Grand River Conservation Authority

Report number: GM-02-17-24

Date: February 24, 2017

To: Management Committee

Subject: Water Quality Conditions Report

Recommendation:

That Report GM-02-17-24, be received for information.

Summary:

This report provides information on the status of water quality conditions between 2013 and 2015 in the Grand River watershed.

Nutrients, phosphorus and nitrogen, are long-standing issues in the watershed and are used as indicators of water quality. General water quality conditions are summarized using a Nutrient Water Quality Index that evaluates the frequency with which nutrient concentrations meet guidelines.

Nutrients promote the growth of algae, which can affect oxygen levels for fish. High nutrient levels, like ammonia, can also use up oxygen when it breaks down in the river. As a result, GRCA monitors dissolved oxygen continuously at nine stations in the watershed. Other water quality parameters like sediment, which can impair habitat or clog intakes; chloride, which can be toxic to fish and bugs, and temperature that can make river conditions not suitable fish, are also highlighted in areas of the watershed where they are issues.

River water quality is influenced by point sources like wastewater treatment plants and runoff from urban areas (e.g. stormwater) and rural / agricultural lands. Flows in the river also influence quality. Point sources can have a significant impact during low flows while diffuse (or nonpoint) sources have an impact during spring freshet and significant rainfall events.

The role of the Grand River Conservation Authority (GRCA) in water quality is

- to monitor and report on water quality conditions;
- maintain a good technical understanding of quality in different parts of the watershed;
- provide advice on how best to improve water quality;
- deliver a rural water quality program;
- maintain a predictive modelling tools for long-term municipal wastewater master planning; and
- work with municipal wastewater plant operators to encourage best practices to improve plant performance.

Further, our role is to encourage actions to continuously improve water quality to ensure the goals of the Water Management Plan are achieved.

Many actions, as identified in the Water Management Plan, are already underway

- upgrades at the Kitchener and Waterloo wastewater treatment plants;
- optimized performance at several wastewater treatment plants;

- best management practices continue to be implemented by the Rural Water Quality Program; and
- stormwater utilities have been established and implementation of significant stormwater works is well underway in Kitchener and Waterloo.

GRCA staff also work with many researchers to assist with advancing the science and understanding of the watershed. Research and monitoring are starting to show improvements in the river's condition. More improvement is predicted in the coming years.

Report:

The Grand River is a 'working river' as it flows from Dundalk to Port Maitland. The quality of the river and reservoir systems varies considerably due to the underlying geology, soils, land use, land management practices, and variable flows in the river.

This report highlights the general conditions at long-term monitoring sites in the headwaters including the upper Nith, Conestogo, Grand, Speed and Eramosa Rivers; the major water management reservoirs; the middle Grand River; the central urban area; the exceptional waters reach between Paris and Brantford; and the southern Grand River / Lake Erie region.

Nutrient concentrations (i.e. nitrogen and phosphorus) are a focus of the water quality conditions report as these contaminants can limit the amount of wastewater discharged to the river system, impact drinking water, promote algae growth, and are long-standing water quality issues in the watershed. Other water quality parameters like sediment, dissolved oxygen, chloride and temperature will be discussed in areas of the watershed where they are also issues.

Water quality is evaluated according to the many valued uses of the river system. The most conservative measure, generally, is the protection of aquatic organisms. Federal and provincial guidelines are used to evaluate water quality data.

A '**Water Quality Index'**, developed by the Canadian Council of Ministers of Environment, summarizes complex datasets into scores and is used to communicate the conditions in the watershed. The scores from the Index are grouped into five categories and allows for a relative comparison among the sampling sites. This report provides a snapshot of the water quality conditions over three years: 2013-2015 (Figure 1). A general description of the Water Quality Index categories are:

Excellent: nutrient levels are never above guideline.
Good: nutrient levels are only occasionally above guidelines and if they are, only by a little
Fair: nutrient levels are above guidelines frequently and sometimes by fair amount
Marginal: nutrient levels are mostly above guidelines and frequently by a lot
Poor: nutrient levels are always above guidelines and by a lot

The data used in this report are restricted, for the most part, to 'open water season' from March to November. However, specific sampling surveys in the winter highlights an emerging nitrate issue. The following summarizes water quality conditions in the basin:

Headwater Region

The headwaters of the Grand River system span an area that is quite diverse in both land use, geology and water quality conditions.

The upper Eramosa and Speed Rivers and Mill Creek drain a unique area of highly permeable gravel terraces and swampy valleys and include areas of the Paris-Galt moraine system. This area also has unique bedrock valleys and karst topography. Many of the cold-water streams in

the basin are located in this region. The water quality conditions are generally '*good*' and are characterized by low nutrient and sediment concentrations and cool temperatures.

The upper Grand River, from Dundalk, down through Grand Valley and into Belwood reservoir, has generally low to moderate nutrient and sediment concentrations and conditions are '*good*' or '*fair*'. The benefits of the Luther Marsh provide not only sustained flows to the upper Grand River that help to assimilate the treated wastewater for Grand Valley, but also a wetland that can capture nutrients and sediment locally. During the spring, however, a large amount of nutrients can flow into Belwood reservoir setting up conditions for algal blooms in the summer.

In contrast, water quality in the upper Conestogo and Nith rivers is generally '*marginal*' with high levels of nutrients and sediments. Long-term efforts to implement Best Management Practices (BMPs) in these areas are slowly showing positive benefits. Researchers at Western University have shown that areas with more BMPs have better water quality. They suggest, however, that BMPs placed in areas that directly drain to creeks will do the most benefit.

Headwaters are under increased development pressures in the towns of Dundalk, Grand Valley, Drayton and Arthur, and agricultural production continues to put stress on the rivers in these regions. GRCA staff continue to advance wastewater treatment through the optimization program at Arthur and Dundalk to achieve higher quality effluent. Staff continue to promote the Rural Water Quality Program to implement rural BMPs.

Water Management Reservoirs

Belwood, Conestogo and Guelph reservoirs continue to experience annual blooms of algae. Although the reservoirs capture snowmelt and rainfall to mitigate downstream flooding, nutrients can also accumulate and cause algal blooms. This high productivity can also support strong fisheries.

During the summer, conditions develop that allow algae and sometimes harmful algae called cyanobacteria or blue-green algae to grow. Caution is urged when recreating in and around the reservoirs when there is blue-green algae. Researchers at Wilfrid Laurier University suggest that these reservoirs have experienced algae blooms since they were built. Management focuses on reducing the frequency and severity of the blooms by continuing to implement upstream rural BMPs, wastewater optimization and manage development around the reservoirs.

Grand River Tailwater

Unique to the Grand River basin is the tailwater fisheries in the Grand and Conestogo rivers. The release of water from the bottom of the reservoirs continues to support cold/cool temperatures throughout the summer, which can sustain an introduced brown trout fishery that draw people from around the world. Generally, water quality is '*fair*' throughout the tailwater during the summer. Continued improvement in this reach is likely as Centre Wellington has upgraded the Elora wastewater treatment plant and they continue to be committed to discharging high quality effluent through good process control at both the Elora and Fergus plants. Further, the Grand River Fisheries Implementation Committee has also invested in river rehabilitation efforts to build deeper pools to improve fish refuge.

Upper Middle Grand

The upper middle Grand includes the tailwater reach down to Bridgeport, just before the Grand River flows into the major urban area. This section of the river flows over unique geology comprised of gravel terraces that have complex surface water - ground water interactions. Major tributaries include Irvine, Carroll, Cox, Swan, Canagagigue, and Conestogo. These

tributaries also drain some of the most productive agricultural land in southern Ontario. Water quality in these major tributaries are considered '*fair'* (Irvine Creek) to '*marginal'* (Canagagigue and Conestogo rivers).

During the summer, water quality in the Grand River tends to be considered 'fair' as the river system can use up (or metabolize) the nutrients that flow into the river. During the winter, however, these tributaries can contribute significantly to the levels of nitrate observed in the river. Nitrate is a type of nitrogen nutrient that is important to aquatic life and downstream drinking water supplies. Researchers at the University of Waterloo have illustrated the link between high stream nitrates to the high nitrates found in flowing tiles draining agricultural fields.

The cumulative sources of nitrate to the Grand River combine to have relatively high nitrate levels at the water quality station at Bridgeport. The Water Management Plan identified increasing river nitrate levels as an issue to monitor. Consequently, GRCA installed a continuous monitor to track concentrations. The unique conditions this fall and winter have resulted in nitrate levels peaking so far around 7.5 mg/L. The guideline to protect drinking water supplies is 10 mg/L. Action should continue to focus on engaging the farming community on '4-R Nutrient Stewardship' by choosing the Right Nutrient Source to apply at the Right Rate in the Right Place at the Right Time.

Although much of the water quality concerns in the Grand River basin center around conventional contaminants such as nutrients and sediment, there is historic contamination of N-nitrose dimethylamine (NDMA) in the Canagagigue Creek subwatershed that continues to be a local concern. The Ministry of the Environment and Climate Change and the local industry continue to work toward remediation.

The Central Grand: Urban Island

By the time the Grand River flows into the Region of Waterloo, it has picked up and carried along with it a lot of nutrients. Consequently, water quality at Bridgeport tends to be '*marginal'*. Although the highest concentrations of nutrients and sediments are generally found in the spring when there are high flows that flush them downstream from the upstream watershed, the urban contribution of treated wastewater can be very significant during the summer.

The Grand River receives the treated wastewater from most of the watershed's population as it flows through the Region of Waterloo. The Grand receives treated wastewater from Waterloo, Kitchener, Preston and Galt. The Speed River also joins the Grand River within the Region and it receives treated effluent from the City of Guelph and Hespeler. Consequently, water quality through this river corridor tends to be the poorest in the watershed, especially during the summer.

When summer flows are low, the biological activity in the river reaches its peak. Aquatic weeds grow at significant rates, which can affect the oxygen levels in the river. Further, high ammonia levels (a nitrogen nutrient) in wastewater effluent can also deplete oxygen as it breaks down in the river. These demands can alter oxygen levels so much that they fall below the level required to keep aquatic life healthy.

A significant commitment and investment by the Region of Waterloo into wastewater treatment at the Kitchener and Waterloo wastewater treatment plants to improve effluent quality is beginning to show a major improvement in river water quality and in the health of the aquatic organisms in the river. Oxygen levels have remained above the provincial objective of 4.0 mg/L and ammonia nitrogen levels are decreasing in the river. Further, researchers at the University

of Waterloo have shown a dramatic recovery of fish health due to the recent upgrades at the Kitchener plant.

Many parts of Waterloo, Kitchener and Cambridge do not have stormwater controls. Consequently, these areas can contribute a significant amount of sediment to the river during large rainfall events as shown by large turbidity responses at the Blair Water Quality Station. . The commitment to stormwater management by Kitchener and Waterloo will provide a great deal of benefit to the local tributaries as well as the Grand River.

Similar challenges exist in the Speed River. Water quality conditions in the upper Speed River tend to be '*good',* however, once the river flows through the City of Guelph, conditions deteriorate to '*marginal*'. The Speed is a relatively small river system and Guelph is a growing community. The city's commitment to high quality effluent through process control and optimization in their wastewater treatment plant goes a long way to maintain the conditions in the Speed River. Oxygen levels below the City remain above the provincial objective most of the summer.

Chloride levels are increasing in the river and although they are not consistently above guidelines, the levels peak at very high levels during snowmelt events. Road salt and water softeners are believed to be contributing to this trend. Programs like '*Curb the Salt'* and '*Smart about Salt'* are necessary to reduce these concentrations over the long-term.

Recovery Reach

As the Grand River flows past Galt and toward Paris, it falls about 50 metres through what is termed the 'recovery reach'. This uniquely carved river valley is one of the largest stretches of intact Carolinian forest in Ontario and it has unique groundwater-surface water interactions. Research by the University of Waterloo, as well as thermal imagery done by the GRCA, confirms the groundwater discharge into this reach that helps to moderate river temperatures. These two elements – the flow of the river down a significant elevation change over riffle sections and the cold groundwater influx into the river combines to help maintain oxygen levels above the provincial objective of 4.0 mg/L most of the time during the summer at Glen Morris. The beauty of this reach brings canoe and kayak enthusiasts to this area throughout the summer.

Exceptional Waters: Paris to Brantford

After the Grand River descends the steep gradient between Cambridge and Paris, it joins the waters from the Nith River. Water quality in the Nith River tends to improve as it flows from the headwaters to the mouth in Paris. Runoff from the upper till plains transports much of the river's nutrients and sediments downstream. Although four small wastewater treatment plants discharge into the Nith river system, much of the nutrients are generated during significant runoff events suggesting a very significant contribution from diffuse sources. As the Nith River flows past Ayr, Canning and then on to Paris, groundwater from the Paris Galt moraine system feeds the river and helps to improve water quality although nutrient levels are still considered to be '*marginal*'.

As the Grand River flows toward Brantford, a truly unique aquatic environment develops whereby cold groundwater from the Paris -Galt and Waterloo moraines and cold groundwater from Whitemans Creek supplement the river system. Although phosphorus levels tend to be low in Whitemans Creek, it tends to have high nitrate (nitrogen) levels and therefore it is considered to have '*marginal'* water quality. These waters combine with the warm Grand River water to create a 'stacked' fishery that supports cold, cool and warm water fish. Although limited water quality data exist for this stretch of the river system, nutrient levels remain high as it flows from

Glen Morris down through Brantford. High nutrient levels contribute to the high productivity, which is evident by the very large changes in daily oxygen levels at the Brant Water Quality Station. These unique conditions – a range of temperature conditions, and high productivity contribute to a valued fishery. Like the recovery reach, this reach is also well used for recreational pursuits in the summer months.

Southern Grand: the largest low-land river in Ontario

The Grand River flows into Brantford as a very large seventh order river that has accumulated flows from over 5,000 km^2 and treated wastewater from 23 wastewater treatment plants serving over 800,000 people.

The Grand River continues to work as it provides the City of Brantford its entire supply of drinking water. Water quality in the Grand River at Wilkes Dam is suitable for treatment although care and diligence is always urged across the watershed to ensure a good supply for all downstream uses.

As the river flows out of Brantford, it flows onto the Haldimand Clay Plain and the physical properties of the water change as clay particles become suspended in the water column and the water takes on a 'chocolate milk' appearance. High sediment and nutrients are characteristic of the river as it flows toward Dunnville and Lake Erie. These high levels contribute to its '*marginal*' designation but are a reflection of both the intense land use upstream and the geology over which it flows.

A significant amount of research and monitoring in the southern Grand River by many agencies characterized its water quality, river flows, and fisheries in the mid-2000s. The Ministry of Natural Resources and Forestry identified areas where oxygen levels drop below the provincial objective to protect fisheries; levels of nutrients and sediment remain high as it flows from Brantford to Dunnville. Therefore, the water quality conditions are '*marginal*' at York.

Intensive monitoring done by Environment and Climate Change Canada from 2012-2014 quantified the nutrient loads from the Grand River in response to the Great Lakes Water Quality Agreement Nutrient Annex focused on Lake Erie. The Grand River delivered, on average, 456 metric tonnes of phosphorus to the eastern basin in those years, the largest of any tributary draining to Lake Erie from Ontario.

The plume of the Grand River can stretch into Lake Erie for several kilometers. The plume tends to hug the shoreline and it is dependent on the currents in the eastern basin. The plume is easily discernable through satellite imagery as it is laden with sediment. The Grand River plays a significant role in the water quality of the eastern basin of Lake Erie as it provides the largest load of phosphorus; however, the science is complex and researchers from Environment and Climate Change Canada and the Ministry of Environment and Climate Change continue to work on advancing their understanding. Consequently, phosphorus load reduction targets for the Grand River, as identified in the Great Lakes Water Quality Agreement, have not yet been set.

Financial implications:

None

Other department considerations:

N/A

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Figure 1. The Grand River watershed showing relative water quality conditions at long-term sampling sites between 2013 and 2015. Conditions describe the levels of nutrients (nitrogen and phosphorus) using the Canadian Council of Ministers of the Environments Water Quality Index. Water Quality Categories: **Excellent:** nutrient levels are never above guideline. **Good:** nutrient levels are only occasionally above guidelines and if they are, only by a little; **Fair:** nutrient levels are above guidelines frequently and sometimes by fair amount; M**arginal:** nutrient levels are mostly above guidelines and frequently by a lot; **Poor:** nutrient levels are always above guidelines and by a lot