

Planning Report No. 57

A CHLORIDE IMPACT STUDY FOR SOUTHEASTERN WISCONSIN

Chapter 9

POTENTIAL FUTURE CHLORIDE CONDITIONS IN SOUTHEASTERN WISCONSIN

This Chapter utilizes information and data from a series of Technical Reports developed by the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) for the Chloride Impact Study (Study). These reports include SEWRPC Technical Report No. 61, *Field Monitoring and Data Collection for the Chloride Impact Study*, September 2024 (TR-61); SEWRPC Technical Report No. 63, *Chloride Conditions and Trends in Southeastern Wisconsin, Month 2026* (TR-63); SEWRPC Technical Report No. 65, *Mass Balance Analysis for Chloride in Southeastern Wisconsin*, December 2025 (TR-65); and SEWRPC Technical Report No. 66, *State of the Art in Chloride Management, Month 2026* (TR-66). Future conditions and Regional projections rely on the information presented in SEWRPC Planning Report No. 55 (3rd Edition), *VISION 2050: Recommended Regional Land Use and Transportation Plan*, June 2024 (VISION 2050). Refer to these reports for additional details.

9.1 INTRODUCTION

The Chloride Impact Study identified some of the main drivers of chloride pollution in the Southeastern Wisconsin Region (Region). Land use has a significant influence on chloride released into the environment, determining where and how chloride is used. Weather patterns, including snow and rain events, are also significant drivers of chloride, influencing both the application and transport of chloride through the environment. Chapter 3 of this Report discusses the major sources of chloride in the Region, which are primarily associated with human activities related to winter deicing, wastewater, and agriculture. Changes to these practices would also affect chloride conditions in the Region.

This Chapter explores how chloride conditions in the Region may change in the future. First, this chapter summarizes the projected physical changes in the Region, describing how and where the Region may experience growth in the future. The projected physical changes caused by future growth and development include increases in urban land use and population, as well as transportation network expansion. This Chapter also considers future weather conditions based on downscaled results from global circulation models, which forecast a warmer and wetter Region by the middle of the 21st century (mid-century) with more extreme weather events. And finally, this Chapter explores how the projected changes in the Region, along with chloride management efforts, may impact both future chloride usage and chloride conditions in the streams, lakes, and groundwater of the Region.

9.2 PROJECTED FUTURE CONDITIONS IN SOUTHEASTERN WISCONSIN

The VISION 2050 plan recommends a long-range vision for land use and transportation in the Southeastern Wisconsin Region. The plan makes recommendations to local and State government agencies to shape and guide land use development and transportation improvements to the year 2050. The third edition of VISION 2050 was adopted by the Commission in 2024 and includes updated projections for planned land use, population growth, and proposed changes to the Regional transportation network. To help envision how the Region may look in the future, the following sections describe the Regional projections developed for VISION 2050, along with consideration of future weather conditions and changes to long-term weather patterns.

Planned Land Use in the Region

The planned land use component of VISION 2050 focused on compact development and modest growth in developed lands across the Region. The plan provided planned land use development patterns and recommendations to accommodate projected growth in the Region in a sustainable manner, consistent with the VISION 2050 plan objectives. Some of the key land use recommendations from VISION 2050 include: preserving primary environmental corridors, preserving the Region's most productive agricultural land, preserving areas with high groundwater recharge potential, focusing urban development in areas that can be efficiently served by essential municipal facilities and services, providing a mix of housing types near employment-supporting land uses, encouraging and accommodating economic growth, developing urban service areas with a mix of housing types and land uses, focus transit-oriented development near rapid transit and commuter rail stations, and encouraging cluster subdivision design in residential development outside urban service areas. **Map 9.1** represents the planned land use for VISION 2050.

To evaluate growth and development across the Region, the VISION 2050 plan compared the planned land use dataset with the 2010 land use dataset for the Region, as presented in [Table 9.1](#). The table indicates a projected 3.2 percent increase in urban land use in the Region from 30.7 percent in 2010 to 33.9 percent in 2050. This translates to an additional 88 square miles of urban land use in the Region. The largest projected growth is predicted for the Residential land use category with a projected 2.3 percent increase (an additional 63 square miles). [Table 9.2](#) presents a similar land use comparison for each County in the Region. The three counties with the largest projected increases in urban land use are Kenosha County (6.4 percent), Racine County (4.0 percent), and Waukesha County (3.9 percent). For each of these counties, residential land use is projected to have the greatest growth with increases of 4.5 percent, 2.3 percent, and 2.8 percent, respectively. Most of the projected gains in urban land use are losses of agricultural land uses.

Commission staff also compared the existing land use and the planned land use developed for VISION 2050 for major watersheds and the SEWRPC stream monitoring site drainage areas. The VISION 2050 planned land use data covers the Region only and does not include portions of the study area outside of the Region, therefore the land use comparison was made for areas within the Region only. The existing land use for the Region used for the Study was developed from the Commission's 2015 land use dataset, as described in TR-61. The existing land use dataset includes highly detailed land use categories and mapping data, while the planned land use dataset is less refined. Due to these differences, a broad comparison between the existing and planned land use was performed based on the percentage of urban land use only. [Table 9.3](#) compares the VISION 2050 planned land use with the existing (2015) land use for the major watersheds in the Region. The largest projected growth in urban land use is expected in the Pike River watershed, with an increase in urban land use from 45.2 to 62.7 percent. The rest of the watersheds had projected urban land use increases of 5.6 percent or less. [Table 9.4](#) compares the VISION 2050 planned land use with the existing (2015) land use for the ten SEWRPC stream monitoring sites in the Region that are projected to experience the greatest increase in percent urban land use.

General Implications of Planned Land Use Changes on Chloride

Results from the Study have indicated a strong correlation between urban land use and chloride, as documented in TR-63 and TR-65. Watersheds and drainage areas with higher percentages of urban land use typically exhibited higher chloride concentrations in surface water and larger estimated chloride source contributions. Urban development includes a variety of different land use categories, and the impact of land use changes on chloride usage and conditions are dependent on the specific type of land use. For example, growth in certain types of land use could increase the amount of wastewater generated or the usage of deicing salt. The impact of land use changes on chloride is also dependent on where the planned

development is located and the type of infrastructure that would be required to service the planned development. Even with the extensive amount of data collected for the Study, it was difficult to establish direct relationships that would allow us to accurately predict changes to chloride concentrations in the surface waters and groundwater around the Region based on planned land use changes. However, Study findings indicate that without any changes to current practices, increases in urban land use would lead to increases in both chloride use and chloride levels in the environment. The potential impacts of planned land use changes on individual sources of chloride are discussed later in this Chapter.

Population and Household Projections for the Region

One of the most important elements of the regional planning process is the development and refinement of future population projections, including potential changes to the size and distribution of the population and households across the Region. VISION 2050 presents population and household projections for the Region from 2010 to 2050. A range of population and household projections were developed for the planning process, including high, intermediate, and low projection levels. The intermediate projections are intended to represent the most-likely growth scenario for the Region, while the high and low projections are provided to encompass the full range of plausible projections (see **Figure 9.1**). The intermediate projections were used to develop VISION 2050. The projections resulting from the VISION 2050 planning process were used to evaluate future population and household conditions in the Region.

Based on VISION 2050, the Regional population is expected to grow by approximately 20 percent from 2010 to 2050 (an additional 401,700 people), with an anticipated 25 percent increase of households in the Region. **Table 9.5** presents the VISION 2050 population and household projections for each County in the Region. **Map 9.2** shows the VISION 2050 projected change in households from 2010 to 2050 across the Region.

The existing and projected population and households were compared by major watershed in the Region, as presented in **Table 9.6**. The table shows the population and households for the portion of the watershed located within the Region only, as the VISION 2050 planned land use does not extend beyond the boundaries of the Region. The Des Plaines River and Pike River watersheds are expected to experience the greatest population growth by percent increase in the Region. A similar comparison was conducted for population and household projections for SEWRPC stream monitoring site drainage areas. **Table 9.7** summarizes the 12 SEWRPC stream monitoring site drainage areas that are projected to experience the greatest population growth by 2050.

VISION 2050 also includes population projections for each sanitary sewer service area (SSSA) in Southeastern Wisconsin and the plan recommends that all development within an existing SSSA should be served by a public wastewater treatment plant (WWTP) by 2050. This means that within an SSSA, all new development and any existing populations that utilize onsite wastewater treatment systems would be connected to the municipal sanitary sewer service. In 2010 nearly 90 percent of the households in the Region were sewered, and it is projected that nearly 94 percent of the households in the Region are projected to be sewered by 2050.

General Implications of Projected Population and Household Changes on Chloride

In general terms, population growth would lead to increased residential chloride usage and more chloride entering the environment. The projected Regional growth in both population and households would create an increased demand for chloride-related products and potential increases to activities that release chloride to the environment, such as residential deicing and water softening. Regarding population and household growth, the most direct impact on chloride usage would be associated with wastewater sources of chloride. There would be more chloride generated through domestic wastewater, with a larger population responsible for using more water, more products containing chloride, and more water softener salt, particularly in areas where the water supply source is from groundwater. Many of the chloride-influencing factors for planned land use are also applicable to population and household growth in the Region. The potential impacts of projected population growth on individual sources of chloride are discussed later in this Chapter.

Planned Transportation Network Expansion Within the Region

The Transportation Component of VISION 2050 addressed a wide array of modes and methods of transporting goods and people throughout the Region. From personal vehicle traffic to public transit, VISION 2050 promotes responsible development of the transportation network while improving mobility, efficiency, and safety. In addition to preserving and maintaining existing transportation infrastructure, VISION 2050 recommends improvements to the arterial street and highway system designed to serve the expected increased usage by the year 2050. These highway improvements are recommended by the plan to address the traffic congestion that may not be alleviated by the other planning elements of VISION 2050.

Map 9.3 presents the planned transportation improvements for arterial streets and highways in the Region. This does not include additions to local streets, which may be significant with future development. The transportation improvements include two categories: expansion represents the planned construction of new roadways whereas widening represents the planned construction of additional lanes on existing roadways.

As shown in **Table 9.8**, the largest increases in arterial street and highway lane miles are planned for Waukesha and Walworth Counties. The total lane miles of planned highway improvements within the SEWRPC monitoring site drainage areas were estimated, and **Table 9.9** summarizes the ten monitoring sites that have the largest planned increases in lane miles within the contributing drainage area upstream of the site.

General Implications of Planned Transportation Network Changes on Chloride

Of all the future projections considered in this Chapter, the planned changes to the transportation network have the most direct relationship to chloride. The amount of deicing salt used on public roadways would be expected to increase proportionally with the projected expansion of the transportation network, assuming the current operational practices remain the same. Road salt used for winter deicing was the largest source of chloride in the Region, based on the analysis presented in TR-65 and summarized in Chapter 3 of this Report. Hence expansion of the transportation network would likely yield some of the most significant increases of chloride contributions to the environment. Increased usage of road salt and other chloride-based deicing materials would ultimately increase the amount of chloride entering the surface water and groundwater sources in the Region, and more significant impacts would be expected in areas with the greatest road densities. The potential impacts of the planned transportation network expansion on individual sources of chloride are discussed later in this Chapter.

Potential Long-Term Weather Patterns and Projections

The potential changes to future weather patterns and projections for Southeastern Wisconsin that are discussed in this section rely on reports and data published by WICCI.¹ WICCI is a statewide collaborative that assesses the risks associated with changes to long-term weather patterns based on global circulation model predictions. Chapter 2 of this report discusses current climate conditions and historical trends, while this section focuses on the future and summarizes the potential long-term weather conditions and projections published by WICCI.² Some of the key findings from WICCI's 2026 Assessment Report are that Wisconsin will continue to get warmer and wetter, and we can expect more extreme weather events, as summarized below.

¹ *Wisconsin Initiative on Climate Change Impacts (WICCI)*, wicci.wisc.edu, accessed April 2026.

² *WICCI projections presented in this report are for the medium greenhouse gas emissions scenario, which represents a realistic middle-of-the-road forecast compared to more extreme higher or lower future scenarios. Additional information is provided on the WICCI website: wicci.wisc.edu/the-future-of-wisconsin-climate, accessed September 2026.*

Rising Temperatures – Greater rates of warming have been historically observed during periods when the weather is typically the coldest, having the greatest impact on winter and overnight temperatures. The first two full decades of the 21st century have been the warmest on record for the State since the 1890s, and the first half of the 2020s have been even warmer (2020 through 2024), with 2024 ranking as the warmest year on record. These warming trends are expected to continue based on WICCI forecasts. Model predictions indicate that by mid-century, Wisconsin will have more days in which temperatures exceed 90 degrees Fahrenheit, as shown in [Figure 9.2](#). Predictions for winter temperatures are also presented in [Figure 9.2](#), which indicate fewer nights with temperatures dropping below freezing by mid-century. Furthermore, March has been traditionally considered a winter month but is transitioning to a spring month due to warming temperatures and fewer days with temperatures below freezing. As weather patterns shift and affect seasonal timing, winter seasons could become shorter in the future.

Increased Precipitation – Warmer air can hold more moisture and as temperatures rise, the Region can expect increased precipitation. The decade from 2010 through 2019 has been the wettest decade on record for the Region, with 2019 and 2018 ranking as the top two wettest years since record-keeping began in the 1890s. The trend toward increased precipitation is also expected to continue through mid-century. [Figure 9.3](#) presents potential future changes in seasonal rainfall across Wisconsin based on mid-century projections. Wetter conditions are expected for the winter and spring months and to a lesser extent during fall, while model predictions indicate that summers could become drier.

Increased Extreme Weather Events and Rapid Shifts – WICCI’s projection for more intense and frequent extreme weather events could cover a range of conditions including intense rainfall and winter storm events. Rapid shifts in weather conditions are anticipated, such as the “precipitation ping-pong effect” which is a term used by the Wisconsin State Climatology Office to describe rapid shifts between very wet and very dry periods. Despite projections indicating that Wisconsin will get wetter, higher temperatures and rapid shifts could make the Region more vulnerable to drought in the future.

The University of Maryland Center for Environmental Science developed an interactive mapping tool showing “climate analogs” to visualize or conceptualize potential future conditions.³ The WICCI website provides a link to the map and describes climate analogs as “places in the United States that currently resemble what Wisconsin’s climate is projected to be like in 2080.” Climate analogs are developed using

³ M. Fitzpatrick and T. Nakov, *University of Maryland Center for Environmental Science – Appalachian Lab*, fitzlab.shinyapps.io/cityapp, accessed June 2026.

statistical techniques and the averaged results from five different projection models. For example, the mapping tool shows that Milwaukee's climate analog is in Oklahoma, approximately 30 miles west of Tulsa. Using the map to identify climate analogs for cities around the Region indicates that future conditions in Southeastern Wisconsin could feel like current-day northeastern Oklahoma by 2080. Even though that area of Oklahoma is located approximately 800 miles to the southwest, they still experience winter storms and rely on chloride-based deicers to maintain roadways during the winter. This suggests that regardless of how winters in the Region may look in the future, there will be a need for anti-icing and deicing activities to maintain roadways, parking lots, and walkways.

General Implications of Long-Term Weather Pattern Changes on Chloride

While we can summarize projections for Southeastern Wisconsin using information provided by WICCI, it is difficult to predict how long-term weather patterns and projected changes will affect chloride. Global circulation models forecast a warmer and wetter Region by mid-century; however, the impact of these changes on winter weather conditions is harder to predict as influencing factors may compete with each other. WICCI reports indicate that winters are warming faster than any other season, while also predicting that the Region will experience more precipitation during the winter. With warming winter temperatures and shifting weather patterns, the Region may experience more mixed precipitation, ice storms, or freeze-thaw cycles.

Changes to the amount of precipitation and the distribution across the seasons could have an array of impacts on chloride usage and movement through the environment. Increased precipitation would provide more dilution for chloride in surface waters and mobilize chloride ions in the environment. Stormwater runoff would carry chloride into surface waters and the excess rainfall that infiltrates into soils would help flush "legacy" chlorides in the soil through subsurface pathways. The projected increase in extreme weather events could result in high-intensity rainfall for which a lot of rain falls over a short period of time. These extreme precipitation events often have rainfall rates that far exceed the soil infiltration rates, generating excess stormwater runoff that contributes to flooding. Extreme rainfall events are not as effective at replenishing soil moisture compared to the same amount of precipitation distributed over several smaller events.

While Wisconsin has been and is predicted to continue getting wetter, projections suggest more rapid swings between very wet and dry conditions. Prolonged dry conditions and warmer temperatures can lead to drought, which can have a range of negative impacts on chloride conditions. Drought conditions typically cause reduced streamflow discharge and low water levels in streams and rivers due to decreases in both

baseflow and surface runoff from a lack of precipitation. Both TR-63 and TR-65 discuss the inverse relationship between streamflow discharge and chloride concentrations, and during drought conditions low water levels provide less dilution for pollutants so we would expect to see elevated chloride concentrations in rivers and streams across the Region. Drought also impacts groundwater levels, as reduced soil moisture and increased the plant water demand prevents groundwater recharge and aquifer replenishment. Drought conditions not only reduce groundwater recharge but typically require increased usage of groundwater for irrigation and other water demands, which puts further pressure on groundwater resources. For a variety of reasons, drought would contribute to worsening chloride conditions in groundwater and surface water. The potential impact on individual sources of chloride is discussed later in this Chapter.

9.3 POTENTIAL FUTURE CHLORIDE CONDITIONS IN SOUTHEASTERN WISCONSIN

The projections and forecasts highlighted in the previous section provide insight into how Southeastern Wisconsin may grow and change in the future. The following sections describe how those projected future conditions could affect chloride contributions to the environment from various sources in the Region. The potential future chloride conditions are considered both without changes to current practices (maintaining the status quo) as well as with chloride reduction efforts that could influence or change the trajectory of future chloride conditions in the streams, lakes, and groundwater within the Region. Since chloride is difficult to remove or eliminate once dissolved in water, the most effective way to reduce the amount of chloride in the environment is to promote chloride source reduction through targeted management practices.

Chloride from Winter Maintenance and Deicing Operations

The analysis presented in TR-65 and summarized in Chapter 3 indicated that winter maintenance operations, including public and private deicing activities, had the highest chloride contribution in Southeastern Wisconsin during the study period. Anti-icing and deicing of public roadways and private parking lots accounted for approximately 59 percent of the average annual chloride load estimated for the Region. Of the total Regional chloride load estimated for winter maintenance operations, approximately 30 percent was attributed to private parking lot deicing while public road deicing activities accounted for 70 percent. The following paragraphs explore how winter maintenance and deicing operations could be affected by projected future conditions, assuming no changes to operational practices or equipment.

Both increased urban development and population growth would cause upward pressure on chloride use, but the impacts on winter deicing are less predictable and would depend on the type of proposed

development. Future development that includes large parking lots and other impervious surfaces that need to be treated with deicing salt in the winter would have a direct increase on private deicing salt usage under current conditions. Similarly, increases in residential development and households would likely result in increased private deicing salt usage.

The impact of urban development and population growth on winter maintenance for public roads would largely depend on where the planned development is located and whether transportation infrastructure exists to serve the development. Although VISION 2050 recommends more compact development that would be able to utilize existing infrastructure, some of the planned urban development for the Region could include the construction of new roads, increasing the amount of deicing salt required to treat public roads in the winter. The planned expansion of the transportation network would have the most direct impact on the use of chloride and deicing salts on public roadways. Without changes to winter management practices, application rates, or equipment, the amount of chloride used for deicing would be expected to increase in direct proportion with the increase in the highway lane-miles that require treatment.

The wildcard for winter maintenance operations are the inherent uncertainties related to winter weather conditions, which affect how much chloride is used during the winter season and changes from year to year. Predicting winter weather conditions from one year to the next can be difficult, and it is even harder to forecast how winter seasons may look decades into the future. Winter weather drives the need for deicing operations and dictates the methods that would be most effective under various conditions. There are many factors that could influence the use of deicing salt and other chlorides used for winter road maintenance, and changes to long-term weather patterns could have wide-ranging effects. If winters become warmer with fewer days below freezing, the winter season could become shorter as well which could result in a shorter “salting season” and overall less chloride usage. However, warming temperatures coupled with increased winter precipitation could lead to more frequent ice storms, mixed precipitation, or freeze-thaw cycles that would require specific deicing considerations and have the potential to use more chloride per event compared to the typical snowfall event.

Chloride Management Alternatives for Winter Deicing Practices

While winter maintenance operations are responsible for the largest contribution of chloride in the Region, this chloride source also has the most promising management opportunities and the highest potential for source reduction. TR-66 and Chapter 8 of this Report provide many options for public and private chloride management as well as state-of-the-art technologies and practices that would help reduce the amount of chloride required for winter maintenance operations. Reducing the amount of winter deicing salt is not only

good for the environment but can provide significant cost savings for public and private winter maintenance operations. Some of these chloride management alternatives for winter deicing practices could provide chloride reductions that offset projected chloride increases due to future development or weather conditions. Options include, but are not limited to, the items summarized below.

- The use of liquid brine and pre-wetted salt has been shown to reduce the amount of chloride used for deicing.
- Routine equipment calibration would reduce and optimize the amount of deicing salt needed.
- Reduced salt applications or “plow-only” routes can be utilized in areas near surface waterbodies or other sensitive environmental areas.
- Smart salting training and liability limitations for winter maintenance contractors could discourage over-salting on private property.
- Education and outreach related to chloride and smart salting for citizens and the general public.

Chloride in Wastewater

The analysis presented in TR-65 and summarized in Chapter 3 indicated that wastewater sources of chloride accounted for the second highest chloride contribution in Southeastern Wisconsin during the study period. The analysis estimated chloride in treated wastewater from public WWTPs, from onsite septic systems, and wastewater discharged from industrial facilities, which combined for approximately 36 percent of the average annual chloride load estimated for the Region. It is important to reiterate that most of the chloride that is discharged with WWTP effluent is not generated at the treatment facility but rather it comes from a variety of sources throughout the service area. The following discussion explores how wastewater sources of chloride could be affected by projected future conditions, assuming no changes to operational practices or equipment.

Projected increases in urban development would be accompanied by an increase in water demand for industrial, commercial, and domestic purposes. For example, commercial development that includes high water usage operations (car washes, laundromats, hotels, etc.) generate wastewater with high concentrations of chloride. Similarly, the expansion of industrial land use would likely increase the amount of water used for industrial processes and the amount of industrial wastewater generated within the Region.

The same is also true for residential development and domestic wastewater, which is discussed further in the following paragraph since domestic wastewater increases are more directly related to population and household growth than planned land use. The increases in water usage and the amount of chloride in wastewater sent to public WWTPs from the projected expansion of various urban land use types would subsequently increase the amount of chloride discharged to the environment with treated wastewater effluent.

The impacts of future development as well as Regional population and household growth on chloride depend on the location and the infrastructure required to serve the additional population and households. VISION 2050 recommends that all existing and new development located within SSSAs should be served by municipal sanitary sewers and treatment facilities, which would increase the amount of chloride sent to and discharged from public WWTPs. Households constructed outside of an SSSA would rely on onsite septic systems for wastewater treatment, which could increase the amount of chloride contributed locally to the soil and potentially the groundwater underlying the new development. Furthermore, any new households in areas of the Region that utilize groundwater as the water supply source would generate more chloride in wastewater due to water softening compared to areas that rely on Lake Michigan water supply. The anticipated increase of chloride in wastewater would have the greatest impact on watersheds with one or more WWTPs discharging to streams and rivers within the watershed. Considering the VISION 2050 projected growth in the populations served by WWTPs, the combined effects from chloride discharged from WWTPs would have the largest impact on chloride conditions in the Fox River, Rock River, and Milwaukee River watersheds.

While the expansion and development of the Regional transportation network is not directly related to chloride in wastewater, there is an indirect connection between chlorides used for deicing activities and the chloride discharged by WWTPs. Dissolved chloride carried by surface water runoff or groundwater can enter sanitary sewer systems via infiltration and inflow (I&I) through cracks in pipes, manholes, through deteriorated joints, or through improper connections to the system. The chloride-laden I&I water would be sent to the public WWTP and discharged with the effluent. Since the proposed expansion of the transportation network would increase the amount of chloride used for deicing without changes to current practices, it would be possible that some of that chloride could contribute to increased chlorides in wastewater due to I&I. These uncontrolled chloride inputs create challenges for WWTP operators at facilities that struggle to meet current chloride effluent limits.

Changes to long-term weather patterns could potentially affect chloride in wastewater and impact chloride conditions in receiving waterbodies. Any activities that increase chloride in groundwater would elevate baseline concentrations in drinking water wells and lead to higher concentrations of chloride in wastewater effluent. Projected precipitation increases and wet weather periods would help dilute chloride concentrations in surface waters receiving treated wastewater effluent. In contrast, summers in the Region are expected to become drier which would increase the risk of drought and reduce baseflow and water levels in surface waterbodies. The analysis presented in TR-65 demonstrated how WWTP effluent can make up a large portion of the water flowing in rivers and streams under low water conditions. Thus during drought, WWTP effluent has a greater impact on rivers and streams and chloride discharged with wastewater could elevate chloride concentrations in the receiving surface waterbody.

Prolonged periods of drought would also have a significant impact on groundwater resources in the Region. As groundwater levels decline due to reduced recharge, the composition of naturally occurring ions, dissolved minerals, and contaminants in groundwater aquifers become more concentrated because there is less freshwater dilution. This phenomenon would increase groundwater chloride concentrations as well as the hardness, and higher levels of hardness in the groundwater supply require more salt for water softening. By increasing both the baseline levels of chloride in the groundwater for communities that rely on groundwater for supply and the water softening salt needed to treat the increased hardness, the combined effects of drought could significantly increase the amount of chloride in wastewater. The increased chloride in wastewater along with the low water conditions also caused by drought would further exacerbate negative impacts on chloride conditions in surface waters receiving treated wastewater effluent discharged by WWTPs.

For industrial processes that require cooling water, projected increased temperatures would reduce cooling efficiencies due to higher ambient air temperatures and potentially elevated temperatures of cooling water sources. These factors would increase the amount of water needed for cooling processes, and in turn increase the amount of wastewater generated. Non-contact cooling water can have increasingly high concentrations of chloride with each cooling cycle, which would negatively impact chloride conditions in the receiving waterbody.

Chloride Management Alternatives for Wastewater Practices

The Study highlighted how standard wastewater treatment processes do not remove chloride from wastewater, and while there are technologies available to remove chloride such as reverse osmosis, electrodialysis reversal, and ion exchange systems, it is often not feasible to operate these technologies at

large-scale municipal plants due to high costs and challenges related to chloride disposal. The most effective way to reduce the amount of chloride in wastewater is to reduce amount of chloride entering at the source. This could be achieved, for example, by reducing or optimizing the amount of salt used for water softening. TR-66 and Chapter 8 of the Report provide options for chloride management as well as state-of-the-art technologies that could reduce the amount of chloride in wastewater, and some of the more feasible options are summarized below.

- There are several strategies that could reduce the amount of salt used for residential water softeners:
 - Timer-based systems should be replaced with demand-based systems for more efficient salt use.
 - Water softener settings should be optimized based on parameters specific to household water usage and the hardness of the water supply.
 - Blending valves and bypass valves for water softeners offer additional salt savings.
 - Promoting water-efficient appliances and technologies would reduce overall water usage as well as the amount of salt used for residential water softeners.
- Water conditioning systems or alternative residential water softening technologies such as reverse osmosis, nanofiltration, or capacitive deionization could help reduce or eliminate the use of water softener salt.
- Municipalities can develop I&I reduction plans to identify and repair areas of the sanitary sewer system that are susceptible to I&I to help reduce chloride inputs to the system.
- For industrial processes that generate wastewater with high concentrations of chloride, consider waste stream segregation to treat the high-chloride waste streams with dedicated chloride removal technologies such as reverse osmosis or mechanical evaporation. These technologies are possible management options but typically are not feasible due to high costs and chloride disposal challenges.

Agricultural Sources of Chloride

Agriculture is a relatively small source of chloride in the Region. The Study considered three agricultural sources of chloride: potash fertilizer, livestock manure, and irrigation. These sources combined for

approximately 5 percent of the average annual chloride load estimated for the Region during the study period based on the analysis presented in TR-65 and summarized in Chapter 3. The following paragraphs explore how agricultural sources of chloride could be affected by projected future conditions, assuming no changes to operational practices.

The growth of urban development puts pressure on agricultural lands, as urban expansion competes with agriculture for valuable land resources. Projected population and household growth has a similar impact, driving the conversion of farmland to residential development. Regional projections indicate decreases in lands devoted to agricultural uses and these changes could decrease the amount of land that is used to grow crops each year, potentially reducing the amount of potash fertilizer that is applied across the Region each year. The effect of increased urban development and population growth on chloride from livestock manure is harder to predict. The loss of agricultural lands could reduce the total number of livestock operations; however, the total number of livestock in the Region may increase through consolidation or the expansion of large, concentrated livestock operations, which would increase the amount of chloride generated from livestock manure. Potential cropland reductions would also shrink the area over which livestock manure could be spread, which would concentrate manure spreading on the remaining fields and could locally increase chloride contributions in these areas.

Changes to long-term weather patterns could have a wide range of effects on agricultural sources of chloride. Projected warmer temperatures could lead to longer growing seasons, as the first frost would be expected to occur later in the fall and the last frost would be expected to occur earlier in the spring. Longer growing seasons would likely increase fertilizer usage along with the demand for irrigation water. Warmer temperatures can also increase stress on livestock and water demands for livestock operations. The increased usage of water and fertilizer for agriculture would in turn increase the amount of chloride contributed to the environment. Drought conditions would apply similar pressure on water demand, but to an even greater extent, increasing water usage and irrigation to make up for the extreme lack of precipitation and soil moisture deficits.

The projected increases in precipitation coupled with expected increases in extreme weather events in the Region could lead to more high-intensity rainfall events, for which most of the rain becomes overland runoff instead of infiltrating into the soil. Increased stormwater runoff and flooding could wash off fertilizers and manure that have been applied to agricultural fields, increasing pollutant levels and degrading water quality of nearby surface waterbodies. Erratic precipitation patterns along with the ping-pong effect (rapid shifts between extreme deluge and drought) would make it difficult to maintain soil moisture and meet crop

water demands, potentially requiring more irrigation. These unpredictable precipitation patterns also pose a challenge for manure application timing and an increased risk for runoff that could increase chloride pollution in surface water.

Chloride Management Alternatives for Agricultural Practices

While agricultural practices are not a major source of chloride in Southeastern Wisconsin, they can still have local impacts. Chloride management alternatives as well as state-of-the-art technologies and practices to reduce agricultural sources of chloride are presented in TR-66 and Chapter 8 of this Report. Future projections can have competing influencing factors, and it is not clear how the overall amount of chloride generated from agricultural practices in the Region may change in the future, but agriculture will likely remain a relatively minor source of chloride in Southeastern Wisconsin. Nonetheless, the following management practices are encouraged, and they provide benefits beyond chloride reduction.

- Preserving highly productive agricultural lands would protect and secure the healthiest and most fertile soil for future agricultural production. When these lands are developed or converted to other land uses, farmers may be forced to use less fertile lands that would require more fertilizer and/or irrigation to support crop yields.
- Management practices to reduce the amount of potash fertilizer, and ultimately chloride, applied to agricultural fields include:
 - Alternative fertilizers or controlled release fertilizers could reduce chloride, but cost and accessibility remain barriers to widespread adoption.
 - Precision agriculture technologies and methods could be used to optimize fertilizer usage and irrigation.
 - Sustainable farm practices could also reduce fertilizer applications and improve soil health over time. Practices such as cover cropping, no-till, and rotational grazing would help retain soil moisture, which would reduce the need for irrigation and help mitigate the effects of drought.

- Management practices related to livestock manure include:
 - Optimize chloride supplementation in livestock diets by taking into account chloride from all sources including feed, supplements, and the chloride content of the water supply.
 - Proper manure management would help limit excess surface runoff that would carry chloride from agricultural fields that receive applications directly into surface waters.
 - Proper maintenance and housekeeping practices at agricultural facilities could limit or prevent chloride pollution from manure storage areas.

Atmospheric Deposition of Chloride

The amount of atmospheric deposition of chloride would be expected to increase with projected increases in precipitation, but since this is such a minor source of chloride in Southeastern Wisconsin, contributing approximately 0.1 percent of the estimated average annual chloride load, these projected increases would have negligible impacts on chloride conditions in the Region.

9.4 CONCLUSIONS

Figure 9.4 summarizes how projected growth and changes in Southeastern Wisconsin could influence future chloride usage and conditions in the Region. Without changes to current practices, Regional projections could put upward pressure on most chloride sources, which would contribute to rising chloride levels in surface water and groundwater and negatively impact environmental chloride conditions in the future. However, chloride reduction strategies could help offset these projected increases and change the trajectory of future chloride conditions in Southeastern Wisconsin. While we can reasonably predict how individual influencing factors may affect future chloride conditions, the interaction between projected changes to the Region, future climate conditions, and chloride reduction efforts contributes to the complexity and makes it difficult to predict future chloride concentrations in Regional surface waterbodies and groundwater. As depicted in Figure 9.5, if future growth and change in the Region outpace the benefits of chloride reduction strategies, future chloride concentrations in the Region's water resources would be expected to increase and chloride conditions would get worse. Alternatively, if chloride reduction efforts offset the impacts of Regional growth and development, future chloride concentrations and conditions would be expected to improve. The impacts of future conditions and long-term weather patterns on chloride conditions remain the biggest unknown.

This evaluation has limitations, as the future is hard to predict and forecasts are wrought with inherent uncertainties. It is difficult to predict with confidence how the changes to chloride usage practices might impact chloride levels in our lakes, rivers and streams. Furthermore, it is difficult to discern how long it could take to flush residual or legacy chloride from our soil and groundwater aquifers before we would start to see some positive results (i.e. reduced chloride concentrations) from various management practices. If groundwater chloride levels remain elevated, the stream and lakes that are groundwater-fed would continue to receive chloride despite improved management practices. The impacts of legacy chlorides in groundwater may be felt for decades or longer, which could significantly delay recovery from degradation due to chloride pollution. The projections of future conditions discussed in this Chapter may shape the Region for decades to come; however, the fate of future chloride conditions in Southeastern Wisconsin are highly dependent on human activities and the actions we take to reduce the sources of chloride to the environment.

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A CHLORIDE IMPACT STUDY FOR SOUTHEASTERN WISCONSIN

Chapter 9

POTENTIAL FUTURE CHLORIDE CONDITIONS IN SOUTHEASTERN WISCONSIN

TABLES

Table 9.1
Existing and Planned Land Use in the Region: 2010 and 2050

Land Use	Existing 2010		Planned Increment		Planned 2050	
	Square Miles	Percent of Total	Square Miles	Percent Change	Square Miles	Percent of Total
Developed Land						
Residential ^a						
Mixed-Use City Center	3.1	0.1	0.3	9.7	3.4	0.1
Mixed-Use Traditional Neighborhood	45.8	1.7	3.3	7.2	49.1	1.8
Small Lot Traditional Neighborhood	41.6	1.5	38.0	91.3	79.6	3.0
Medium Lot Neighborhood	88.2	3.3	6.4	7.3	94.6	3.5
Large Lot Neighborhood	160.5	6.0	4.7	2.9	165.2	6.1
Large Lot Exurban	31.9	1.2	2.7	8.5	34.6	1.3
Rural Estate	29.9	1.1	7.5	25.1	37.4	1.4
Residential Subtotal	400.9	14.9	63.0	15.7	463.9	17.2
Commercial	35.6	1.3	13.9	39.0	49.5	1.8
Industrial	35.2	1.3	9.4	26.7	44.6	1.7
Transportation, Communication, and Utilities	213.8	8.0	13.9	6.5	227.7	8.5
Governmental and Institutional	37.0	1.4	1.9	5.1	38.9	1.4
Recreational ^b	56.0	2.1	6.9	12.3	62.9	2.3
Unused Urban	46.0	1.7	-21.3	-46.3	24.7	0.9
Developed Land Subtotal	824.5	30.7	87.7	10.6	912.2	33.9
Undeveloped Land						
Agricultural ^c	1,155.5	43.0	-65.8	-5.7	1,089.7	40.6
Natural Resource Areas						
Surface Water	84.7	3.1	0.0	0.0	84.7	3.1
Wetlands	315.2	11.7	0.0	0.0	315.2	11.7
Woodlands	191.4	7.1	0.0	0.0	191.4	7.1
Natural Resource Areas Subtotal	591.3	21.9	0.0	0.0	591.3	21.9
Unused and Other Open Land ^d	118.5	4.4	-22.0	-18.6	96.5	3.6
Undeveloped Land Subtotal	1,865.2	69.3	-87.7	-4.7	1,777.5	66.1
Total	2,689.7	100.0	0.0	0.0	2,689.7	100.0

Note: Off-street parking area is included with the associated use.

^a Refer to **Map 9.1** for details related to dwelling units per net residential acre.

^b Includes only intensive use recreational land.

^c Includes farmed wetlands.

^d Includes landfills and mineral extraction sites.

Source: SEWRPC

Table 9.2
Existing and Planned Land Use in the Region by County: 2010 and 2050

Land Use	Kenosha County (square miles)			Milwaukee County (square miles)			Ozaukee County (square miles)			Racine County (square miles)		
	2010	Increment	2050	2010	Increment	2050	2010	Increment	2050	2010	Increment	2050
Developed Land												
Residential												
Mixed-Use City Center ^a	0.1	0.0	0.1	2.8	0.2	3.0	0.0	0.0	0.0	0.2	0.0 ^b	0.2
Mixed-Use Traditional Neighborhood	2.8	1.1	3.9	37.7	1.2	38.9	0.0	0.1	0.1	3.8	0.3	4.1
Small Lot Traditional Neighborhood	4.8	9.3	14.1	12.8	3.0	15.8	2.2	2.2	4.4	4.4	5.6	10.0
Medium Lot Neighborhood	10.1	0.7	10.7	16.3	0.2	16.6	6.9	0.2	7.0	12.9	0.4	13.2
Large Lot Neighborhood	10.4	0.4	10.8	9.0	0.1	9.1	16.2	0.9	17.1	15.7	0.4	16.1
Large Lot Exurban	1.0	0.3	1.3	1.0	0.0	1.0	2.6	0.5	3.1	0.2	0.2	0.4
Rural Estate	3.2	0.6	3.9	1.4	0.0	1.4	3.6	0.8	4.3	4.6	1.2	5.8
Residential Subtotal	32.4	12.4	44.8	81.0	4.8	85.8	31.5	4.6	36.0	41.8	8.0	49.8
Commercial	2.7	1.5	4.2	12.3	1.9	14.2	1.8	1.0	2.9	3.6	1.7	5.3
Industrial	2.9	1.5	4.5	11.2	0.7	11.9	2.0	1.2	3.1	4.3	2.8	7.1
Transportation, Communication, and Utilities	19.4	3.4	22.8	53.2	0.7	53.9	15.9	0.9	16.9	22.7	2.4	25.1
Governmental and Institutional	3.2	0.6	3.8	13.4	0.0	13.4	2.1	0.1	2.2	3.9	0.3	4.2
Recreational ^c	5.9	1.5	7.4	12.3	0.2	12.5	4.1	0.4	4.5	5.3	1.0	6.3
Unused Urban	4.5	-3.1	1.4	14.7	-4.5	10.2	3.0	-1.6	1.4	5.8	-2.7	3.1
Developed Land Subtotal	71.1	17.8	88.9	198.1	3.8	201.9	60.4	6.6	67.0	87.4	13.5	100.9
Undeveloped Land												
Agricultural ^d	136.6	-14.1	122.5	15.6	-2.4	13.2	118.2	-4.6	113.6	180.7	-10.8	169.8
Natural Resource Areas												
Surface Water	8.8	0.0	8.8	2.4	0.0	2.4	4.1	0.0	4.1	9.4	0.0	9.4
Wetlands	28.9	0.0	28.9	11.6	0.0	11.6	30.8	0.0	30.8	29.8	0.0	29.8
Woodlands	15.9	0.0	15.9	7.4	0.0	7.4	11.4	0.0	11.4	19.6	0.0	19.6
Natural Resource Areas Subtotal	53.7	0.0	53.7	21.4	0.0	21.4	46.3	0.0	46.3	58.7	0.0	58.7
Unused and Other Open Land ^e	17.1	-3.7	13.4	7.5	-1.4	6.1	10.6	-2.0	8.6	13.8	-2.6	11.2
Undeveloped Land Subtotal	207.4	-17.8	189.6	44.6	-3.8	40.7	175.1	-6.6	168.4	253.2	-13.5	239.7
Total	278.4	0.0	278.4	242.7	0.0	242.7	235.4	0.0	235.4	340.6	0.0	340.6

Table continued on next page.

Table 9.2 (Continued)

Land Use	Walworth County (square miles)			Washington County (square miles)			Waukesha County (square miles)			Region (square miles)		
	2010	Increment	2050	2010	Increment	2050	2010	Increment	2050	2010	Increment	2050
Developed Land												
Residential ^a												
Mixed-Use City Center	0.0	0.0	3	0.0	0.0	0.0	0.0b	0.0b	0.1	3.1	0.3	3.4
Mixed-Use Traditional Neighborhood	0.0	0.0	0.0	0.6	0.5	1.1	0.9	0.1	1.0	45.8	3.3	49.1
Small Lot Traditional Neighborhood	2.9	4.6	7.4	4.6	5.2	9.7	10.0	8.2	18.1	41.6	38.0	79.6
Medium Lot Neighborhood	9.0	1.2	10.2	7.1	0.5	7.6	25.9	3.3	29.3	88.2	6.4	94.6
Large Lot Neighborhood	16.3	0.6	16.9	19.9	0.2	20.2	72.9	2.1	75.0	160.5	4.7	165.2
Large Lot Exurban	0.9	0.0	0.9	8.3	1.1	9.4	18.0	0.6	18.6	31.9	2.7	34.6
Rural Estate	7.2	1.2	8.4	6.6	2.0	8.6	3.3	1.7	5.0	29.9	7.5	37.4
Residential Subtotal	36.3	7.6	43.9	47.0	9.5	56.5	131.0	16.0	147.0	400.9	63.0	463.9
Commercial	2.4	1.5	3.9	2.7	1.6	4.3	10.2	4.6	14.7	35.6	13.9	49.5
Industrial	2.5	0.5	3.0	2.9	1.1	4.1	9.3	1.6	11.0	35.2	9.4	44.6
Transportation, Communication, and Utilities	26.1	1.6	27.7	26.3	1.8	28.0	50.4	3.1	53.5	213.8	13.9	227.7
Governmental and Institutional	2.9	0.2	3.1	2.7	0.2	3.0	8.8	0.7	9.5	37.0	1.9	38.9
Recreational ^c	7.3	1.1	8.4	6.5	0.4	6.9	14.7	2.2	16.9	56.0	6.9	62.9
Unused Urban	3.4	-1.7	1.7	3.1	-1.8	1.3	11.1	-5.8	5.3	46.0	-21.3	24.7
Developed Land Subtotal	80.9	10.7	91.6	91.2	12.9	104.1	235.4	22.5	257.9	824.5	87.7	912.2
Undeveloped Land												
Agricultural ^d	352.6	-8.2	344.4	203.0	-8.8	194.2	148.8	-16.7	132.1	1,155.5	-65.8	1,089.7
Natural Resource Areas												
Surface Water	23.7	0.0	23.7	8.0	0.0	8.0	28.2	0.0	28.2	84.7	0.0	84.7
Wetlands	51.4	0.0	51.4	72.7	0.0	72.7	89.9	0.0	89.9	315.2	0.0	315.2
Woodlands	51.8	0.0	51.8	37.6	0.0	37.6	47.7	0.0	47.7	191.4	0.0	191.4
Natural Resource Areas Subtotal	127.0	0.0	127.0	118.3	0.0	118.3	165.8	0.0	165.8	591.3	0.0	591.3
Unused and Other Open Land ^e	16.0	-2.5	13.5	23.0	-4.0	19.0	30.5	-5.8	24.7	118.5	-22.0	96.5
Undeveloped Land Subtotal	495.5	-10.7	484.9	344.3	-12.9	331.4	345.1	-22.5	322.6	1,865.2	-87.7	1,777.5
Total	576.5	0.0	576.5	435.6	0.0	435.6	580.5	0.0	580.5	2,689.7	0.0	2,689.7

Note: Off-street parking area is included with the associated use.

^a Refer to [Map 9.1](#) for details related to dwelling units per net residential acre.

^b Less than 0.05 square miles.

^c Includes only intensive use recreational land.

^d Includes farmed wetlands.

^e Includes landfills and mineral extraction sites.

Source: SEWRPC

Table 9.3
Existing and Planned Land Use for Watersheds in the Region: Percent Urban 2015 and 2050

Watershed	Existing Land Use Percent Urban 2015 (percent)	Planned Land Use Percent Urban 2050 (percent)	Difference (percent)
Pike River	45.2	62.7	17.5
Des Plaines River	18.9	24.5	5.6
Root River	37.4	42.0	4.6
Oak Creek	73.5	77.1	3.6
Menomonee River	69.9	72.8	2.9
Lake Michigan Direct Drainage	63.4	65.6	2.2
Kinnickinnic River	97.4	99.1	1.7
Milwaukee River ^a	33.3	32.7	-- ^b
Fox River ^a	25.7	24.7	-- ^b
Sheboygan River ^a	9.2	8.1	-- ^b
Sauk Creek ^a	14.7	12.6	-- ^b
Rock River ^a	19.8	17.3	-- ^b

^a The table presents data for the portion of the watershed that is within the Region only, planned land use data was not available for the portions of the watershed located outside of the Region.

^b A smaller planned percent urban land use does not necessarily indicate a projected decrease in urban lands, rather it may reflect the less detailed nature of the planned land use mapping compared to the Commission's existing land use mapping, particularly in nonurban areas.

Source: SEWRPC

Table 9.4
SEWRPC Stream Monitoring Sites with the Largest Projected Change in Percent Urban Land Use

Site ID	Site Name	Existing Land Use Percent Urban 2015 (percent)	Planned Land Use Percent Urban 2050 (percent)	Difference (percent)
15	Kilbourn Road Ditch	12.3	42.9	30.6
10	Pike River	41.1	61.2	20.1
30	Des Plaines River	19.2	25.9	6.7
59	Root River near Horlick Dam	35.0	39.8	4.8
13	Ula Creek	32.5	36.9	4.4
9	Oak Creek	72.3	75.8	3.5
57	Menomonee River at Wauwatosa	67.3	70.5	3.2
33	Pebble Brook	41.9	44.5	2.6
12	Lincoln Creek	97.4	100.0	2.6
1	Fox River at Waukesha	54.0	56.2	2.2

Source: SEWRPC

Table 9.5
Existing and Projected Population and Households in the Region: 2010 and 2050

County - Population	Existing (2010)	Projected (2050)	Change	Percent Change (%)
Kenosha	166,400	251,100	84,700	50.9
Milwaukee	947,700	1,019,100	71,400	7.5
Ozaukee	86,400	109,100	22,700	26.3
Racine	195,400	239,800	44,400	22.7
Walworth	102,200	140,600	38,400	37.6
Washington	131,900	180,500	48,600	36.8
Waukesha	389,900	481,400	91,500	23.5
Region	2,019,900	2,421,600	401,700	19.9

County - Households	Existing (2010)	Projected (2050)	Change	Percent Change (%)
Kenosha	62,600	100,900	38,300	61.2
Milwaukee	383,600	427,800	44,200	11.5
Ozaukee	34,200	44,500	10,300	30.1
Racine	75,700	98,900	23,200	30.6
Walworth	39,700	58,900	19,200	48.4
Washington	51,600	74,300	22,700	44.0
Waukesha	152,700	195,900	43,200	28.3
Region	800,100	1,001,200	201,100	25.1

Source: U.S. Bureau of the Census and SEWRPC

Table 9.6
Existing and Projected Population and Households for Watersheds in the Region: 2010 and 2050

Watersheds	Population			Households		
	Existing 2010	Projected 2050	Percent Change (%)	Existing 2010	Projected 2050	Percent Change (%)
Des Plaines River	31,480	65,180	107.1	11,550	26,020	125.2
Fox River ^a	364,960	470,600	28.9	142,560	193,000	35.4
Kinnickinnic River	156,810	158,290	0.9	58,530	61,590	5.2
Lake Michigan Direct Drainage	217,570	239,610	10.1	87,040	100,840	15.9
Menomonee River	320,850	350,850	9.4	131,110	148,480	13.2
Milwaukee River ^a	474,420	543,720	14.6	189,690	225,470	18.9
Oak Creek	56,590	67,670	19.6	24,230	29,820	23.1
Pike River	51,610	87,020	68.6	20,060	35,480	76.9
Rock River ^a	155,440	200,460	29.0	59,090	80,720	36.6
Root River	179,010	222,740	24.4	71,730	93,450	30.3
Sauk Creek ^a	9,700	13,100	35.1	3,940	5,470	38.8
Sheboygan River ^a	1,550	2,310	49.0	560	860	53.8

^a The table presents data for the portion of the watershed that is within the Region only, population and household projections were not available for the portions of the watershed located outside of the Region.

Source: U.S. Bureau of the Census and SEWRPC

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Table 9.7
SEWRPC Stream Monitoring Sites with the Largest Projected Population Growth

Site ID	Site Name	Existing Population (2010)	Projected Population (2050)	Percent Increase (percent)
15	Kilbourn Road Ditch	570	1,400	145.6
30	Des Plaines River	27,850	58,350	109.5
13	Ula Creek	2,130	4,380	105.6
10	Pike River	25,790	50,740	96.7
48	White River at Lake Geneva	9,910	15,800	59.4
32	Turtle Creek	20,720	32,230	55.6
16	Jackson Creek	820	1,260	53.7
52	Cedar Creek	13,460	20,390	51.5
36	Honey Creek Downstream of East Troy	7,490	10,710	43.0
6	White River near Burlington	25,010	34,060	36.2
51	Rubicon River	14,160	19,030	34.4
1	Fox River at Waukesha	120,800	152,760	29.8

Source: SEWRPC

Table 9.8
VISION 2050 Planned Highway and Arterial Street
Improvements by County

County	Planned New Lane Miles ^a		
	Expansion	Widening	Total
Kenosha	7.9	48.0	55.9
Milwaukee	26.4	96.7	123.0
Ozaukee	5.9	58.8	64.7
Racine	17.5	17.9	35.5
Walworth	118.3	28.0	146.3
Washington	31.0	56.8	87.8
Waukesha	8.6	230.9	239.5
Total	215.7	537.0	752.7

^a Does not include future additions to local streets.

Source: SEWRPC

Table 9.9
SEWRPC Stream Monitoring Sites with the Largest Planned Transportation Network Expansion

Site ID	Site Name	Planned New Lane Miles ^a		
		Expansion	Widening	Total
1	Fox River at Waukesha	4.3	118.7	123.0
4	Sugar Creek	35.4	--	35.4
9	Oak Creek	20.7	2.7	23.4
10	Pike River	10.0	20.8	30.8
13	Ula Creek	0.8	20.7	21.4
23	Milwaukee River Downstream of Newburg	28.9	5.7	34.6
30	Des Plaines River	3.9	19.1	23.0
57	Menomonee River at Wauwatosa	3.8	90.8	94.6
59	Root River near Horlick Dam	2.5	50.1	52.6
60	Root River at Grange Avenue	--	20.6	20.6

Note: This table represents the planned transportation network improvements for all arterial streets and highways combined within the drainage areas upstream of the SEWRPC stream monitoring sites.

^a Does not include future additions to local streets.

Source: SEWRPC

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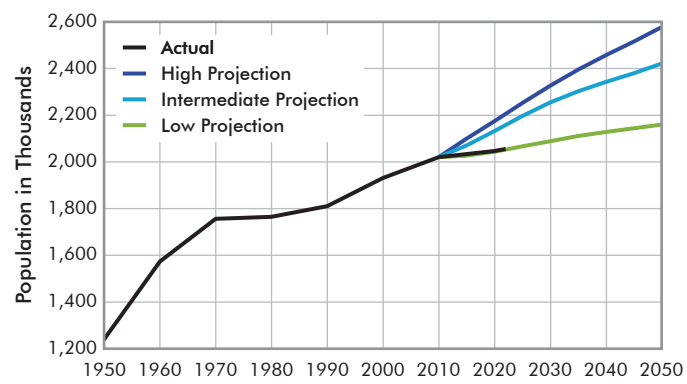
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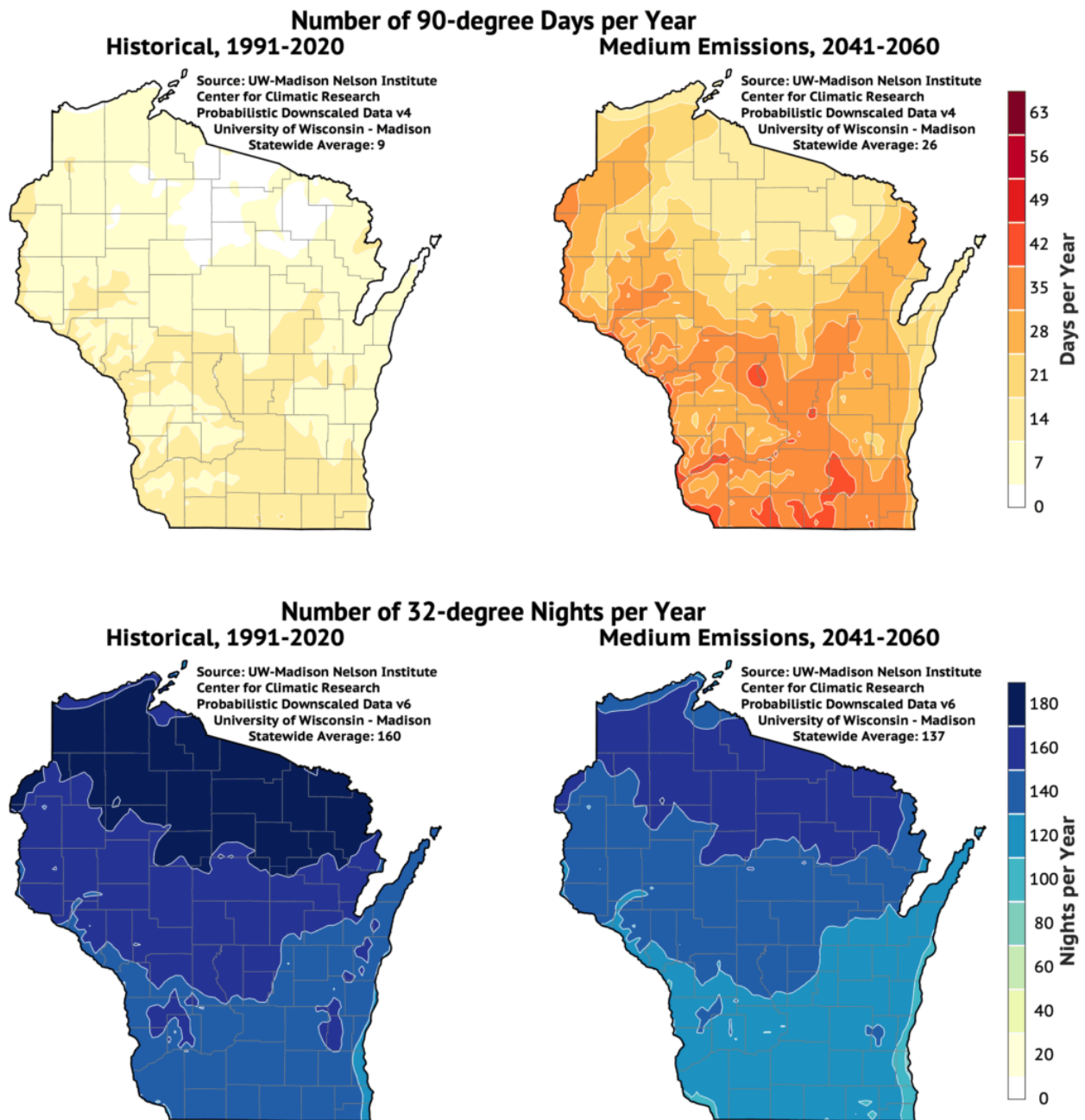
FIGURES

Figure 9.1
Actual and Projected Population in the Region



Source: U.S. Census Bureau and SEWRPC

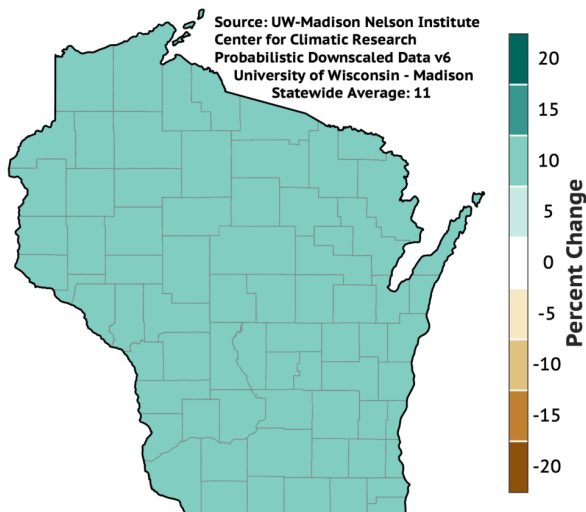
Figure 9.2
Temperature Projections for Wisconsin: Observed Average (1991-2020) and Projected (2041-2060)



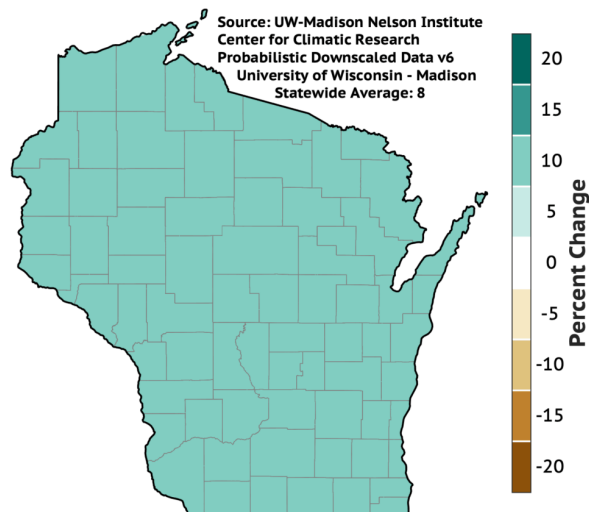
Source: WICCI

Figure 9.3
Projected Changes in Seasonal Precipitation for Wisconsin by Mid-Century

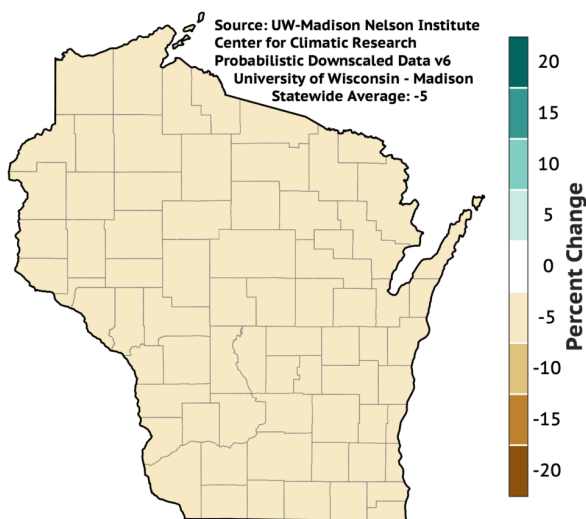
Change in Winter Precipitation
Medium Emissions, 2041-2060 vs. 1991-2020



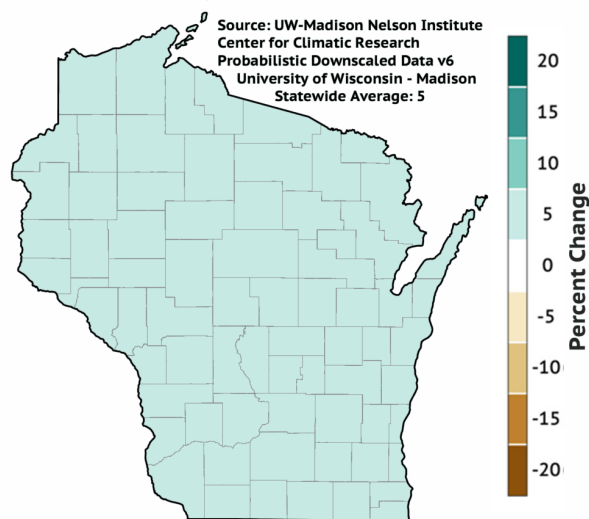
Change in Spring Precipitation
Medium Emissions, 2041-2060 vs. 1991-2020



Change in Summer Precipitation
Medium Emissions, 2041-2060 vs. 1991-2020



Change in Fall Precipitation
Medium Emissions, 2041-2060 vs. 1991-2020



Source: WICCI

Figure 9.4
Summary of Impacts on Future Chloride Usage and Conditions in Southeastern Wisconsin

Scenario	Chloride Impacts			Waterbody Chloride Concentrations
	Winter Maintenance Sources	Wastewater Sources	Agricultural Sources	
Future Conditions – No Changes to Current Practices				
Increased Urban Development	↑	↑	↓	↑
Population and Household Growth	↑	↑		↑
Highway and Arterial Expansion	↑			↑
Future Climate Projections				
Wetter Conditions/Winters	↑			↑
Warmer Conditions/Winters	↔		↑	
More Rainfall				↓
Less Rainfall/Drought		↑	↑	↑
Future Conditions – With Chloride Reduction Efforts				
Smart Salting Practices (Brine, Pre-Wetting, etc.)	↓			↓
Routine Equipment Calibration	↓			↓
Water Softener Optimization and Upgrades		↓		↓
Chapter 10 Recommendations ^a	↓	↓	↓	↓

 Increase

 Decrease

 Mixed Results

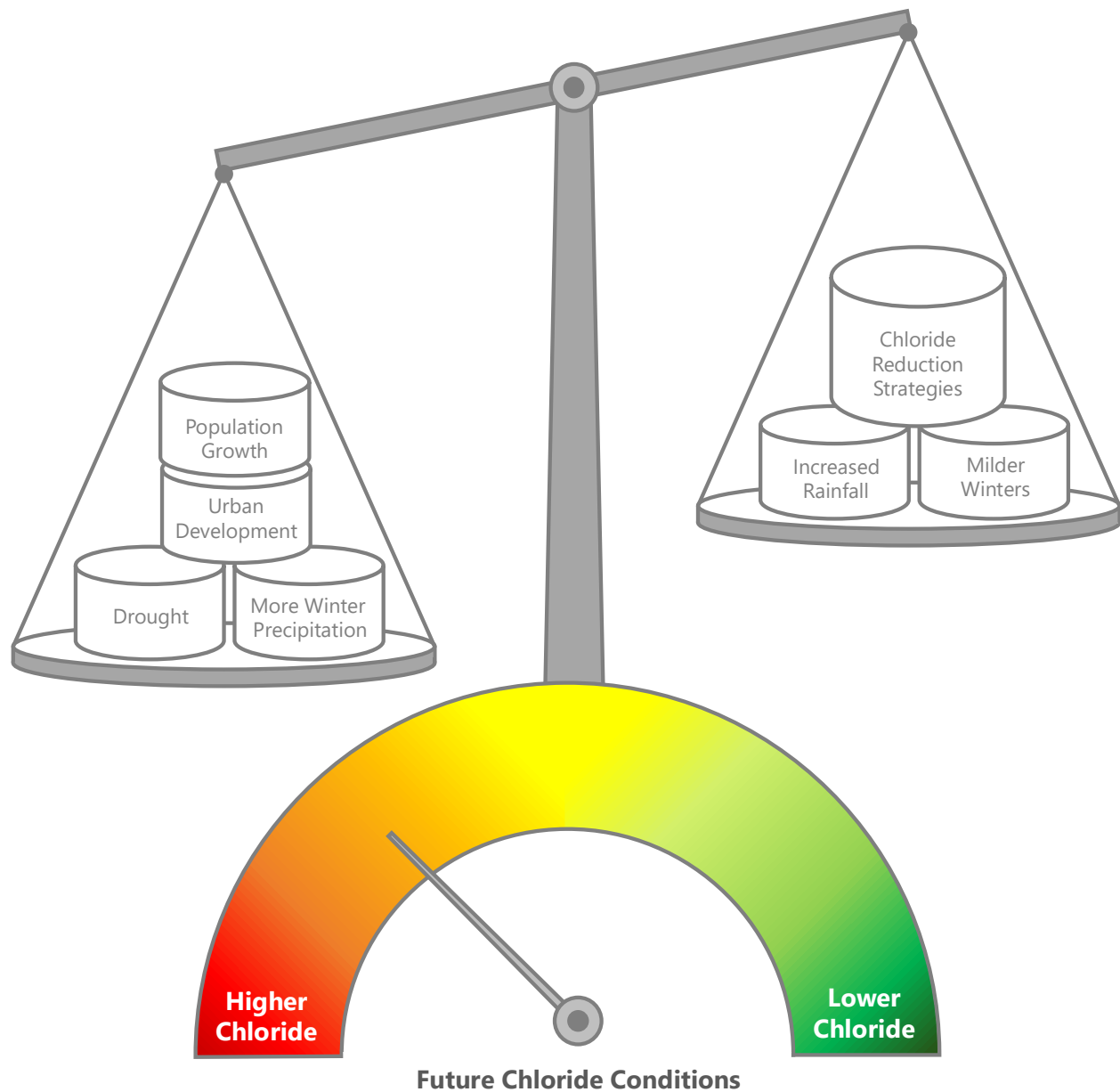
 Indirect Increase

 Indirect Decrease

^a Refer to Chapter 10 for additional recommendations related to chloride source reduction.

Source: SEWRPC

Figure 9.5
Balance of Factors Influencing Potential Future Chloride Conditions in Southeastern Wisconsin



Source: SEWRPC

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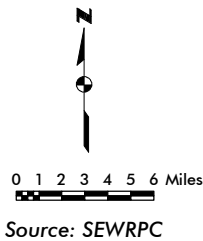
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MAPS

VISION 2050 Planned Land Use Development Pattern



VISION 2050 Planned Highway and Arterial Street Improvements

- ☐ PRESERVE EXISTING CROSS-SECTION

Note: Refer to VISION 2050 for additional information.

