitan area is not all connected – groundwater does not flow all the way from Anoka County to Dakota County and vice versa. Consequently, the amount of available groundwater is not uniform from community to community.

Figure 19 illustrates how hydrogeologic conditions and community development combine to create a patchwork of different water supply conditions across the region. Each color represents a different combination of aquifers and groundwater recharge and discharge areas. Different shading illustrates different community development patterns, where darker indicates communities served by public water supply systems and lighter indicates communities mostly served by private wells.

Figure 19. Hydrogeologic conditions and community development create subregional differences in water supply planning issues.



Metropolitan Council recognizes that sustainable water supply planning means something different from community to community. The Council will work with communities to support information sharing and technical work that meets the various needs of water supply stakeholders in each of the metro area's hydrogeologic subregions.

Regulatory considerations

The regulatory complexity of water management in Minnesota has been identified as challenging for decades. Public water suppliers and communities have identified several challenges, including:

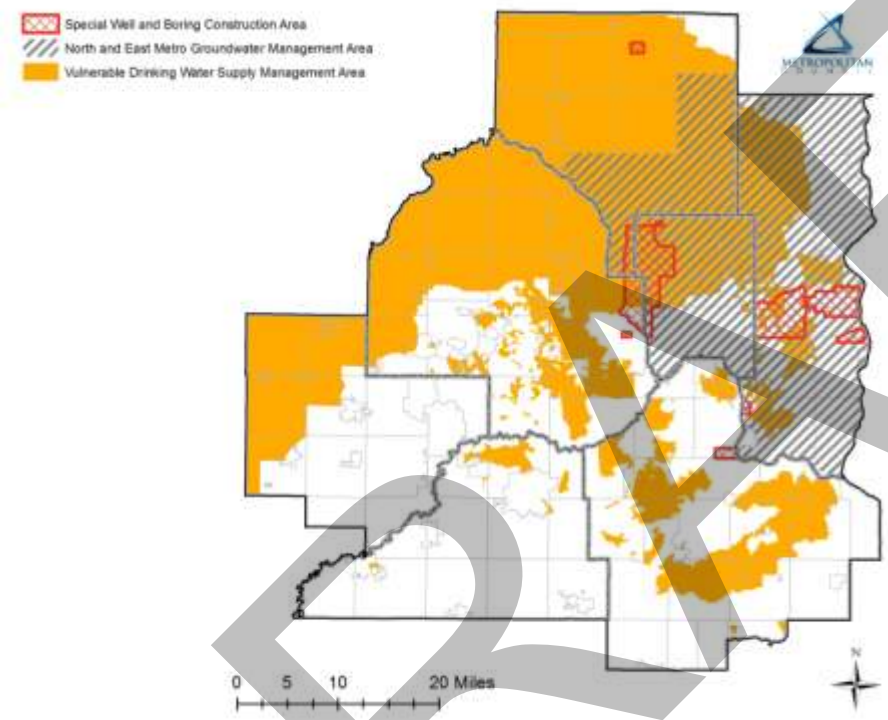
- Supplying, treating and distributing water to consumers in compliance with Safe Drinking Water Act standards, water appropriation permits and well code
- Multi-agency permit requirements that may contradict one another
- Source water protection guidance that limits stormwater infiltration, conflicting with increased requirements for onsite stormwater management
- Minnesota rules preventing use of wells for injection to enhance recharge
- Plumbing code that limits and causes confusion about how water may be reused

Where the following management areas have been designated, the challenges raised above may be exacerbated:

- Groundwater management Area
- Special Well and Boring Construction Areas
- Vulnerable Drinking Water Supply Management Areas (DWSMAs)

Figure 20 illustrates DNR-designated Groundwater Management Areas and MDH-designated Special Well and Boring Construction Areas and Vulnerable Drinking Water Supply Management Areas.

Figure 20. Areas where additional regulatory conditions exist due to documented issues or vulnerability.



Managing Water Demand

Water demand is a driving factor for water resource planning. Water demand is shaped by various socioeconomic and climate factors, but planning and maintaining efficient systems are common goals.

The following are indicators that changes in water supply system development and maintenance or demand management could result in significant water use reduction:

- Water that is not accounted for (non-revenue) makes up more than 10% of the total water use, which is a goal recommended by the American Water Works Association
- Residential per capita water demand is greater than 75 gallons per person per day, which is the goal recommended by the Minnesota Department of Natural Resources
- The trend in total per capita water use is not decreasing, which is a goal recommended by the Minnesota Department of Natural Resources
- A ratio of maximum demand day to an average demand day exceeds 2.6, which is the goal recommended by the Minnesota Department of Natural Resources

The challenges of water demand management vary throughout the region, primarily driven by differences in level of development. For example, individual public water suppliers vary in the amount of unaccounted water varies from 0% - 20%(?) in the region based on different metering systems or the age of the infrastructure. New development may be associated with higher per capita use and peak summer water use as new vegetation is established. Older communities with aging infrastructure may have higher amounts of unaccounted for water use.

Water use conflicts and well interference

There are tens of thousands of wells in the region, supplying diverse users. Where water users compete, conflicts must be resolved – often a costly process. Water use conflict is defined in Minnesota Rules (part 6115.0740) as a condition where the available supply of water in a given area is limited by a competing demand that exceeds the reasonably available waters. However, even where there is adequate water for a proposed project, a well interference can occur if that project interferes with the ability to withdraw water from a public water supply well or private domestic well.

The following are specific indicators of increased risk of well interference:

- Documented well interference problems
- High volume water users in proximity to residential wells

Because private wells are pervasive in the metro area, there is a potential for well interference for all water users. Complaints about well interferences are reported to the Minnesota Department of Natural Resources (DNR), which then works to resolve the issue through the process set forth in Minnesota Rules (part 6115.0730).

Aquifer water levels

Aquifer levels are useful for providing information about groundwater flow directions, relationships between groundwater and surface water systems, and water levels near wells, so the issue of aquifer water levels is closely related to issues like water quality, surface water –groundwater relationships, and well interference. Monitoring networks provide information about current and past conditions, and modeling is a valuable tool to anticipate potential future conditions.

In several parts of the metropolitan area, *historical* DNR groundwater level monitoring data suggest long-term declines. Groundwater levels in other parts of the metro area have remained relatively constant over time. One example of long-term decline can be found in Orono, Minnesota where groundwater-level monitoring has documented declines of one foot per year in the Prairie du Chien-Jordan aquifer. However, water levels in the St. Peter aquifer in Roseville have generally trended upward since the early 1990s.

While some parts of the metro area have not yet experienced groundwater declines, existing data show that aquifer decline is an issue that needs to be addressed in parts of our region (figure 21). Aquifer decline issues vary throughout the region, primarily driven by differences in aquifer properties and level of development.

The Department of Natural Resources evaluates water level impacts on confined aquifers using the definition of safe yield found in Minnesota Rules (6115.0670). Those rules define safe yield as 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. For unconfined aquifers, Minnesota Rules (chapter 6115) requires that withdrawal from the aquifer system

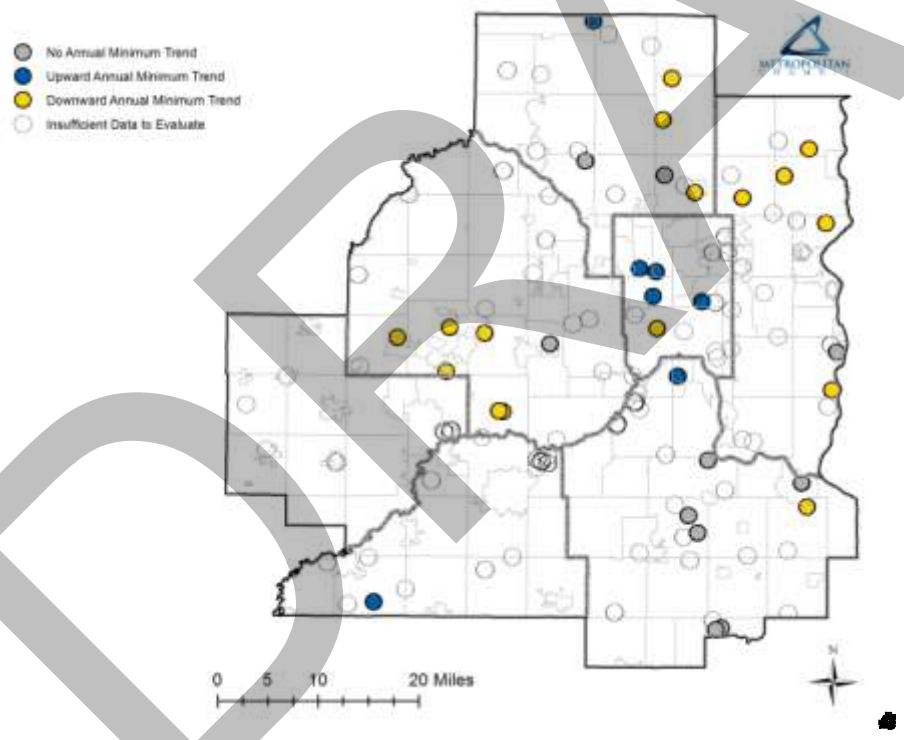
does not exceed long term average recharge to the aquifer system. Also, Minnesota Statues (Chapter 103G) protects surface waters from harmful impacts to groundwater withdrawal.

The following are indicators of increased risk of significant aquifer water level decline:

- DNR observation well data documents a declining trend in aquifer levels, suggesting groundwater withdrawals exceed safe yield amounts, as defined above
- Regional groundwater flow modeling highlights areas where the range of projected 2040 water demand may exceed safe yield amounts, as defined above, if current use patterns and water sources are used to meet that demand; this may be considered as a warning threshold to allow time for contingency plans to be in effect if water levels decline

Figure 21 is a map of DNR observation wells that monitor aquifer levels. Trends in annual minimum water levels were developed for wells with complete records between 1993 and 2012. Blue circles indicate an upward trend in the annual minimum water level during that time period. Yellow circles show a downward trend, and white circles indicate wells without enough data to evaluate trends. This map does not identify the cause of these trends, which may represent aquifer response to climate variability or groundwater pumping or both. Regardless of the cause, however, groundwater in areas of downward trends should be reviewed regularly and water levels in nearby wells monitored to prepare for any needed management changes.

Figure 21. Active DNR observation well and trends in annual water level minima (1993 – 2012).



Regional groundwater flow modeling (Metro Model 3) is a tool that allows water supply planners to consider a range of potential *future* aquifer levels under a set of planned and alternative water demands and sources (Appendix 3). Metro Model 3 is a planning tool, not a regulatory tool, and it provides information to support regional planning and cooperation to ensure sustainability.

Regional groundwater modeling, which simultaneously evaluates the combined impacts of all wells in the region, suggests that our current (2015) plans for water supply are likely to cause further declines in aquifer levels .

Figure 22 is a map of Metro Model 3 model scenarios illustrating aquifer declines under projected 2040 groundwater pumping conditions, which are expected to fall within a range 20% above or below the 2040 projection described in Appendix 2:

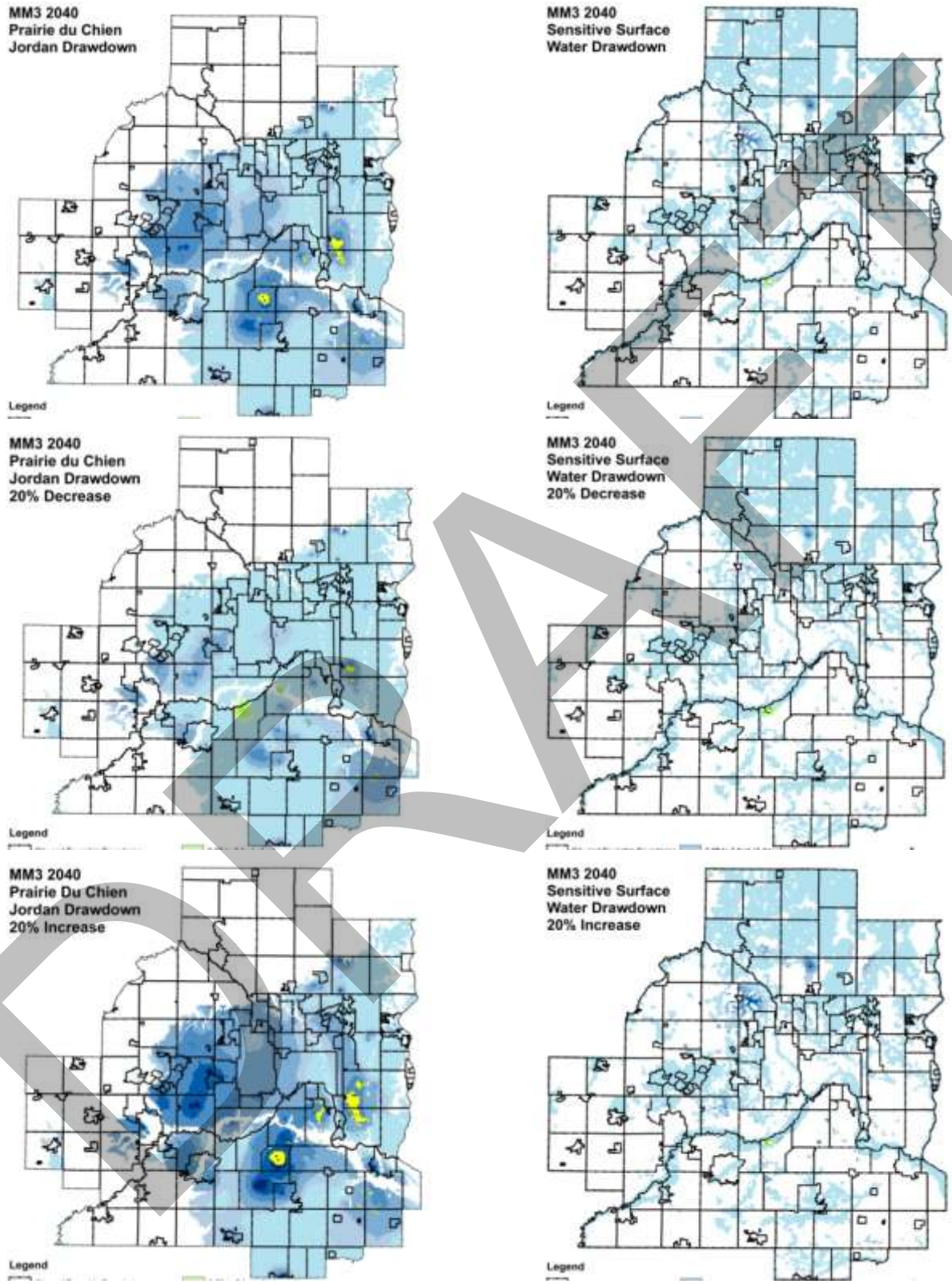
- Prairie du Chien-Jordan aquifer (left column)
- Water Table aquifer under sensitive surface waters (middle column)
- Tunnel City-Wonewoc aquifer (right column)

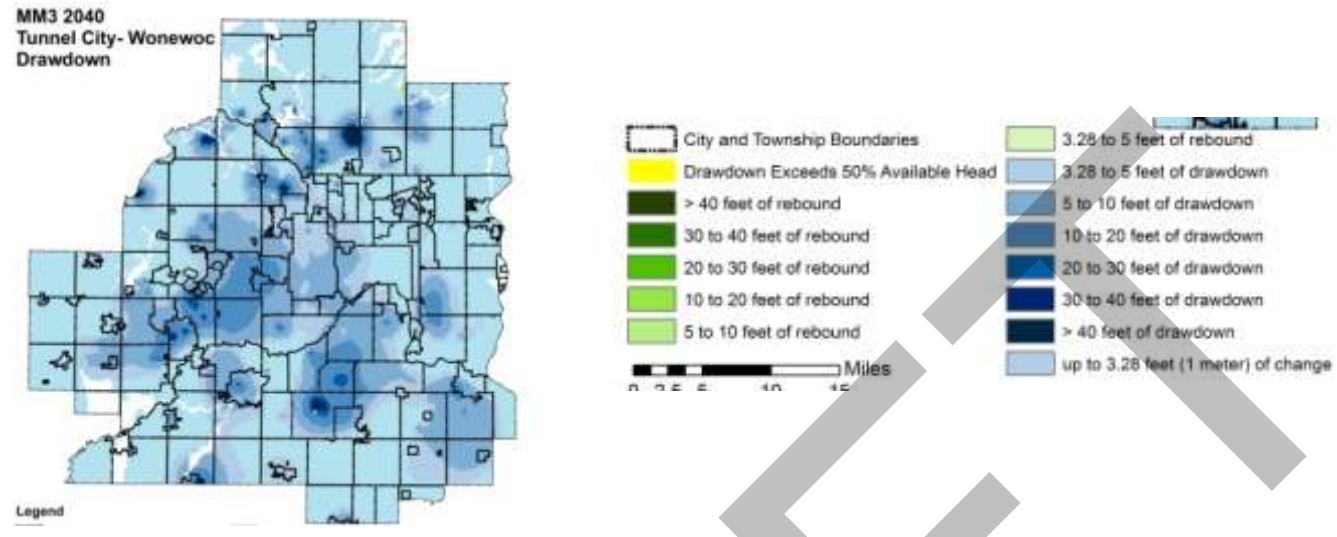
On the map:

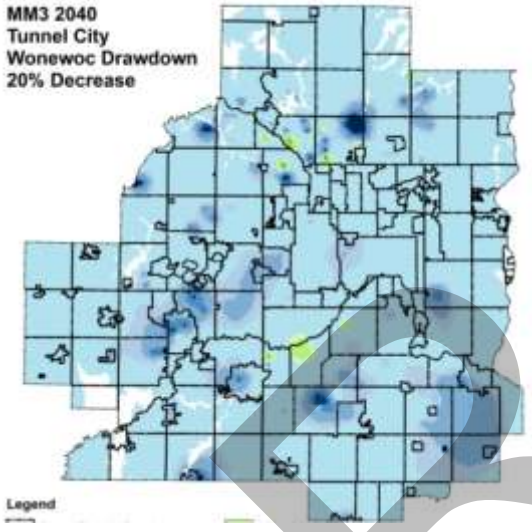
- Green areas show areas where water levels are likely to rise
- Blue-green areas illustrate places that are likely to experience relatively minor or no water level decline
- Darker blue shows areas where water levels are likely to drop the most
- Yellow illustrates where confined aquifers are especially sensitive to water level declines and where local monitoring, analysis and planning should be done to ensure that groundwater pumping does not exceed safe yield conditions, as defined in Minnesota Rules (part 6115.0630)

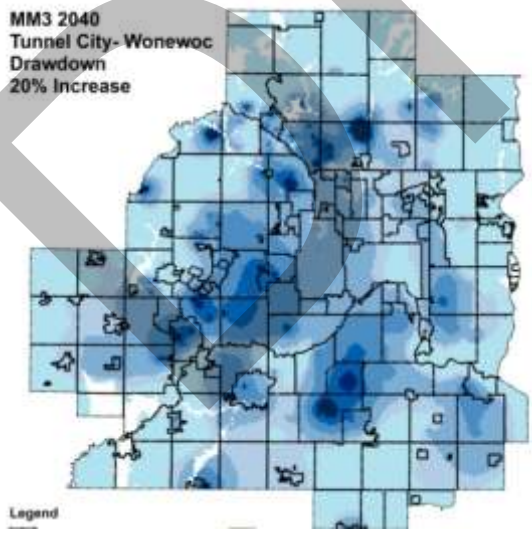
These model results include some uncertainty, which is discussed later in this chapter. As statistician George E. P. Box famously said, “all models are wrong, but some are useful”. The regional groundwater flow model, and the water demand projections it evaluates, provide useful information to consider as part of regional growth planning; it is the best tool available to illustrate “the big picture” pattern of aquifer decline that may occur if 2040 demand is supplied solely by currently (2015) planned sources.

Figure 22. Scenarios of aquifer and water table declines from Metro Model 3 groundwater model.




MM3 2040
Tunnel City- Wonewoc
Drawdown
City and Township Boundaries
Drawdown Exceeds 50% Available Head
> 40 feet of rebound
30 to 40 feet of rebound
20 to 30 feet of rebound
10 to 20 feet of rebound
5 to 10 feet of rebound
3.28 to 5 feet of rebound
3.28 to 5 feet of drawdown
5 to 10 feet of drawdown
10 to 20 feet of drawdown
20 to 30 feet of drawdown
30 to 40 feet of drawdown
> 40 feet of drawdown
up to 3.28 feet (1 meter) of change
Miles
Legend


MM3 2040
Tunnel City
Wonewoc Drawdown
20% Decrease
Legend


MM3 2040
Tunnel City- Wonewoc
Drawdown
20% Increase
Legend

Groundwater-surface water relationships

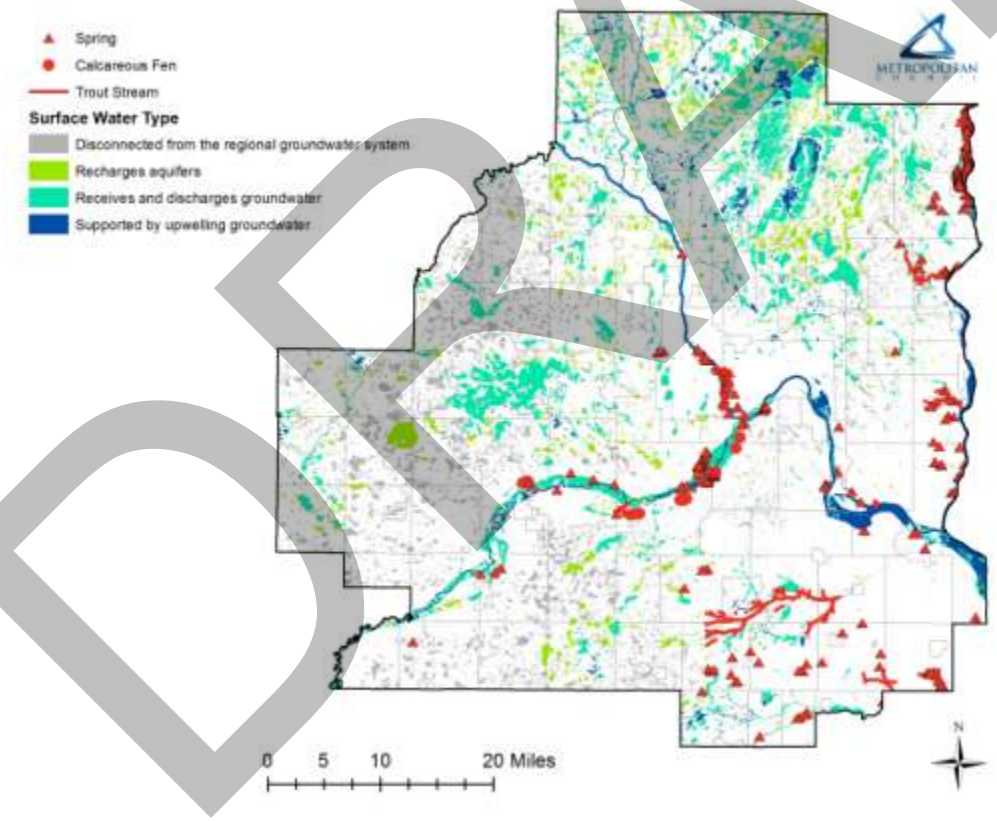
A regional evaluation of hydrogeologic conditions suggests that about half of the surface water features in the metropolitan area are likely to be directly connected to the regional groundwater flow system (Figure 23) (CITATION IN ANNOTATED BIBLIOGRAPHY). When groundwater near one of these features is pumped excessively, water levels in the surface water feature may decline and water quality changes may occur.

Some examples of surface waters under the influence of groundwater include:

- Itaska Lake in Anoka County
- Seminary Fen in Carver County
- Vermillion River in Dakota County
- Lake Minnetonka in Hennepin County
- Vadnais Lake in Ramsey County
- Savage Fen, Eagle Creek and Boiling Springs in Scott County
- Valley Creek in Washington County

Surface water impacts vary throughout the region, driven by differences in the level of development and by different hydrogeologic conditions that shape groundwater and surface water interactions.

Figure 23. Surface water features likely connected to regional groundwater flow system.



Minnesota Rules (6115.0670) specify that appropriation from groundwater shall be limited if the commissioner of the Department of Natural Resources determines that a direct relationship of groundwater and surface waters exists such that there would be adverse impact on the surface waters.

Minn. Stat., Sec. 103G.287 specifies that the applicable laws protecting surface water uses in Section 103G.285 apply to groundwater uses where there will be a negative impact on surface waters from groundwater pumping.

The following are groundwater-dependent land or surface water features at increased risk, depending on their proximity to groundwater pumping:

- State-designated trout streams
- State-designated calcareous fens
- Springs
- Surface waters where hydrogeologic conditions suggest a connection between groundwater and surface waters such that there is a potential to impact surface water levels and stream flows

These indicators should not be considered regulatory cut-offs. Rather they are to help provide information about planning expectations, so that there are fewer surprises when permits are requested or plans are made. Where groundwater and surface water are likely to interact, additional monitoring and assessment may be needed to evaluate impacts of increased groundwater pumping or stormwater best management practices.

Water quality

For several communities, water quality is a more challenging issue that water quantity. Public water suppliers are responsible for providing water that meets Safe Drinking Water Act and other state requirements. The Minnesota Department of Health is the responsible agency for all public and private water quality issues. Depending on potential contamination sources, whether the system uses wells or surface water, depth to wells, geology and past test results, the Minnesota Department of Health may test a public water supply for up to 118 different contaminants.

Surface water and groundwater supplies are susceptible both to chronic and acute contamination from natural and human-produced sources. Spills in the Mississippi River affect the Minneapolis Water Works and Saint Paul Regional Water Services systems; large industrial contamination plumes affect many groundwater users, and nitrate contamination is a considerable issue in some parts of the metropolitan area such as Dakota County.

Chronic contamination in both surface water and groundwater can have long-term public health and economic consequences. While chronic contamination of municipal supplies can often be treated once it is discovered, treatment costs may cause significant price increases for consumers and may, in severe cases, limit use of the water source. All costs associated with treating known contaminants in a public water supply are borne by that system. Private well owners also face considerable costs when groundwater supplies are contaminated.

ADD LANGUAGE FROM LOCAL PLANNING HANDBOOK PAGE FOR PROTECTION!

The following points are important to consider when evaluating risk of water supply contamination:

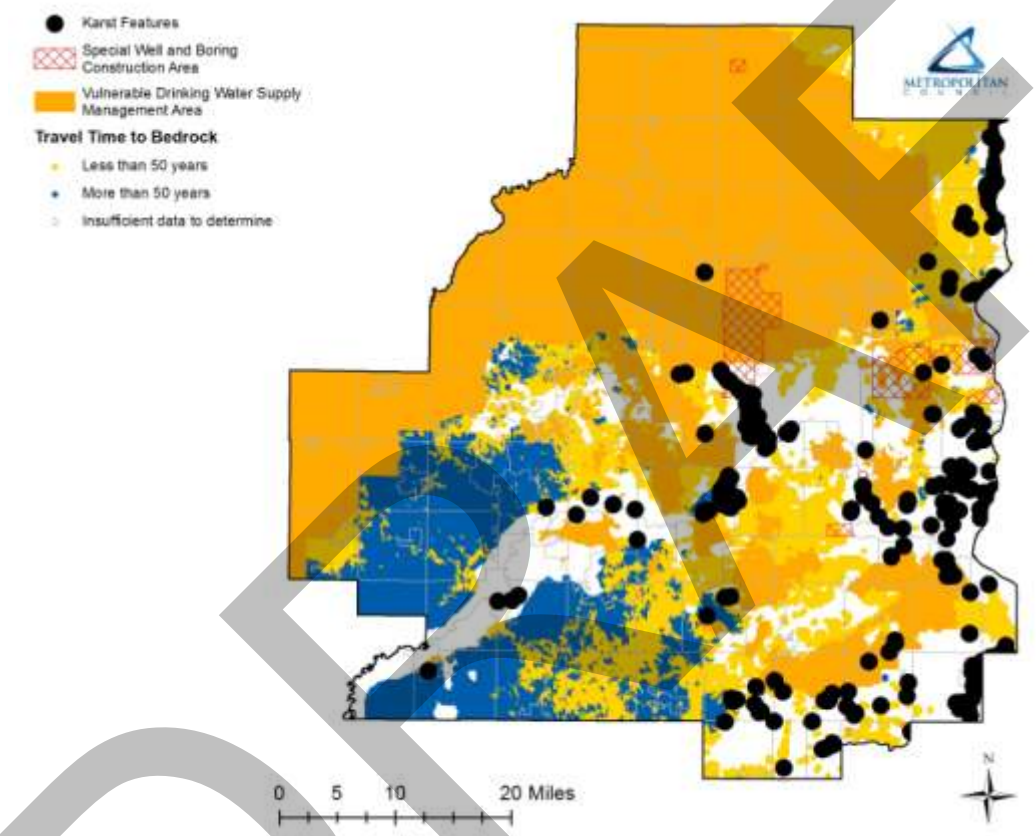
- Proximity to known areas of groundwater contamination, such as Special Well and Boring Construction Areas
- Proximity to designated Wellhead Protection Areas, Drinking Water Supply Management Areas, or Source Water Protection Areas
- Proximity to karst features such as sinkholes, which provide direct connections between land surface and underlying aquifers

- Estimated vertical travel time from land surface to bedrock aquifers

Efforts to protect and manage water supply quality should consider, as shown in Figure 24:

- Vulnerable source water protection areas (in orange)
- Designated Special Well and Boring Construction Areas (red cross-hatched areas)
- Karst features (black dots)
- The relative amount of time it takes for spills or infiltrating stormwater to reach bedrock aquifers. Blue areas take more than fifty years; yellow areas take less than 50 years; white areas have insufficient data to evaluate

Figure 24. Characteristics of land and geologic features to be considered in protection and management efforts.



Contamination issues vary throughout the region, primarily driven by differences in hydrogeologic setting and in level of development. The most cost-effective way to address contamination is usually to prevent it through source water protection.

Uncertainty regarding aquifer productivity and extent

Parts of the region have limited information about aquifer productivity and extent. There is local and regional benefit in filling these information gaps. Partners such as the Minnesota Department of Natural Resource, the U.G. Geological Survey, the Minnesota Department of Health, communities and others have an important role to play in directing resources to install monitoring wells, update geologic atlases, and conduct aquifer tests.

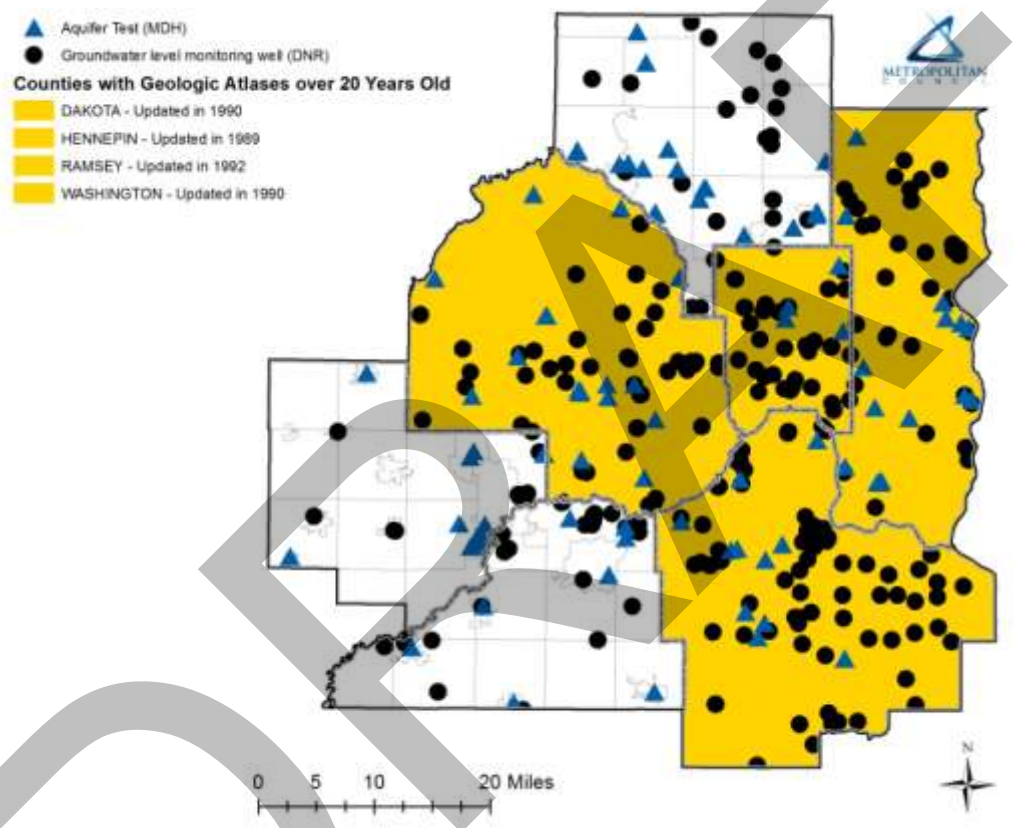
The following are some indicators of increased uncertainty regarding water supply source sustainability:

- No aquifer test in the supply aquifer has been performed within 1.5 miles of the community
- No long-term observation well data available for areas within one mile of the community
- The most recent geologic atlas is over 20 years old

Aquifer uncertainty varies throughout the region, primarily driven by differences in available data. Where wells have been drilled, for example, more data exists to support geologic mapping and other water supply assessments. Figure 25 shows the locations of:

- DNR observation wells (black circles)
- MDH aquifer tests conducted by the Minnesota Department of Health (blue triangles), and
- Counties with geologic atlases that are over 20 years old (yellow)

Figure 25. Indicators of uncertainty about aquifer sustainability.



Reliability of Water Sources

Fifty-two communities in the metropolitan area use only one source to supply all of their water demand. Major sources in the region include the Mississippi River, four major aquifers, and potentially the reuse of stormwater and wastewater.

While communities already implement a number of federal and state regulations and programs to identify and establish protocols for protecting the safety, security and reliability of their water supplies, there may be opportunities in some areas to improve the protection of water supplies as a priority for ensuring water supply reliability in the region.

The following may be indicators of reliability issues:

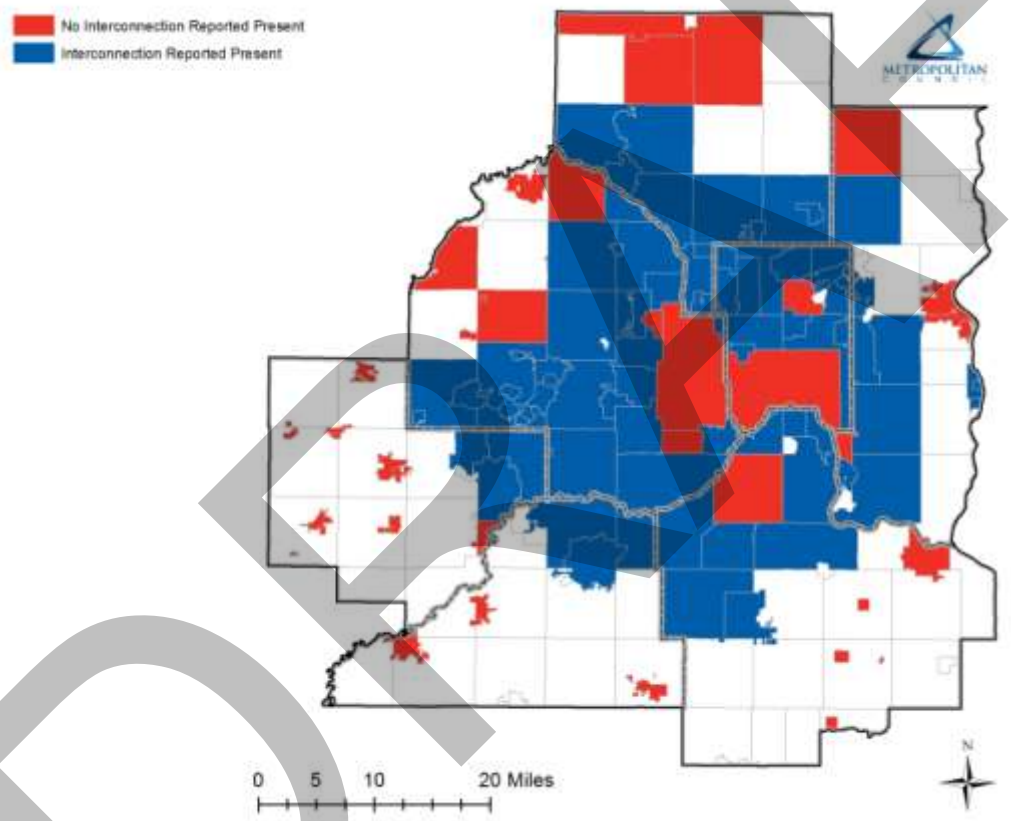
- Water supply system draws from only one water supply source, limiting back-ups in case of emergency
- No permanent emergency interconnection exists

Reliability issues vary throughout the region, primarily driven by differences in hydrogeologic conditions and level of development.

Figure 26 shows whether communities in the metro area have reported a connection to more than one water supply source (interconnection):

- Communities in blue have reported interconnections.
- Communities in red do not have interconnections.
- Communities in white do not have a public water supply system.

Figure 26. Water supply interconnection status by community.



Funding/finance

High-quality drinking water and wastewater treatment systems are essential to public health, business and quality of life. These water supply system investments are a critical, and costly, component of community planning. Costs include planning and design, capital costs, operation and maintenance costs, and costs to monitor and report compliance with regulatory requirements.

Going forward, these costs are expected to increase. The American Water Works Association and others have documented that water and wastewater infrastructure in North America – including Minnesota - is aging and that many communities and wastewater treatment providers must significantly

increase their levels of investment in its repair and rehabilitation to protect public health and safety and to maintain environmental standards.

Public water suppliers, wastewater providers, community planners, and elected officials stress the need for financial support for infrastructure changes to achieve sustainable solutions. Some examples of challenges include:

- Rebuilding and building new infrastructure
- Mitigating the revenue impact of decreased water demand, due to water conservation, on existing systems
- Addressing the need for more intense monitoring and treatment in systems with mixed water sources
- Lack of reliable and adequate funding sources for implementing many stormwater reuse opportunities

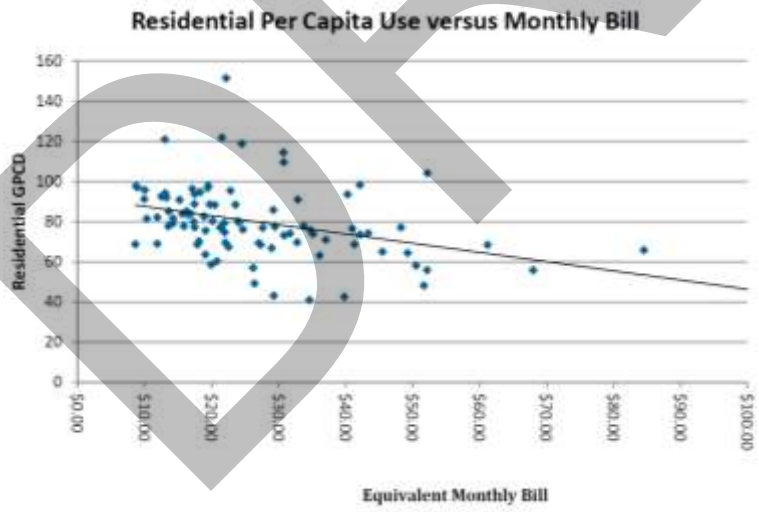
The 2015 Drinking Water Revolving Loan Fund Project Priority List illustrates the scope of the need; the list includes requests from eight metropolitan communities for over $67 million dollars to support water supply infrastructure improvements.

To provide water supply services, public water suppliers also use a variety of rate structures. A 2014 survey of public water suppliers documents the range of rate structures, provides information about how rates among communities compare, and investigates the impact that rates have on water use (CITATION IN ANNOTATED BIBLIOGRAPHY). When water rates in the metro area are normalized to one another, the monthly household bill ranges from $8.60 to $123.31, with an average of $29.10.

For comparison, the monthly average retail rate per household for wastewater service in the Twin Cities metro area was $18.00 in 2011.

There is evidence that higher monthly water bills are correlated to lower residential per capita water use (Figure 27).

Figure 27. Correlation of monthly water bills to residential per capita water use.



Infrastructure costs are one of the biggest hurdles to expanding the use of surface water and reclaimed wastewater in the region. Water treatment requirements for surface water are usually higher than for

groundwater, and most water users are located considerable distance from surface water and reclaimed wastewater sources. Even where the treatment costs are similar between groundwater and surface water, it is usually more financially feasible to gradually expand a groundwater supply system than to secure the up-front costs to construct a complete surface water system.

There are currently only two surface water treatment plants in the region, operated by Minneapolis Water Works and Saint Paul Regional Water Services. Investing in additional surface water treatment plants is a large cost. The capital cost of a new surface water treatment plant to serve select communities in the north and east metropolitan area was estimated to be $44-291 million dollars. Operations and maintenance costs for such a system are estimated to be $4-9 million per year, proportioned based on relevant Saint Paul Regional Water Services costs. Distribution costs are equally challenging. For example, an assessment of the costs and benefits of using the St.Croix River to augment White Bear Lake highlights the high costs of installing forcemain and the energy needed to pump water from the river valley up to potential users (CITATION IN ANNOTATED BIBLIOGRAPHY). In 2015, the cost to construct a 50 million gallon per day treatment plant along the Minnesota River was estimated to be $150 million (CITATION IN ANNOTATED BIBLIOGRAPHY).

Costs to collect and store large amounts of stormwater can also be costly. For example, work in Dakota County suggests that capital costs for stormwater capture and use systems for over 500,000 gallons is approximately $150,000-1,500,000 depending on the use of stormwater ponds versus underground storage systems (CITATION IN ANNOTATED BIBLIOGRAPHY).

Key Factors Contributing to Uncertainty

This chapter provides a regional screening of some key water supply issues. The information presented here provides a starting place for more localized water supply planning and technical analyses, if work is not already underway.

The analyses conducted for this plan incorporate the best regionally available technical information to answer questions of water supply availability, and much of it was collected through local studies. The information in this chapter reflects guidance by a wide variety of stakeholders based on issues identified as important at this time.

However, uncertainty is a constant factor, several questions remain unanswered, and other questions will inevitably emerge over time. Water supply planning must be done in such a way that the plans can adapt to factors such as climate changes, technology and emerging contaminants, and changing cultural priorities and attitudes.

There are different types of uncertainties related to the issues discussed in this chapter. For instance, a distinction can be made between monitoring uncertainty and uncertainty regarding future conditions. Also, science has its limitations when dealing with complex societal problems where there are many system uncertainties, and where facts and values are intertwined. And insights may change over time as new information becomes available.

Water suppliers and planners work in a dynamic environment that requires ongoing action, even in face of less than 100% certainty. This process of “learning by doing” has also been called “adaptive management’ - a structured, iterative process of decision-making, with a goal of reducing uncertainty via system monitoring.

Monitoring Uncertainty

Monitoring uncertainty generally refers to how well measurements represent real world conditions. Factors that commonly contribute to monitoring uncertainty include imprecise or inaccurate

measurement equipment, inadequate measurement frequency, the length of the monitoring record, and the spatial distribution of the monitoring sites.

When monitoring data is used to model hydrologic conditions, uncertainty in the data contributes to uncertainty in the model results. Informed decisions must be made about what data to include in model analyses and how to weight data with higher accuracy and precision more heavily than data with greater uncertainty.

The process to develop and calibrate the regional groundwater flow model (Metro Model 3) illustrates this approach. For example, multiple water level datasets were used to calibrate the model including well logs reported in the Minnesota County Well Index (CWI), DNR observation wells, and synoptic water level measurements made by the DNR and USGS. Data compiled from CWI have the most inherent error; however they have the largest geographic extent. Data from synoptic water level datasets and DNR observation wells have the least amount of error, but they are not available everywhere. All data was used to calibrate the regional groundwater model, but the CWI data was not weighted as heavily as the higher quality data (CITATION IN BIBLIOGRAPHY).

In addition to improving analytical results, a thorough examination of monitoring uncertainty identifies gaps in information where resources can be directed. For example, the process of calibrating Metro Model 3 highlighted the importance of expanding monitoring networks to assess the connection between surface waters and the regional groundwater system.

Predictive Uncertainty

The most common focus for discussions of predictive uncertainty related to this Master Water Supply Plan is the Metro Model 3 (Appendix 3) and water demand projections that the model evaluates (Appendix 2).

Metro Model 3 is a tool that supports a flexible process for water suppliers and planners to explore a wide variety of different water supply approaches under a range of potential future conditions.

Model uncertainty comes from four main factors:

1. *Conceptual framework uncertainty*
2. *Model parameter uncertainty*
1. *Calibration uncertainty*
2. *Predictive uncertainty*

Metro Model 3 predicts future aquifer conditions under a projected range of water demand. Because it is a steady-state model, it does not represent water levels for a specific day and time. Instead, it is intended to illustrate where aquifer water levels will come to equilibrium under a given water budget (recharge, pumping, baseflow). In other words, it illustrates where things will ultimately end up.

This ability to compare regional groundwater impacts under different demand and source assumptions is what Metro Model 3 was designed, conceptualized, and calibrated for. It is used as a planning tool to inform regional planning, support this Master Plan, and assess potential impacts associated with changes in regional pumping and/or land use change.

The single biggest contributor to predictive uncertainty is uncertainty in future water demand. There is some uncertainty about how many people will live in the metro, where they will live, how much water they will use, or if sources of water will remain the same. This is where input from city administrators and engineers is critical; no one knows the city and its water supply better than the city or utility staff.

Therefore, Metropolitan Council has worked closely with city staff to learn more about population, population served, per capita water use, water sources, and well locations.

Appendix 2 describes the method used to evaluate future water demand. The process included an exploration of predictive uncertainty resulting from the variability of the historical data the projection was based on and the use of different projection methods. Based on this work, water demand projections are represented as a range of future conditions.

The Metropolitan Council recognizes the error in the model compared to the real world. This error can be minimized when comparing model output to model output. Drawdown shows you the change between two conditions, the starting and ending place doesn't matter as much as the difference between the two conditions.

Table 2: Uses for "out of the box" Metro Model 3

Acceptable	Marginally Acceptable*	Not Acceptable
Compare regional scenarios	General well field placement	Localized well field optimization
Compare sub-regional scenarios	Estimate groundwater/surface water connections	Site specific evaluations
Identify areas where more information is needed	Wellhead protection plans	Predicting time dependant water table elevations
Identify possible problem areas		

*The model can be used as a "back of the envelop calculation" giving the user an idea of a starting place for further analysis.

Metro Model 3 supports a flexible process for water suppliers and planners to explore a wide variety of different water supply approaches under a range of potential future conditions. This type of exercise can inform a broad range of discussions among local water supply providers and other partners about potential water supply approaches. Working collaboratively with the local providers will be the pathway to success in the area of sustainability.

Other Sources of Uncertainty

Uncertainty regarding predictions of future climate, technological capabilities and limitations, and future priorities are also important factors to consider when planning approaches to supply future water needs.

For example, longer growing season and increased risk of drought may change the region's water demand, sustainable limits on water supply sources, the severity and types of issues affecting the region's water supply sources, and the priorities set by decision makers.

The 2014 Minnesota State Hazard Mitigation Plan concludes that it is clear that temperatures are rising and weather patterns are changing, with an increase in severe weather events and extreme precipitation. The impacts of this change on water supplies is not fully understood, however.

Many difficult-to-predict technological changes have significant implications for sustainable water supply management. Examples include the development of new chemicals which may or may not lead to new drinking water quality standards , advancements in our water quality testing laboratories that allow contaminants to be detected at very low levels, and new water treatment technologies that may allow for increased use of water sources previously thought to be unusable.

6. Moving toward water sustainability: Outcomes

Introduction

The Master Water Supply Plan's goal is a sustainable water supply for the region, which supports the broader regional vision of moving toward sustainability described in *Thrive MSP 2040*.

This chapter identifies some measureable outcomes that can be tracked to monitor progress toward the goal of sustainability. These outcomes will reduce the water supply issues identified in Chapter 5.

Sustainable Water Use

This Master Plan has a single overarching goal: The region's water supply is sustainable now and in the future. The region's water supplies will be considered sufficient and sustainable when:

- Sustainable amounts of groundwater are planned and use
- Demand exceeding sustainable groundwater withdrawal rates is supplied by the most feasible combination of surface water, reclaimed wastewater and stormwater reuse
- Legislative changes are made that align agency directions on all aspects of water supply

Figure 26 compares projected water use with the sustainable limits of available sources. The chart on the left shows projected water demand compared to the sum of available water supply sources. The charts on the right show projected water demand compared to each water supply source individually.

Figure 26. Projected water use versus sustainable limits on available water supply sources in the metro area. [Being updated by Communications]

Regional groundwater modeling indicates that the maximum amount of groundwater that can be sustainably withdrawn from areas near existing high capacity wells is currently estimated to be approximately 400-500 million gallons per day. Subregional and local hydrogeologic conditions affect the amount of groundwater that can be withdrawn in different parts of the metropolitan area. Table 1 summarizes the subregional estimates of sustainable groundwater withdrawal rates. Demand above these rates may require new investments – either exploration of new well fields and expanded distribution or development of new sources and/or more aggressive water conservation.

Table 3. Summary of the subregional estimate of sustainable groundwater withdrawal rates.

Subregion	Estimated Sustainable Groundwater Withdrawal Rate (MGD)	Difference between Estimated Sustainable Groundwater Withdrawal Rate and 2040 Projected Groundwater Withdrawal Rate	Key types of constraints on groundwater availability
North and East		Qualitative description - TBD	
Southeast		Qualitative description – TBD	
Southwest		Qualitative description – TBD	
Northwest		Qualitative description – TBD	
North		Qualitative description – TBD	
West	Range - TBD	Qualitative description - TBD	

The information presented above is a general estimate of the amount groundwater sustainably available in different parts of the Twin Cities metropolitan area. This information is intended to inform regional and sub-regional planning activities and to help track progress toward regional goals. At this scale, this information is not appropriate for using in local permit decisions. More information about the method used for this estimates is in Appendix 4.

Supporting Outcomes

Water conservation

Desired Outcomes:

That, as a region, the average total municipal (including residential, commercial, and industrial) per capita water use is 90 gallons or less per person per day; the ratio of summer to winter monthly water use is equal to or less than the 1990-1994 average ratio as discussed in Chapter 3; and the per capita residential water use is equal to or less than 75 gallons per capita per day.

Based on its policy on water conservation and reuse, the Council will work with partners to identify emerging issues and challenges for the region and to work together on solutions that include the use of water conservation.

Analysis of historical and projected water use and population data shows that decreasing the average total municipal per capita water use from its 2010 rate of 125 gallons per person per day to 90 gallons per person per day, 2040 population growth could occur with no regional increase in water use by municipal public water supply systems.

By decreasing the summer versus winter monthly ratio to 1990s levels, the region could achieve a 15% reduction in total water use, reducing the need for infrastructure expansion for many communities.

Measures

- Regional average total municipal water use per person
- Winter versus summer water use
- Regional average residential water use per person

Increased collaboration

Desired Outcomes:

That work groups are formed and active in all hydrogeologic subregions and include participation by all water sectors including regulatory agencies and public and private entities, and supported by the Metropolitan Council.

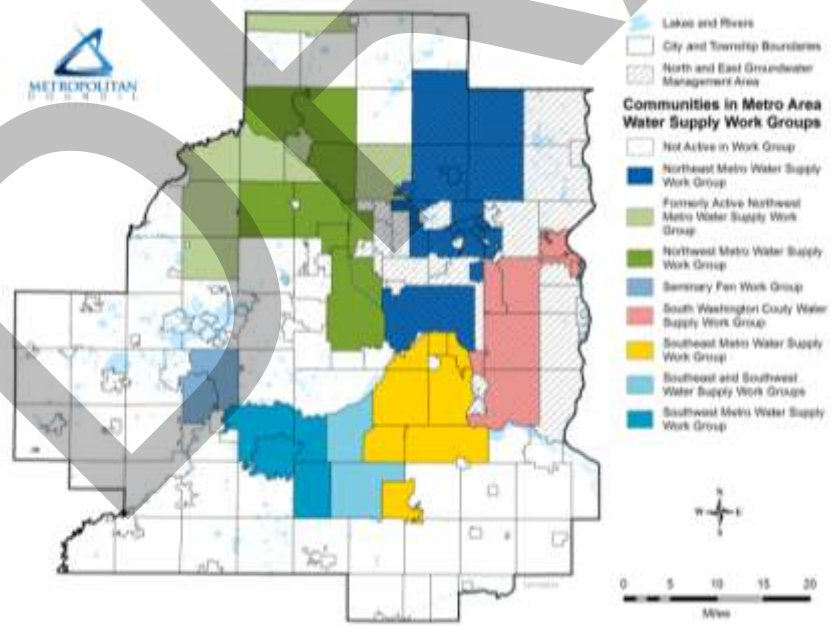
That all public water suppliers have emergency supplies through interconnectivity or multiple sources of water, including emergency connections.

As the Metropolitan Council works with local partners to identify and implement the best options for their situations, subregional feasibility analyses will be done, guided by local work groups, to evaluate the costs and benefits of different approaches. This information can inform local water supply plan updates, permits, environmental review documents, county groundwater plans, and source water protection plans, as appropriate. Figure 27 shows participating communities in the work groups.

Measures

- Number of partners participating in Council-facilitated work groups
- Number of partnerships reported in local water supply plans (updated on 10-year cycle)
- Number of subregional solutions acted on and implemented

Figure 27. Communities participating in subregional work groups in 2015.



Improved planning and plan implementation

Improved Local Planning Assistance

Desired Outcome:

By 2016, the Council will provide a level of technical assistance that ensures that communities clearly understand plan and permit expectations for consistency with Council policy and the Master Water Supply Plan. Local comprehensive plans, including implementation plans that support regional water supply sustainability, will be approved by 2020.

A community's comprehensive plan is expected to accommodate the population and employment forecasts and to meet the densities specified in the Council's Thrive MSP 2040 plan.

A community's comprehensive plan must include:

- A water supply plan that is informed by the Twin Cities metro area Master Water Supply Plan and meets the Department of Natural Resources plan requirements
- A local surface water management plan that is consistent with Minnesota Rules Chapter 8410 and Council policy and does not adversely impact the regional wastewater system, and
- A comprehensive sewer plan that is consistent with the regional wastewater system plan.

Measures

- Communication, internal and external
- Record of planning guidance provided, including workshops, presentations, planning tools provided, and other related information
- Approved community comprehensive plans

Implementation of alternative water source projects

Desired Outcomes:

Use of surface waters, reclaimed wastewater and stormwater for appropriate water uses becomes an option explored by communities and implemented by many.

As partners collaborate to identify and implement the best water supply options for different parts of the region, it may become clear that the least expensive, most expedient water supply options may not be sustainable. In those cases, alternative water supply sources may be needed.

Subregional work groups are exploring the costs and benefits of alternative water supply approaches. Examples of existing projects and lessons learned are highlighted in Appendix 5.

Measure

- Projects accomplished? Volume of water used from alternative sources?

Source water assessment and protection

Aquifer levels are protected and enhanced

Desired Outcomes:

Groundwater is adequately monitored across the region, and all groundwater observation wells in the seven county metropolitan area show a steady or upward trend.

Groundwater levels are the most direct indicator of groundwater sustainability. Trends in groundwater levels will be monitored regularly to evaluate impacts of changes in water supply management. Due to the slow recharge rates of some aquifers, it is expected that a significant delay may occur between water supply management changes and response in groundwater levels. Groundwater level monitoring must occur over the long-term.

Measure

- Trend in groundwater observation wells and piezometers, including those located at fens and trout streams

Source water areas are protected

Desired Outcomes:

Potential contaminant sources are reduced and/or restricted in areas identified as sources of public drinking water supplies.

Protection of source water is a way to prevent drinking water from becoming polluted by managing potential sources of contamination in the area that supplies water to a public well or surface water intake. Much is done to prevent pollution, such as the wise use of land and chemicals. Public health is protected and expense of treating polluted water or drilling new wells is avoided though source water protection efforts.

Measures

- Number of wells sealed in wellhead protection areas
- Planning and zoning controls for wellhead protection areas

7. Taking action

Introduction

Currently, over 100 independent water supply systems operate throughout the region, and regional sustainability hinges on collaboration among these many systems. There is no simple solution, no one answer. Rather, the future of water management will involve many partnerships and tweaks and enhancements to a highly complex set of systems. The approaches will be varied, they will be creative, and they will require nimble thinking.

Now is the time to be thoughtful about our water future and take action to protect our water supply. Water supply planning should not be done "after the fact", when options are limited, more costly, or possibly more harmful to the natural environment. The plans made now for the growth and expansion of the region should lay out a combination of steps that will keep our water supply safe and plentiful for generations to come.

In partnership with key water supply stakeholders, the Metropolitan Council will help the region achieve a sustainable water supply by implementing the water supply policies of the Council's *Water Resources Policy Plan* consistent with the principles and information provided in this Master Plan.

This chapter provides more detail about implementation strategies including: deliverables, milestones, key partners, estimated resources needed and tracking criteria. More information about the Council's responsibilities and partners' potential roles related to these actions are discussed in Chapter 8.

Approach

Providing sustainable water supplies across the region is a huge and ongoing endeavor. Our water supplies and the resources they support are a dynamic system that changes through time. Public water suppliers, planners, scientists and engineers have been working together on this challenge for over a century (Hall et al, 1911); this will continue to be a critical effort.

While this is an iterative process, experience shows that efforts tend to be most successful when the process includes certain steps (Table X) (Appendix 5). The Metropolitan Council's approach to regional water supply plan implementation supports these steps by promoting a region-wide process for water supply education, subregional collaboration, water supply research, and technical and planning assistance.

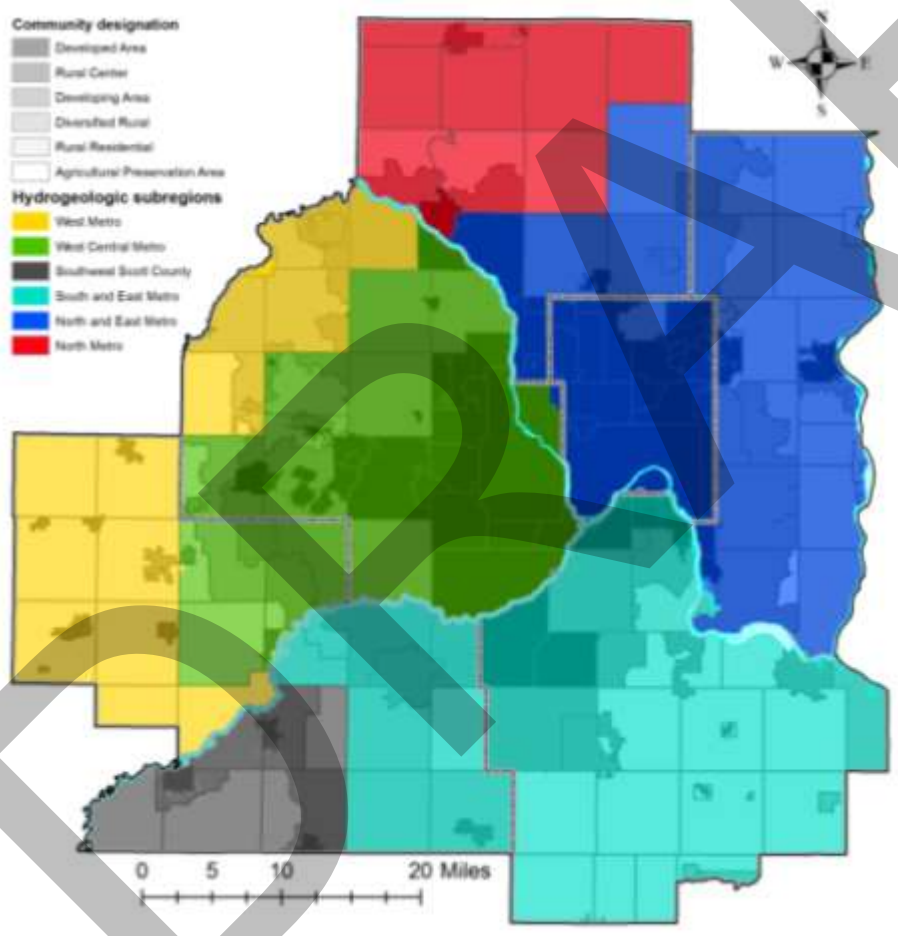
Table 4. Steps in the Metropolitan Council's approach to support sustainable water supply planning.

Step	Council Role	Local Role
Increased Public Knowledge	Support public forums, meetings, training opportunities	Support public forums, meetings, training opportunities
Water Supply Problem Identification and Analysis	Regional and subregional source assessments, mapping	Local monitoring and aquifer testing and analysis, mapping
Identification of Possible Solutions	With partners, identify categories of water supply approaches	Identify local details for each category of possible approach
Analysis of the Feasibility of Possible Solutions	Provide financial resources and contract management	Guide analyses, provide local inputs, review results
Selection of Preferred Approaches	Recommend decisions that provide regional benefit while serving local needs	Select approaches that serve local needs while proving regional benefit
Project Approval and Funding	Commit resources as	Commit resources and request

Step	Council Role	Local Role
	appropriate for wastewater reuse-related projects; identify and recommend potential funding mechanisms for others	additional funding as needed
Build, Operate and Maintain	Implement wastewater reuse as appropriate	Implement other approaches as appropriate

This Master Plan recognizes that subregional and local differences in water availability and potential issues. To ensure that planning support is provided across the region's varied hydrogeologic settings, the Council has identified six sub-regional planning areas based on hydrologic boundaries and generally reflecting groupings of similar resources and other development characteristics (Figure x). This subregional framework does not impose regulatory limitations or requirements; it is solely for purposes of planning and technical analysis.

Figure X. Map of hydrogeologic subregions (SIMPLIFY TO ONLY INCLUDE 6 SUBREGIONS).



Funding

Funding for Master Water Supply Plan implementation strategies comes from multiple sources.

- The Council's property tax levy, separate from its wastewater rates, helps to support outreach and data management components of water supply-related strategies.

- Fees derived from cost of wastewater service support water supply-related strategies are tied to meeting wastewater regulatory requirements, implementing MCES infrastructure rehabilitation and repair needs, and providing wastewater capacity for growth consistent with the Council's Thrive MSP 2040.
- State revenue – the Clean Water Fund in particular - supports technical projects undertaken by the Council with regard to water supply planning.

Schedule

The timeline in Figure 31 illustrates the major milestones, and subsequent text provides more detail, including key milestones from each strategy.

Figure 31. Timeline of major milestones toward water sustainability.

Year(s)	Major Milestone
Ongoing	Outreach, education, data collection and analyses, tool development
2020	Subregional work groups established in each hydrogeologic subregion All local water supply plans are informed by the Master Water Supply Plan, and local controls are adopted
2025	All local water plans and watershed management plans are informed by the Master Water Supply Plan
2024	Master Water Supply Plan updated prior to update of *Water Resources Policy Plan* and to reflect updated regional development framework
2027	All wellhead protection plans are informed by the Master Water Supply Plan
2021-2030	Water supply technical information informs Crow River and Northeast Area wastewater reclamation facilities
Post-2040	Water supply technical information informs East Bethel Wastewater Reclamation Facility Expansion Long-term Capital Improvement Program continues to support wastewater reclamation and reuse

Progress and New Strategies

The 2010 Master Plan described activities intended to meet 6 regional objectives:

1. Improve the predictive accuracy of the Twin Cities Metropolitan Area Groundwater Flow Model Version 2.00 (Metro Model 2).
2. Assess local conditions in areas where this plan predicts that issues may arise should withdrawals continue at projected levels and from traditional sources.
3. Develop a more thorough understanding of aquifer extent, capacity, and recharge, as well as long-term trends in the levels of the region's surface and groundwater systems to manage future water supply availability.
4. Develop a better understanding of the distribution of natural and manmade contaminants and source water vulnerability.

5. Guide water supply development toward regionally optimal locations and sources.
6. Incorporating new information and using updated tools will improve the evaluation of new pumping sources, locations, and pumping rates to determine regionally optimal withdrawal scenarios.

Since then, many projects have been undertaken and multiple sub-regional work groups have been formed and begun analyses of various water supply approaches. Examples include update of the Metro Model 2 to Metro Model 3; mapping of aquifer properties to provide better local and regional information about aquifer extent, capacity, recharge and vulnerability to contamination; an updated Conservation Toolbox and a new Stormwater Reuse Guide. More information about these and other efforts are available on the Council website at *http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning/Studies-Projects-Workgroups-(1).aspx*

One of the outcomes of previous work, particularly efforts by sub-regional water supply work groups, is the identification of remaining gaps in information and implementation tools. Some key information and tools are still needed to support the approach outlined in Table 4 above.

The rest of this chapter outlines strategies to address water supply needs that were identified through previous projects, by subregional work groups, and through the update of the *Water Resources Policy Plan*:

- Collaborate with partners to update the Master Water Supply Plan
- Review and comment on plans and permits
- Increase knowledge of subregional and regional water supply issues
- Technical studies
- Research and promote practices that protect and enhance water sources
- Promote and support water conservation
- Investigate reusing treated wastewater
- Support investments in water supply

For each strategy, information is provided about key partners and their possible roles and what successful achievement of the strategy might look like.

The desired achievements identified for each strategy reflect input from the region's many water supply stakeholders. However, their success is dependent on the availability of Metropolitan Council and partners' funding and staffing resources.

Collaborate with partners to update the Master Water Supply Plan

The Metropolitan Council will collaborate with state agencies, watershed organizations, and community water suppliers to update the regional Master Water Supply Plan. This effort helps to implement Council's Water Resources Policy Plan policy on sustainable water supplies, and it supports community efforts to improve water supply resiliency through the identification and evaluation of potential water supply issues and economically and technically feasible water supply alternatives.

This collaboration with agency partners is critical to ensure water supplies are sufficient and sustainable for the region's current population and projected growth. For example, increased collaboration will address the issue of regulatory complexity that was repeatedly raised by stakeholders during the update of the Master Water Supply Plan. Collaboration may reduce or eliminate contradictory regulations, may better leverage program funds to support common goals, and coordinate guidance that may help communities and water suppliers focus on actions that provide multiple water resource benefits and shift the region to a more sustainable mix of water supply approaches.

Progress will be documented through outreach event and work group meeting materials, progress reports, public comments on the draft plan, and plan approval notification.

Key Partners	Activities
Metropolitan Council	• Lead the effort to update the Master Water Supply Plan and provide staff support, guided by policy and technical work groups • Provide public engagement opportunities throughout the process
Communities/ Water Suppliers	• Participate on policy and technical work groups to provide guidance regarding policy and to share relevant technical information
DNR	• Provide staff participation on policy and technical work groups to provide guidance regarding policy and to share relevant technical information • Approve the updated Master Water Supply Plan
Others	• Provide staff participation on policy and technical work groups to provide guidance regarding policy and to share relevant technical information

Achievements (what successful achievement of this strategy might look like)

- The Master Plan continues to reflect regional policies and provides the most up-to-date information about the region's water supplies, emerging issues, and water supply alternatives
- Consistent and regular communication of regulatory and planning expectations
- Ongoing relationship building among potential partners

Review and Comment on Plans and Permits

The Council will review and comment on:

- Local water supply, source water protection, surface water, comprehensive sewer, and county groundwater plans as required by Minnesota Statutes
- Groundwater Management Areas and water appropriation permits as requested by the Minnesota Department of Natural Resources

This effort helps to implement Council's Water Resources Policy Plan policy on sustainable water supplies, and it fulfills statutory responsibilities to support local planning. Through this process, which includes local planning assistance, local plans will be better coordinated. Progress will be documented through formal review comments.

Key Partners	Activities
Metropolitan Council	• Provide local planning assistance to communities in the development of local water supply plans, through the Local Planning Handbook, participation on planning teams, and other venues • Review local water supply plan, using review criteria outlined in the Local Planning Handbook and coordinate comments with DNR, communities and others • Maintain a process to review wellhead protection plans and share recommendations with MDH, communities, and water suppliers • Maintain a process to review water appropriation permits upon request, and share recommendations with DNR, communities, and water suppliers • Maintain a process to review county groundwater plans and share recommendations with counties, communities, and others • Support DNR, communities and water suppliers in developing and implementing a plan for the North and East Metro Groundwater Management Area, and other areas as needed. May include directing technical work to fill information gaps and promote water conservation/reuse
Communities/ Water Suppliers	• Fulfill statutory obligations for water supply planning, water supply-related permits • Complete local water supply plan template, with for input from neighboring and overlapping jurisdictions, adopt final plans • Complete source water protection plan, with input from neighboring and overlapping jurisdiction, adopt final plans • Complete local water supply plan • Work with DNR in the development and implementation of a Ground Water Management Area, should one be designated • Input on county groundwater plans, watershed management plans
DNR	• Issue water appropriation permits and amendments, supported by a process to solicit and incorporate recommendations from partners • Lead the development and implementation of Groundwater Management Area plans • Approve local water supply plans
Others	• As a neighboring or overlapping jurisdiction, provide input on local water supply plans, source water protection plans, county groundwater plans, permits, Ground Water Management Area plans • As a responsible agency, adopt or approve plans as required

Achievements (what successful achievement of this strategy might look like)

- Regional technical and planning information exchanged with partners as part of collaborative efforts related to GMAs, source water protection, etc.
- Local Planning Handbook and other technical and planning assistance provides clear guidance and support for local planning
- By 2020, updated local comprehensive plans, including water supply plans, that reflect the Master Water Supply Plan and supported by adoption of local controls and capital improvement plan
- By 2027, all wellhead protection plans reflect the Master Water Supply Plan and local water supply plans

Increase Knowledge of Subregional and Regional Water Supply Issues

The Metropolitan Council will facilitate discussions on water supply issues that transcend community boundaries, though subregional work groups and on an ad hoc basis as needed. This effort supports Council policy on sustainable water supplies.

Subregional information sharing is needed to achieve the following outcome: water supplies are sufficient and sustainable for the region's current population and projected growth. Subregional discussions help to address the issue of water conflicts among different users, options for funding/finance, and sharing information to ensure everyone is working from the same base of the best available information.

This inclusive effort supports a common understanding of the region's water supply issues and vision, and it generates endorsement of collaborative efforts to achieve sustainability. Progress will be documented through deliverables such as work group meeting materials, public forums, and presentations to local and sub-regional organizations.

Key Partners	Activities
Metropolitan Council	• Provide staff and materials to facilitate subregional work groups as needed • Provide staff and education materials for public forums and workshops • Develop process and tools to collect and manage data as needed
Communities/ Water Suppliers	• Support staff and community participation on work groups to provide guidance regarding policy and to share relevant technical information
DNR	• Support staff and community participation to provide guidance regarding policy and to share relevant technical information
Others	• Support staff and community participation to provide guidance regarding policy and to share relevant technical information

Achievements (what successful achievement of this strategy might look like)

- Improved collaboration supported through training opportunities for emergency response and other issues.
- Increased awareness of regional, subregional and local water supply issues and solutions through support for educational events such as water supply displays at local events and subregional and regional water forums/public meetings.
- Consistent and regular communication of regulatory and planning expectations, how the need for technical projects was identified and scoped through work group and other public meetings, and how potential solutions to water supply issues are identified
- Ongoing relationship building among potential partners through annual or more frequent meeting of subregional water supply work groups
- Process employed to reach some consensus on "desired conditions" that shape definition of sustainable water supply and on possible approaches that might be implemented to achieve it
- Enhanced information and resource sharing to identify and fill gaps in monitoring networks and technical information
- Local technical work leveraged to increase the value of regional and subregional studies
- Increased impact of water supply project implementation, due to resource sharing
- Facilitated training in emergency response provided to communities on an annual basis.
- Enhanced information sharing and technical guidance (including lessons learned) implementing alternative water supply approaches such as water conservation, enhancing recharge, and expanding the use of groundwater, surface water and reclaimed stormwater and wastewater

- Implement groundwater recharge and irrigation (for example, golf courses) in East Bethel and demonstrate reuse with University of Minnesota at UMore park, as demonstration projects for the region

Technical studies

In partnership with others, the Council will:

- Work with our partners to fill gaps in assessments of lake, stream, river, and groundwater data.
- Maintain a regional database that contains easily accessible water quality, quantity and other water related information collected as part of the Council's monitoring programs.
- In partnership with others, complete technical studies to understand regional and subregional long-term water supply availability and demand.
- Support community efforts to identify and evaluate the economic and technical feasibility of water supply approaches and best practices that increase water conservation, enhance groundwater recharge, and make the best use of groundwater, surface water, reclaimed wastewater, and stormwater.

This effort supports Council policy on assessing and protecting regional water resources. Technical information generated through these efforts will also support the other strategies outlined in this chapter. Progress will be documented through progress reports and project deliverables.

Key Partners	Activities
Metropolitan Council	• Support regional and subregional technical studies by convening subregional work groups, managing consultant contracts, and provide technical expertise
Communities/ Water Suppliers	• Participate in subregional work groups to shape scope of work, review interim and final deliverables
DNR	• Participate in subregional work groups to shape scope of work, review interim and final deliverables
Others	• Participate in subregional work groups to shape scope of work, review interim and final deliverables

Achievements (what successful achievement of this strategy might look like)

- Public review process supported through technical advisory committees and other venues
- Identification and prioritization of areas by monitoring partners, such as where enhanced groundwater monitoring is needed to better characterize groundwater and surface water interaction
- Ongoing monitoring of key resources
- Identification of subregional indicators for desired conditions
- Collaborative process and tools developed to collect and manage water supply infrastructure data
- Regional and subregional technical studies provide information to support regional and local water supply planning and implementation. Examples of projects identified by stakeholders through the Master Water Supply Plan update process include:
  - The effectiveness of new water conservation technologies and planning and zoning controls are evaluated
  - Identification of high-potential recharge areas
  - Subregional groundwater modeling, including transient and optimization models, in all six hydrogeologic areas
  - Evaluation of how stormwater reuse potential varies across the metro
  - Data collection and analyses supporting revision of curve runoff numbers and stormwater, recharge, and groundwater models
  - Stormwater reuse tools supported and projects implemented
  - Evaluation and development of best management practices to mitigate local water supply issues

- Examples of how conservation makes financial benefit for a range of community types
- Data developed to better estimate the costs and benefits of stormwater capture and recharge projects

Promote and support water conservation

The Metropolitan Council will promote and support water conservation measures, including education, outreach and tool development. These efforts support the Council's policy on water conservation and reuse.

The value of water conservation was a common theme at public meetings and other outreach for this Master Plan. Some challenges that need to be overcome were also identified, including:

- Mitigating the impact of decreased water use on utility revenue
- Lack of funding for local education, incentive and enforcement activities
- Different conservation approaches for different users (e.g. residents, industries, agricultural irrigators)
- Building public support

Key Partners	Activities
Metropolitan Council	• Maintain the Conservation Toolbox • Partner with Minnesota Technical Assistance Program (MnTAP) to conduct water audits • Develop planning goals and metrics for assessing the wise use of water
Communities/ Water Suppliers	• Connect key local water users, decision-makers with information to shape water use • Adopt policies, ordinances and fee structures that promote the water conservation
DNR	• Adopt and enforce policies to ensure permitted water users are incorporating conservation practices in their operations
Others	• Support water conservation efforts

Achievements (what successful achievement of this strategy might look like)

- Agency partnerships enhance information about municipal, industrial and agricultural conservation and reuse opportunities
- A grant program is initiated and supported to implement water conservation, reuse and/or cooperative water use practices
- Tools such as the Conservation Toolbox are developed, maintained and promoted
- Documented increase in water conservation awareness and implementation
- Evaluation of effectiveness of conservation best management practices for long-term reductions and for emergency/contingency planning across different community settings

Investigate reusing treated wastewater

The Council will investigate reusing treated wastewater to supplement groundwater and surface water as sources of water to support regional growth, and when cost-effective, implement reuse. These efforts support the Council's policy on water conservation and reuse.

Key Partners	Activities
Metropolitan Council	• Lead by example to maximize wastewater reuse within Council wastewater treatment facilities • If feasible, integrate nonpotable water systems into plans for future regional wastewater reclamation facilities • Facilitate collaboration with regulatory agencies to clarify reuse project requirements • Collaborate with partners to demonstrate reuse
Communities/ Water Suppliers	• Partner with Metropolitan Council to reuse treated wastewater, where feasible
DNR	• Collaborate, advise
Others	• Collaborate, advise

Achievements (what successful achievement of this strategy might look like)

- Increase wastewater reuse within Council wastewater treatment facilities – that is, lead by example
- Water audits conducted at all Metropolitan Council wastewater treatment facilities
- Develop and implement a plan to address the key implementation challenges associated with a nonpotable water system for toilet flushing and irrigation uses
- State regulations governing reuse are clarified
- Enhanced information about industrial reuse opportunities
- Reuse demonstrated through partnerships between Metropolitan Council and nonpotable water users
- Integrate nonpotable water systems into plans for future regional wastewater reclamation facilities.
- Wastewater investments consider regional water supply benefits

Support investments in water supply

The Council will support cost-effective investments in water supply infrastructure to promote sustainable use and protect the region's water supply by:

- Developing criteria to identify water supply projects with regional benefit
- Promoting equitable cost-sharing structure(s) for regionally-beneficial water supply development projects
- Supporting cost-benefit analyses of alternative water supply options
- Identifying funding mechanisms for regionally-beneficial water supply development projects

These efforts support the Council's policy on investment.

Key Partners	Activities
Metropolitan Council	• Promote state funding for regionally beneficial infrastructure projects at the state legislature • Support local and subregional efforts to develop cost-sharing structures and other approaches to secure funding for regionally beneficial infrastructure projects by connecting local planners and subregional work groups with funding sources • Gather information and collaborate on methods to estimate costs
Communities/ Water Suppliers	• In partnership with neighbors, lead discussion/direction to explore and implement various water supply approaches as needed • Collaborate on methods to estimate costs and benefits of various approaches
DNR	• Collaborate, advise
Others	• Collaborate, advise

Achievements (what successful achievement of this strategy might look like)
• Criteria developed to identify water supply projects with regional benefit • Promotion of equitable cost-sharing structure(s) for regionally-beneficial water supply development projects • Cost-benefit analyses of alternative water supply options completed, with key costs estimated in a way that allows for comparison between alternative approaches • Funding mechanisms for regionally-beneficial water supply development projects identified • Interconnections, such as one between Minneapolis Water Works and Saint Paul Regional Water Services, are supported • Legislative funding requests for regionally-beneficial projects are supported

Tracking implementation

Implementation will be tracked to ensure success.

Partners	Activities
Metropolitan Council	• Develop benchmarks • Track and report on benchmarks
Communities/ Water Suppliers	• Provide data
DNR	• Provide data
Others	• Provide data

Achievements (what successful achievement of this strategy might look like)
• Measureable benchmarks are developed and periodically reviewed • Data collection and analysis support benchmark reporting • Progress toward outcomes is reported annually

Staff, Contract, and Materials Needed

Council staff resources are needed to support the activities set forth in this chapter. In addition, some activities will result in costs for outside consulting services, printing, and other expenses.

Activity	Planning Hours	Eng./Sci. Hours	Outreach Hours	GIS/IS Hours	Finance Hours	Contract Needed	Materials Needed
Collaborate with partners to update the Master Plan	Yes	Yes	Yes	Yes	No	Yes	Yes
Review and comment on plans and permits	Yes	Yes	Yes	No	No	No	Yes
Increase knowledge of water supply issues	Yes	Yes	Yes	No	No	Yes	Yes
Technical studies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Promote water conservation measures	Yes	Yes	Yes	No	No	Yes	Yes
Investigate reusing wastewater	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Support investments in water supply infrastructure	Yes	Yes	Yes	No	Yes	Yes	Yes
Tracking Implementation	Yes	Yes	Yes	No	No	Yes	Yes

8. Roles and responsibilities

Introduction

Everyone has a responsibility for sustainable water supply planning and management. Collaborative actions are needed at the individual level, the community level, the regional level, and the state and federal level. This chapter describes those responsibilities and highlights the roles and responsibilities that support the implementation of the Master Water Supply Plan and achieving regionally sustainable water management.

This Master Water Supply Plan recognizes that community public water suppliers are responsible for managing the largest category of non-consumptive water use in the metropolitan area; they are required to provide a safe and adequate supply of water.

Metropolitan Council's water supply role is to work with partners to develop a regional plan, maintain a base of technical information, provide assistance to communities in developing their local water supply plans, and to identify approaches for emerging issues.

Minnesota Department of Natural Resources supports sustainable use of water through the water appropriation permit program, information collection and analysis activities, law enforcement responsibilities, education and technical assistance opportunities.

Sustainable water management is most successful when these efforts are coordinated. Despite an ever increasing level of coordination among the state agencies, there remains confusion among stakeholders as to who does what and where to get the information and answers they seek.

Summary of Roles

The metropolitan area's water supply management activities are divided among multiple partners; the Anoka County 2014 Water Resources Report provides an excellent summary of partner responsibilities (CITATION IN ANNOTATED BIBLIOGRAPHY). This Master Water Supply Plan focuses on a few key partners driving the successful implementation of the plan: high volume private water supply (well) owners, communities and public water suppliers, the Metropolitan Council, and the Minnesota Department of Natural Resources. Other agencies, counties, and watershed management organizations provide additional support. Coordination of these many water management activities occurs in four areas that support sustainable water supplies:

1. **Ongoing local implementation and support for local implementation** is at the heart of the Master Plan strategy for sustainable water supplies.
2. **Monitoring and assessment** determines the condition of the region's source waters and informs future implementation actions.
3. **Regulation** helps ensure the best use of water resources for economic, environmental and social interests and provides for equity and fairness among water users
4. **Planning** is where information comes together in regional, subregional, and local commitments for prioritized, targeted, and measureable action.

Key Partners

- *Private Water Supply (Well) Owners* develop, maintain and use infrastructure (primarily wells) for domestic, industrial or agricultural purposes.
- *Communities/Public Water Suppliers* provide water to customers in compliance with Safe Drinking Water Act standards, set rates to support system, develop and maintain infrastructure,

monitor drinking water quality and quantity, may regulate water use and well drilling, and plan for land use, water supply and capital improvements.

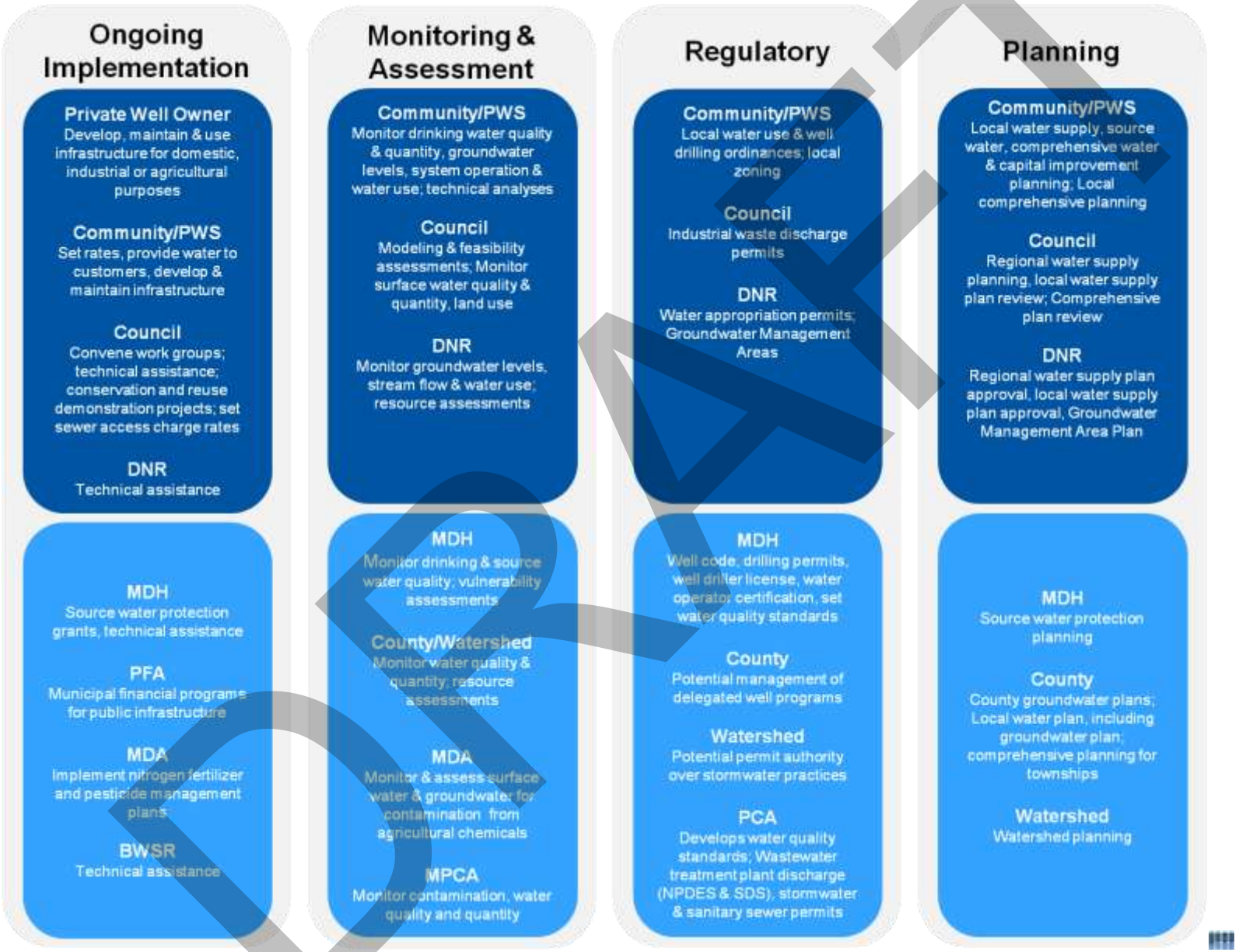
- *Metropolitan Council* provides water supply and surface water planning support and direction, operates state's largest wastewater treatment system, and provides regional water quality and quantity monitoring.
- *Minnesota Department of Natural Resources* collects and analyzes information on water, regulates water use and riparian land use activities, manages public land, and oversees water supply plans.

Supporting Partners

- *Minnesota Department of Health* 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, licenses professions impacting drinking water.
- *Minnesota Pollution Control Agency* develops water quality standards, monitors surface water and groundwater quality in non-agricultural settings, and restricts discharges of pollutants through use of permits.
- *Minnesota Department of Agriculture* is responsible for fertilizer and pesticide regulation and management, activities include implementing the state Nitrogen Fertilizer and Pesticide Management Plans to protect groundwater; develops voluntary best management practices; monitors groundwater in agricultural settings; registers products with potential water impacts; and trains and licenses applicators.
- *Minnesota Public Facilities Authority* manages municipal financing programs to help communities build and upgrade drinking water, wastewater and storm water infrastructure.
- *Minnesota Board of Water and Soil Resources* provides resources and technical assistance to local governments, manages conservation easements, and provides oversight to local water management entities.
- *Counties/Soil and Water Conservation Districts* prepare and adopt county groundwater plans, set priorities, address issues, and build local capacity for the protection and management of groundwater.
- *Watershed Management Organizations:* work to conserve the natural resources of the state by land use planning, flood control, and other conservation projects.
- *Minnesota Legislature* provides policy direction and, in some cases, directs funding

Figure 32 shows roles and responsibilities in water supply planning – primary ones as dark blue boxes and supporting (light blue boxes).

Figure 32. Roles and responsibilities supporting water supply planning. Dark blue activities directly support the outcomes of this Master Plan; light blue provide secondary don't directly relate to the regional outcomes in Chapter 6 but are still key water supply planning functions.



Private Water Supply (Well) Owners

Role

Regardless of size, owners of private wells and surface water intakes can take steps to use water as efficiently as possible and protect intakes or wellheads from becoming contaminated.

Responsibilities

Master Plan implementation

- Learn about and implement, as appropriate, water demand management strategies
- Collaborate and convene with state, regional and local partners to maintain, and enhance the protection of the quality and quantity of the region's water supply (for example, participate or promote your water sector's participation on subregional water supply work groups)
- Partner with agencies to comply with water supply regulations and implement up-to-date best management practices for water conservation and pollution prevention

Additional activities

- Develop, maintain, and use water supply infrastructure – wells and surface water intakes - for private water needs such as domestic, industrial and/or agricultural purposes
- If applicable, fulfill wastewater and stormwater management requirements

Communities/Public Water Suppliers

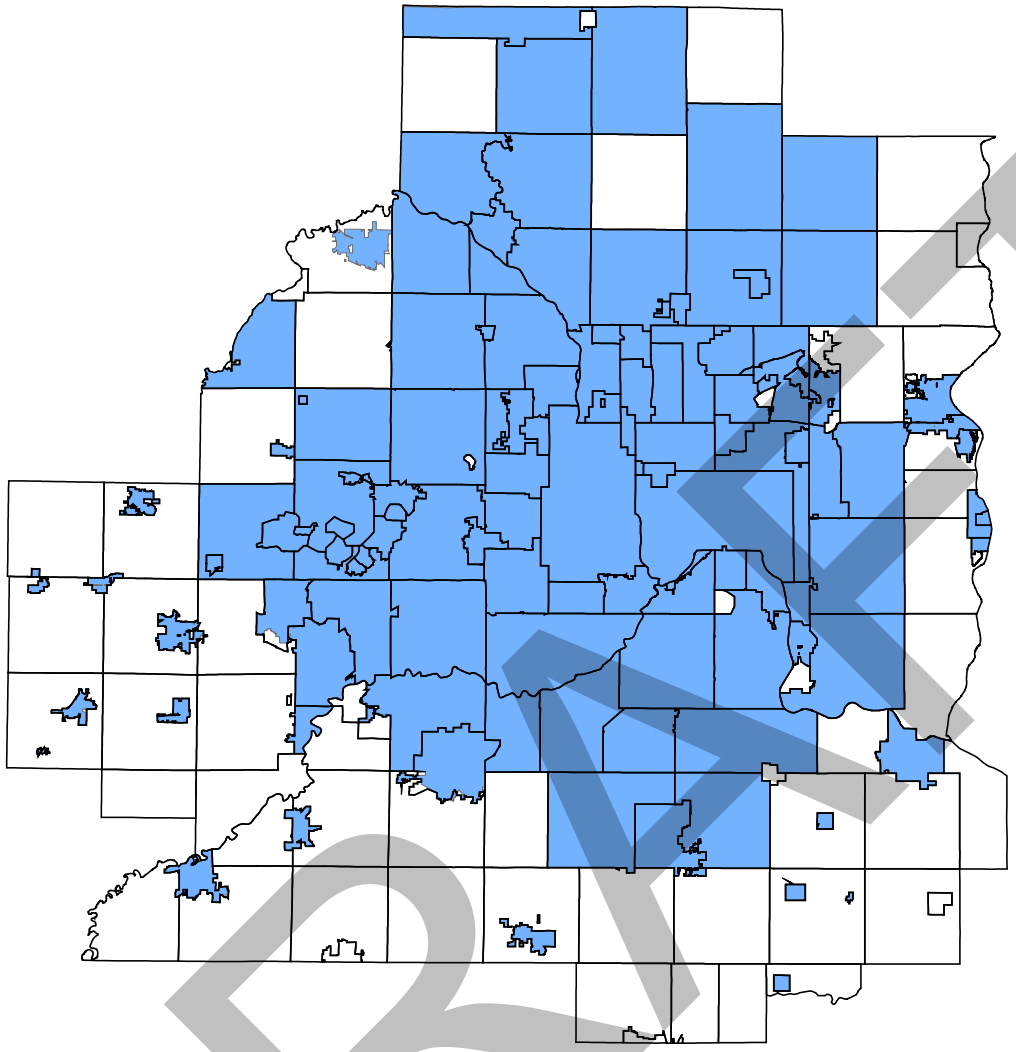
Role

The Metropolitan Council recognizes that water supply roles and responsibilities vary across the region. Some communities are fully served by public water supply systems and others have none. However, all communities can plan for sustainable water supply.

Communities with public water supplies are faced with two major challenges: first, conducting today's business operation and maintenance, and second, thoroughly planning for tomorrow's business operation and maintenance – including adapting to changing water demand. (2014 AWWA State of the Water Industry Report).

Communities without public water supplies also have an important role to play, encouraging the use of environmentally sensitive development techniques and promoting best management practices for agricultural activities in order to protect the integrity of the region's water supply and the quality and quantity of surface and groundwater resource.

Figure 33. Communities with (blue) and without (white).



Responsibilities

Master Plan implementation

- Collaborate and convene with state, regional and local partners to protect, maintain, and enhance the protection of the quality and quantity of the region's water supply
- Comply with regulations
- Accommodate planned growth – including local controls and capital improvement programs – consistent with Council allocations of forecasted population
- Encourage the use of environmentally sensitive development techniques
- Promote best management practices for agricultural activities, where appropriate
- Prepare and implement local water supply plans that reflect this Master Plan and source water (wellhead) protection plans, consistent with Minn. Rules Part 4720, in all communities with municipal water supply

Additional activities

- Develop and maintain water supply infrastructure
- Manage finances of infrastructure, including setting water rates

- Monitor drinking water quality and quantity, groundwater levels, system operation, and water use
- Conduct technical analyses
- Develop and adopt local comprehensive plans (including the local water supply plan), source water protection plans, comprehensive water plans, and capital improvement plans
- Develop and enforce ordinances and zoning addressing issues such as water conservation, wellhead protection, and well drilling within municipal water supply service areas
- Stay up to date about and implement best management practices for water conservation and pollution prevention, including education of customers
- Educate residents and customers about pollution prevention, water conservation, and stormwater management
- If county has an approved Groundwater Plan, then ensure that the community's water supply plan is consistent with it.
- Use local zoning to promote land use that minimizes potential contaminant sources in drinking water management areas and that uses water efficiently including land use that maximizes opportunities for reuse of stormwater and/or reclaimed wastewater
- If delegated to a local board of health by the Minnesota Department of Health, manage delegated well programs for regulating of water wells, monitoring wells, and/or dewatering wells such as Minneapolis and Bloomington

Metropolitan Council

Role

The mission of the Metropolitan Council Environmental Services division is to provide wastewater services and integrated planning to ensure sustainable water quality and water supply for the region.

The role of the Council in water supply planning is to:

- Work with partners to develop a regional plan
- Maintain a base of technical information
- Provide assistance to communities in developing their local water supply plans, and
- Identify approaches for emerging issues

The Metropolitan Area Water Supply Advisory Committee and other work groups guide the Council in this work.

The Council is not a water supplier. The regional planning process has been designed and applied to ensure local water suppliers have control of and responsibility for their water supply systems.

Responsibilities

Master Plan Implementation

- Collaborate with state agencies, watershed organizations, and community water suppliers to update the regional Master Water Supply Plan.
- Support community efforts to improve water supply resiliency by cooperatively identifying economically and technically feasible water supply alternatives.

- As required by Minnesota Statutes, review and comment on local water supply plans.
- As requested by the DNR, review and comment on Groundwater Management Areas and water appropriation permits.
- As required by Minnesota Statutes, review and comment on wellhead protection and county groundwater plans.
- Facilitate discussions on water supply issues that transcend community boundaries, through subregional work groups and on an ad hoc basis as needed.
- Collaborate with partners to perform special studies as needed.
- Work with our partners to fill gaps in assessments of lake, stream, river, and groundwater data.
- In partnership with others, complete technical studies to understand regional and subregional long-term water supply availability and demand.
- Support community efforts to identify and evaluate the economic and technical feasibility of water supply approaches and best practices that increase water conservation, enhance groundwater recharge, and make the best use of groundwater, surface water, reclaimed wastewater, and stormwater.
- In partnership with others, research and promote low impact development, land use practices, agriculatural best practices, and cooperative water use practices that minimize impacts on aquifers and maximize groundwater recharge, where practical.
- Promote and support water conservation measures, including education, outreach and tool development.
- Investigate reusing treated wastewater to supplement groundwater and surface water as sources of water to support regional growth, and when cost-effective, implement reuse.
- Support cost-effective investments in water supply infrastructure to promote sustainable use and protect the region's water supplies
- Evaluate impacts of planned growth and water demand on aquifer levels and water supply sustainability

Additional water supply-related activities

- Promote residential development patterns that protect natural resources, the quality and quantity of our water resources, and our water supply
- Monitor surface water quality and quantity
- Issue industrial wastewater discharge permits
- Monitor groundwater quality and quantity at recharge sites such as the East Bethel wastewater reclamation facility

Minnesota Department of Natural Resources

Role

The DNR plays an important role in supporting sustainable use of water through its water appropriation permit program, information collection and analysis activities, law enforcement responsibilities, education and technical assistance opportunities.

The DNR assists public water suppliers in developing local water supply plans to address the unique needs and resource characteristics of the individual communities. These plans are required of every public water supplier serving more than 1,000 people, but DNR staff also work closely with smaller public water suppliers that want to engage in water supply planning. DNR

ensures that water use permits for public water suppliers are congruent with that community's local water supply plan. In the metropolitan area, the DNR collaborates with the Metropolitan Council on water supply planning activities. Through its local water supply plan review and approval process, the DNR ensures that local water supply plans reflect the Metropolitan Council's Master Water Supply Plan efforts.

Responsibilities

Master Plan Implementation

- Develop a local water supply plan template and notify public water suppliers of the timeline for completing their plan
- In partnership with Metropolitan Council, review local water supply plans for consistency with the metropolitan area master water supply plan
- Administering the water appropriation permit program to ensure water appropriation permits are consistent with approved local water supply plans
- In partnership with the Metropolitan Council, providing advice for plan development and implementation, including guidance on demand reduction methods and water conservation

Additional water supply-related activities

- Monitor groundwater and basin water levels, stream flow, and climate
- Map natural resources, including geologic atlases and ecological surveys
- Develop sustainability thresholds
- Establish Groundwater Management Areas in areas with difficult groundwater-related resource challenges

Minnesota Department of Health

Role

The Minnesota Department of Health (MDH) has three primary areas of responsibility that relate to water supply planning:

- Regulate public water supplies under the federal Safe Drinking Water Act and state rules and statutes
- Regulate well construction including designation of special well and boring construction areas
- Assessment of drinking water contaminant risks

The MDH Drinking Water Protection Program protects public health by ensuring a safe and adequate supply of drinking water at all public water systems, which are those that serve water to the public. The MDH Well Management Program protects both public health and groundwater by assuring the proper construction of new wells and borings, and the proper sealing of unused wells and borings.

The MDH Environmental Surveillance and Assessment Program operates in collaboration with local, state, and federal environmental and health agencies and academic institutions to collect and assess data regarding exposures to chemicals and other substances that may pose health risks to the public.

Water supply planning activities include assisting public water supplies with infrastructure planning and response to drinking water contaminant issues, and planning for wellhead

protection for public water supplies. A number of advisory groups provide input and advice to the MDH on drinking water issues. These include the Water Utility Council, the Advisory Council on Wells and Borings, and the Advisory Council on Water Supply Systems and Wastewater Treatment Facilities. In addition, the MDH provides technical assistance to local government, public water supply staff and the public, and access to water planning information through resources like the County Well Index.

Responsibilities

Master Plan Implementation

- Partner with the Metropolitan Council to provide guidance to communities for considering source water protection in local comprehensive plans
- Administer the code governing wells, certify well operators, and in partnership with DNR issue permits that are consistent with DNR preliminary well screening criteria and MDH requirements

Additional water supply-related activities

- Monitor public drinking water supplies for contaminants regulated under the Safe Drinking Water Act
- Educate water suppliers about public health and drinking water, including water supply management and protection
- Assist local government, business, and the public in managing risks to and from drinking water supplies through:
    - Protecting the sources that supply drinking water to the public by mapping drinking water sources, identifying source water areas, identifying risks of impacts to water supplies
    - Supporting capacity for developing and implementing source water protection plans
    - Applying groundwater models and interpreting hydrogeology
    - Identifying interactions between groundwater and surface water
    - Identifying recharge areas
    - Identifying potential contaminant sources
    - Evaluating future water demand
    - Evaluating risk of land use changes to water quality and quantity
- Develop human health guidance
- Evaluate and communicate scientific information about the potential for health risks from exposures to newly identified health hazards in drinking water
- Identify ambient groundwater quality through initial sampling of private wells
- Collect and maintain information for the state about well construction and well logs as it relates to drinking water wells (County Well Index)
- Provide cost share funds for sealing unused wells that could become a pathway for contaminants to enter drinking water sources
- Oversee, along with the Minnesota Public Facilities Authority, the Drinking Water Revolving Loan Fund
- Delegate specific responsibilities for the regulating water wells, monitoring wells, and/or dewatering wells to local boards of health, such as Dakota County, Minneapolis, and Bloomington

Minnesota Pollution Control Agency

Role

The Minnesota Pollution Control Agency's mission is to protect and improve the environment and enhance human health.

Responsibilities

Master Plan Implementation

- Partner with the Metropolitan Council to provide guidance to communities to consider source water protection as part of stormwater management

Additional water supply-related activities

Although MPCA is not directly responsible for water supply infrastructure or management, several activities indirectly affect water supply sources in the region:

- Monitor ambient groundwater quality as an early warning system identifying threats to the quality of shallow and vulnerable aquifers.
- Consult and provide support to the DNR for water supply concerns and dropping lake levels in the North and East Metro Groundwater Management Areas
- Participate on the Interagency Groundwater/Drinking Water collaborative team working with the Clean Water Fund
- Investigate and remediate non agricultural contaminated sites, including monitoring to assess the containment of contaminant plumes from Superfund sites, petroleum releases and closed landfills.
- Monitor the waters of the state to assess their quality, using a systematic intensive watershed approach to determine physical, chemical and biological integrity.
- Promote protection of drinking water use and identify source water protection areas in certain projects with limits on the Total Maximum Daily Load of pollutants (TMDL) and in Watershed Restoration and Protection Strategies (WRAPS)
- Maintain and update standards and rules to be consistent with other rules and statutes protecting water supply sources
- Adapt monitoring, prevention, regulation and remediation efforts for contaminants of new/emerging concern
- Identify and investigate interactions between groundwater and surface water
- Work with local government units to promote and implement best management practices that protect surface and groundwater quality
- Ensure compliance with the Minnesota Groundwater Protection Act
- Minimize and regulate pollutant discharges via permits, technical/financial assistance, and enforcement

Minnesota Department of Agriculture

Role

The mission of the department is to enhance Minnesotan's quality of life by ensuring the integrity of the food supply, the health of the environment, and the strength of the agricultural community. The Minnesota Department of Agriculture (MDA) is the lead agency for all aspects of pesticide and fertilizer environmental and regulatory functions.

Responsibilities

Master Plan Implementation

- Partner with Metropolitan Council to provide guidance to communities to consider agricultural best management practices within source water protection areas.

Additional water supply-related activities

While MDA is not directly responsible for water supply infrastructure or management, several of its activities indirectly affect water supply sources in the region.

MDA is responsible for or involved in many water quality programs and initiatives. These include but are not limited to the following:

- Serve as lead agency for groundwater contamination from pesticide and fertilizer non-point source pollution
- Conduct monitoring and assessment of agricultural chemicals (pesticides and nitrates) in ground and surface waters
- Oversee agricultural chemical remediation sites and incident response
- Regulate use, storage, handling and disposal of pesticides
- Regulate storage, handling and disposal of fertilizer

Minnesota Public Facilities Authority

Role

The Minnesota Public Facilities Authority (PFA) is a multi-agency authority that provides municipal financing programs and expertise to help communities build public infrastructure that preserves the environment, protects public health, and promotes economic growth.

Master Plan Implementation

- To be defined

Additional water supply-related activities

- Administer three revolving loan funds and other programs to help local units of government fund public infrastructure projects

Program(s) funding source(s)

- State General Fund
- Clean Water Fund
- Federal Funds

Funding provided to Local Governmental Units for Implementation

- Clean Water Revolving Fund
- Drinking Water Revolving Fund

Board of Water and Soil Resources

Role

The Board of Water and Soil Resources (BWSR) is the state soil and water conservation agency, and it administers programs that prevent sediment and nutrients from entering our lakes, rivers, and streams; enhance fish and wildlife habitat; and protect wetlands.

Responsibilities

Master Plan Implementation

- To be defined

Additional water supply-related activities

Although BWSR is not directly responsible for water supply infrastructure or management, several activities indirectly affect water supply sources in the region:

- Identify strategies for groundwater protection
- Identify potential locations for infiltration projects/BMPs that may include wetland restoration, enhancements, or creation
- Technical assistance to Soil and Water Conservation Districts
- Direct private land soil and water conservation programs through the action of SWCDs, counties, cities, townships, watershed districts, and water management organizations.
- Link water resource planning with comprehensive land use planning.
    - Approve county groundwater plans
    - Approve watershed management organization plans
- Provide resolution to water policy conflicts and issues. To implement the comprehensive local water management acts
- Provide the forum (through the board) for local issues, priorities, and opportunities to be incorporated into state public policy
- Advise local governmental units that administer for the Wetland Conservation Act
- Coordinate state and federal resources to realize local priorities

Statutory Requirements/Authority

- Minnesota Statutes Chapter 103B.101
- Minnesota Statutes Chapters 103C, 103D, 103F
- Minnesota Statutes Chapters 103A.211, 103A.305, 103A.315, 103A.311
- Minnesota Statutes Chapters 103B.201, 103B.255, 103B.301
- Minnesota Statutes Chapters 103G

Counties

Role

In 1987, metropolitan counties were given the authority to prepare and adopt groundwater plans. That provided a mechanism for counties to set priorities, address issues, and build local capacity to protect and manage of groundwater.

This is an important issue in the metropolitan area. Counties in the area rely heavily on their groundwater for their domestic, municipal, industrial, and agricultural water supplies. Additionally, the metropolitan area has productive aquifers, but they have limits. Development and urban sprawl can increase demands on groundwater and disrupt groundwater recharge areas.

A number of successes have come out of this planning process. Every county in the metro area has technical capacity to deal with groundwater issues at some level. Metropolitan counties with approved groundwater plans can use matching grants to implement items in their plans.

Responsibilities

Although counties are not directly responsible for water supply infrastructure or management, they may engage in several activities that indirectly affect water supply sources in the region.

Master Plan Implementation

- In close coordination with cities that develop their own groundwater plans, write, coordinate, and administer county groundwater plans that reflect the Master Water Supply Plan
- Review local water supply plans and recommend Metropolitan Council approval, if a county groundwater plan has been adopted (persuant to Minnesota Statutes 473.859, Subd. 6)

Additional water supply-related activities

- Convene local stakeholders to ensure and enable coordination with respect to groundwater issues and activities
- Conduct comprehensive planning for townships (except Ramsey and Hennepin)
- Establish and enforce standards to prevent contamination of groundwater
- If delegated to a local board of health by the MDH, manage delegated well programs for regulating water wells, monitoring wells, and/or dewatering wells, such as in Dakota County
- Coordinate monitoring networks and monitoring groundwater and surface water quality and quantity
- Regulate individual sewage treatment systems, if a program exists
- Regulate feedlots
- Enforce building codes
- Monitor water resources
- Test private wells
- License solid and hazardous wastes
- Provide well sealing grants and technical assistance
- Educate the public, businesses, organizations and others about water appropriation and conservation
- Identify sensitive areas that may be vulnerable to adverse water supply impacts

Soil and Water Conservation Districts

Role

Soil and Water Conservation Districts (SWCDs) are local units of government that manage and direct natural resource management programs at the local level. Districts work in both urban and rural settings, with landowners and with other units of government, to carry out a program for the conservation, use, and development of soil, water, and related resources.

One crucial niche districts fill is that of providing soil and water conservation services to owners of private lands.

Responsibilities

SWCDs provide needed technology, funding and educational services. Counties and Soil and Water Conservation Districts may collaborate or delegate all responsibilities to one or the other.

Master Plan Implementation

- Write, coordinate, and administer county groundwater plans, if they are developed, that reflect the Master Water Supply Plan
- Review local water supply plans and recommend Metropolitan Council approval, if a County Groundwater Plan has been adopted persuant to Minnesota Statutes 473.859, Subd. 6

Additional water supply-related activities

- Monitor groundwater and surface water resources
- Promote best management practices that protect and enhance water supplies, particularly in rural areas

Watershed Management Organizations

Role

The organization of watershed management responsibilities varies across the metropolitan area. Watershed management may occur through Watershed Management Organizations (WMOs), Watershed Districts, or counties. Regardless of the management structure, watersheds work to conserve the natural resources of the state by land use planning, flood control, and other conservation projects using sound scientific principles for the protection of public health and welfare and wise use of the natural resources.

In the metro area, watershed activities are guided by the Metropolitan Area Surface Water Management Act (*Minnesota Statutes 103B.201 to 255*) which requires watersheds to prepare and implement watershed management plans.

Responsibilities

Master Plan Implementation

Although watersheds are not directly responsible for water supply infrastructure or management, several activities may indirectly affect water supply sources in the region.

- Foster incentivize low-impact development practices to reduce irrigation and increase infiltration
- Use communication media to disseminate information about source water protection
- Monitor groundwater-surface water connections

Additional water supply-related activities

Watersheds have the option to engage in water supply management, shaped by Minnesota statutes and rules. If this option is pursued, responsibilities might include:

- Fund water supply protection activities (well sealing, for example)
- Support stormwater infiltration approaches that protect and enhance groundwater
- Monitor groundwater and surface water quality and quantity to evaluate water supply sustainability
- Issue permits for water appropriations, if the watershed management organization has permitting authority
- Complete a watershed management plan that is consistent with the Minnesota Rules 8410

- If a county has an approved groundwater plan, ensure that the community's own groundwater plan is consistent with it.

Funding Sources for Implementation

Drinking Water Infrastructure

For building or maintaining infrastructure for drinking water, there are several funding options available to municipalities and drinking water utilities. These include traditional revenue generating methods such as utility water rates, and other customer fees and charges for specific benefits or services.

Large capital projects often require multiple funding sources to finance projects and minimize the impact on user rates. Projects of this type can be financed through municipal revenue bonds, which are generally paid for over time by water rates, or with other sources, including low-interest loans or grants that may be available through state and federal programs.

Several programs relevant to water utilities in Minnesota are described below. Some of the funding programs target small communities and rural areas, and may have limited applicability in more urbanized areas. These qualifications are noted, where possible.

Table 5. Funding sources for drinking water infrastructure.

Program	Rural Development, U.S. Department of Agriculture
Objective	Provide loans and grants for development of water systems in rural areas and towns with a population of 10,000 or less.
Applicant	Public entities, non-profit organizations, and Indian tribes. Several areas in the seven-county metropolitan area are ineligible.
Uses	Construction, land acquisition, legal fees, engineering fees, capitalized interest, equipment, initial operation and maintenance costs, project contingencies, and any other cost that is determined by the Rural Development program to be necessary for the completion of the project. Projects must be primarily for the benefit of rural users.
Population	Less than 10,000 in rural areas.
Terms/ Conditions	Must show that applicant is unable to secure funds at affordable rates otherwise. Rates are set quarterly. Loans are made based on the applicant's authority and the life expectancy of the system's project.
Website	http://www.rurdev.usda.gov/MN_dispdirectloansgrants.htm
Program	Small Cities Development Grant Program, Minnesota Department of Employment and Economic Development
Objective	Provide grants to help cities and counties with funding for public infrastructure. Benefits individuals and households with low and moderate incomes, eliminates urgent threat to public health or safety.
Applicant	Cities, township and counties. In seven-county metropolitan area, only Carver County and Scott County are eligible.
Uses	Public facility improvements, including wells, water towers, distribution systems.
Population	Cities with population of 50,000 or less. Counties with population of 200,000 or less.
Terms/ Conditions	Maximum grant is $600,000. Must benefit low and moderate-income persons or households. Timeline to complete projects is normally 30 months.

Website	http://mn.gov/deed/government/financial-assistance/community-funding/ http://www.rurdev.usda.gov/MNP_dispdirectloansgrants.htm
Program	Drinking Water Revolving Fund, Minnesota Department of Employment and Economic Development
Objective	Provide loans to help communities build drinking water storage, treatment and distribution systems to comply with standards in the Safe Drinking Water Act.
Applicant	Cities, counties, townships, sanitary districts or other governmental subdivisions responsible for providing public drinking water. Projects must be on the MDH Project Priority List (PPL) and the Public Facility Authority's Intended Use Plan (IUP). Must be certified by MDH before loan approval.
Uses	Allowable costs include land costs, site preparation, construction, engineering, equipment and machinery, bond issuance, and certain fees and contingency costs. Projects that are primarily to serve growth are not eligible
Population	No cap or minimum. Rate discounts may apply for applicants with populations less than 2,500.
Terms/ Conditions	Discounted loan rates. Loans are amortized up to a maximum of 20 years or up to 30 years if the average annual resident cost would exceed 1.2% of median household income.
Website	http://www.mn.gov/deed/government/public-facilities/funds-programs/drinking-

Stormwater Infrastructure

There are several potential funding sources for local stormwater infrastructure projects. These may include user rates and charges, grants, or low-interest loan programs. Revenues generated from stormwater utility fees and charges can be used to fund capital projects.

Similarly, watershed districts (and some water management organizations) can fund capital projects with revenues collected through their taxing authority, or through special fees. Additional opportunities may be available to public entities through either community partnerships or public-private partnerships. In some cases, granting organizations will support nonprofit, nongovernmental or educational programs, but are restricted from directly funding government operations.

Community partnerships, where a school, non-profit, or other similar organization is the primary grant applicant and the governmental agency is a partner or subrecipient, may open other granting opportunities where the costs and implementation responsibilities could be shared between organizations. Often, collaborative arrangements, multidisciplinary or public-private partnerships, and the involvement of community stakeholders are supported by granting organizations.

The table below summarizes two state programs that could potentially be used to finance stormwater projects in Minnesota. Some programs focus on water quality improvement projects, so water quality benefits of any candidate project would have to be clearly demonstrated.

Table 6. Funding sources for storm water infrastructure.

Program	**Point Source Implementation Grant Program, Minnesota Department of Employment and Economic Development**
Objective	Provide grants to local units of government to assist with the cost of wastewater or stormwater projects. Projects should befocused on water quality.
Applicant	Cities, counties, townships, sanitary districts. Must be on the MPCA's Project

	Priority List (PPL).
Uses	Build, repair and improve public wastewater or stormwater systems. Must address an issue involving the total maximum daily load (TMDL) of identified pollutants.
Population	No cap or minimum.
Terms/ Conditions	Provides grants for up to 50% of eligible costs up to $3 million.
Website	http://www.mn.gov/deed/government/public-facilities/funds-programs/point-source-grants.jsp
Program	**Projects and Practices, Board of Water and Soil Resources**
Objective	Provide grants for on-the-ground projects and practices that will protect or restore water quality in lakes, rivers or streams, or will protect groundwater or drinking water. Must be consistent with approved state or local water management document or plan.
Applicant	Soil and Water Conservation Districts, Watershed Districts, Watershed Management Organizations, Counties, Cities, and joint powers board of these organizations.
Uses	Eligible activities can consist of structural practices and projects, non-structural practices and measures, project support, and grant management and reporting.
Population	No cap or minimum.
Terms/ Conditions	Requires minimum 25% nonstate match. Minimum request of $30,000
Website	*http://www.bwsr.state.mn.us/cleanwaterfund/FY12_BWSR_CWF_Policy_Final.pdf*
Program	**Targeted Storwwater Grant, Metropolitan Council**
Objective	Provide grants for projects that serve as visual demonstration projects, are easy to replicate, focus on highly urbanized areas, include long-term monitoring and provide information on challenges and opportunities.
Applicant	More information needed
Uses	More information needed
Population	More information needed
Terms/ Conditions	More information needed
Website	More information needed

Other sources

Other sources, although more difficult to secure, include special appropriations from state or federal government. These include the State and Tribal Assistance Grant (STAG) program administered by the regional offices of the U.S. Environmental Protection Agency, or other infrastructure funding included in special legislation or appropriations.

In the past, these funds have, in the past, helped to finance a portion of the costs associated with water infrastructure projects. Projects that are selected for special funding provisions often demonstrate collaborative approaches to resource or infrastructure challenges, and present solutions with regional benefits. Financial hardship to the affected communities or rate payers may also be considered, among other criteria.

Shared water infrastructure projects have secured special funding consideration in Minnesota in the past. The Joint Powers Water Board, a shared utility that serves Albertville, Hanover and Saint Michael secured approximately $1 million in grant money to establish a joint utility in 1977. The Burnsville/Kraemer Quarry water project received $5.5 million in state funding in 2008 for construction of a new water treatment plant that serves the Cities of Burnsville and Savage. Rural water systems in Minnesota have also secured federal and state funding for capital improvements and expansion.

The size and scope of major infrastructure projects often require a combination of funding sources, which can include rate payer-generated funds, bonds, low-interest loans, or grants. Many of the loan or grant programs require some component of matching funds; pursuing a diversified financing strategy is recommended to maximize opportunities, and minimize the impact on rate payers. As supply and resource availability issues continue to emerge in the region, a shared-system approach to water supply may provide both supply reliability and a framework for equitable resource use, as well as economic opportunities.

Annotated Bibliography

American Water Works Association. 2014. AWWA State of the Water Industry Report.
The American Water Works Association (AWWA) has been formally tracking issues and trends in the water industry since 2004 through the State of the Water Industry (SOTWI) study. The Association continues to conduct this annual survey in order to: identify and track significant challenges facing the water industry, provide data and analyses to support water professionals as they develop and communicate strategies to address current issues, discover and highlight potential problems or concerns on the water industry's horizon, and inform decision makers and the public of the challenges faced by the industry.

Anoka County Community Health and Environmental Services. 2014. Water Resources Report. Anoka County: Anoka, MN.
This report addresses the environmental health issues identified for Anoka County. Natural resources management, environmental protection and environmental health protection share many goals. For example, the protection and management of Mississippi River water quality is a goal of a natural resources program such as the Clean Water Act, and a public health program including the Safe Drinking Water Act. This report will be used to address environmental health issues identified in Anoka County through the Community Health Services assessment and planning process, and will be incorporated into the Community Health Improvement Plan (CHIP). Appendix A provides a detailed summary of the authority and responsibility for water resources management, including information about federal, state and local entities.

Barr Engineering Company. 2015 (DRAFT). Technical Memorandum to Metropolitan Council: Metro Pumping Optimization 3.
This technical memorandum describes the optimization of pumping in the seven-county metropolitan
area. The goal of the optimization was to maximize total pumping from existing wells while meeting
constraints on baseflow, hydraulic head, and flow direction as specified by the Metropolitan Council. The optimization uses the steady-state version of the Twin Cities Metropolitan Area Groundwater Flow Model, Version 3.0 (Metro Model 3; Metropolitan Council, 2014).

Hall, C.W. et al. 1911. Geology and Underground Waters of Minnesota. Work done in cooperation with the Minnesota State Board of Health. United States Geological Survey: Washington D.C.
The purpose of this investigation was to determine to the fullest extent practicable the principal facts in regard to the underground waters – their quantity, head, mineral content, sanitary conditions, and their depths below the surface – as well as the best methods for drilling to the them and finishing wells for their utilization and to consider all other questions relating to their recovery for human use.

Kloprogge, Penny, Eronene van der Sluijs and Arjan Wardekker. 2007. Uncertainty Communication: Issues and Good Practice. Copernicus Institute – Research Institute for Sustainable Development and Innovation, Universiteit Utrecht: Utrecht, The Netherlands.
Dealing with uncertainty is essential because assessment results regarding complex environmental issues are of limited value if the uncertainties have not been taken into account adequately. A careful analysis of uncertainties in an environmental assessment is required, but even more important is the effective communication of these uncertainties in the presentation of

assessment results. This report explores the issue of uncertainty communication in detail, and contains more detailed guidance on the communication of uncertainty.

Minnesota Department of Health. 2015. County Well Index. http://www.health.state.mn.us/divs/eh/cwi/.
The CWI database contains basic information, such as location, depth, and static water level, for wells drilled in Minnesota. The database contains construction and geological information from the well record (well log) for many wells. CWI Online also provides mapping of wells onto aerial photos, allowing users to visually identify well locations.

Minnesota Department of Natural Resources. 2013. Permit Information Report: Active Permit Information (Excel spreadsheet file).
Minnesota water use data were gathered from permit holders who report the volume of water used each year. Permit information reports are generated directly from the main database files. The Permit Information Report was updated 2/4/2013

Minnesota Department of Natural Resources. 1989. Drought of 1988. Saint Paul, Minnesota.
The 1988 drought broke long-standing records; strained water use controversies; enhanced public concern about water resources; and generally challenged the energies, talents and perseverance of water managers and the public at large.

Little could be done to manage natural disasters such as the 1988 drought; however impacts can be managed and minimized. Although drought impacts are very damaging to some industries and the environment, it also creates the opportunity to learn and improve future ability to manage such crises.

Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S.. 2014. Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405.
This report, “Estimated use of water in the United States in 2010,” is the 13th in a series of U.S. Geological Survey (USGS) Circular reports that have been published every 5 years since 1950. The 60-year span of national reports represents the longest compilation record of water-use data by a Federal agency in the United States.

Metropolitan Council. 2015. Conservation Toolbox. Prepared by CDM Smith. Metropolitan Council: Saint Paul, MN.
This online tool supports efforts to conserve water.

Metropolitan Council. 2015. Regional Feasibility Assessments: Technical Analysis Supporting Long-Term Reliability and Sustainability of Water Supplies in the Twin Cities Metropolitan Area. Prepared by HDR. Metropolitan Council: Saint Paul, MN.
Metropolitan Council recognition of water supply planning as an integral component of long-term regional and local comprehensive planning has led to the implementation of a number of projects to provide necessary technical information to form the basis for sound water supply decisions. This Regional Feasibility Assessments study will inform the Council and the participating communities about the potential to diversify water sources to support a sustainable and reliable long-term regional water supply in the Twin Cities Metropolitan Area.

Alternative water supply approaches evaluated include:

- Enhanced recharge
- Surface water

- Groundwater
- Stormwater

Metropolitan Council. 2015. Thrive MSP 2040. Metropolitan Council: Saint Paul, MN.
Under state law, the Council prepares a long-range plan for the Twin Cities region every 10 years. Thrive MSP 2040 sets the policy foundations for systems and policy plans developed by the Council: the Transportation Policy Plan, the Water Resources Policy Plan, the Regional Parks Policy Plan, and the Council's first Housing Policy Plan update in nearly 30 years.

Metropolitan Council. 2014. October 1, 2014 Memo to Twin Cities Metropolitan Area Water Suppliers: Water Demand Projection Method and Preliminary Results.
This memorandum provides a summary of the methods used to project water demand for the public water supply systems in the Twin Cities Metropolitan Area. This work is being done in support of the regional Master Water Supply Plan update that is currently in progress. Presented are the data sources used, assumptions made, and exceptional cases and how they were addressed.

Metropolitan Council. 2014. Feasibility Assessment of Approaches to Water Sustainability in the Northeast Metro. Prepared by Short Elliott Hendrickson Inc. Metropolitan Council: Saint Paul.
The Metropolitan Council retained Short Elliott Hendrickson Inc. (SEH) to complete this technical assessment of the capital and operational costs, as well as the potential benefits, of alternative approaches to water supply in the northeast metro area. The report also looks specifically at the direct augmentation of White Bear Lake with water from the major rivers in the region. This study has been carried out with input from and engagement with local stakeholders, including community public water utilities, through a water supply work group. This group continues to meet regularly to discuss the study along with other water supply topics of importance to group members.

Metropolitan Council. 2014. Twin Cities Metropolitan Area Regional Groundwater Flow Model, Version 3.0. Prepared by Barr Engineering. Metropolitan Council: Saint Paul, MN.
This report summarizes the result of work to update the regional groundwater flow model, which meets the requirements of Minn. Stat., Sec. 473.1565 calling for the Council to engage in planning activities which must include "development and maintenance of a base of technical information needed for sound water supply decisions including surface and groundwater availability analyses, water demand projections, water withdrawal and use impact analyses, modeling, and similar studies".

The report is organized into six major sections. The introduction provides an overview of the Council and the need for the project. The next five sections discuss methods and results.

Metropolitan Council. 2014. Assessing the Opportunity and Barriers for Water Conservation by Private Industrial Water Users. Prepared by Minnesota Technical Assistance Program (MnTAP). Metropolitan Council: Saint Paul, MN.
This project supported the intent of the Metropolitan Council to better understand the industrial water use needs of private well water users in an eleven county area including Anoka, Carver, Chisago, Dakota, Hennepin, Isanti, Ramsey, Scott, Sherburne, Washington, and Wright counties. Through this project, the Metropolitan Council and MnTAP worked to identify opportunities for industrial water conservation as well as factors that motivated implementation of operational changes to capture water conservation savings. The project helped to fill an existing knowledge gap in water conservation data in the metropolitan area. Data gained from this project will be used in water supply planning projections for the metropolitan area. Private

industrial water users received site-specific water conservation recommendations and will continue to be followed up with through at least 2015 to see if additional assistance is useful.

Metropolitan Council. 2013. Assessing the Opportunity and Barriers for Water Conservation by Private Industrial Water Users: For the Twin Cities Metropolitan Area. Prepared by the Minnesota Technical Assistance Program. Metropolitan Council: Saint Paul, MN.
This project supports the intent of the Metropolitan Council to better understand the industrial water use needs of private well water users in an eleven county area including Anoka, Carver, Chisago, Dakota, Hennepin, Isanti, Ramsey, Scott, Sherburne, Washington, and Wright counties. Through this project, the Metropolitan Council and MnTAP will identify opportunities for industrial water conservation as well as factors that motivate implementation of operational changes to capture water conservation savings. The project will fill an existing knowledge gap in water conservation data in the metropolitan area. Data gained from this project will be used in water supply planning projections for the metropolitan area. Private industrial water users will receive site-specific water conservation recommendations.

Miller, T.P., J.R. Peterson, C.F. Lenhart, and Y. Nomura. 2012. The Agricultural BMP Handbook for Minnesota. Minnesota Department of Agriculture.
The purpose of this handbook is to present the findings of a comprehensive inventory of agricultural Best Management Practices (BMPs) that address water quality impairments in Minnesota. This handbook provides water quality practitioners with the information necessary to identify suitable agricultural BMPs for agricultural watershed in Minnesota.

Minnesota Department of Health. 2014. Aquifer Test Database Design Documents.
These are database design documents generated by the Aquifer Test Workgroup whose members included representatives of Federal, State and Local Agencies. This database is designed to satisfy the needs of the various groups to track aquifer tests performed in Minnesota. These tests are primarily conducted on high-capacity wells but may include tests of other types of wells such as those used for domestic supply, or groundwater contamination. The purpose collecting and managing the information is to provide robust scientifically-justified support to decision-makers at all levels to promote the wise use of water resources and protect drinking water and the environment. This database is a filing system for all data collected during a test, not just a list of calculated aquifer properties.

Metropolitan Council. 2013. Groundwater Digest. Metropolitan Council: Saint Paul, MN.
This digest explains how groundwater “works” and why it is important to the region.

Metropolitan Council. 2010. Evaluation of Groundwater and Surface-Water Interaction: Guidance for Resource Assessment: Twin Cities Metropolitan Area, Minnesota. Prepared by Barr Engineering. Metropolitan Council: Saint Paul, MN.
This project provides a screening method to identify areas where groundwater withdrawals are most likely to have an impact on surface waters. In these areas, further characterization of the groundwater-surface water connection may be an important part of local water supply development. This study was conducted to: (1) prioritize surface water features for impact monitoring and resource assessment and (2) recommend monitoring and analysis techniques that will provide early warning to water supply managers to help avoid impacts on surface water features from groundwater pumping.

Metropolitan Council. 201X. Stormwater Reuse Guide. Prepared by CDM Smith. Metropolitan Council: Saint Paul, MN.
Text needed.

Metropolitan Council. 2015 (DRAFT). Water Billing and Consumption Analysis: Water Usage Practices in 189 Cities and Townships in the Twin Cities Metropolitan Area, Minnesota. Prepared by CDM Smith. Metropolitan Council: Saint Paul, MN.

This project included collection and dissemination of data regarding water costs and conservation programs in the seven-county metropolitan area, including:

- Evaluating all water rate structures of the communities in the seven-county metro area. The information on rates by community was correlated with community per capita values, peaking ratios, and other water use characteristics.
- Evaluating all water conservation programs in the communities in the seven-county metro area.
- Developing and analyzing water use characteristics by community and sector to determine trends in water use, including inter-community comparisons.

Minnesota Department of Public Safety – Division of Homeland Security and Emergency Management. 2014. Minnesota State Hazard Mitigation Plan 2014. Minnesota Department of Public Safety: St. Paul, MN.

The State All Hazard Mitigation Plan represents the efforts of the state of Minnesota in fulfilling the responsibility for hazard mitigation planning. The purpose of this Plan is to identify the State's major hazards, assess the vulnerability to those hazards, and take steps to reduce vulnerability using the technical and program resources of Minnesota agencies. The Plan identifies goals and recommended actions and initiatives for state government to reduce and/or prevent injury and damage from hazardous events. The intent of the plan is to provide unified guidance for ensuring coordination of recovery-related hazard mitigation efforts following a major emergency/disaster, and to implement an on-going comprehensive state hazard mitigation strategy intended to reduce the impact of loss of life and property due to disasters.

State of Minnesota. 2014. Clean Water Fund Performance Report: A Report of Clean Water Funds Invested, Actions Taken, and Outcomes Achieved. Minnesota Pollution Control Agency: St. Paul, MN.

The Framework includes a set of performance measures that will convey the most meaningful information about clean water activities to key audiences across Minnesota. These performance measures generally fall into the following categories:

- Environmental and drinking water measures to track whether our water is getting cleaner
- Partnership and leveraging measures to track local government and citizen actions supported by the Clean Water Fund
- Organizational performance measures to track state government-led actions supported by the Clean Water Fund
- Financial measures to track how much and where Clean Water Fund money is being spent

The Framework also describes the connection between short-term activities and long-term results. The multi-agency Team grouped the measures into three other categories: financial investments, actions taken, and outcome measures. Together these measures track how Clean Water Fund investments result in actions taken and ultimately, clean water outcomes achieved. In the early years of the Clean Water Fund, more progress will be reported in short-term actions taken than long term outcomes.

Minnesota DNR - Division of Ecological Resources - Natural Heritage & Nongame Research Program. Calcareous Fens - Source Feature Points [map]. Scale Not Given. August 2008. http://deli.dnr.state.mn.us (December 2014)
Pursuant to the provisions of Minnesota Statutes, section 103G.223, this database contains points that represent calcareous fens as defined in Minnesota Rules, part 8420.1020. The calcareous fens in this shapefile correspond to the fens listed in Identification Order No. 08-001, which was published in the State Register on June 2, 2008 (32 SR 2148-2154). The current list of fens is posted on the DNR web site at http://files.dnr.state.mn.us/publications/waters/calcareous_fen_list_nov_2009.pdf

Minnesota DNR - Division of Waters. 2009. Minnesota Statewide Drought Plan. Saint Paul, MN.
This plan provides a framework for preparing for and responding to droughts to minimize conflicts and negative impacts on Minnesota's natural resources and economy.

Minnesota DNR - Division of Fisheries. Minnesota Trout Streams [map]. Scale Not Given. March 2002. http://deli.dnr.state.mn.us (December 2014)
This layer shows legally designated trout streams and trout stream tributaries as identified in Minnesota Rules Chapter 6264. See http://www.revisor.leg.state.mn.us/arule/6264/0050.html for legal descriptions and restrictions associated with designated trout waters. This data layer is a subset of the DNR 24K streams layer, a statewide streams-hydrography data set cooperatively developed amongst many units of government within Minnesota.

University of Minnesota, Department of Geology and Geophysics; Minnesota DNR - Division of Waters. Karst Feature Inventory Points [map]. Scale Not Given. January 2003. http://deli.dnr.state.mn.us (December 2014)
Since the early 1980s, the Minnesota Geological Survey and Department of Geology and Geophysics at the University of Minnesota have been mapping karst features and publishing various versions of their results in the form of 1:100,000 scale County Geologic Atlases. In the mid 1990s, the Minnesota Department of Natural Resources was assigned responsibility for the hydrogeology portions of the County Atlases and is now responsible for the karst mapping. Dalgleish and Alexander (1984), Alexander and Maki (1988), Witthuhn and Alexander (1995), Green and others (1997), Shade and others (2001), and Tipping and others (2001) published sinkhole distribution maps for Winona, Olmsted, Fillmore Counties, Leroy Township, Pine and Wabasha Counties respectively. Published Atlases of Washington, Dakota, and the counties of the Twin Cites Metro area contain limited information on sinkhole occurrences. This karst feature database of Southeastern Minnesota has been developed to allow sinkhole and other karst feature distributions to be displayed and analyzed across existing county boundaries in a GIS environment. The karst inventory points are point features such as sinkholes, springs, and stream sinks.

Minnesota Department of Health – Well Management. Special Well and Boring Construciton Areas (Formerly known as Speical Well Construction Areas and before that "Well Advisories"). http://www.health.state.mn.us/divs/eh/wells/swca/. Accessed February 26, 2015.
Minnesota Department of Health website describing Special Well and Boring Construction Areas. A Special Well and Boring Construction Area is sometimes also called a well advisory. It is a mechanism which provides for controls on the drilling or alteration of public and private water-supply wells, and 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.

Minnesota Geological Survey. 2011. Distribution of Vertical Recharge to Upper Bedrock Aquifers, Twin Cities Metropolitan Area. Minnesota Geological Survey: Minneapolis, MN.
This report summarizes work performed by the Minnesota Geological Survey (MGS) in partial fulfillment of work as described under contract 10I021 between the University of Minnesota and the Metropolitan Council. The goal of this investigation was to provide datasets that would assist the Metropolitan Council with regional ground water planning. Specifically, vertical travel times were calculated from a regional water table surface to bedrock in order to gain a better understanding of recharge to upper bedrock aquifers in the extended Twin Cities Metropolitan Area (TCMAx). A focus of this investigation, therefore, was on the permeability of unconsolidated sediments overlying the bedrock surface, and the regional distribution of vertical hydraulic gradient.

Minnesota Department of Natural Resources. 2015. Ground Water Level Data Retrieval. http://climate.umn.edu/ground_water_level/ (February 20, 2015)
Since 1944, DNR has managed a statewide network of water level observation wells (obwells). Data from these wells are used to assess ground water resources, determine long term trends, interpret impacts of pumping and climate, plan for water conservation, evaluate water conflicts, and otherwise manage the water resource. Soil and Water Conservation Districts under contract with DNR measure the wells monthly and report the readings to DNR. Readings are also obtained from volunteers at several locations.

Hydrographs, well descriptions and water level data are available for each well in the Ground Water Level Observation Well Database.

Minnesota Pollution Control Agency. 2014. Water Governance Evaluation: Update 2014 – Recommendations to streamline, strengthen, and improve sustainable water management. Minnesota Pollution Control Agency: St. Paul, MN.
This report is a follow-up to the 2013 Water Governance Evaluation, prepared by the Minnesota Pollution Control Agency (MPCA) in collaboration with the other state water management agencies at the direction of the Legislature. This 2014 progress report focuses on:

- initiatives that have been completed or are in progress
- new initiatives that the group has identified; and
- issues in need of further legislative action or direction

Dickinson, Mary Ann. 2014. The Real Relationship Between Conservation and Rising Water Rates. Downloaded from National Geographic website on April 29, 2015 at http://voices.nationalgeographic.com/2014/10/05/the-real-relationship-between-conservation-and-rising-water-rates/
This article discusses three reasons why water efficiency is a smart investment for both utilities and consumers and not solely a revenue buster as is currently perceived:

- Water rates will rise regardless of whether water conservation occurs.
- Water efficiency has been proven to actually slow down the increases in consumer rates.

- Efficiency is often the cheapest source of new supply and can help avoid the expensive costs of adding new storage or treatment capacity.

Glossary

Abandoned Well
Any well (drinking water, oil and gas, etc.) which is not used for a long period of time, is not maintained properly, and/or is not properly sealed when its useful life is over.

Acre-foot
Enough water to cover an acre of land one-foot deep (i.e., 325,851 gallons, or 43,560 cubic feet).

Adaptive Management
A process for continually improving management policies and practices by learning from the outcomes of management actions.

Agricultural Area
Communities that encompass areas with prime agricultural soils that are planned and zoned for long-term agriculture. Maximum allowable density is 4 units/40 acres.

Approach
The high-level category of water supply projects that could be applied at the subregional level to improve the sustainability of the Twin Cities metropolitan area water supply. For example, water conservation is an approach. (NEEDS WORK!!)

Appropriation
Use of water permitted by the Minnesota Department of Natural Resource. Except for some exempted purposes, a water use (appropriation) permit from DNR is required for all users withdrawing more than 10,000 gallons a day or 1 million gallons per year.

Aquifer
Rock or sediment that is saturated and able to transmit economic quantities of water to wells and surface waters. Minnesota Administrative Rules 6115.0630 defines aquifer as any water-bearing bed or stratum of earth or rock capable of yielding groundwater in sufficient quantities that can be extracted.

Aquitard
A water-saturated sediment or rock whose permeability is so low it cannot transmit any useful amount of water.

Artesian Aquifer
See confined aquifer. An aquifer with a confining layer at the top, causing the groundwater to be under pressure. Minnesota Administrative Rules 6115.0630 defines artesian aquifer or a confined aquifer as 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.

Artesian Well
A well drilled in a confined aquifer where the elevation of the well water (i.e., potentiometric surface) is above the top of confined aquifer. If this well flows at the land surface without mechanical pumping, it is a flowing artesian well.

Available Head
An informal term to specify the amount of decline in water level that can occur in a confined aquifer before artesian conditions change to water table conditions. For the purposes of the Master Water Supply Plan, "available head" is defined as the difference in elevation between an aquifer's long-term average water level, as predicted by the Metropolitan Council's groundwater flow model, and ten feet above the top of the upper bedrock surface of that aquifer.

Baseflow
The amount of water in a stream, lake or wetland that is supplied by groundwater. This is also referred to as dry weather flow.

Basin
Minnesota Administrative Rules 6115.0630 defines a basin as 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.

Benchmark
A measurable water resource condition against which historic, current, and projected conditions can be compared to evaluate the sustainability of the region's water supplies.

Beneficial Use
Use of a [water] resource that includes, but is not limited to, domestic (including public water supply), agricultural, commercial, industrial, water-based recreational uses and the propagation and growth of aquatic life.

Best Management Practices
A set of recommendations pertaining to the development and maintenance of varied land uses, aimed at limiting the effects of development, such as soil erosion and stormwater runoff, on the natural environment. See the Council's *Urban Small Sites Best Management Practices Manual* for specific examples of Best Management Practices.

Calibration
The process of using historical data to estimate parameters in a groundwater model, hydrologic forecast technique, routings, and unit hydrographs.

Capita
Latin for 'person'.

Community Public Water Supply
Community public water supplies serve at least 25 persons or 15 services connections year-round, which includes municipalities, manufactured mobile home parks, etc. These systems are required to provide a safe and adequate supply of water under the federal Safe Drinking Water Act. Also known as a *public water supply system*.

Cone of Depression
A cone-shaped depression of the water table.

Confined Aquifer
An aquifer with a confining layer at the top, causing the groundwater to be under pressure. Minnesota Administrative Rules 6115.0630 defines artesian aquifer or a confined aquifer as 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.

Confining Unit
A hydrogeologic unit of impermeable or distinctly less permeable material bounding one or more aquifers and is a general term that replaces aquitard.

Conjunctive Use
The coordinated management of surface water and groundwater supplies to maximize the yield of the overall water resource. An active form of conjuctive use utilizes artificial recharge, where surface water is intentionally percolated or injected into aquifers for later use. A passive method is to simply rely on surface water in wet years and use groundwater in dry years.

Conservation
The management of natural resources to prevent waste, destruction or degradation.

Consumptive Use
Minnesota Administrative Rules 6115.0630 defines consumptive use or consumption as water withdrawn and not directly returned to the same waters as the source for immediate further use in the area.

Conservation
The management of natural resources to prevent waste, destruction or degradation.

Density
The number of dwelling units per net residential acre of land.

Developable Land
Land that is suitable as a location for structures and that can be developed free of hazards to, and without disruption of, or significant impact on, natural resource areas.

Diversified Rural
Communities that are home to a variety of farm and nonfarm land uses including very large-lot residential, clustered housing, hobby farms, and agricultural uses. Located adjacent to the Emerging Edge Suburban communities, the Diversifies Rural designation protects rural land for rural lifestyles today with the potential of becoming urbanized after 2040. Maximum allowable density is 1-2.5 units for existing lots, and 1 unit/10 acres where possible.

Drawdown
The lowering of the water table in and around a pumping well. It is the difference between the pumping water level and the original water level.

Drinking Water Supply Management Area
A drinking water supply management area (DWSMA) is the Minnesota Department of Health approved surface and subsurface area surrounding a public water supply well that completely contains the scientifically calculated wellhead protection area and is managed by the entity identified in a wellhead protection plan. The boundaries of the drinking water supply management area are delineated by identifiable physical features, landmarks or political and administrative boundaries.

Emerging Suburban Edge
Cities, townships and portions of both that are in early stages of transitioning into urbanized levels of development. In the majority of these communities, less than 40% of the land has been developed. Parts of Emerging Suburban Edge communities are in the MUSA and all have a minimum average net density of 3-5 units/acre.

Essential Use
Nonessential use is defined by Minn. Stat. 103G.291 as water that is used for drinking, cooking, cleaning or sanitation (i.e. domestic water use).

Equity
Equity is defined in *Thrive MSP 2040* as just and fair inclusion where all can participate and prosper.

Equitable development
Equitable development is an approach to creating healthy, vibrant, communities of opportunity. Equitable outcomes come about when smart, intentional strategies are put in place to ensure that low-income communities and communities of color participate in and benefit from decisions that shape their neighborhoods and regions.

Evapotranspiration
Loss of water from the soil both by evaporation from the soil surface and by transpiration from the leaves of the plants growing on it. Factors that affect the rate of evapotranspiration include the amount of solar radiation, atmospheric vapor pressure, temperature, wind, and soil moisture.

Forecast
In *Thrive MPS 2040*, a calculation of growth in population, households and jobs based on data about current conditions (e.g., the 2010 Census) that is extrapolated into the future.

Full Build-Out
Having absolute development under the proposed future land use and the guidelines of the 2040 Comprehensive Plan Update (see Ultimate Build Out).

Geologic Formation
Rocks or unconsolidated deposits that form a unit and may be dominated by a certain type of deposit or rock, or may have some other common feature.

Greywater
Domestic wastewater that does not contain human wastes such as tub, shower, or washing machine water.

Groundwater
Water stored in the pore spaces of rock and unconsolidated deposits found in the saturated zone of an aquifer (compare to surface water). Minnesota Administrative Rules 6115.0630 defines groundwater as 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).

Hydrology
Science dealing with the properties, distribution, and flow of water on or in the earth.

Hydraulic Conductivity
A measure of the permeability of the porous media. It is commonly measured in feet per day (ft/day).

Hydraulic Gradient
The change in an aquifer's water level elevation over a given distance.

Impermeable
Material that does not permit fluids to pass through it.

Impervious
The ability to repel water or not let water infiltrate.

Infiltration
1. The seepage of water from land surface down below the root zone. This water may move horizontally through the soil toward nearby streams, wetlands, and lakes – becoming baseflow. Or this water may move vertically down to recharge deeper regional aquifers.
2. The seepage of groundwater into sewer pipes through cracks or joints in the pipes.

Infrastructure
Fixed facilities, such as sewer lines and roadways; permanent structures.

Integration
The incorporation of all planning aspects (e.g., land use, transportation, housing, water resources, and natural resources) into decisions about development.

Investments, Regional Investments
Investments made by the Metropolitan Council into regional infrastructure.

Karst
Topography formed over limestone, dolomite or gypsum and characterized by sinkholes, caves, and significant rapid underground drainage. The Minnesota Pollution Control Agency (MPCA) recognizes portions of southeastern Minnesota as a karst area, including all or parts of these metropolitan area counties: Dakota, Hennepin, Ramsey, Scott and Washington. In these counties, the MPCA recommends treating the following geologic units as karst aquifers: Platteville Formation, St. Peter Formation, and the Prairie du Chien Group.

Local Comprehensive Plan
Plans for local land use and infrastructure. Counties, cities and townships are required to have their local comprehensive plans reviewed by the Metropolitan Council to ensure that they are consistent with metropolitan system plans. (Compare with *comprehensive plan.*)

Local Government
Municipal units of government, such as counties, cities and townships.

Metro Model
The Twin Cities metropolitan area regional groundwater flow model. The current modeling effort builds upon the Minnesota Pollution Control Agency's 2000 Metro Model. The current Metro Model (version 3) is used to evaluate the groundwater impacts of current and projected groundwater withdrawals. Information provided by the Metro Model helps set regional goals, screen for future risks, and evaluate/compare the regional impact of different water supply approaches.

Metropolitan Area Water Supply Advisory Committee
The 2005 Minnesota State Legislature passed a measure that directs the Metropolitan Council to carry out planning activities addressing the water supply needs of the Twin Cities metropolitan area. To assist the Council in its planning activities, the legislature established the Metropolitan Area Water Supply Advisory Committee. The Advisory Committee, which was instrumental in the development of the Metropolitan Area Master Water Supply Plan, meets regularly to discuss plan implementation and other relevant water supply topics.

Metropolitan Development Guide
The collection of regional plans that includes Thrive MSP 2040 and the policy plans for the regional systems: transportation, wastewater and water quality, regional parks and open space.

Metropolitan Land Planning Act
Minnesota Statute 473 directing the Council to adopt long-range, comprehensive policy plans for transportation, airports, wastewater services, and parks and open space, and authorizing the Council to review the comprehensive plans of local governments.

Metropolitan Urban Service Area (MUSA)
The area, in which the Metropolitan Council ensures that regional services and facilities under its jurisdiction are provided.

Model
A model is any device that represents an approximation of a field situation. A mathematical groundwater model, such as Metro Model 3, simulates groundwater flow indirectly by means of a governing equation thought to represent the physical processes that occur in the system, together with equations that describe heads or flows along the boundaries of the model.

Multifamily housing
Residential structure with two or more separate dwelling units.

Nitrate
Used generically for materials made of nitrogen and oxygen; sources include animal wastes and some fertilizers.

Nonconsumptive Use
Nonconsumptive use is water withdrawn and directly returned to the same waters as the source for immediate future use in the area. Compare with *consumptive use*.

Nonessential Use
Nonessential water uses defined by Minn. Stat. 103G.291 include lawn sprinkling, vehicle washing, golf course and park irrigation and other nonessential uses. Nonessential use refers to water that is not used for drinking, cooking, cleaning or sanitation (i.e. nondomestic water use). Compare with *essential use*.

Nonurban Land Uses
Residential, commercial or industrial land uses that are not found in the urban area, and where urban services are unavailable. (Compare with *urban land uses.*)

Observation Well
A non-pumping well used for observing the elevation of the water table or piezometric surface.

On-site Septic System
System for disposing and treating human and domestic waste at or near the location where the waste is generated, such as a septic tank and soil absorption system or other system, allowed by state and city when access to the municipal sewer system is not required of feasible.

Open Space
Public and private land that is generally natural in character. It may support agricultural production, or provide outdoor recreational opportunities, or protect cultural and natural resources. It contains relatively few buildings or other human-made structures. Depending on the location and surrounding land use, open space can range in size from a small city plaza or neighborhood park of several hundred square feet, corridors linking neighborhoods of several acres to pasture, croplands or natural areas and parks covering thousands of acres.

Option
Water supply project that could be applied at the subregional level to implement an approach to water supply sustainability. Options were developed as part of the Master Plan to better quantify the costs and benefits of implementing sustainable water supply approaches. (NEEDS WORK!!)

Ordinance
A law or regulation set forth and adopted by a governmental authority, usually a city or county.

Peak Use (Demand)
The maximum water demand occurring in a given period, such as hourly or daily or annually.

Per Capita Use
Water use per person.

Permeability
Ability of a rock or unconsolidated deposit to transmit water through connected spaces between grains. The size and shape of the spaces controls how easily water flows.

Pollutant
An impurity (contaminant) that causes an undesirable change in the physical, chemical, or biological characteristics of the air, water or land that may be harmful to or affect the health,

Porosity
Volume of open pore space between particles of clay, silt, sand, gravel, cobble or within rock in a geologic formation.

Prediction
Prediction quantifies the response of a system to future events.

Pressure Head
Height of the water column due to aquifer pressurization.

Projection
A projection indicates what future values for the unknown would be if the assumed patterns of change were to occur. They are not a prediction that the unknown will change in this manner. A projection simply indicates a future value for the unknown if the set of underlying assumptions occur.

Public Water System
Community public water supply systems serve at least 25 persons or 15 services connections year-round, which includes municipalities, manufactured mobile home parks, etc. These systems are required to provide a safe and adequate supply of water under the federal Safe Drinking Water Act. Also known as a *community public water supply system*.

Recharge
The natural or manmade infiltration of surface water into the zone of saturation. For the purposes of regional recharge modeling using the SWB model, recharge is the portion of infiltration that moves from the unsaturated sediment below the root zone into the underlying aquifers (saturated zone).

Recharge Area
An area where surface water from rainfall, snowmelt or other sources seeps through the soil into the saturated zone.

Redevelopment
Any proposed expansion, addition, or major façade change of an existing building, structure, or parking facility.

Regional Infrastructure
Infrastructure pertaining to any of the Council's systems: wastewater, transportation, and parks and open space (See also *regional systems.*)

Regional Systems
Systems for which the Metropolitan Council is the responsible planning and operating authority. They include wastewater services, transportation, parks and open space, and airports. (See also *regional infrastructure*.)

Reuse
1) GET DNR definition. Reuse of water already authorized by a permit is exempt to water appropriation permit requirements.

Runoff
The rainfall, snowmelt, or irrigation water flowing that has not evaporated or infiltrated into the soil, but flows over the ground surface.

Rural Centers
Local commercial, employment, and residential activity centers serving rural areas in the region. These small towns are surrounded by agricultural lands and serve as centers of commerce to those surrounding farm lands. The density is 3-5 units/acre.

Rural Residential Area
Communities that have residential patterns characterized by large lots and do not have plans to provide urban infrastructure. Maximum allowable density is 4 units/40 acres.

Safe Yield
Amount of groundwater that can be withdrawn from an aquifer system without degrading the quality of the aquifer and without allowing the long-term average withdrawal to exceed the available long-term average recharge to the aquifer system. Minnesota Administrative Rules 6115.0630 defines "Safe yield for water table condition" as 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. Minnesota Administrative Rules 6115.0630 defines "Safe yield for artesian condition" as 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

Saturated Zone
Zone with only water in the interconnected spaces.

Simulation
The imitative representation of the functioning of one system or process by means of the functioning of another, such as a computer simulation of groundwater flow.

Soil Moisture
Moisture contained in the soil above the water table, including water vapor.

Source Water Protection
Source water refers to water from streams, rivers, lakes or underground aquifers that is used for drinking. There are three primary parts to Minnesota's Source Water Protection Program, administered by the MN Department of Health:

1. Wellhead Protection
2. Source Water Assessments
3. Protection of Surface Water Intakes

Special Well and Boring Construction Area
A Special Well and Boring Construction Area is sometimes also called a well advisory. It is a mechanism which provides for controls on the drilling or alteration of public and private water supply wells, and 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.

Specified Flow
Cumulative depletion of groundwater that results in greater than 15% reduction of groundwater base flow, as represented by average August flow rate.

Stormwater
Surplus surface water generated by rainfall that does not seep into the earth but flows overland to flowing or stagnant bodies of water. (See also *runoff.*) DNR defines stormwater more specifically as runoff from impervious surfaces.

Stormwater Reuse
The collection and use of stormwater runoff that is reclaimed for specific, direct, and beneficial uses. The term is also used to describe water that is collected on-site and utilized in a new application. It is also called rainwater harvesting, rainwater recycling, or rainwater reclamation. The Minnesota Department of Natural Resources more specifically defines stormwater reuse as the secondary use of water for a purpose other than what it was originally appropriated for. (GET VERIFICATION FROM DNR).

Subregion
A Metropolitan Council Water Supply Planning management area defined to ensure that technical analyses are distributed equitably throughout the region, reflect all the varied water supply conditions/environments, and that sustainability issues and approaches are distributed in a targeted way.

Suburban Area
Communities that saw their primary era of development during the 1980s and early 1990s. Suburban communities also include places that were once resort destinations along Lake Minnetonka and White Bear Lake and along the St. Croix River. Suburban communities are in the MUSA and have a minimum average net density of 5 units/acre.

Suburban Edge
Communities that have experienced significant residential growth beginning in the 1990s and continuing to the 2010s. At least 40% of the land in these communities is developed, but significant amounts of land remain for future development. Suburban Edge communities are in the MUSA and have a minimum average net density of 3-5 units/acre.

Superfund Site
A Superfund site is an uncontrolled or abandoned place where hazardous waste is located, possibly affecting local ecosystems or people.

Surface Water
Water on the earth's surface exposed to the atmosphere such as rivers, lakes and creeks. (Compare with *groundwater.*)

Sustainable Development
Development that maintains or enhances economic opportunity and community well-being while protecting and restoring the natural environment upon which people and economies depend. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable Water Use
Use of water that does not harm ecosystems, degrade water quality, or compromise the ability of future generations to meet their own needs.

Technical Assistance
Aid provided by Council staff to local governments to implement *2030 Development Framework,* including the *Master Water Supply Plan*.

Transpiration
Loss of water from a plant, mainly through the stomata of leaves.

Ultimate Build-out
Having absolute development under the proposed future land use and the guidelines of the 2040 Comprehensive Plan Update (see Full Build Out).

Unconfined Aquifer
Aquifer without a confining layer at the top and a lack of pressure that allows the water level to easily rise and fall.

Unsaturated Zone
Area below the land surface that contains a mixture of air and water.

Urban Area
Communities that are adjacent to the Urban Center communities and have seen considerable development and growth along highways. Urban areas are in the MUSA and have a minimum average net density of 10 units/acre.

Urban Center
Communities that include the largest, most centrally located and most economically diverse cities of the region. Urban centers are in the metropolitan urban service area (MUSA) and have a minimum average net density of 20 units/acre.

Wastewater
Water carrying waste from domestic, commercial, or industrial facilities together with other waters that may inadvertently enter the sewer system through infiltration and inflow.

Wastewater Treatment Plant
A facility designed for the collection, removal, treatment, and disposal of wastewater generated within a service area.

Water Cycle
The path that water takes through its various states – vapor, liquid, solid – as it moves throughout the ocean, atmosphere, groundwater, lakes and streams.

Water Table
The elevation at which the pore water pressure is at atmospheric pressure.

Wellhead Protection Area
The fundamental goal of wellhead protection (WHP) is to prevent contaminants from entering public wells. To accomplish this goal, public well owners must first determine where the water supplying their well(s) is coming from—this area is called the WHP area (WHPA). It can also be thought of as the recharge area to the public well and is ultimately the area to be managed by the public water supplier, as identified in the WHP plan.

Acronyms and Initialisms

CFS – Cubic Feet per Second

CWI – Minnesota County Well Index

DNR – Department of Natural Resources (of Minnesota)

DWSMA – Drinking Water Supply Management Area

GPCD – Gallons per Capita (Person) per Day

GPM – Gallons per Minute

LPA – Local Planning Assistance department of the Metropolitan Council

MAWSAC – Metropolitan Area Water Supply Advisory Committee

MCES – Metropolitan Council Environmental Services division

MDNR – Minnesota Department of Natural Resources

MDA – Minnesota Department of Agriculture

MDH – Minnesota Department of Health

MGD – Million Gallons per Day

MPCA – Minnesota Pollution Control Agency

PCA – Pollution Control Agency (of Minnesota)

PWS – Public Water System

SDWA – Safe Drinking Water Act

SWBCA – Special Well and Boring Construction Area

WHPA – Wellhead Protection Area

WHPP – Wellhead Protection Plan