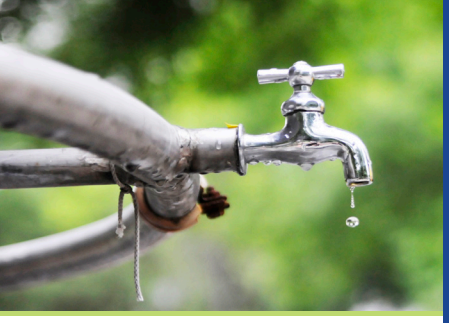
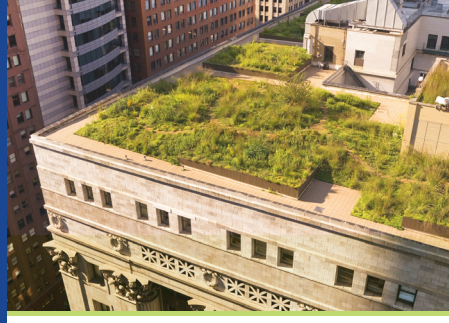


GREATER LAKES

Reconnecting the Great Lakes Water Cycle



The Potential to Restore the Natural Water Cycle in Three Oakland County Communities

A Case Study of the Greater Lakes Project | February 2016

The Greater Lakes project explores ways local governments can use or mimic the natural water cycle to manage drinking water, wastewater and stormwater in a way that is more environmentally friendly, cost effective, and reliable. This case study summarizes our analysis and findings within three Oakland County, Michigan communities and promotes water conservation efforts as a critical first step toward restoring the natural water cycle and creating a more resilient and financially sustainable water management system.

The three Michigan communities—Commerce Township, Lyon Township, and Oakland Township—are all located in Oakland County, in the southeast portion of Michigan. These communities are neither highly urban nor rural. To that end, they are more typical of many newer suburban communities across the Great Lakes region.

The Fractured Water Cycle

Suburban communities like Commerce, Lyon and Oakland townships have been built in a way that disrupts the natural flow of water (or water cycle). Water, when withdrawn from the ground or a stream, is rarely returned to the same place. Once used, water is treated as waste – whether as wastewater or stormwater – to be discarded as quickly as possible through pipes discharging to streams or rivers. This has been the traditional approach to drainage and flood control. However, the traditional approach "fractures" the water cycle, preventing flows from percolating into the ground, where they can replenish local groundwater supplies and support natural stream flows. Recent increases in storm frequency and intensity as a result of climate change exacerbate the negative impacts from the fractured water cycle. Consequently, these communities, and hundreds of others like them around the Great Lakes, experience more dramatic surface runoff during storms, along with associated flooding of streets, businesses and homes, and erosion of stream banks when water rushes in faster than a stream can assimilate it. We have come to realize that restoring the natural hydrology is a sustainable and cost-effective approach to addressing these problems,[1] if approached in a stepwise manner. This case study focuses on a logical first step: conservation of the potable water supply.

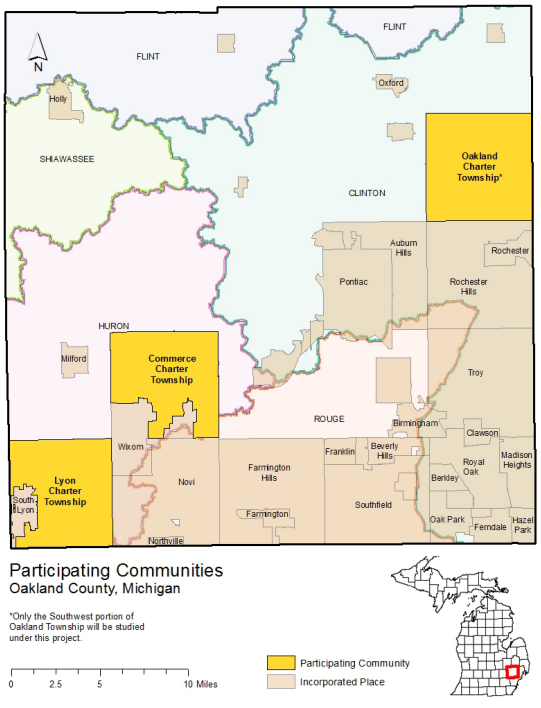


Figure 1.

1 For more details on the fractured urban water cycle and actions to heal it, refer to the *Healing Fractured Water Systems Fact Sheet* (http://glc.org/files/GreaterLakes-FracturedWaters-FactSheet-20151007.pdf).

Existing Water Management Systems within Selected Oakland County Communities

Oakland County is the headwaters for five main rivers and their surrounding watersheds: Flint, Shiawassee, Rouge, Clinton and Huron. The impacts of fractured water management within Oakland County are felt locally—where the storm events occur—as well as in the downstream communities in each watershed.

The three communities in Oakland County share two common water management system challenges. First is meeting water demand, specifically high peak water usage during the hot and dry summer months when the residents and businesses water their lawns. This peak demand drives up the need for, and costs associated with, expanding infrastructure to withdraw, treat and deliver water to these communities. Second is managing excessive water discharges. As discussed above, fractured water management systems result in increased flooding and damage to local rivers and streams because the system of pipes and receiving waters simply cannot handle the increasing volume of water delivered over relatively short periods of time. New requirements under Michigan's Municipal Separate Storm Sewer Systems (MS4) permit program[2] (part of the National NPDES MS4 program under the U.S. Clean Water Act) drive communities to manage their stormwater in ways that avoid these negative impacts. The challenge for Oakland County communities is that Michigan's MS4 permitting program relies almost exclusively on infiltration as a means of managing stormwater from new developments and redevelopment. This infiltration requirement is an important method for restoring the natural water cycle. Since soil conditions make infiltration difficult in many areas of Oakland County, communities are working with state regulators to establish a protective, yet practical alternative.

Commerce Township Water System

Commerce Township has a population of 40,186 according to the 2010 U.S. Census. The township is located at the headwaters of the Huron River watershed and features a large number of smaller inland lakes. The township began as a seasonal community where the abundance of natural resources initially made the township a weekend and summer destination for Detroit area residents. Over the course of the township's development, cottages that were initially constructed as seasonal residences have become permanently occupied – some with inadequate water and wastewater systems. To meet the needs of a growing population, developers have constructed several residential subdivisions which also contribute to increased water demand. Approximately half of the township's potable water supply comes from Lake Huron sourced water provided by the Detroit Water and Sewerage Department (DWSD);[3] the other half comes from privately-owned residential wells.

During peak water demand periods, areas of higher elevation in the township experience lower water pressure. To resolve this problem, a two million gallon storage tank is under construction. The storage tank is expected to be operational in 2016.

Sanitary wastewater originating from the older residential areas within the township is primarily managed by private on-site disposal systems. More recent developments are serviced by a sanitary sewer system that collects and transports sanitary wastewater to the Commerce Wastewater Treatment Plant, which is operated by the Office of the Oakland County Water Resources Commissioner. The effluent is highly treated before it is discharged into a high quality tributary stream within the Rouge River Watershed. Special requirements were placed by the state on the discharge permit to protect the Red-sided Dace, an endangered fish.

Lyon Township Water System

Lyon Township is located in the southwest corner of Oakland County, with a population of 14,545 according to the 2010 U.S. Census. Between the years of 2000 and 2010, the township experienced a 32 percent population increase as a large part of the township developed into residential areas. The township primarily drains to the Huron River, which is subject to limits on how much phosphorous can be discharged into it via a Total Maximum Daily Load.

The township relies on groundwater resources for its potable water supply. Its drinking water distribution system includes eight wells and two elevated storage tanks. Approximately half of the residents are on privately-owned wells. Like Commerce Township, Lyon Township faces decreases in water pressure during peak water use periods. To help equalize the pressure and availability during peak usage, the township is installing an additional water main to "loop" the water distribution system as well as providing addition-

2 Stormwater discharges from a regulated MS4 to a surface water of the state in an urbanized area are subject to regulation under the National Pollutant Discharge Elimination System. The goal of the MS4 program is to reduce the discharge of pollutants to surface waters of the state.

3 As of January 1, 2016, DWSD was replaced by the Great Lakes Water Authority.

al iron removal treatment. Expanding water system storage in the southern portion of the township is also part of the water system master plan. To protect the quality of drinking water, the township government instituted a wellhead protection program for three separate wellhead areas.

The Lyon Township Sewage Treatment Plant holds a groundwater discharge permit from the state of Michigan. The permit sets strict limits on sodium and chloride concentrations in the effluent. The sanitary sewer system within the township is separated from stormwater collection. The stormwater collection system consists of privately and publically owned conveyance systems.

Oakland Township Water System

Oakland Township is located within the Clinton River Watershed. The southwest portion of the township has experienced rapid residential development that is comprised of very large homes that consume above average quantities of water. This portion of the township is supplied by a public water system whereas the rest of Oakland Township is serviced by private residential wells.

The township's potable water supply is provided by groundwater. Its water supply system is comprised of nine wells, which produce water that has phosphate and chlorine added to address iron-related concerns. The township faces a challenge similar to those of Commerce and Lyon townships – decreased water pressure during peak water usage periods. As an initial step to meet this challenge, the Oakland County Water Resources Commissioner surveyed water customers to ask whether they would prefer: a) connection to the DWSD water system; b) staying with the current groundwater system; or c) installing a centralized groundwater iron removal/softening treatment plant. The most popular option with the public was to connect to the DWSD supply (44%), while the second preference was the installation of a centralized groundwater treatment plant (33%). Ultimately, however, the township opted not to connect to DWSD because of concerns over DWDS's higher rates and concern about becoming part of a much larger water system in which they felt they would have little influence. Instead, the township chose to continue to rely on municipal wells as their main public water source. Consequently, the township must build storage to comply with design standards of its water system and to alleviate the water pressure problems during peak usage periods.

Wastewater originating from one portion of the township is treated by a private wastewater treatment plant. A portion of the wastewater flow generated in another section of the township is diverted to the DWSD sewage treatment plant, which discharges to the Detroit River. The township has a separated sewer system.

Forecasting Water, Energy and Financial Savings

Commerce, Lyon, and Oakland townships have few water conservation programs.[4] Yet, current and projected demands on their water supply systems warrant asking the question: can additional water conservation programs make a difference in these communities and the watersheds in which they reside? To answer this question, the Greater Lakes project analyzed the potential water, energy and emission savings from seven water conservation and efficiency programs as a first step toward healing the fractured water cycle by lessening the impacts of human use.[5] These programs included:

- **Residential High-Efficiency Toilet Rebate:** Offer a $100 incentive to residential customers for replacing toilets of 3.5 gallons per flush or greater with WaterSense labeled high-efficiency toilets. Participating customers would be required to replace all 3.5 gallons per flush or greater toilets on the property. Each toilet replacement is estimated to save 9,861 gallons per year.
- **Residential High-Efficiency Clothes Washers Rebate:** Offer a $100 incentive to residential customers for the purchase of a high-efficiency clothes washer. Each clothes washer rebate is estimated to save 7,043 gallons per year.
- **Residential Efficient Irrigation Nozzle Replacement Program:** Provide professional installation of high-efficiency nozzles in residential irrigation systems. The total cost for each nozzle is $10. Each nozzle is estimated to save 187 gallons per year.
- **Residential Irrigation ET Controller Rebate:** Offer a $250 incentive to residential customers for technology that adjusts irrigation schedules according to real time measures of evapotranspiration (ET). Irrigation systems are often set to automatically water the landscape on a predetermined schedule regardless of weather or need, resulting in substantial waste of water. Irrigation controllers bypass the scheduled irrigation times when watering is not needed. Each ET controller is expected to save 6,781 gallons per year.

4 Commerce Township does have a landscape water use ordinance.

5 This analysis was conducted by the Alliance for Water Efficiency (AWE), a project partner, using their Conservation Tracking Tool. http://www.allianceforwaterefficiency.org/Tracking-Tool.aspx

- **Residential Soil Moisture Sensor Rebate:** Like ET based irrigation controllers, prevent irrigation systems from operating when watering is not needed. Instead of evaporanspiration data, soil moisture sensors rely on readings of soil moisture to determine if plants and turf grass require irrigation.
- **Large Landscape Survey Conservation Program:** Provide site visits, training, device adjustment, equipment upgrade recommendations, or strategies such as water budgets for large landscapes (an acre of irrigable area on average). Although hardware improvements may result in cost for the customer, this program does not specifically provide utility side rebates, distribution, or direct installation for efficiency techniques. Each survey is expected to cost the water utility or municipality $600 and result in savings of 97,898 gallons per year.
- **Large Landscape Irrigation Controller Rebate:** Provide a survey and incentive for ET irrigation controllers for large landscapes. The cost of each rebate is estimated to be $2,100 ($600 for the site visit and $1,500 as an actual rebate for the irrigation controller). Each rebate is expected to save 147,692 gallons per year.

Saving Water by Reducing Peak Water Use

Figure 2 displays water consumption by quarter for each of the three Oakland County communities. The second and third quarters, which includes the dry summer months, shows a substantial increase in water consumption, mainly due to watering lawns and other outdoor water uses. Notably southwest Oakland Township's third quarter use was over three times its quarter water use. Lyon and Commerce also exhibit large seasonal peaks in water consumption.[6] Implementing outdoor water conservation programs to reduce that peak summer use is a promising water management strategy for Oakland County. Bringing down those sea-

2010 Total Water Consumption by Quarter (MG)

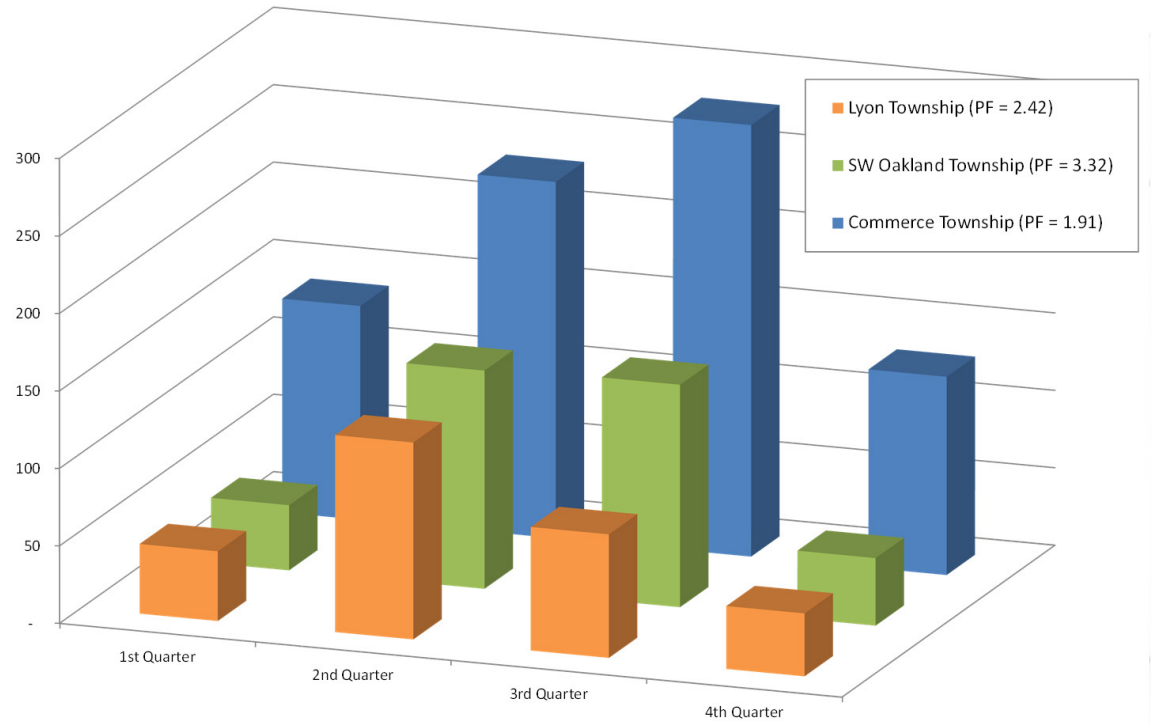


Figure 2. 2010 Total Water consumption by Quarter for Oakland County, Michigan (in millions of gallons). Source: Alliance for Water Efficiency. PF is the Peaking Factor. In this instance, it refers to the ratio of the quarter with the highest consumption and the quarter with the lowest consumption.

6 Refer to figure 2 that shows a peaking factor (PF) for Southwest Oakland County Township of 3.2. In this instance, the PF is the ratio of the quarter with the highest consumption and the quarter with the lowest consumption to the average daily flow in a water system.

sonal peaks will alleviate the water pressure challenges that these communities have during the summer. The most effective, outdoor water conservation programs for the three Oakland County townships in reducing those peaks are: 1) Residential Efficient Irrigation Nozzle Replacement Program, 2) Residential Irrigation ET Controller Rebate and 3) Residential Soil Moisture Sensor Rebate.

The Financial Savings

Our analysis further shows that a few cost effective water conservation programs are available for the three communities. However, the three programs that we just listed as being most effective at reducing peak water demand are more cost-effective for Commerce Township than for Lyon and Oakland townships. This is because Commerce Township purchases its water from the much more expensive DWSD system. Commerce Township customers pay nearly four times more per unit for water than do those in Lyon and Oakland townships. In the other two, the savings are not substantial enough to drive them into action because water is comparatively cheap.

For Lyon and Oakland townships, which provide water more cheaply by pumping local groundwater, only one conservation program - the high-efficiency toilet rebate – was identified as cost-effective. If in the future the local groundwater supplies decline substantially, the groundwater becomes contaminated or water pressure issues increase, Lyon or Oakland townships may need to purchase water from DWSD. In those circumstances, the water costs for the utility and the consumer would go up, and consequently cost-effectiveness of the other conservation programs would be expected to be similar to Commerce Township. Alternatively, in the long term, it would make sense to institute water management strategies that restore the natural water cycle and sustain the groundwater supply to avoid going to the more expensive Detroit water.

Energy Savings and Emission Reductions

Water conservation and efficiency programs reduce the need to pump, treat and deliver water to customers and decrease the amount of water being treated in wastewater treatment plants. Also, decreased water use in homes reduces the energy costs to

Value of Energy Savings

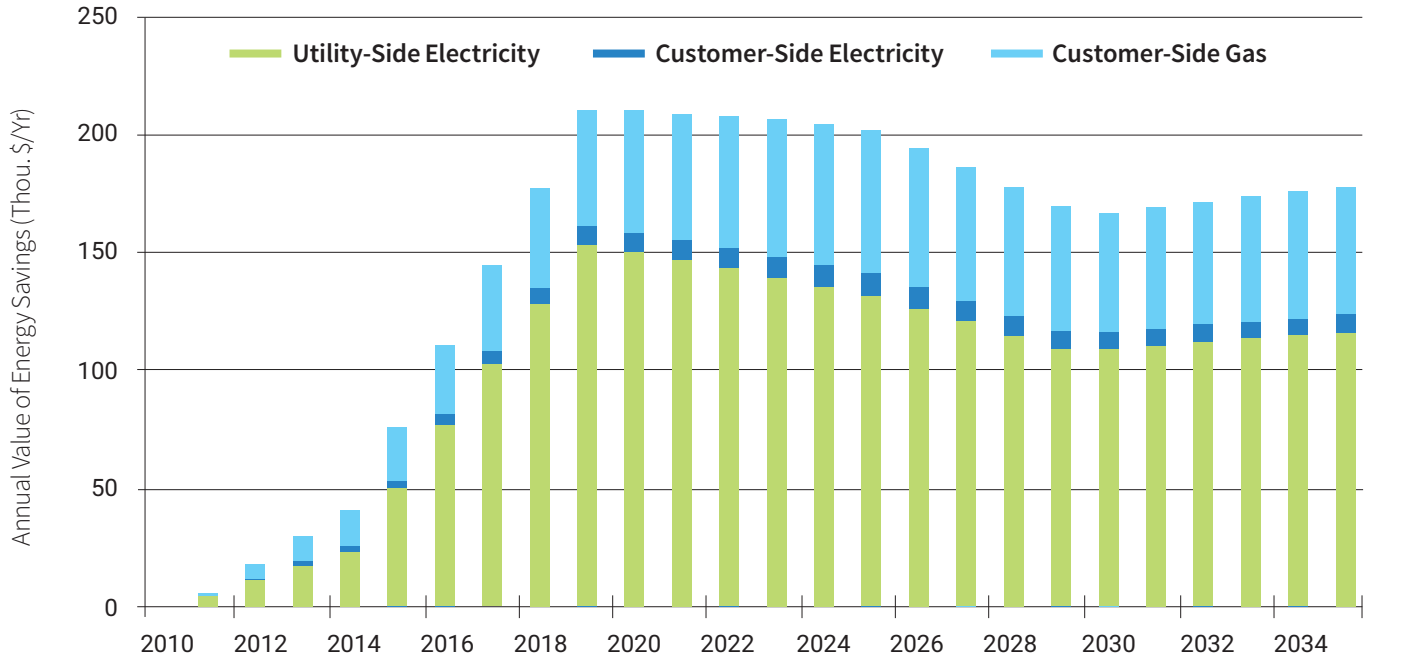


Figure 3. Value of Energy Savings for Utility Electricity and Customer Electricity and Gas for Oakland County, Michigan Communities. Source: Alliance for Water Efficiency.

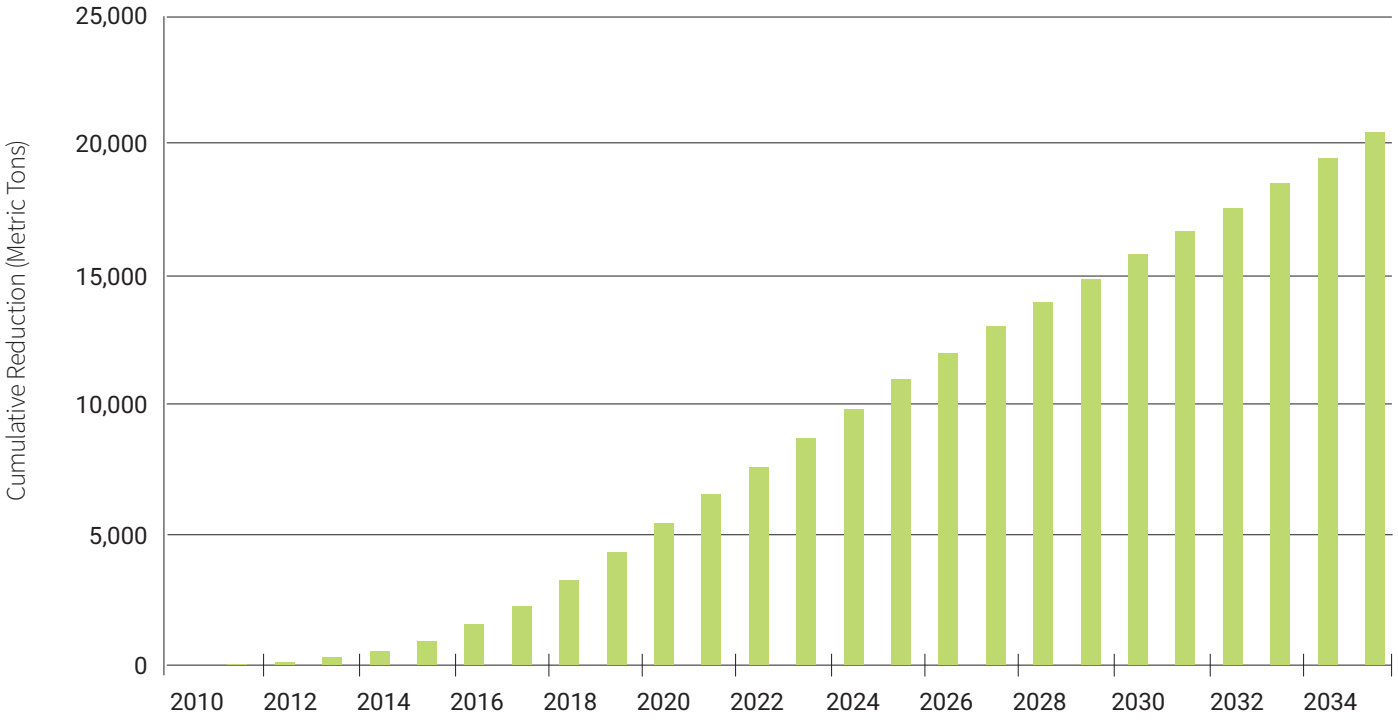


Figure 4. Carbon Dioxide Emission Reductions for Selected Communities in Oakland County, Michigan. Source: Alliance for Water Efficiency.

residents to heat the water. These in turn reduce the energy consumption and greenhouse gas emissions associated with these processes. Figure 3 illustrates the value of energy savings from projected reductions in water demand. The green part of the bars displays the value of annual energy savings incurred by the utility through investments in conservation and efficiency programs. The blue and red parts of the bars display the annual value of energy saving that the customers receive from participating in the conservation programs. Figure 3 shows an exponential increase in energy savings for both the utility and the customers within the first ten years of implementing the seven water conservation programs, and then the energy savings are sustained and taper off over the next fifteen years thereafter. Figure 4 displays the associated reductions in metric tons for the greenhouse gas carbon dioxide as a result of implementing the seven water conservation programs and thereby reducing the energy use in the treatment and distribution of water and residential use. The chart illustrates that if conservation programs were implemented, these communities would experience consistent reductions in carbon emissions each year. By 2034, they would avoid over 20,000 tons of carbon emissions.

Actions to Improve the Fractured Water Cycle

Conservation of the potable water supply is an important first step toward managing a community's water resources in a more effective manner that makes environmental and financial sense. Urbanization has severely altered the natural water cycle. Capturing rainfall close to where it falls, allowing portions to infiltrate, storing some of the excess flows and releasing those flows at a controlled rate, supports groundwater supplies as the receiving waters are allowed to recover and helps restore the natural environment. In conclusion, our analysis shows that suburban and urbanizing communities like those we examined in Southeast Michigan could see tangible environmental, social and economic benefits from adopting strategies and making investments that:

- **Reduce peak summer use:** Targeting peak summer use with outdoor water conservation programs is a promising water management strategy for the selected communities in Oakland County. Reducing peaks in water use will alleviate the water pressure challenges that these communities now have during the summer.

- **Reduce costs, energy and emissions:** The analysis of the seven water conservation and efficiency programs shows that communities can reduce water consumption and save money, energy and related greenhouse gas emissions. The Oakland County communities should further evaluate these programs for their water systems.

Recommended additional steps to restore the natural water cycle include:

- **Treat rainwater where it falls:** The communities within Oakland County will be expected to comply with evolving Michigan state stormwater permit requirements, and as such, will be expected to enable greater infiltration of stormwater on the site where it falls. To meet this requirement, these communities will be encouraged by state regulators to adopt the following green infrastructure strategies:
    - ***Marrying the Green and Grey:*** Green infrastructure is an approach that incorporates both the natural environment and engineered systems to water management that protects, restores, or mimics the natural water cycle. Grey infrastructure is the traditional approach to water management using treatment plants and pipes to pump, treat, store and deliver, and then collect, treat and discharge wastewater. Recent studies have documented that a combination of green and grey infrastructure provides the most effective means of achieving the ecological, technical and financial goals of returning to a more natural urban drainage system.
    - ***Align municipal policies and codes to encourage the use of Green Infrastructure that supports a reconfigured drainage system:*** City leaders should consider the benefits of green infrastructure as they craft the policies impacting the urban drainage system.
- **Develop policies among watershed communities to protect downstream areas:** Because Oakland County is the headwaters for five major Great Lakes watersheds, its water management strategies impact downstream communities and the Great Lakes. Oakland County should work with downstream and upstream communities to develop water management strategies that encourage the use of green infrastructure and support the recharge of groundwater sources. Existing municipal codes should be reviewed and augmented where appropriate to implement these strategies.

For More Information

Visit the Greater Lakes project website at www.glc.org/water-resources/greater-lakes.

This publication was authored by Rebecca Pearson, Great Lakes Commission, and edited by John Jackson, Greater Lakes project manager, Victoria Pebbles, Great Lakes Commission, Laura Bretheim, Great Lakes and St. Lawrence Cities Initiative, Bill Christiansen, Alliance for Water Efficiency, and Jim Ridgway, Environmental Consulting & Technology, Inc. Special thanks to Connie Sims, Oakland County Water Resources Commissioner's Office, for providing guidance.