Changing water demand:

Projecting water use in the Chicago region to 2050

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Introduction

Communities across the globe face an increasing array of water resource challenges. Growing population, habitat degradation, and climate change continue to impact the provision of clean, reliable water to residents and businesses. The Chicago region is not immune. Despite access to Lake Michigan, significant portions of the region — especially those dependent upon groundwater sources — are already encountering water supply and quality issues. The region's comprehensive plan, ON TO 2050, anticipates these issues will grow unless additional steps are taken to coordinate and conserve the region's shared water supply resources. While overall water use is stable, forecasted water demand will exceed available groundwater supplies in some areas. Yet with additional conservation and efficiency measures, the region can maintain its long-term drinking water supplies.

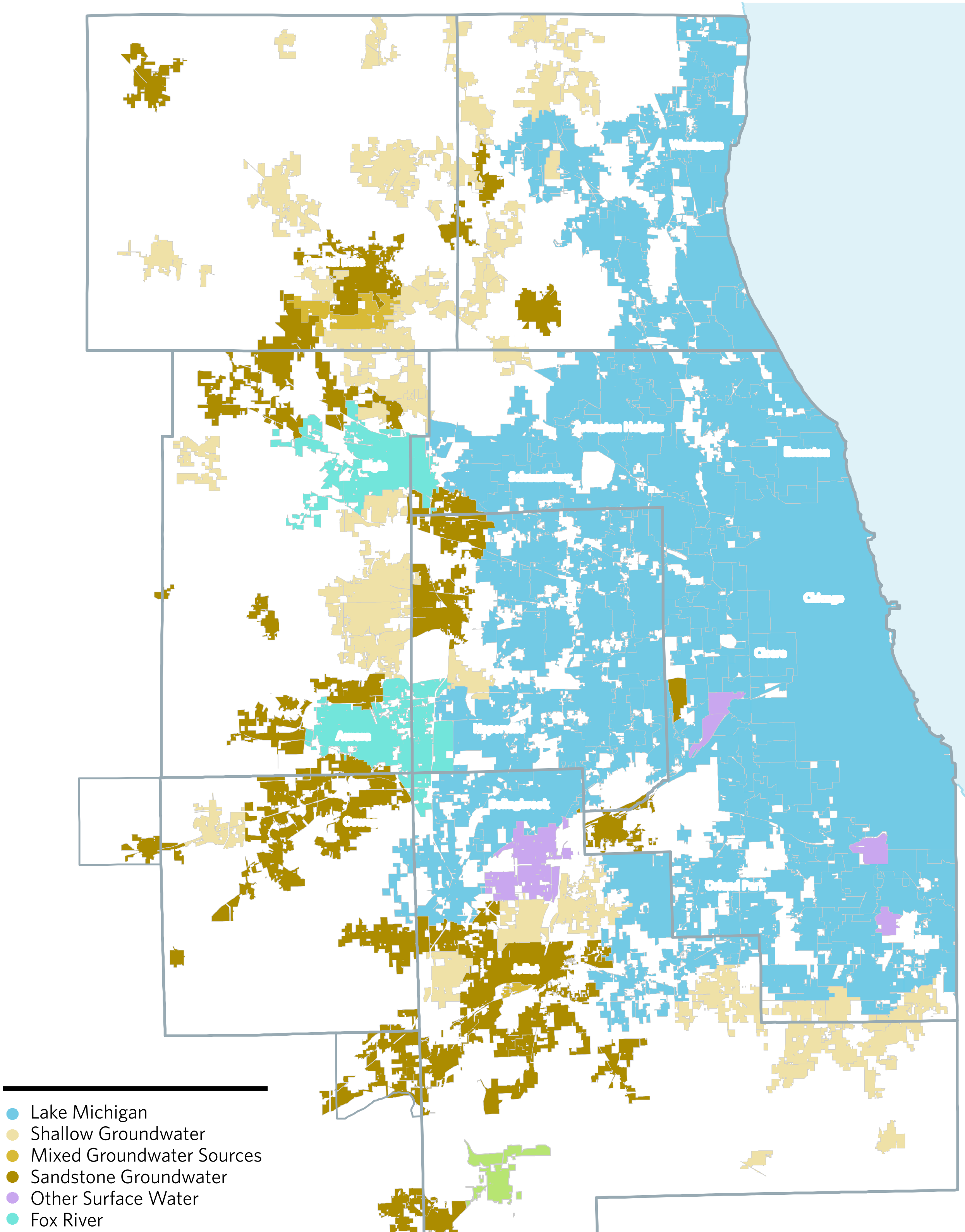
Understanding future water demand is key for sustainable management. The ON TO 2050 Regional Water Demand Forecast allows the region and municipalities to assess long-range demands in the context of available water supply. The forecast is designed to inform local and regional planners about the sufficiency of water sources and encourage actions that conserve water, protect supply, and pursue alternative drinking water sources. This guide provides a brief overview of forecasted water demand by 2050, important factors driving water demand, and how planning decisions can help to conserve shared water supply resources.

What is the demand forecast?

CMAP, Illinois-Indiana Sea Grant, and University of Illinois Extension developed the forecast to estimate future water demand to the year 2050 at the municipal, county, and regional scales as well as by water source and sector for the 7-county region. For more information on the methodology, see the ON TO 2050 Regional Water Demand Forecast report.[1]

Future demand will exceed supply in some areas unless we coordinate and conserve our shared resources.

Figure 1. Primary water source



Note: The water source of a community is based on the source of the majority of withdrawals from all wells and intakes within community, including industrial and commercial businesses.

Source: CMAP ON TO 2050 Regional Water Demand Forecast.

Regional demand for water in 2050

By 2050, the region is projected to add more than 2.3 million residents and 900,000 jobs.[2] Despite the demands of a growing population and economy, total water demand in northeastern Illinois is projected to stay relatively stable (Figure 2). By 2050, total water withdrawals are estimated to be 1,127 million gallons per day (MGD), an increase of less than one percent from withdrawals in 2013.

Overall water use is estimated to be stable despite this growth because water conservation and efficiency practices are expected to continue. The Chicago region continues to implement conservation practices, such as installation of efficient plumbing fixtures and appliances, more compact and infill redevelopment, industrial innovation, and infrastructure maintenance leading to water loss reductions. The ON TO 2050 Regional Water Demand Forecast assumes continuation of recent conservation trends (Figure 3). Water use per person and per employee is estimated to decrease approximately 20 percent from 2013, to 65 gallons per capita per day (GPCD) for the residential sector and 84 gallons per employee per day (GPED) for the nonresidential sector.

Figure 2

Regional Water Demand and Socioeconomic Forecast

Note: Private residential wells are not included.

Source: CMAP ON TO 2050 Regional Water Demand Forecast CMAP ON TO 2050 Socioeconomic Forecast.

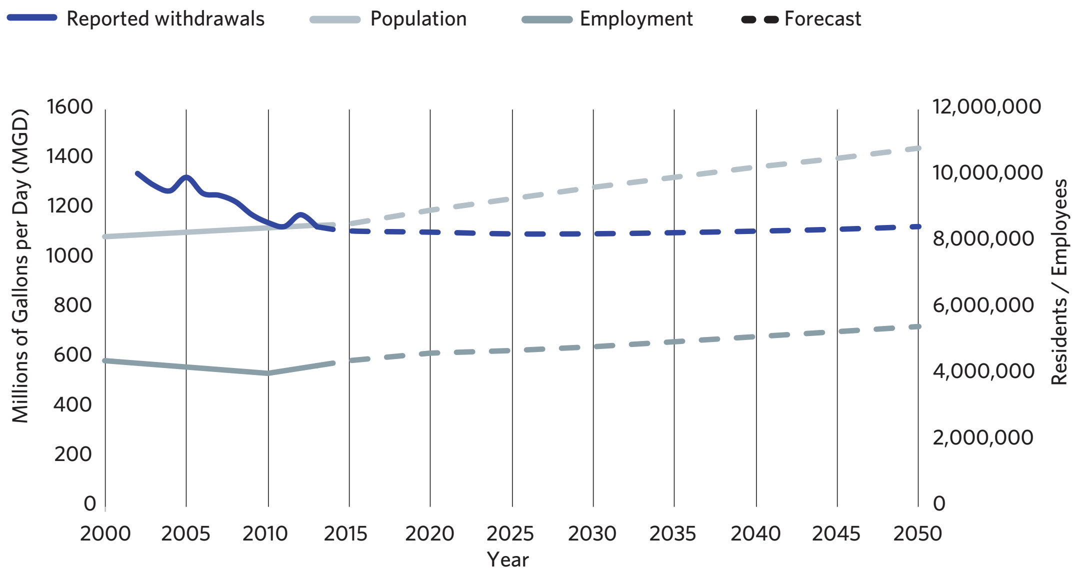
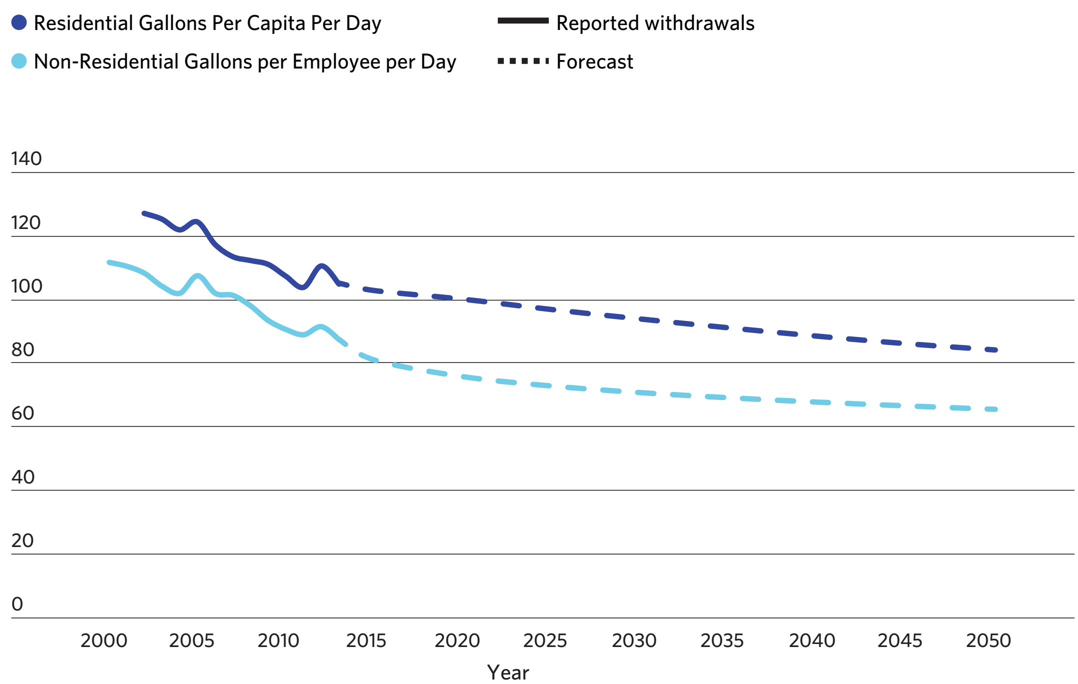


Figure 3

Daily per capita / employee water use by sector

Source: CMAP ON TO 2050 Regional Water Demand Forecast.



Forecasted demand exceeds available groundwater supplies

Despite increasing water conservation and efficiency, long-term sustainability of the region's water supply depends on the location of demand and source of water. The future location of population and employment — the main drivers of water demand — is needed to understand potential impacts to water supply sources. The water demand forecast uses the CMAP ON TO 2050 Socioeconomic Forecast to estimate the location of future population and employment based on existing conditions, market trends, and the regional policy recommendations for land use and transportation patterns.[3] CMAP anticipates an additional 1.47 million residents and 470,000 jobs in communities that currently depend on groundwater.

Consequently, water demand is projected to substantially increase in areas currently relying on shallow and sandstone groundwater aquifers (Figure 4 and Figure 5). However, the Illinois State Water Survey currently estimates that withdrawals from sandstone aquifers are occurring at twice the natural recharge rate.[4] The resulting decline in groundwater levels raises concerns about the ability of groundwater wells to continue to provide the necessary quantity and quality of water to meet local water demands. If demand continues at its current rate or increases, further declines of this resource will likely force some communities and businesses to switch to alternate water sources, such as the Fox and Kankakee Rivers or Lake Michigan, and incur the associated costs.[5] Shallow groundwater sources are also facing quality constraints that may require similar shifts.[6,7]

Figure 4

Projected changes in water demand by water source, 2011-50

Source: CMAP ON TO 2050 Regional Water Demand Forecast.

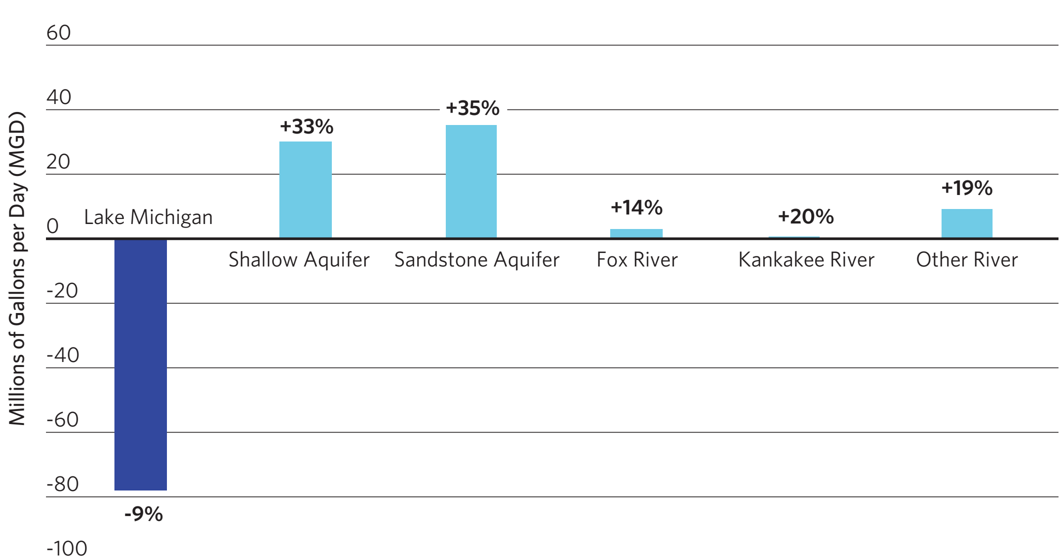
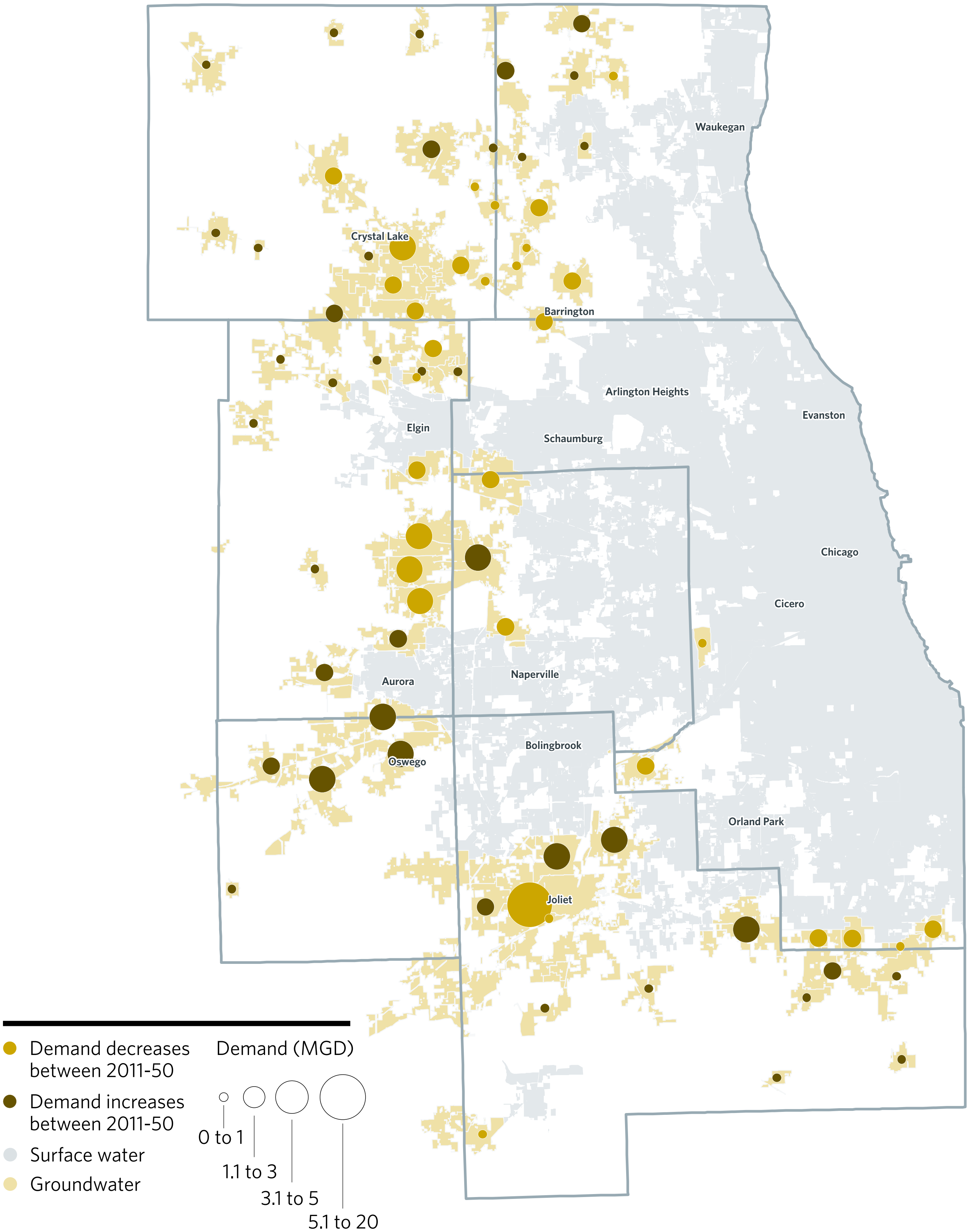


Figure 5. Projected change in demand for groundwater dependent municipalities, 2011-50 (MGD)



Source: CMAP ON TO 2050 Regional Water Demand Forecast.

Switching sources, however, is not without challenges. Regulatory, technological, and financial considerations may limit a community's ability to use alternate water sources. Cost, infrastructure capacity, as well as political, and legal complexity, (e.g. Great Lakes Compact), will constrain Lake Michigan water as an option. Gaining access to Lake Michigan water will not be feasible for all interested communities. Access to the Fox and Kankakee Rivers is also regulated to ensure sufficient flows during drought conditions to protect aquatic life.[8] Even if several communities are able to switch water sources, the supply constraints may remain for some time given that historical withdrawals have surpassed sustainable yields.[9] Therefore, reducing demand on sandstone groundwater aquifers will also be needed to ensure this resource continues to be available as a primary or secondary source for communities.

Although communities and industrial and commercial facilities may switch water sources in the coming years, predicting these changes is difficult; thus, the forecast assumes that communities and facilities will continue to rely on their current source.[10] However, this is considered unlikely as water demand is projected to outstrip supply in some areas.

One of the most cost effective ways to maintain water supplies is to conserve water.

How do municipal characteristics shape the regional water demand forecast?

Water demand is a function of demand drivers, such as population, employment, price, household income, housing density, and others, which influence the amount of water used. The forecast uses data from individual municipalities to understand the relationship between municipal characteristics and water withdrawals. Long-range forecasts require making projections about future conditions contributing to demand; this method relies on the ON TO 2050 Socioeconomic Forecast as well as other local and regional trends. Municipal-scale forecasts add up to generate county and regional demand estimates.

1

Collect annual data community characteristics

Water attributes
Locations of wells or intakes
Residential water withdrawals
Nonresidential water withdrawals
Water source(s)

Municipal characteristics
Population
Employment
Housing density
Household income
Water price
Conservation trends

2

Analyze past demand trends

Understand the relationship between municipal characteristics and water withdrawals → **Water use per person/employee**

3

Anticipate future conditions

ON TO 2050 Socioeconomic forecast
Population
Employment
Housing density
Household income

Additional assumptions
Water price
Conservation trends

4

Calculate future water demand per municipality

Water use per person/employee X Anticipated future conditions = Municipal future water demand

5

Sum of 245 communities and unincorporated county areas demand estimates = Regional future water demand

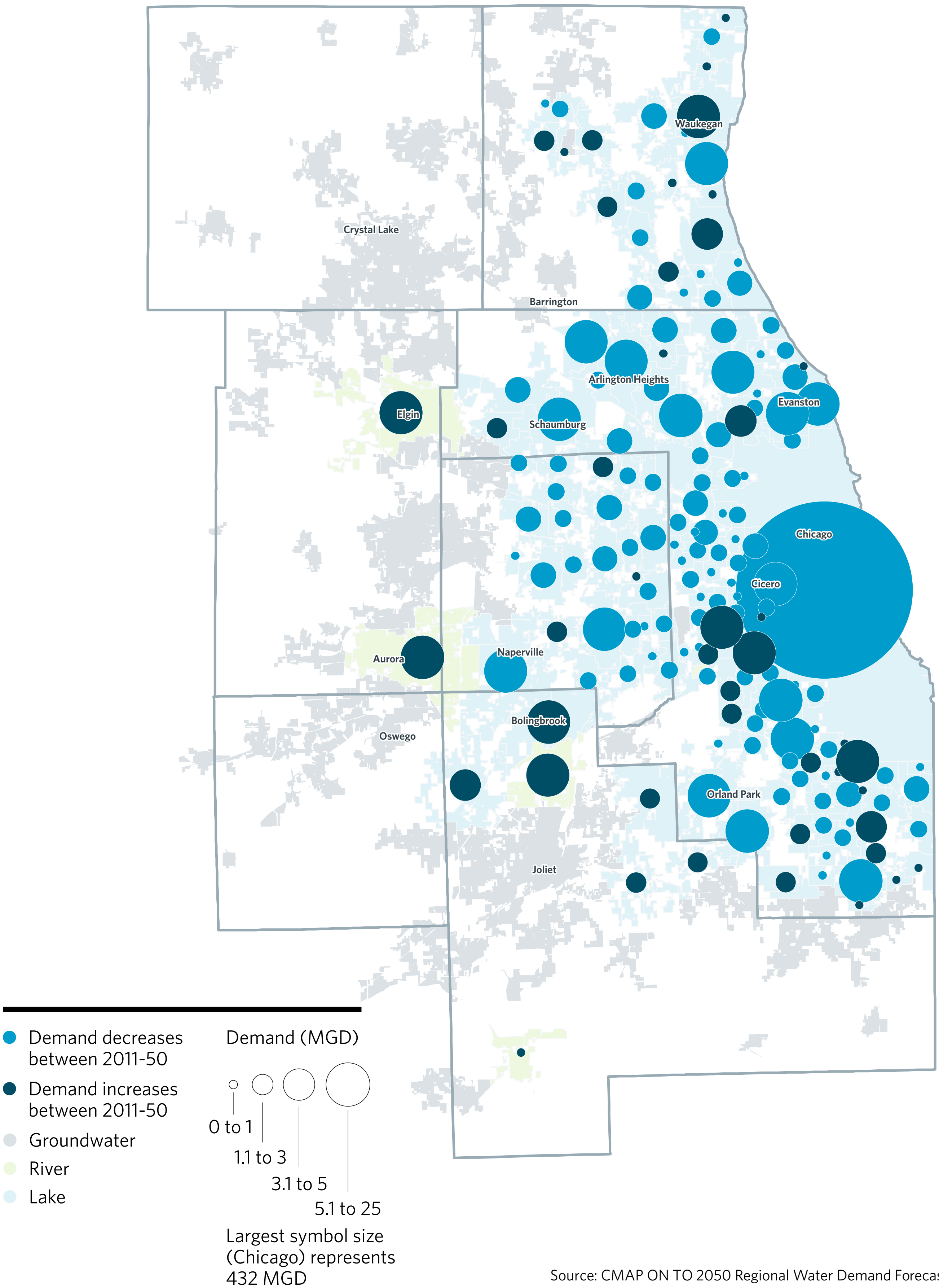
Stewardship of Lake Michigan water promotes resilience

Illinois withdraws, uses, and then diverts Lake Michigan water out of the Great Lakes Basin to the Mississippi River system, a modification which resulted in a U.S. Supreme Court Consent Decree that governs Illinois withdrawal of lake water. The Illinois Department of Natural Resources (IDNR) manages the Lake Michigan Water Allocation program and issues permits to communities and industries to ensure that the State stays within the established diversion rate. In addition, IDNR implements a water management and conservation program that requires wise water management by Lake Michigan permittees.

The ON TO 2050 Regional Water Demand Forecast reconfirms the long-term trend of declining water demand in areas served by Lake Michigan water (Figure 4 and Figure 6). Even as population and employment increases are projected for the Lake Michigan service region, conservation and efficiency practices are anticipated to outweigh new demand from additional residents and employees.

Continued declines in water demand in the current Lake Michigan service area could allow water to be allocated to additional communities and industries, including those relying on scarce groundwater sources. However, the Lake Michigan Allocation process is complicated and requires ongoing assessment by IDNR. Accounting for climate change — both within the region and nationwide — will be particularly important. Climate change is anticipated to impact water supplies in a variety of ways while also increasing water demand due to warming.[11] Increasing conservation practices will better position the region to respond to both groundwater constraints and climate change impacts.

Figure 6. **Projected change in demand for Lake Michigan and river dependent municipalities, 2011-50 (MGD)**



Source: CMAP ON TO 2050 Regional Water Demand Forecast.

River water offers opportunities

The ON TO 2050 Regional Water Demand Forecast anticipates growing demand of river water to supply both municipal drinking water as well as water used for industrial and commercial purposes (Figure 4 and Figure 6). Currently, Aurora and Elgin use the Fox River for their drinking water supply. Water 2050 estimated that the Fox River has the potential to support an additional 40 to 45 million gallons of withdrawals in the future.[12] The Kankakee River currently supplies the Village of Wilmington and has potential to meet additional demands as well. Today, several groundwater dependent communities are considering switching to river water sources.

Many commercial and industrial businesses already rely on the Chicago, Calumet, Des Plaines, and Fox Rivers, and the Cal-Sag and Chicago Sanitary and Ship Canals for their water supply. Additional businesses that currently rely on groundwater may be able to switch to river sources to meet their needs and reduce their reliance on constrained supplies.

Incorporate water supply and demand considerations into local planning

Understanding both the available supply of water and current and future demand is critical to making informed land use, transportation, and infrastructure investment decisions. With some communities anticipating significant increases in water demand by the year 2050, ensuring that there is an adequate and sustainable water supply will become increasingly important. During a comprehensive planning process, future land use plans should consider how proposed growth patterns could impact available supplies and infrastructure capacity and adjust policies accordingly. This could include actions that conserve water, protect supply, and pursue alternative drinking water sources. As new development is proposed, communities could review potential demand generated from the development to help implement water resource goals. To make these assessments, land use planners and water utility managers will need to work together and align local planning efforts with current and future water supply constraints.

Declining water demand — as projected for the majority of communities in the region by 2050 — benefits the entire region in maintaining a long-term supply. Yet it presents its own set of challenges. Declining demand often means less billed water per customer, and therefore, less revenue to cover the costs of maintaining water service. Compact development is even more important in these situations as adding additional infrastructure likely exacerbates the mismatch between costs and revenues. Planners can help utility managers by supporting strategies such as considering shared services with nearby communities and adjusting water rates to be more resilient to variability in water use. The relationship between land use and development, water demand, and water rates and revenues is ever evolving; land use planners and water utility managers will need to continue to work together.

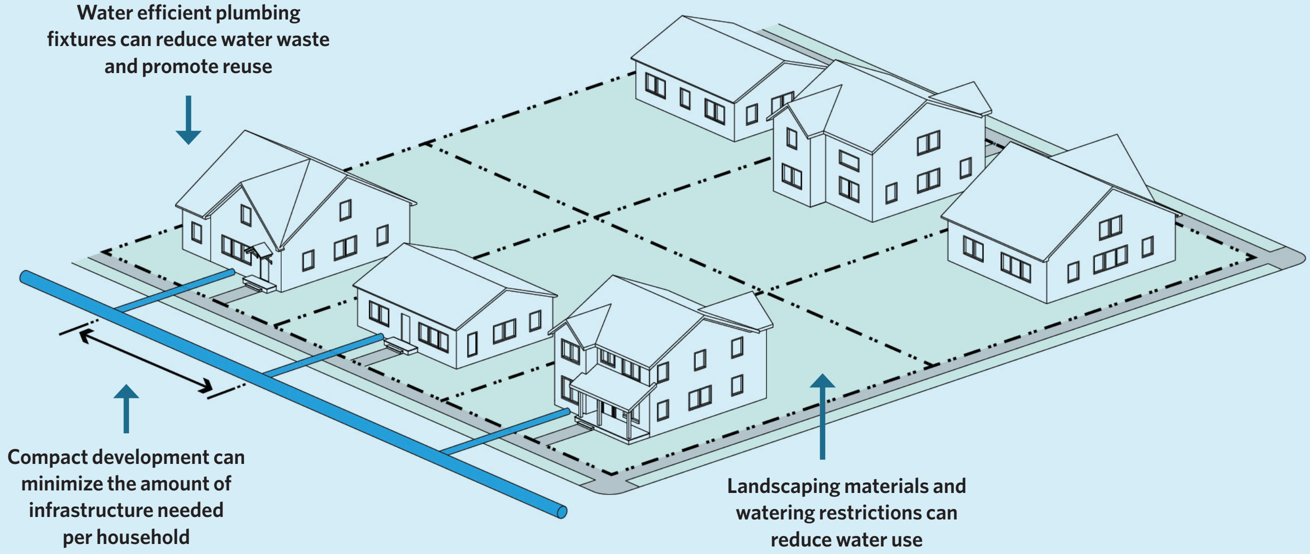
Local water demand forecasts can help bridge land use, transportation, and municipal finance and asset management decisions as development patterns affect water use and also long-term infrastructure maintenance costs. As part of the ON TO 2050 Regional Water Demand Forecast, individual demand forecasts, reported water withdrawals, and data on current and projected demand drivers for 245 municipalities are available for download via the CMAP DataHub. Local decision-makers can incorporate forecast results in planning activities, update projections as additional community data is available, and explore future scenarios. At a larger scale, groups of municipalities can aggregate the demand forecast to a sub-regional level and by water source to compare with water supply estimates.

How development decisions impact drinking water management

Addressing drinking water issues has historically been left to water utilities. Yet planning and development decisions influence the amount of water used, the supply and quality of water sources, and the cost of maintaining water service. Understanding how planning decisions impact drinking water provision is essential for maintaining a long-term supply and a well-functioning utility. Planners and utility managers can work together on a variety of fronts to integrate water resource and asset management goals into development decisions.

Protect the quantity and quality of drinking water sources

Development typically includes impervious surfaces that reduce the infiltration capacity of the ground below and generates runoff. Stormwater runoff can pick up pollutants — like road salts and fertilizers — and pollute nearby streams and groundwater aquifers. Ideally, development should avoid areas that provide valuable groundwater infiltration and water purification services. Infill and redevelopment, as well as clustered, conservation design can reduce the impact of new development on groundwater recharge and protect natural areas. Implementing stormwater best management practices and other pollution prevention strategies, such as sensible salting, can improve the quality of drinking water by improving the quality of stormwater runoff.



Reduce water use through land use and development standards

Certain land uses, building types, and development patterns consume more water than others. In northeastern Illinois, residential rates of water use tend to be lower in communities with more compact development.[13] Compact development, as well as water efficient plumbing, building, and landscaping standards can make it easier for residents to reduce water use. In addition, implementing outdoor lawn watering ordinances and other efficiency programs can reduce the amount of water used throughout a community.

Reduce infrastructure costs through development design and location

Development patterns also play a role in water system design and infrastructure maintenance. Larger lot sizes in widely dispersed development tracts typically increase the length of pipes and other infrastructure needed to provide water service. The additional infrastructure can lead to higher long-term costs due to increased potential of water loss, replacement needs, and energy demands. With water use held constant, studies have shown that a utility's annualized service costs per household for a ¼-acre residential lot are 50 percent less than the costs for a 1-acre lot.[14] At the same time, lower density developments have fewer customers to shoulder the increased costs, leading to higher water prices for residents.

The location of new development also matters. Infill development, as opposed to greenfield development, can improve the efficiency of the system by increasing the size of the customer base that helps maintain the existing infrastructure. Greenfield development requires new infrastructure, and therefore, adds to the system's long-term capital costs.[15]

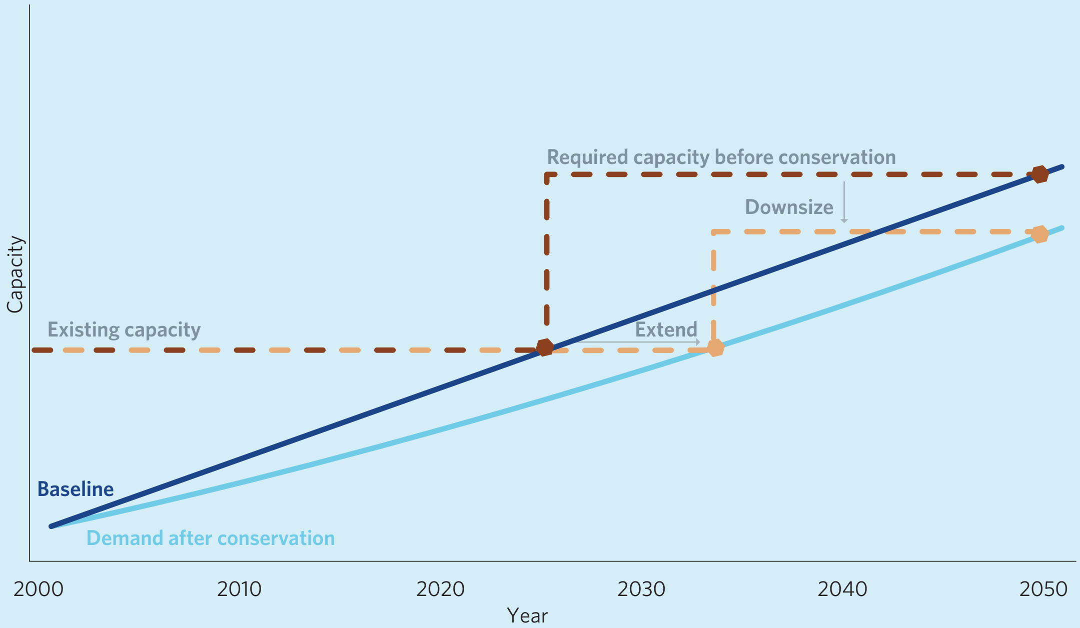
Conservation can delay and minimize expensive infrastructure investments

Water efficient land use decisions and other conservation practices have an additional benefit of helping utilities reduce the costs of expensive capacity expansion. The diagram (Figure 7) illustrates how an effective water conservation program can affect the timing of capital facility construction and thus, save money for the water utility.[16] As a growing community reaches the capacity of their water treatment plants, they design expanded capacity to meet future projected demand. Reducing water demand through conservation strategies can potentially achieve two cost saving measures — delaying when new expansion is needed and downsizing the size of the infrastructure when it becomes necessary.

Figure 7

Example of extending or downsizing a capital facility, peak demand/capacity in million gallons per day

Source: American Water Works Association, 2006. Water Conservation Programs - A Planning Manual. AWWA Manual M52, First Edition, page 75.



Increase conservation practices to maintain long-term supply

The ON TO 2050 Regional Water Demand Forecast reveals that existing water supply challenges will continue to grow unless additional conservation measures are taken. While overall water use is stable, forecasted water demand will exceed available groundwater supplies in some areas. Addressing the water supply constraints facing parts of the region will require increased conservation practices throughout, not just in locations facing short-term supply challenges. Regardless of a community's location or source of water, water efficiency and conservation is a critical strategy to maintain our long-term supply. ON TO 2050 recommends strategies to coordinate and conserve shared water supply resources. By implementing conservation practices and carefully considering the location and extent of new development, communities can work together to manage our shared water resources.

Resources

For more information on how to incorporate water supply and demand considerations into planning, see ON TO 2050 and the detailed conservation best practices outlined in Water 2050.[17,18] Download individual municipal water demand forecasts, reported water withdrawals, and data on current and projected demand drivers for 245 municipalities via the CMAP DataHub.

CMAP has an array of additional resources, including a model water conservation ordinance and guides to full cost water pricing and landscaping irrigation practices.[19] To introduce fellow community leaders and elected officials to drinking water management issues and solutions, see the Metropolitan Planning Council's Drinking Water 1-2-3.[20]

Endnotes

1 Chicago Metropolitan Agency for Planning, “ON TO 2050 Regional Water Demand Forecast for Northeastern Illinois, 2015-2050,” 2018, https://www.cmap.illinois.gov/programs/water/supply-planning/resources/2050-water-demand.

2 Chicago Metropolitan Agency for Planning, “ON TO 2050 Socioeconomic Forecast Appendix,” 2018, http://www.cmap.illinois.gov/documents/10180/911391/FINAL+Socioeconomic+Forecast+Appendix.pdf/84809136-9d7e-6a9e-f406-ff43c73744eb Additional population and employment values compare 2015 to 2050.

3 Ibid.

4 Abrams, Daniel B. 2017, “The Illinois Groundwater Flow Model: New Applications and Insights for Northeastern Illinois,” Presentation to the Northwest Water Planning Alliance Technical Advisory Committee on October 24, 2017.

5 Abrams, Daniel B. et all, 2015, “Changing Groundwater Levels in Sandstone Aquifers of Northern Illinois and Southern Wisconsin: Impacts on Available Water Supply,” Illinois State Water Survey, Contract Report 2015-02.

6 Walton R. Kelly, Daniel R. Hadley, Devin H. Mannix, “Shallow Groundwater Sampling in Kane County, 2015,” Illinois State Water Survey, March 2016, http://www.isws.illinois.edu/pubdoc/CR/ISWSCR201604.pdf.

7 Walton R. Kelly, Samuel V. Panno, Keith Hackley, “The Sources, Distribution and Trends of Chloride in the Waters of Illinois,” Illinois State Water Survey, March 2012, http://www.isws.illinois.edu/pubdoc/B/ISWSB74.pdf.

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9 Abrams, Daniel B. “The Illinois Groundwater Flow Model: New Applications and Insights for Northeastern Illinois,” Presentation to the Northwest Water Planning Alliance Technical Advisory Committee on October 24, 2017.

10 Some water facilities rely on more than one water source and the proportion coming from each source can vary over time due to a variety of factors, including weather and infrastructure maintenance. To account for these variations, the forecast generated an average source mix from ten years of data (2003-13) and then used that ratio to estimate future water demand by source. Communities that made permanent transitions to different sources during this time period were accounted for; the average source mix was calculated from the time period using their new source.

11 Lall, U., T. Johnson, P. Colohan, A. Aghakouchak, C. Brown, G. McCabe, R. Pulwarty, and A. Sankarasubramanian, 2018: Water. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 145–173. doi: 10.7930/NCA4.2018.CH3.

12 Chicago Metropolitan Agency for Planning, “Water 2050: Northeastern Illinois Regional Water Supply/Demand Plan,” 2010, http://www.cmap.illinois.gov/programs/water/supply-planning/water-2050.

13 Dziegielewski Benedykt, “Residential Water Use in Northeastern Illinois, Estimating Water-Use Effects of Infill Growth versus Exurban Expansion,” 2009, Southern Illinois University Carbondale, http://www.cmap.illinois.gov/documents/10180/14452/NE+IL+Residential+Water+Use.pdf/9a07c0d8-3733-48c3-94f6-abaa5bad1477.

14 Speir, Cameron and Stephenson, Kurt, “Does Sprawl Cost Us All: Isolating the Effects of Housing Patterns on Public Water and Sewer Costs,” 2002, Journal of the American Planning Association, 68:1, 56-70.

15 U.S. EPA, “Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies,” 2006, https://www.epa.gov/sites/production/files/2014-01/documents/growing_water_use_efficiency.pdf.

16 American Water Works Association, “Water Conservation Programs – A Planning Manual,” 2006. The savings available to a utility result from the difference in the present value of the costs associated with building a new facility in 2027 versus 2020, see page 75.

17 Chicago Metropolitan Agency for Planning, “Coordinate and conserve shared water supply resources,” ON TO 2050 Regional Comprehensive Plan, 2018, https://www.cmap.illinois.gov/2050/environment/water-supply.

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20 Metropolitan Planning Council, “Drinking Water 1-2-3: A guide for local officials and community leaders,” 2018, https://drinkingwater123.metroplanning.org/.

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The Chicago Metropolitan Agency for Planning (CMAP) is our region's comprehensive planning organization. The agency and its partners developed and are now implementing ON TO 2050, a new long-range plan to help the seven counties and 284 communities of northeastern Illinois implement strategies that address transportation, housing, economic development, open space, the environment, and other quality-of-life issues. See www.cmap.illinois.gov for more information.

Funding acknowledgment

This project was supported through the CMAP Water Resources Planning program, which is funded by the Illinois Department of Natural Resources and Illinois Environmental Protection Agency. CMAP would like to thank Illinois Department of Natural Resources Office of Water, Illinois State Water Survey, Illinois-Indiana Sea Grant, and University of Illinois Extension for their support of this project.

FY19-0053 | IISG19-RCE-RLA-030 | APRIL 2019