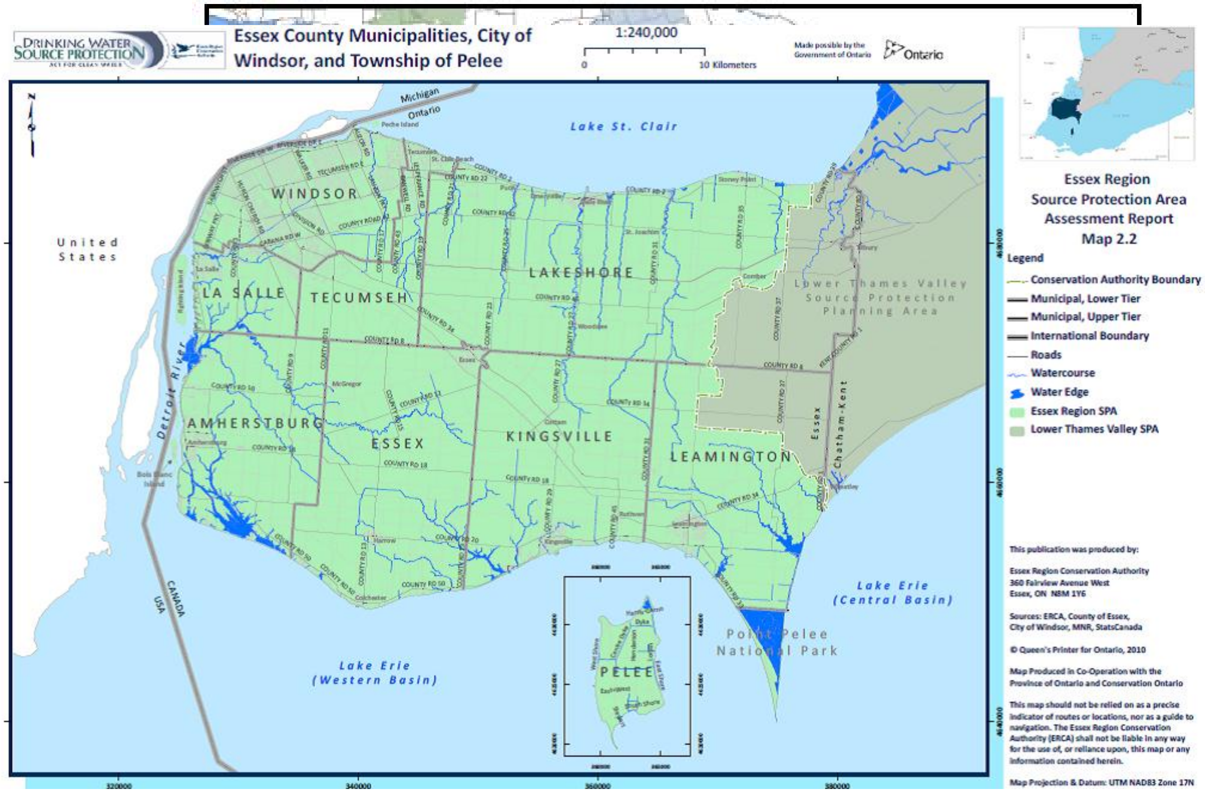

Figure 2-10: Source Water Protection Areas in Ontario, Canada

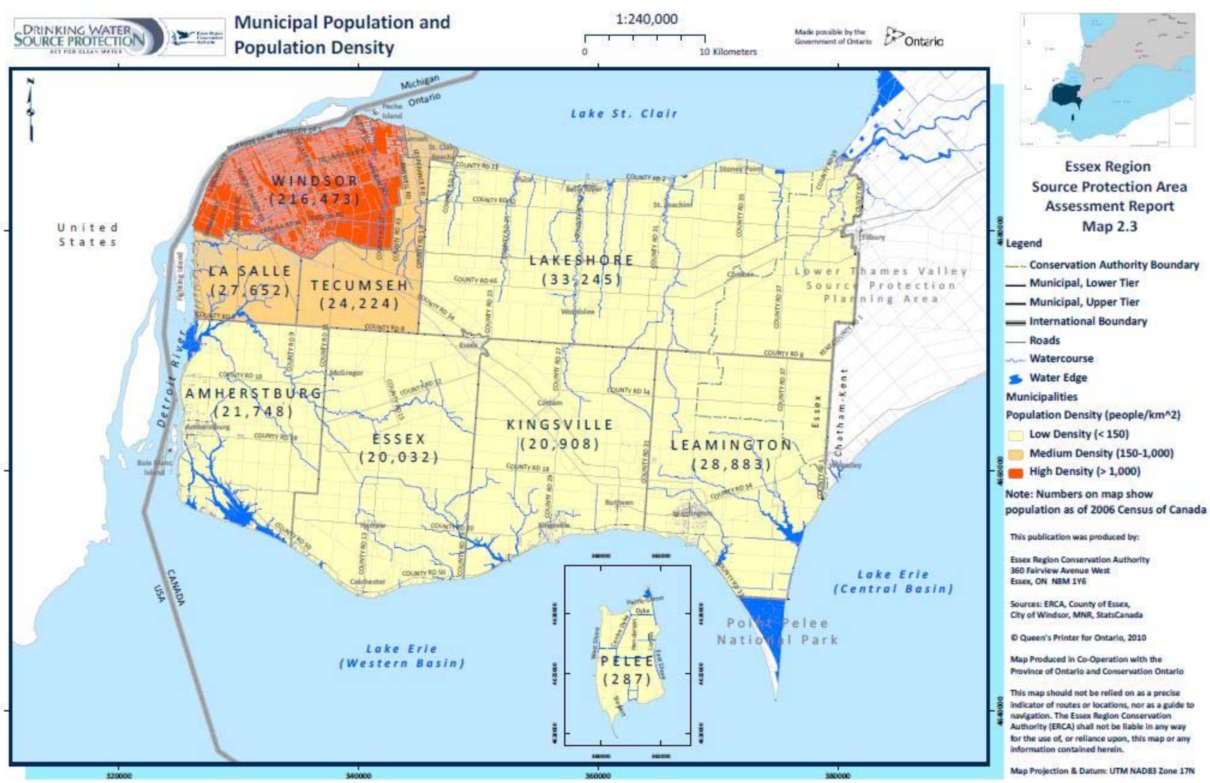

Figure 2-11: Essex Region Source Water Protection Areas

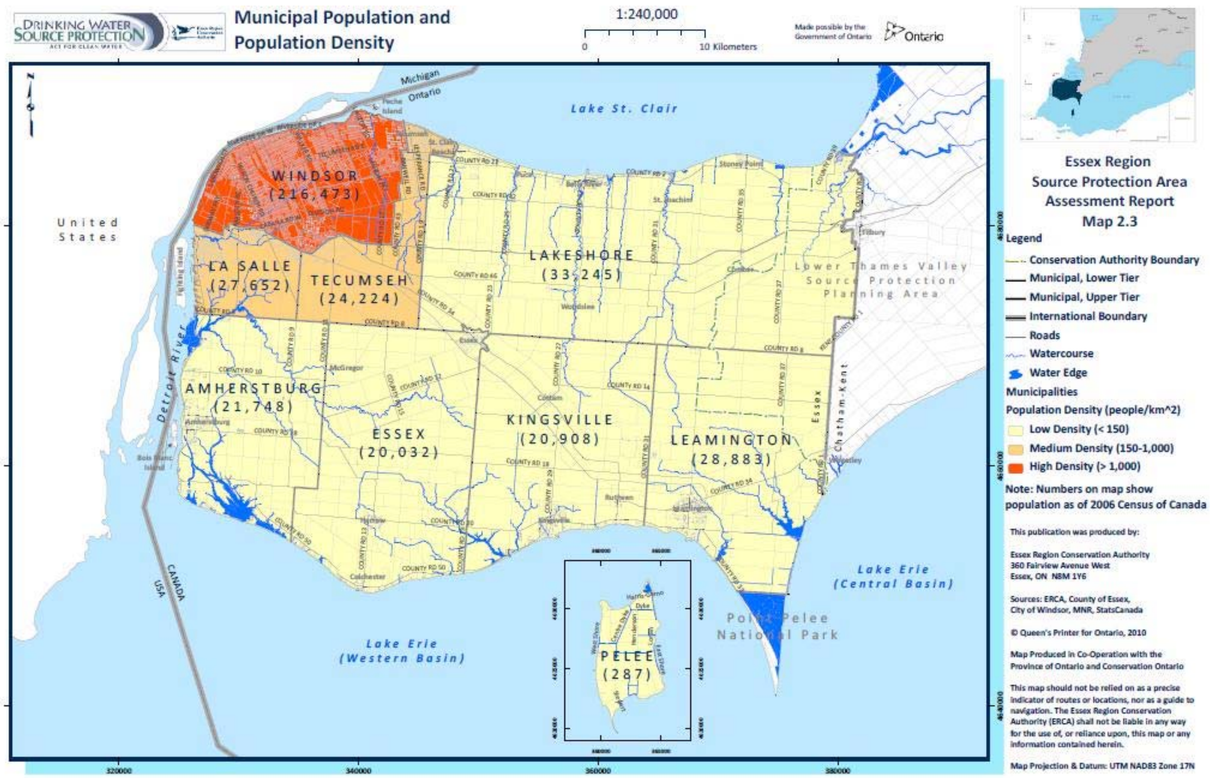

Figure 2-12: Essex Region Land Cover

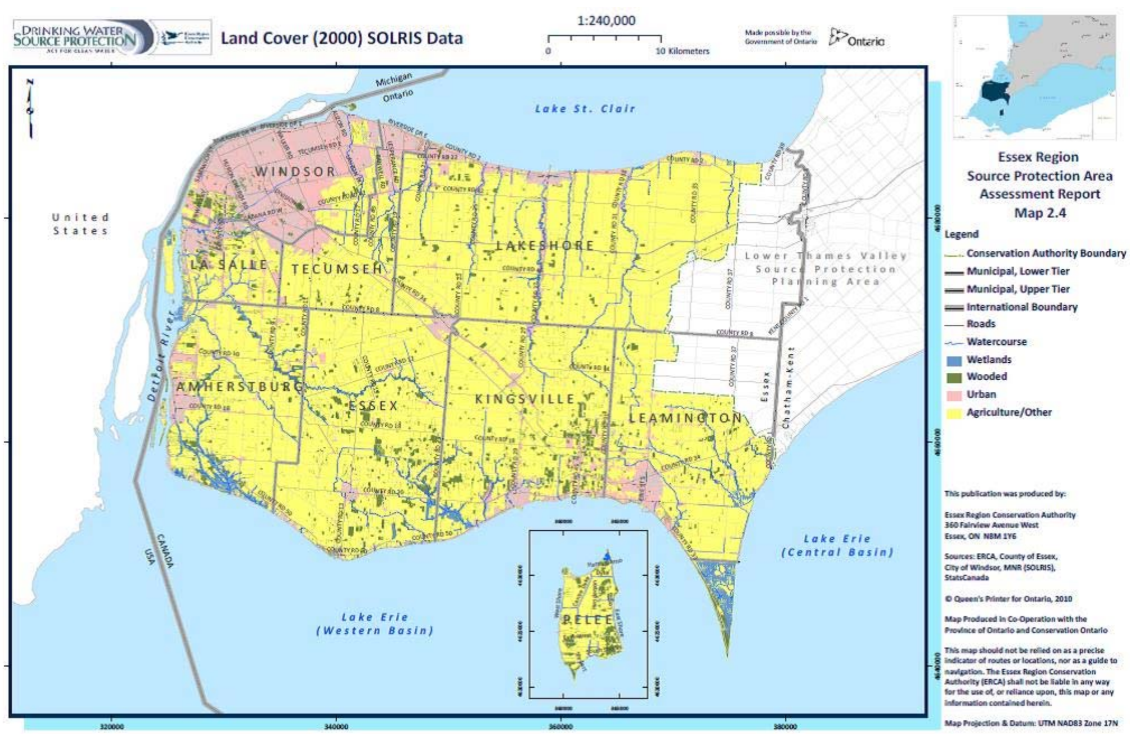

Figure 2-13: Essex Region Population Density

2.2.3 Other Regulations Relating to Source Water

There are a variety of State and Federal regulations which relate to and will enhance source water quality. Through these regulations, both point and non-point sources are managed and minimized thereby improving source water quality. Some of the key regulations include TMDLs (Total Maximum Daily Load), Stormwater Management, Combined Sewer Overflows, Sanitary Sewer Overflows and NPDES (National Pollutant Discharge Elimination System) permits.

When a lake or river does not meet Water Quality Standards (WQS), then the MDEQ requires that a study be performed to determine the allowable amount(s) of pollutant(s) from both point and nonpoint sources that will still provide for compliance with the WQS. A TMDL (total Maximum Daily Load) is established by the MDEQ when a lake or stream does not meet water quality standards. Some of the water bodies where the drinking water intakes are located and some of the waters that discharge to these locations have established TMDLs. A TMDL was developed for E. coli in the Detroit River in 2008 which addressed concentrations at Belle Isle and Fighting Island. MDEQ has established TMDLs for Lake St. Clair beaches for phosphorus and for E. coli. No TMDLs have been approved for Lake Huron. The most common TMDL is for E. coli (**Table 2-4**)

Table 2-4: TMDLs for Water Bodies that may Impact DWSD Intakes

TMDL		
Water Body	**County**	**Pollutant**
Bear Creek	Macomb	E. coli
Black River	St. Clair	E. coli
Clinton River	Macomb, Oakland, St. Clair	E. coli
Coon Creek	Macomb	E. coli
		Dissolved Oxygen
Detroit River	Wayne Oakland, Washtenaw	E. coli
Lake St. Clair beaches	Macomb	E. coli
Red Run Drain	Macomb	E. coli
Rouge River	Oakland, Wayne	E coli

DWSD has an active stormwater management program that addresses the storm water system. The City of Detroit's storm water discharges are currently regulated by the jurisdictional general storm water discharge permit MIS04000 issued February 23, 2003. This permit is met by implementing best management practices to address the following:

- Public education program on storm water impacts
- Public involvement and participation
- Illicit discharge elimination program
- Post-construction storm water management program for new development and redevelopment projects
- Construction stormwater runoff control
- Pollution prevention and good housekeeping for municipal operations

National Pollutant Discharge Elimination System (NPDES) permits provide water quality protection related to discharges from wastewater treatment plants (WWTPs). These permits establish operating conditions and allowable discharge limits for a variety of parameters, including fecal coliform, nutrients and other pollutants. There are five WWTPs which discharge to the Detroit River (Detroit, Wayne County, Trenton, Grosse Ile Township and South Huron Valley Utility Authority). There are additional wastewater plants that discharge to Lake St. Clair and Lake Huron. A map of critical facilities, including DWSD wastewater plants is provided in **Figure 2-14**.

Combined sewer overflow and sanitary sewer overflows (CSO/SSO) are typically associated with wet weather conditions and therefore occur intermittently. These discharges are regulated to control pollutant discharges for parameters such as E. coli and nutrients. MDEQ tracks and reports CSO discharges on their website at http://www.deq.state.mi.us/csosso/recent_events.asp. In addition, the MDEQ issues annual reports on both CSO and SSO operations and discharges. There are many CSOs in the Lake Huron and Detroit River watershed. A map of Detroit CSO facilities is provided in **Figure 2-15**.

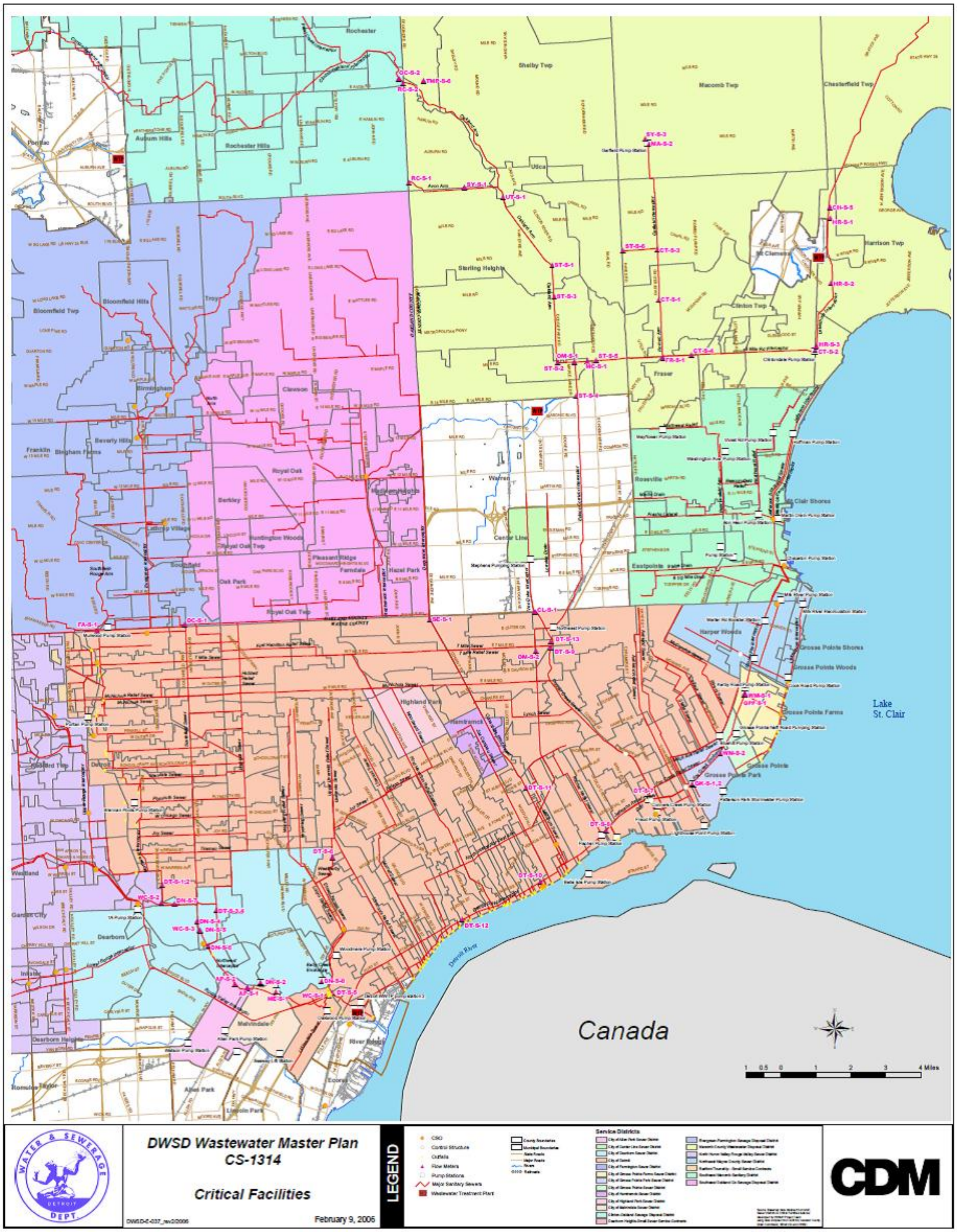

Figure 2-14: Map of Critical Facilities in the Source Water Area, DWSD Wastewater Master Plan (2006)

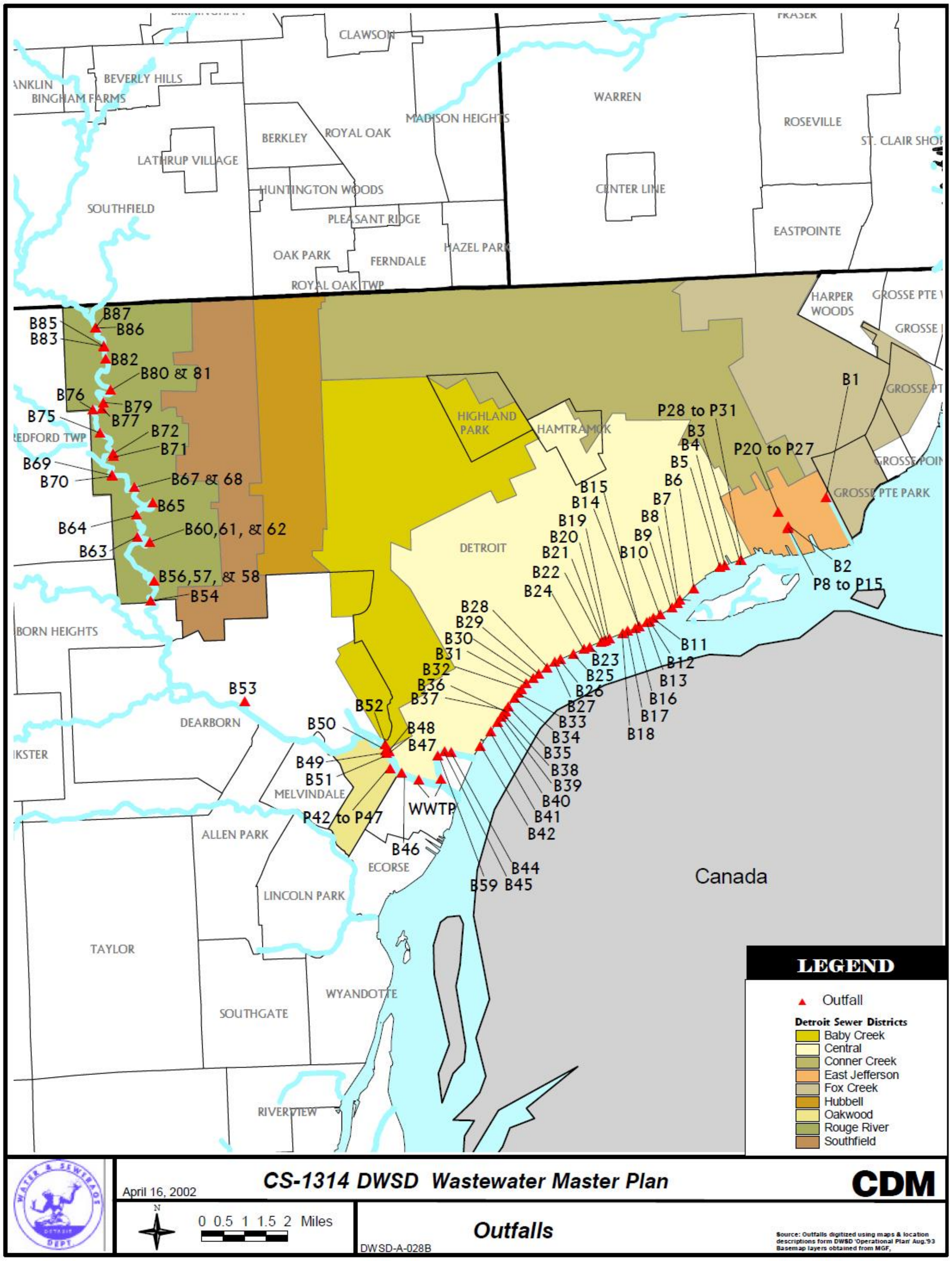

Figure 2-15: Map of CSOs along the Detroit River (2002)

2.2.3 Future Regulatory Trends in Source Water

With a continually evolving regulatory framework at both the federal and state levels, it is reasonable to assume that source water quality, quantity and protection will remain items of regulatory interest. A potential regulatory development would be for the MDEQ to make SWAP and SWIPP required rather than optional programs. This would provide consistency with the existing wellhead protection programs. Credit for approved SWAPs and SWIPP activities are already awarded points in DWRF (Drinking Water Revolving Loan Fund) applications. Completion of a SWAP is beneficial for any utility which seeks funding through the Drinking Water Revolving Loan Fund.

The Great Lakes Charter and Annex will continue to be of interest as challenges over use of the Great Lakes waters arise. As these criteria are implemented throughout the Great Lakes States and Provinces, new issues may arise thereby leading to further development and modification of the requirements.

2.3 Potential Impacts of Climate Change

Climate change has multiple potential impacts on water quality and water quantity. Therefore it is important to consider and plan for these impacts as part of the comprehensive water master plan evaluation. In the Great Lakes area, reports of increased storm severity leading to rapidly fluctuating water quality and reports of increased cyanobacteria (blue-green algae) blooms leading to concerns over taste and odor and microcystin production have been reported. In September, 2013, the Carroll Township, Ohio water plant was taken off line due to a cyanobacteria bloom in Lake Eric (http://www.usatoday.com/story/news/nation/2013/10/13/lake-erie-algae-drinking-water/2976273/) and the concern over toxin production associated with the bloom, DWSD reports that up to 60% of the algae identified in the summer at the Fighting Island intake are cyanobacteria. Therefore while the source water quality at the DWSD intakes is better than is Lake Erie, there are trends and blooms particularly at the Fighting Island intake that may be of current and future concern. Zamayadi et al. (2013) reported a cyanobacteria bloom that occurred from Lake St. Clair to Lake Erie (CBC News April 29, 2013; **Figure 2-16**).

The potential impact of climate change on source water quality for the Detroit Water and Sewerage Department (DWSD) discussed in this section include:

- Potential changes in source water quality in the Lake Huron, St. Clair River, Lake St. Clair, and Detroit River watersheds from which DWSD draws its water
- Impacts of water quality changes on water treatment processes, distribution system water quality, operations, and regulatory compliance
- Potential changes in water demand due to changes in precipitation

Figure 2-16: Cyanobacteria Bloom 2013 from Lake St. Clair to Lake Erie

2.3.1 Potential Changes in Source Water Quality

The USEPA anticipates that much of the Midwest, including the Detroit metropolitan area, will see a dramatic increase in the frequency and intensity of precipitation due to climate change. As a result of this increased precipitation, excess runoff and snowmelt may alter the water quality in the DWSD watershed. Increased runoff may cause the following changes to source water quality:

- Increased total organic carbon (TOC), pathogen, and nutrient loading
- Decrease in raw water alkalinity
- Elevated raw water turbidities

Further, the increased frequency of storm events also may create fluctuations in temperature and pH.

2.3.2 Impacts of Water Quality Changes

Each of the water quality changes identified in the previous section carries ramifications for DWSD's water treatment system and ultimately distribution system water quality. **Table 2-5** lists each of the potential water quality changes associated with climate change along with the potential treatment, cost, and regulatory impacts.

2.3.3 Impacts of Water Quantity Changes

In addition to water quality concerns, water quantity changes are a potential impact of climate change. As total precipitation increases, water demands may decrease. However, this prediction is complicated by the timing of the precipitation. Dry summers are also a possibility which would lead to potentially increased water demands. At this time, the best recommendation is that DWSD monitor precipitation patterns as related to water demands.

Table 2-5: Effects of Climate Change Induced Water Quality Changes on Treatment Processes, Finished Water Quality and Future Regulatory Compliance

Change in Water Quality	Impact on Treatment Process	Potential Regulatory and Cost Impacts
Increased total organic carbon	1. Increased chlorine demand 2. Greater risk for disinfection by-product formation 3. Change in regulatory definition of source water under the Stage 1 Disinfectants and Disinfection by-Products Rule requirements	1. Requirement to provide TOC removal in process if average raw water TOC increase above 2.0 mg/L 2. Potential for DBP compliance challenges 3. Greater chemical usage and associated costs
Increased nutrient loading	1. Increased cyanobacteria (blue-green algae) blooms 2. Greater risk of taste and odor (T&O) episodes 3. Higher raw water nitrogen levels in the form of ammonia, nitrate, and/or nitrite	1. More frequent monitoring of T&O 2. Potential addition of T&O treatment technologies 3. Occurrence of microcystin and need for new/modified treatment processes to remove it 4. Additional chlorine demand due to potential increase in ammonia levels 5. Greater chemical usage costs for chlorine and/or T&O control compounds 6. Regulatory impacts of increased nitrate/nitrite
Increased pathogen loading	1. Increase in Cryptosporidium exposure risk 2. New/increased occurrence of emerging pathogens	1. Placement in higher bin categorization for Cryptosporidium risk 2. Requirement to provide advanced treatment for additional Cryptosporidium barrier 3. Provide treatment for new pathogen removal/inactivation
Decrease in raw water alkalinity	1. Change in water treatability with alum coagulants 2. Increased drop in pH in treatment processes upon addition of alum coagulant	1. Increased finished water corrosivity 2. Potential changes to lead and copper corrosion and control strategy 3. Conditioning chemicals such as caustic may be required to maintain acceptable pH in finished water
Elevated and fluctuating raw water turbidities	1. Increased coagulant usage 2. Increase in sludge generation 3. Additional monitoring required to effectively target coagulant dosage to respond to rapid changes in source water quality	1. Greater chemical costs for coagulants 2. Increase in operating costs for sludge handling and disposal 3. Without effective raw water turbidity monitoring, over or underfeeding of coagulant will be common 4. Challenge with turbidity compliance requirements

All of these impacts will lead to increased labor costs for water quality monitoring and water treatment process assessment. In addition, increased costs in chemical usage to adequately treat the water are possible. Some of the potential outcomes, such as the occurrence of cyanobacteria blooms with production of microcystin, will necessitate new or modified treatment processes to ensure removal of this toxic compound. Microcystin can be removed using ozone, GAC, increased chlorine residual, and coagulation. However, the latter results in a toxic sludge which creates disposal issues. Therefore it is important that DWSD track source water quality and periodically assess the impacts of climate change.

2.4 Zebra and Quagga Mussel Impacts and Control

Zebra mussels (*Dreissena polymorpha*) and Quagga mussels (*Dreissena rostriformis bugensis*) have spread throughout the Great Lakes, rivers and inland lakes of the upper Midwest and Ontario. The mussels secrete sticky threads that are used to firmly attach to any hard surface in the water. The ability of these mussels to attach in large clumps can create numerous problems, such as clogging water intake pipes and killing native mussels. The mussels are filter feeders and consume significant quantities of phytoplankton. The filter feeding results in improved lake clarity, which in turn promotes macrophyte growth and extensive weed beds. The mussels deposit pseudofeces on lake and river beds which provide a nutrient source for other organisms. The mussels foul beaches, interfere with food webs, smother native mussels, clog water intakes, impart taste and odor, and are linked to fish and wildlife die-offs. As such, they have a significant and typically negative impact on any water ecosystem. Quagga mussels are not currently as common as zebra mussels in the Great Lakes (**Figure 2-17**) and often are found at greater depths.

The control of zebra mussels is important for a water utility in order to prevent clogging or flow restrictions in intake piping. Many utilities apply chlorine to the front edge of the intake pipe to prevent mussel colonization and to kill any mussels that have already attached. DWSD practices such chlorination at the Belle Isle intake. The Belle Isle intake was last inspected in 2005. It was observed that the bar racks were up to 80 percent blocked by seaweed and algae growth along the lower eight feet of the bar. The upper half was relatively clear. Zebra mussel accumulation was light with up to 50 percent blockage in a few isolated areas. While past surveys indicated that the chemical treatment was effective, there were zebra mussels observed on most surfaces within the intake system with up to 100 percent coverage on the concrete walls. It was concluded that zebra mussel infestation had increased since 1991. Therefore the chlorine dosage was increased. It is recommended that DWSD continue to evaluate the effectiveness of this zebra mussel control strategy.

At the other intakes, DWSD relies upon the large intake size as a sufficient approach to zebra mussel management (tolerates buildup of zebra mussels but flow is still allowed as it is difficult to plug a large diameter pipe). However, the presence of zebra mussels in an intake pipe will still create an increase in pipe roughness and thereby increase pumping costs. They will also decrease pipe diameter. In addition, zebra mussels can contribute unpleasant taste and odor to the water, which will need to be addressed in the WTP treatment process. Allowing zebra mussels to colonize the intake pipes will provide them with an opportunity to enter the plant processes where further colonization may occur. For these reasons, it is recommended that mussel control be implemented at all intakes. Extension of chlorination to the raw water inlet is the simplest approach, although there are a variety of other control measure ranging from application of oxidants, mechanical removal, and special pipe coatings. Chlorine does not need to be applied continuously. Intermittent application of 1.0 mg/L chlorine during breeding season in the summer is usually sufficient.

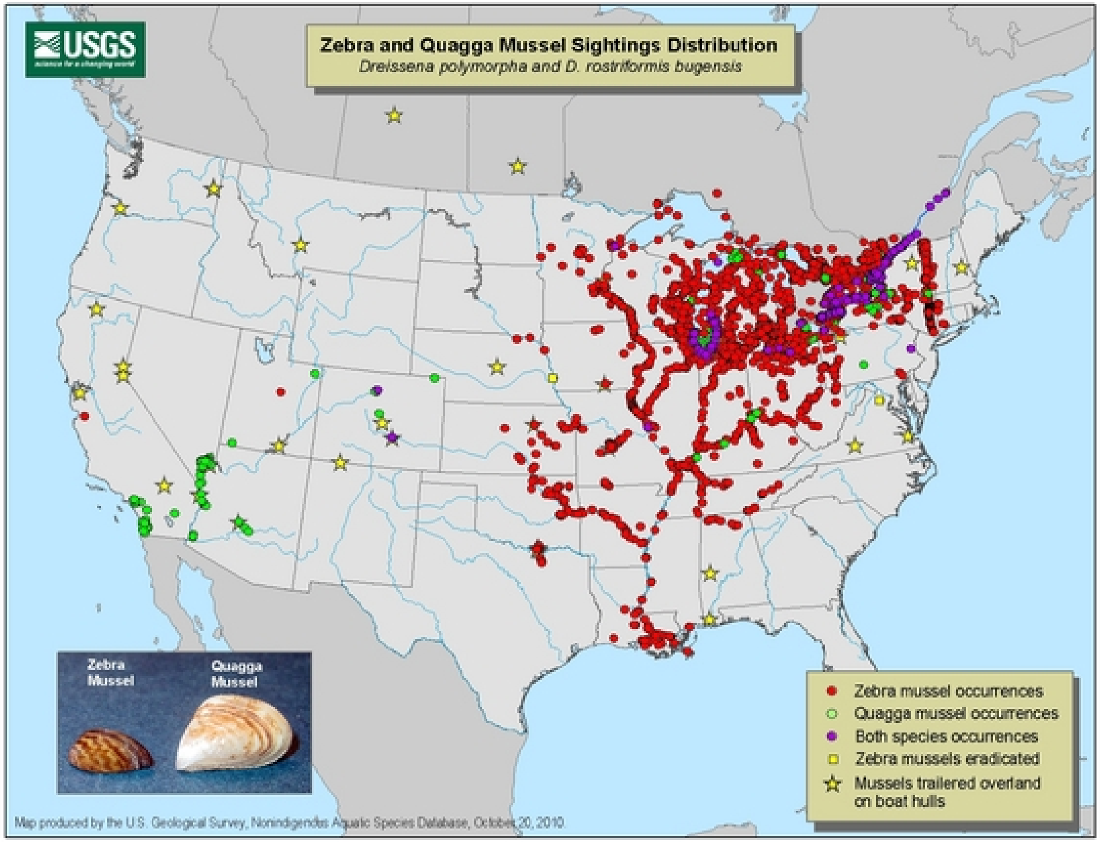

Figure 2-17: Map of Zebra Mussel and Quagga Mussel Occurrence, 2010

2.5 Spills in Lake Huron and Detroit River System

Spills of pollutants are a concern for source water protection. Spills may occur from:

- Industry/Point source spills associated with local manufacturing or chemical storage. Both of these industries are present in the watershed, particularly in the St. Clair and Detroit Rivers.
- Transportation of substances can lead to spills on land or water. Such spills are unpredictable in duration, content and magnitude.
- Non-point sources typically impact water quality over a significant period of time such as seasonally. An example of this would be agricultural runoff.

Three sources were reviewed to assess recent spill information. The State of Michigan Pollution Emergency Alerting System (PEAS) for 2005 to 2010, the Ontario Spills Action Centre (OSAC) for 2005 to 2009/2010 and online media were reviewed. Online data from PEAS and OSAC were not available after 2010. Therefore analysis of spill information for 2011 to present had to rely on reports published in the media.

The US Coast Guard also maintains a spill reporting center (http://www.nrc.uscg.mil/). This database is the most extensive and is up-to-date. It allows for multiple search criteria including "medium affected" with a choice for "water". However, it does not provide for a level of detail beyond County so the database requires extensive interpretation to determine if the spill impacted DWSD's intakes and watershed protection areas. Data can be exported to an Excel spreadsheet. Those data are presented in Appendix A. From 2004 through October 1, 2013, 405 water related spills were reported in Wayne County, 154 in Macomb County, 124 in St. Clair County and 11 in Sanilac County. The most common spill substance was oil. Gasoline and polychlorinated biphenyls were also repeatedly reported.

In addition, the 2004 Master Plan reports that there were over 700 spills along the St. Clair River system from 1986 to 2004 (reported by both the United States and Canada). Two of the most notable spills were:

- 2003 of 134 kg of vinyl chloride
- 2004 42,000 gallons of methyl ethyl ketone

From recent media, two stories reported spills:

- An oil spill in 2011 in the Detroit River at Ecorse
- A very small oil spill of 10-20 gallons in the Rouge River in 2012

The PEAS spill reports are shown in **Table 2-6**. PEAS collects data by county, city, date, time, incident description, name of pollutant, volume of pollutant, whether it impacted water and the MDEQ responder. **Table 2-6** lists the PEAS incidents where water was known to be involved. Water sources in Wayne, Macomb, St. Clair and Sanilac Counties were examined and any waters that discharged above the DWSD intakes were reviewed. As can be seen from this table, the most common spill is oil. The most impacted county is St. Clair. Significant spills are:

- 45,000 gallons of a trucked chemical (unidentified) into Turkey Creek, Wayne County in 2004
- 165 gallons of nickel sulfate into the Clinton River, Macomb County in 2004
- 40,000 gallons of ethylene glycol into Bear Creek, Macomb County in 2007
- 100 barrels of methyl ethyl ketone into St. Clair River, St. Clair County in 2004
- 3,375 gallons of high pH liquid into St. Clair River, St. Clair County in 2004
- 180 mg/L chlorinated water (unknown amount) into St. Clair River, St. Clair County in 2005
- 24,000 liters of brine into St. Clair River, St. Clair County in 2006
- Two incidents of dead fish in St. Clair River, St. Clair County in 2006
- 20 kg of acetonitrile into St. Clair River, St. Clair County in 2008
- 83 µg/l of ethyl benzene and 92.3 µg/l of xylene (total quantities unknown) into St. Clair River, St. Clair County in 2009
- 50 gallons of oil into Jordan Creek & Pine River, St. Clair County in 2009
- 60,000 gallons of chlorinated water into the Black River, St. Clair County in 2009

- 100 gallons of diesel fuel and 1,900 gallons of milk into Lake Huron, Sanilac County in 2008

From the PEAS spill data, it is observed that the most common substance reported is oil. A variety of other substances are also observed including fuel (diesel) and volatile organic chemicals (VOCs). VOCs are more common in St. Clair County. A number of spill reports include unknown substances, with a few instances of major fish kills, particularly in Macomb County.

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