APPENDIX II

Excerpts from AECOM Sandy Lake Watershed Study 2014

10. Policy E-17 Objectives

A complementary objective of the study is to provide a number of guidelines and recommendations for the planning, design and implementation of new developments that will protect water quality from further degradation. More specifically, the objectives of a watershed study are listed in Policy E-17 of the Regional Plan. Each sub-heading of Policy E-17 is listed below with a reference to where the item is addressed within the report, or if the sub-heading is not addressed directly in the report, it is addressed below.

a) Recommend measures to protect and manage quantity and quality of groundwater resources.

As summarized in Section 2.6 (Groundwater) and **Appendix A** (Environmental Conditions), groundwater is a source of domestic water for many residents living within watershed and contributes 11 % of the flow from the watershed (**Appendix D**). The constraints mapping (Section 3.3) identifies areas with high recharge rates (>150 mm/yr) as Tier 2 constraints that can allow for development, but with controls in place to allow for recharge to continue to contribute to groundwater quantity and with controls that protect water quality. These areas provide pathways for water to enter the groundwater system at higher rates than other areas in the watershed. Protection measures during future development are recommended to preserve the hydraulic properties of these areas. Recommendations to protect these areas include maintaining a high proportion of permeable surfaces, maintaining native plants, avoiding compaction of soils and use of rain gardens. Protecting the areas with high recharge rates to encourage sustainable groundwater use will need to be coupled with measures to protect the quality of water entering the groundwater system. Recommendations to protect the quality of recharge water include prohibition of bulk fuel storage, prohibition of hazardous material facilities, prohibition of aggregate extraction, spill prevention for home heating fuel tanks, limited lawn fertilizer use and reduced use of road salts in these areas of high recharge potential.

b) Recommend water quality objectives for key receiving watercourses in the watershed.

Water quality objectives are established in Section 7 Receiving Water Quality Objectives for nitrate, un-ionized ammonia, total suspended solids, chloride, *E. coli* and total phosphorus objectives for each lake based on maintaining the current lake trophic state as measured by TP concentrations. The objective, an early warning alert value and the method of determining each was provided.

c) Determine the amount of development and maximum inputs that receiving lakes and rivers can assimilate without exceeding the water quality objectives recommended for the lakes and rivers within the watershed.

It is very difficult to provide a single expression of the amount of development or nutrient inputs that a lake can assimilate before the water quality objectives are exceeded. This is because of the inter-connectedness of the lakes and streams within a watershed and because of the range of nutrient concentrations derived from different development types (that is, different land uses). With respect to the inter-connectedness, "using up" the available capacity on an upstream lake will also use some portion of available capacity on all downstream lakes. Alternatively, using available capacity on a downstream lake may eliminate or preclude the development on an upstream lake. With respect to the effect of different types of development, for example, the phosphorus export coefficient used in the LCM in this study ranges from 200 g/ha/yr to 600 g/ha/yr for large lot residential and commercial land uses, respectively. This means that a given watershed can accommodate more hectares of large lot residential development than of commercial development. Given this variability in export coefficients, the type of development must be known before the amount of allowable development can be defined. In addition, municipal policy requires that stormwater management plans, designed to manage both runoff water quality and quantity, are submitted in support of applications for development agreement. These stormwater management plans use various combinations of best management practices and engineered facilities to manage runoff and each of these practices and installations have different efficiencies and effects on water quality.

With this variability in mind, the effects of the different development scenarios modeled for this study are described in Section 8 Lakeshore Capacity Model. The results of Scenario 2 (Planned Developments) indicate that water quality objectives are not exceeded for Sandy Lake and Marsh Lake.

Table 16 summarizes the estimated residual phosphorus concentration "capacity" for each lake in the watershed following the completion of the approved developments as per Scenario 2.

Table 16. Estimate of Conceptual Residual Capacity Remaining for Each Lake Following Approved Developments as per Scenario 2

Lake	Measured and Predicted TP Concentration Following Implementation of Approved and Planned Developments from Table 21 (Scenario 2)	Water Quality Objective	Early Warning Alert Value	Conceptual Residual Capacity (Difference Between Objective and Modeled Concentration Following Implementation of Scenario 2)
Sandy Lake	16	18	15	2
Marsh Lake	13	15	13	2

d) Determine the parameters to be attained or retained to achieve marine water quality objectives

The Sandy Lake Watershed does not have a marine component. Due to the relatively good quality of Sandy Lake and Marsh Lake, existing and future inputs from the Sandy Lake Watershed to the Sackville River and Bedford Basin will not have a measureable effect on marine water quality. In fact, nitrate loadings (which are more important in saltwater ecosystems than in freshwater systems) and other nutrient inputs due to changes in upstream land use will be minimal compared to discharges from the Mill Cove Sewage Treatment Plant.

e) Identify sources of contamination within the watershed

Several sources and potential sources of contamination are located in the Sandy Lake watershed. Non-point sources of contamination are distributed throughout the watershed and point sources of contamination have discreet locations. Both types of contamination present risks and impacts to the water quality of the waterbodies in the Sandy Lake watershed. The sources and potential sources are identified and discussed, while mitigation and prevention methods are presented in Section f, below.

Non-point sources:

- Deforestation
  - Deforestation may impact water quality by increasing the organic content and sedimentation of runoff. Studies completed in the Pockwock watershed (NFA 2005) indicate the impact of deforestation on water quality is negligible when compared to the changes in phosphorus, chlorophyll-a, Secchi depth or pH from seasonal variations. However, best management practices for logging will limit the potential for impacts on water quality from deforestation.
- Stormwater runoff
  - Stormwater runoff directs overland flow from developed areas through rudimentary drainage systems to streams and lakes. Sandy Lake is the primary receiving waterbody in the Sandy Lake watershed. Overland flow from developed areas represents a significant urban non-point source of pollution and contributes sediments, oil, anti-freeze, road salt, pesticides, nutrients and pet and waterfowl droppings to Sandy Lake. This urban runoff generally accelerates the eutrophication or natural aging process of urban lakes by adding sediment and nutrients. The added nutrients can contribute to algal blooms, decreased water clarity, and an increase in the amount of rooted aquatic plants growing in the shallow near-shore waters of a lake. All of these can reduce the recreational value of a lake by hindering swimming, boating, fishing and reducing its overall aesthetics.

- Bedrock
  - Acid rock drainage (ARD) is a naturally occurring process that results from the oxidation of sulphide minerals when the rock is exposed to oxygen. The breakdown of the sulphide minerals releases sulphuric acid, iron, and may also release arsenic, aluminum, cadmium, copper, manganese and zinc into the environment. The oxidation process and release of ARD is accelerated when bedrock is exposed to air by excavation or blasting. In HRM, several examples of ARD impacting water quality (Fox et al. 1997) are documented, resulting in low pH surface waters that were attributed to fish kills (Scott 1961, Porter-Dillon 1985). The Nova Scotia Environment Act limits the excavation and requires disposal of displaced rock with sulphide weight more than 0.4%. Detailed bedrock mapping and chemical analyses of distinct lithologies by White and Goodwin (2011) identify the Cunard Formation of the Halifax Group (northwest area of Sandy Lake watershed) and the Beaverbank Formation of the Goldenville Group (~1km band trending northeast near Lucasville) have acid generating potential. The Beaverbank Formation also displays high concentrations of metals such as arsenic, copper and zinc. The remaining bedrock underlying the Sandy Lake watershed is composed of Taylors Head Formation of the Goldenville Group and is not anticipated to have significant acid generating potential (White and Goodwin 2011). Despite the generalizations of White and Goodwin (2011), water quality results from the tributary draining into the northwest arm of Sandy Lake displayed decreased pH and elevated metal concentrations compared to other Sandy Lake water quality data (Conrad 2002). Development, excavation or aggregate removal that disturbs bedrock in Sandy Lake will generate acidic discharge. The north western portion of the watershed is more likely to have significant ARD and development in that area should avoid exposing bedrock to air and in situations where this is unavoidable, mitigation measures should be put in place to prevent ARD entering Sandy Lake.
  - Historic mine shafts: Five historic mine shafts are located in the northwest area of the Sandy Lake watershed. The Nova Scotia Abandoned Mine Database indicates the mine shafts were for gold exploration and reached a depth of 12 m. The mine shafts are filled in and considered to have low hazard potential.
- Road salt application: road salts pose a risk to plants and animals in the aquatic environment. Road salt application can also impact groundwater quality, leading to elevated concentrations of chloride in drinking water. HRM recognizes the potential impacts to surface and groundwater quality and utilizes several best management practices to reduce the impacts when possible (HRM 2012). However, the application of road salts along Hammonds Plains Road and to a lesser extent on secondary residential roads contributes to chloride loading in Sandy Lake.

Point sources:

- Septic systems: Properly functioning septic systems allow the infiltration of clarified discharge to soils. Nutrients and bacteria are utilized by organisms in the soil. Septic systems less than 300 m to water bodies and malfunctioning septic systems likely contribute nutrients and bacteria to the water bodies in Sandy Lake. There are approximately 20 residences within 300 m of Sandy Lake and approximately 200 residences within 300 m of watercourses that utilize septic systems.
- Illegal garbage disposal occurs when garbage is dumped in ditches, forests, pits or ponds that are not designated for waste disposal. Contamination from illegal dumping depends on the quantity and type of materials disposed of. Sandy Lake watershed is not known to have significant illegal dumping; however illegal dumping is known to occur in rural Nova Scotia and has likely occurred within the watershed. If illegally dumped material is found on HRM property, the municipality should be notified. The municipality is not responsible for removing illegally dumped material on private property. If dumped material is found on private property it should be placed for curbside collection or arrangements should be made for the material to be removed from their property.
- Wastewater treatment facilities: The Uplands Park Wastewater Treatment Facility (WWTF) is located in the Sandy Lake watershed. It has been operational since 1969 and is a source of nutrients to Sandy Lake. The facility may overflow and bypass the treatment cycle during storms or malfunctions. Untreated wastewater discharge carries high nutrient loads, especially phosphorus and can significantly add to the natural and non-point loading of phosphorus to lakes resulting in their rapid eutrophication. The impact of the wastewater overflows is difficult to quantify for several reasons:

- Overflows typically occur during extreme weather events. The timing, frequency and severity of these events are not possible to predict and so the water quality impacts from overflows cannot be quantified or modeled.
- Halifax Water monitors the volumes and locations of overflows but does not measure the concentration of effluent released to the environment during an overflow event. Given this, it is not possible to gauge the nutrient loading that may occur during these events.

We assume that reduction and ideally elimination of these overflows will be a priority within the plans for expansion of the waste water collection and treatment system within the watershed.

- Timber Trails mobile home park: Timber Trails is serviced by a private communal septic system. Approximately 233 homes are located in Timber Trails and a proposed expansion of the park is conditional on improvement and expansion of the septic system. The septic system is a source of phosphorus, nitrate and bacteria to surface water and groundwater. In the past, the park has struggled with wastewater treatment issues such as overflow and seepage during rain events. The park is approximately 4 km from Sandy Lake, so it doesn't represent a direct impact on the water quality of Sandy Lake. However, the septic system can impact local groundwater which is used for potable water supply in the area.
- Gas Stations: gas stations hold large quantities of fuel in underground and above ground storage tanks. Under typical conditions gas stations represent a minor risk of hydrocarbon impact from small spills during fuel transfer. However, the large volume of fuel represents potential large impacts to groundwater and surface water. Leaks of fuel and large releases of fuel are not common, but are known to occur.
- Residential oil tanks: Nova Scotia Environment considers a domestic oil spill to be a release of petroleum at a private residence such as an oil tank leak. A domestic fuel spill can impact soils, groundwater and potentially surface water. Hundreds of residential oil spills occur in Nova Scotia each year (NSE 2013). The risk of residential oil spills on the surface water of Sandy Lake is low considering the small volumes of oil and the distance of most residences from water bodies.
- Landfills (current or historic): There are currently no active landfills in the Sandy Lake watershed. However, considering the watershed has been populated for a long period of time, there is potential for historic landfills or dumping areas that have been abandoned. Neglected historic landfills could leach metals and toxic chemicals into the waterbodies of Sandy Lake.
- Motor boats: Motorized water crafts can impact water quality and lake ecology by increasing turbidity and re-suspension of sediments which can increase phosphorus concentrations. They can also lead to an increase in hydrocarbons.
- Animal feces: Animal feces contribute bacteria and nutrients to Sandy Lake. Bird populations such as ducks, loons and gulls contribute the nutrient and bacteria load to Sandy Lake. However, the excrement of pets also contributes to the loading of Sandy Lake through the stormwater drainage system and more directly at the Sandy Lake Park on-off leash area. Sandy Lake was closed for swimming in July 2013 because of high bacteria levels. It is not clear what the source of the bacteria was, but pet feces may have contributed.
- Fertilizers used on lawns and gardens are used to promote healthy lawns and gardens on residential and commercial properties. Excessive or improper application of fertilizers can lead to nutrient loading of surface water bodies.

f) Identify remedial measures to improve fresh and marine water quality

There are several ways that water quality can be improved. These improvements generally fall into two categories: management practices and engineered solutions. Not all the improvements identified below are necessarily practical or viable: some may be cost prohibitive, technically impossible, or lack a regulatory requirement or enforcement mechanism. Nevertheless, these remedial measures represent options that may be considered to improve water quality.

1. Undertake a survey of septic systems to better characterize their age, maintenance and functionality. Older systems (more than 15 years) can be subjected to a dye test to verify they continue to function as designed.

Replace degraded septic systems or require alternatives (aerobic systems, holding tanks etc.) if the site is not capable of accommodating a conventional septic system under current design specifications. Encourage residents to have systems inspected and pumped on a regular basis. HRM can consider adopting a by-law that requires period inspection, testing and pumping of private septic systems, similar to that enacted in Chelsea, QC.

2. Retrofit or improve existing stormwater management systems through the introduction of sediment/water control basins, constructed wetlands, vegetated swales, flow-through filter strips, stormwater infiltration systems and disconnection of roof drains from stormwater systems.
3. Ban phosphorus-containing fertilizers and encourage proper and minimal use of other fertilizers and herbicides.
4. Encourage homeowners to plant naturalized riparian buffers or increase the width and density of existing buffers.
5. Encourage homeowners to pick up after pets.
6. Educate residents to use non phosphate soaps when washing vehicles or use a car wash.
7. Educate residents to refrain from disposing of oil, antifreeze or other potentially harmful wastes into municipal drains and provide collection centers for these liquid wastes for safe disposal.
8. Require sediment management on construction projects including silt fencing to control runoff and washing of vehicles prior to departing the site to avoid mud and dirt being deposited on roadways for eventual runoff into storm sewers.
9. Report illegal dumping or unusual conditions in lakes and streams (high suspended sediments, oil sheens, algae blooms).
10. Strive to eliminate sewage system overflows through expansion of the system and upgrades as appropriate.
11. Maintain the water quality and water quantity monitoring program at a base level such as recommended here to ensure compliance with water quality objectives and expand the database for future modeling enhancements.
12. Apply a no net change to flow, suspended sediment and phosphorus loads from new developments by requiring site specific evaluations and implementation and maintenance of storm water mitigation measures.

Marine water quality was not considered during this study since the watershed does not include a marine estuary component.

g) Recommend strategies to adapt HRM's stormwater management guidelines to achieve the water quality objectives set out under the watershed study

HRM's Stormwater Management Guidelines (Dillon Consulting Ltd. 2006) describes criteria for the design of stormwater management best management practices (BMPs) to minimize the negative water quality effects of stormwater runoff from urban development. In this report, the term "best management practice" applies to both in-ground infrastructure (pipes, retention basins, etc.) as wells as activities, such as street cleaning and land use restrictions, that may impact water quality. As the report notes:

> There is no single BMP that suits every development, and a single BMP cannot satisfy all stormwater control objectives. Therefore, cost-effective combinations of BMPs may be required that will achieve the objectives.

At this time, stormwater control infrastructure requires provincial approval from Nova Scotia Environment under the Environment Act and in accordance with the Storm Drainage Works Approval Policy. HRM's authority with respect to stormwater management comes from the HRM Charter Act, which allows HRM to make and enforce municipal by-laws related to land use. Existing municipal planning strategies already include certain land use restrictions that have beneficial effects on water quality. These restrictions include, for example, prohibiting or limiting construction within flood plains, wetlands and steep slopes. In addition, municipal planning strategies also include stormwater management provisions, such as the requirement to obtain municipal approval of stormwater management plans, water quality monitoring plans and erosion control plans prior to development approval.

Other strategies that may be useful in adapting HRM's stormwater management guidelines to achieve the water quality objectives include:

- Implementation of financial resources or financial mechanisms (including cost sharing) to fund infrastructure, testing, operating and maintenance;
- Exploration of new stormwater management and treatment technology;
- Educational programs to encourage homeowners to reduce sediment and other pollutant discharge (fertilizers, grass cuttings) to storm sewers; and
- Apply a no net change to flow, suspended sediment and phosphorus loads from new developments by requiring site specific evaluations and implementation and maintenance of storm water mitigation measures.

h) Recommend methods to reduce and mitigate loss of permeable surfaces, native plants and native soils, groundwater recharge areas, and other important environmental functions within the watershed and create methods to reduce cut and fill and overall grading of development sites;

The protection of areas and functions that are important to a healthy watershed can be achieved through the implementation of general planning principles and through the integration of site specific design plans.

The replacement of permeable soils by roads, sidewalks and roofs can be reduced during the planning process and through specific design features. An effective planning method is to cluster buildings and infrastructure in defined, less permeable or otherwise less sensitive areas in order to maximize permeable vegetated open space.

Stormwater management best management practices and design standards aimed at promoting infiltration rather than runoff can be required during the site plan approval process. These measures are described in detail in HRM's Stormwater Management Guidelines and would include, for example, discharge of roof drainage to infiltration trenches or ponds, the use of vegetated swales and perforated conveyance pipes, and the installation of wet ponds and artificial wetlands. Design of properties and landscape provides opportunities to improve infiltration and partially offset the loss of permeable surfaces. Lawns and driveways can be designed to promote infiltration and water from roof drains can be collected in rain barrels, discharged to rain gardens or retained with roof top gardens. Disconnecting foundation drainage from storm sewer reduces the flow to the stormwater system and increases infiltration. Landscaping effects water drainage and when used effectively can be designed to encourage infiltration and reduce runoff.

Reducing the loss of native plants and soils is an effective way of reducing sediment and water runoff to stormwater systems. The design of new developments requires the removal and displacement of some native soils and plants, but the extent of the displacement can be mitigated through planning and local design.

Development may inadvertently disturb or destroy vegetation communities such as wetlands, riparian buffers and vegetation found in indistinct flow conveyance channels that play a significant role in maintaining water quality.

Developers should be requested to provide detailed "wet areas mapping" of properties proposed for development so these vegetation communities can be accurately delineated and their hydrological functions maintained.

Groundwater recharge in the Sandy Lake area is presented in **Figure 6**. The areas of highest recharge are located near Sandy Lake and Marsh Lake. These areas contribute to local groundwater and to Sandy Lake. The surficial aquifer located in the northeastern part of the watershed is not well defined and has not been tested and characterized. However, considering its proximity to Sandy Lake, Marsh Lake and the Sackville River, it is likely hydraulically connected to the surface water bodies. Development in the areas of high recharge should include specific plans to reduce impermeable surfaces. In addition, development in the areas of high recharge should include aquifer protection measures similar to wellhead protection areas. Recommended land use restrictions include prohibition of bulk fuel storage, prohibition of hazardous material facilities, prohibition of aggregate extraction, spill prevention for home heating fuel tanks, limited lawn fertilizer use, and reduced use of road salts.

i) Identify and recommend measures to protect and manage natural corridors and critical habitats for terrestrial and aquatic species, including species at risk

As noted in Appendix A Section 5.1, Atlantic salmon of the Nova Scotia Southern Upland population are known to be in Sandy Lake. Atlantic salmon are listed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered. Fish habitat in Peverills Brook was modified in 2012 by the Sackville Rivers Association to encourage salmon migration and spawning. Maintenance of the fish stream modifications and upgrading as needed will ensure the modifications continue to function as designed. A monitoring program of salmon populations in the Sandy Lake watershed is recommended to evaluate the salmon population and identify measures to encourage growth in the population. Additional design measures aimed at maintaining water quality, especially mitigating stormwater quality, will equally protect aquatic habitat. These measures are described above.

Within the Sandy Lake watershed, no plant species of federal conservation concern have been recorded. Seven vascular plants of provincial concern have been recorded within five kilometers of the centre of the watershed; of these seven species, two – the wavy leaved aster (*Symphyotrichum undulatum)* and the Greenland stitchwort (*Minuartia groenlandica)* have been observed in the Marsh Lake area. Both plants are listed as S2 (provincially rare); their general status rank is sensitive. Constraints to development on slopes will help to protect and preserve these species.

The Atlantic Canada Conservation Data Centre records 25 animal species of conservation concern within the Sandy Lake watershed (Appendix A). Although most of these species are birds, there are two amphibians present: the snapping turtle and the wood turtle. The wood turtle is classified as threatened under Canadian Species at Risk Act (SARA) and COSEWIC. Wood turtles are fairly tolerant of changes to adjacent land uses, but require stream and woodland habitat to remain intact. An assessment of the wood turtle habitat range in the Sandy Lake watershed would provide site specific information that could be used to assess habitat improvements and protection. Until a habitat assessment can be completed, it is recommended that a 20 m buffer to all streams and waterbodies be kept free from disturbance and development.

j) Identify appropriate riparian buffers for the watershed

Under Watercourse Setbacks and Buffers The Halifax Mainland Land Use By-Law" [14QA(1)] states:

> "No development permit shall be issued for any development within 20 m of the ordinary high water mark of any watercourse. Where the average positive slopes within the 20 m buffer are greater than 20%, the buffer shall be increased by 1 m for each additional 2% of the slope, to a maximum of 60 m."

As noted in Section 3.3 Development Constraints, a 20 m buffer along all water courses is reported to eliminate more than 70% of suspended sediment and more than 60% of phosphorus (Hydrologic Systems Research Group

2012). The maintenance of a minimum 20 m wide riparian buffer is appropriate for all watercourses within the watershed.

k) Identify areas that are suitable and not suitable for development within the watershed

Please refer to Section 3.3 Development Constraints and Figure 7, which identifies areas suitable and not suitable for development. Unsuitable areas include:

Type 1 Constraints
- Watercourses, wetlands and riparian buffers

Type 2 Constraints
- Slopes greater than 20%
- Bedrock with acid generating potential
- Groundwater recharge (>150 mm per year)

If land is not constrained, then it is potentially suitable for development. The total area that can or should be developed and the nature of the development both need to be carefully planned so that established water quality objectives will be maintained following development.

l) Recommend potential regulatory controls and management strategies to achieve the desired objectives

Regulatory controls and programs already in place that contribute to the maintenance of water quality include:

- Halifax Water Regulations and Guidelines for Stormwater Management;
- Design and Construction Specifications (referring to quantity of stormwater only);
- HRM Municipal Design Guidelines 2013; and,
- 2009 Stormwater Inflow Reduction program.

A stormwater management by-law would be helpful to manage and enforce stormwater related nutrient and sediment inputs to watercourses. In addition to such a by-law, the following additional controls and strategies are recommended for consideration:

1. Adopt the proposed water quality objectives.

2. Preserve natural storage, infiltration and filtration functions; develop SWM systems that reproduce or mimic natural functions.

3. Revisit land use planning restrictions that provide for stormwater management (such as restricting development in flood zones, in sensitive areas, on slopes, in wetlands, etc.) and compare them with similar policies in other jurisdictions to determine if these policies should be updated or upgraded to improve their effectiveness.

4. Require developers to demonstrate no net increase of sediment and TP loadings to adjacent water features.

5. Require developers to financially support a water quality monitoring program to assess compliance with the water quality objectives.

6. Enforcement of stormwater management for quality and quantity as per the HRM Stormwater Management Guidelines.

7. Elimination of sanitary sewer overflows within the watershed.

8. Elimination of Waste Water Treatment Plant by-passes.

9. Inspection and testing of septic systems in the watershed; phased replacement if they are not functioning due to high water table, poor design, inadequate maintenance, close to surface water. Consideration of alternative treatment systems to replace existing septic systems.

m) Recommend a monitoring plan to assess if the specific water quality objectives for the watershed are being met

The monitoring plan is described in Section 9: Recommendation for Water Quality and Quantity Monitoring.

11. Summary and Conclusions

The Sandy Lake watershed is designated as an Urban Settlement area and currently hosts urban development along main thoroughfares (Hammonds Plains Road, Lucasville Road), in industrial areas and in suburban style communities. Portions of the watershed are serviced with municipal water and wastewater services and portions of the watershed utilize on-site water wells and septic systems.

A development constraints map of the watershed identifies areas that are not suitable for development (wetlands, watercourses and riparian zones) and areas that may require environmental mitigation to be included in development plans if the areas are developed.

Possible future development scenarios are identified in the watershed and land use maps depicting existing conditions and three future development scenarios were prepared. The land use maps were used as inputs to a phosphorus load model (Lake Capacity Model) to predict how future development may impact the phosphorus concentrations of the lakes. Phosphorus is identified as a key water quality parameter to assess the trophic status of the lake.

Historic water quality samples and water samples collected during the course of this study were used to identify water quality objectives for parameters that are influenced by development. The water quality in Sandy Lake and Marsh Lake is currently being affected by urban development in the water as displayed by the increasing phosphorus concentration in Sandy Lake. Both Sandy Lake (12 µg/L) and Marsh Lake (10 µg/L) have median phosphorus concentrations that place them in the lower end of the mesotrophic range. Water quality objectives and early warning values are set at 18 µg/L and 15 µg/L for Sandy Lake and 15 µg/L and 13 µg/L for Marsh Lake respectively.

Cumulative impacts of development on phosphorus concentrations are predicted to increase to 16 µg/L for Sandy Lake and 15 µg/L for Marsh Lake when mitigation measures to decrease phosphorus loading are not implemented. These levels are above the early warning values, but below the water quality objectives. Removing point sources of phosphorus such as the Uplands WWTF and septic systems near Sandy Lake by connecting them to municipal wastewater services decreases the predicted phosphorus concentrations to 15 µg/L and 14 µg/L for Sandy Lake and Marsh Lake respectively. Additional phosphorus mitigation measures using advanced stormwater management that reduces phosphorus runoff by 50% is predicted to decrease the phosphorus concentration of Sandy Lake to 13 µg/L and of Marsh Lake to 12 µg/L.