APPENDIX A-8: COUNTY OF SIMCOE WATERSHEDS NUTRIENT MODELING ASSESSMENT

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Phosphorus Loading Analysis

The following describes the phosphorus loading analysis carried out for Alcona South within the Innisfil Creeks subwatershed; the Coldwater and Sturgeon Rivers draining to Severn Sound and the Nottawasaga River watershed draining to Georgian Bay. CANWET^{TM} 4.0 was used to update previous modelling work that was done using earlier versions 2 and 3 of CANWET^{TM}. For the three (3) areas where modelling was updated, an existing conditions model was setup and run using available data. Subsequently, the model was used to consider alternate scenarios in order to compare loading rates and, where applicable, in-stream concentrations.

CANWET^{TM} combines surface water quality algorithms with a daily water budget model and integrates a MapWindow GIS environment. The simulations use daily temperature and precipitation data; accounts for nutrient loading from private septic systems (with an estimated failure rate) and agricultural tile-drainage flow; and imports surface and groundwater extraction records, including records from Ontario's Permit to Take Water (PTTW) database. The model structure is distributed based on land use classification and includes predictive modelling capabilities for evaluating rural and urban pollution reduction strategies. Wastewater treatment plants and upgrades, septic system removals, changes in livestock populations and storm water management ponds/wetlands can be evaluated using these tools.

CANWET^{TM} was developed as a water allocation, nutrient management and source water protection tool designed to estimate water budgets, nutrient and sediment loadings at a subwatershed scale under Canadian conditions. The model has been successfully calibrated on numerous watersheds in Southern Ontario. Model runs for this study use both spatial and non-spatial input data developed using available GIS and monitoring datasets from provincial and federal agencies. Data sets are used to determine spatially-distributed parameters needed to evaluate nutrient and sediment loading rates.

Surficial Soil Erosion

Depending on the nature of pre-development land use, topography and soil conditions, the rate of surficial soil erosion can be impacted differentially by future land use changes. Lands used predominantly for agricultural purposes are often associated with a relatively high rate of surficial soil erosion. This results from the large area of exposed soil, especially apparent in row crops.

Development which consists of residential, commercial, and industrial land use will consist predominantly of paved and grassed surfaces which are more resistant to the erosion processes, but accumulate debris and pollutants through deposition and application of fertilizers in manicured spaces that is later washed off during storm events. By their impervious nature, urban lands are less likely do permit infiltration of stormwater to the extent that natural and rural lands to thus preventing the filtering of nutrients by the soil media prior to discharge into water courses.

Depending on soil, topography, and management practices net loading rates of sediment and nutrients can sometimes be reduced by a change to urban land usage with accompanying beneficial management practices (BMPs) for the post development condition. However, increased loading from treated wastewater effluent must also be considered in the overall evaluation.

Urban Stormwater Runoff

The effects of urbanization on surface water quality resulting from uncontrolled releases of urban storm water runoff can be significant. The potentially adverse impacts associated with urban storm water runoff include:

- Degradation/impairment of surface water quality in the tributary watercourses as well as receiving water bodies (Lake Simcoe, Severn Sound, Georgian Bay);
- Restriction of water uses for drinking and recreation;
- Degradation of aquatic habitats through increased algae and plant growth;
- Thermal warming of cold water receiving streams; and
- Reduction in the number and diversity of fish and other aquatic species.

Significant impacts of proposed development within the Study Area could result during construction. Impacts during construction could result in direct impacts to surface water quality arising from increased surficial erosion. During the construction phase of new development, pollutant export can be expected to increase significantly due to the erosion of soil material, without the implementation of mitigation measures. Increased sediment loading can cause deterioration of water quality and stream aesthetics, reduced flow capacity of downstream channels and culverts, and degradation/destruction of fish and aquatic habitats. Although the construction phase is not quantified in this assessment, it can account for sediment and nutrient loading rates that are much higher than either the pre- or post-development conditions and must be managed accordingly to mitigate these impacts.

Agricultural/Rural Runoff

In the absence of agricultural Beneficial Management Practices, pollutants such as suspended sediments from eroded soil, nutrient discharges (phosphorus, nitrogen) from fertilizers, livestock effluent, decaying vegetation, and bacterial inputs from septic systems, manure spreading, livestock access and barnyard runoff will continue to reach the watercourses and ultimately receiving waters. The widespread use of private septic systems in rural areas is potentially a large contributor of nutrients to groundwater and receiving waters if they are not properly designed and maintained. The potentially adverse impacts associated with agricultural/rural land runoff include:

- Degradation/impairment of surface and ground water quality;
- Restriction of water uses for drinking, livestock watering and recreation;

- Degradation of aquatic habitats through increased algae and plant growth; and
- Reduction in the number and diversity of fish species.

Control Measures for Phosphorus Load Reductions

Stormwater Management Controls

The 2003 MOE SWM Manual identifies constraints associated with various water quality control measures. A general evaluation of SWM water quality control measures are presented in Table A-8-1 and A-8-2.

Table A-8-1: Evaluation of General MOE SWM Options – Physical Constraints

SWMP	Topography	Soils	Bedrock	Groundwater	Area
Wet pond	None	None	None	None	>5 ha
Dry pond	None	None	None	None	>5 ha
Wetland	None	None	None	None	>5 ha
Infiltration Basin	None	Loam (min. inf. Rate ≥ 60 mm/h	> 1 m below bottom	> 1 m below bottom	<5 ha
Infiltration Trench	None	Loam (min. inf. Rate ≥ 15 mm/h	> 1 m below bottom	> 1 m below bottom	<2 ha
Reduced lot grading	< 2%	Loam (min. inf. Rate ≥ 15 mm/h)	None	None	None
Soakaway pit	None	Loam (min. inf. Rate ≥ 15mm/h)	> 1 m below bottom	> 1 m below bottom	<0.5 ha
Rear Yard Ponding	<2%	Loam (min. inf. Rate ≥ 15mm/h)	> 1 m below bottom	> 1 m below bottom	<0.5 ha
Grassed Swales	<5%	None	None	None	<2 ha
Pervious Pipes	None	Loam (min. inf. Rate ≥ 15 mm/h	> 1 m below bottom	> 1 m below bottom	None
Vegetated Filter Strips	<10%	None	None	>0.5 m below bottom	<2 ha
Sand Filters	None	None	None	>0.5m below bottom	<5 ha
Oil/Grit Separators	None	None	None	None	<2 ha

Wet pond, wetland and wet pond-wetland hybrids all represent effective storm water quality control end of pipe facilities. For the purposes of this Study, all SWMFs have been evaluated as wet pond facilities.

It should be noted that stand alone post-development influent phosphorus removal for SWM facilities have been estimated at 83% (TRCA, 2004), which represents optimal removal efficiency from well designed and maintained facilities.

Table A-8-2: Relative Effectiveness of SWMFs

Description of SWMP for General Class	TSS	Total P	Total N	Heavy Metals	O&M	Overall Efficiency	Seasonal Efficiency	Ranking SWMFs
Wet pond	High Potential	Medium Potential	Medium Potential	High Potential	High	High	High	1
Dry pond	Low Potential	Low Potential	Low Potential	Low Potential	Low	Low	Low	3
Wetland	High Potential	Medium Potential	Medium Potential	High Potential	Medium	Medium	Low-Medium	2
Wet Pond Wetland Hybrids	High Potential	Medium Potential	Medium Potential	High Potential	Medium	Medium	Low-Medium	2

Several options exist to enhance phosphorus loading reductions from storm and sanitary waste water loads:

- Employ additional treatment technologies in conjunction with end of pipe SWMFs (e.g. filtration systems);
- Provide at source controls in upstream drainage areas, external to the development lands;
- Examine storm water retrofit opportunities within the affected sub-watersheds;
- Consider the use of enhanced treatment options such as the use of “inert” additives with the ability to coagulate and bind phosphorus in treated storm water;
- Implementation of agricultural BMPs;
- At source reduction of sanitary flows through water conservation;
- Enhanced urban storm water infiltration design to minimize storm water runoff;
- Investigate the potential for recycling of treated effluent water (of a high quality) for use as nutrient enriched irrigation water or to supply wet industry needs (where appropriate);
- Increase forested land cover in affected sub-watersheds.
- Implement a septic system inspection and maintenance program to reduce the number of estimated septic systems failing; and
- During the construction phase, strict measures should be put in place and regularly maintained to ensure that exposed soil susceptible to wind and runoff erosion are minimized and that exposed areas are protected from erosive forces and that bottom of slope capture and filter methods are also in place to reduce off-site transport of sediment and nutrients.

Data Development for CANWET^{TM} Models

The modeling software requires a series or spatial and temporal data sets in order to populate input model parameters. These are briefly described as follows:

Point Sources: Existing municipal waste water treatment facilities were considered in the modeling. Data on spatial locations, monthly average flow and phosphorus loading was taken from data collected by Greenland (2006) for assimilative capacity studies for the Lake Simcoe and Nottawasaga River basin. Some gaps were identified and filled using information from available C of As for the missing facilities.

Stream Flow: Water Survey of Canada stations in the Coldwater and Nottawasaga rivers were used in the limited validation. Stations used were in catchment 33 of the Nottawasaga River model and catchment 26 of the Coldwater River model.

Water Quality: Select data from the Provincial Water Quality Monitoring Network database and location shape file were downloaded from the Ministry of Environment website. Data from the years 2002 and 2003 were used in the limited model validation for the Coldwater and Nottawasaga rivers.

Tile Drains: Spatial data was downloaded from the Land Information Ontario warehouse. The dataset was Ontario wide so it was clipped and projected to UTM Zone 17N with the NAD 83 datum by the County of Simcoe GIS Department.

Septic Systems: Spatial data was derived from the municipal parcel layer, local knowledge and proximity of parcels to sewage treatment plants to establish areas serviced by private septic systems. For the project area outside of the County of Simcoe, the septic density was determined for the county and applied to a polygon which was created to represent the project area outside the county of Simcoe. Spatial analysis was completed by the County of Simcoe GIS Department.

Animal Density: The animal density layer was created using the Statistics Canada 2006 Census of Agriculture data on livestock populations located at http://www.statcan.gc.ca/start-debut-eng.html and joining these numbers to the FarmOP codes from the municipal parcel layer. For the areas outside of the County boundaries where parcel data was unavailable, only the course data from Statistics Canada was used. For these areas animal populations are known within a large area (Consolidated Censis Subdivision (CCS) units), but the location of actual livestock operations are unknown. Spatial analysis was completed by the County of Simcoe GIS Department.

Land use/Cover: Land use data was derived from a combination of the Lake Simcoe Region Conservation Authority (LSRCA) Ecological Land Use Classification and the SOLARIS 2 land use data available from the Land Information Ontario warehouse.

Digital Elevation Map (DEM): Topographic information used was a combination of 5m resolution data from the LSRCA and 10m resolution data from the Ontario Ministry of Natural Resources prepared by the County of Simcoe GIS department.

Soils Data: Spatial layer was derived by Greenland from available data from Agriculture and Agri-foods Canada prepared previously for other projects.

Stream and Catchment Delineations: were completed by Greenland using automatic delineation tools in MapWindow (TauDEM) applied to the DEM.

Meteorological Data: The CANWET^{TM} 4 software provides a linkage and access to ANUSPLINE interpolated weather data provided by AAFC and formatted by Greenland for use in CANWET^{TM}. Data is available for the period 1965-2003 at a 10 km grid interval across Canada.

Innisfil Creeks - Alcona South Phosphorus Loading Analysis

Complete development of all lands identified in the Alcona South Secondary Plan will result in a 62% increase in urbanization within the drainage catchments of Water course 5, 6 and 7 of Innisfil Creeks subwatershed which drain to Lake Simcoe.

Approximately 72% of the collective contributing drainage area for the Innisfil Creeks subwatershed, that contains the subject water course catchments, will remain under rural land use in the foreseeable future. Intensive crop production will continue, as will other agricultural practices.

Comparison of Pre and Post Development Phosphorus Loading

Pre- and post-development nutrient loading models were developed using CANWET^{TM} 4 for the two (2) catchments of Innisfil Creeks subwatershed (Watercourse 5 and 6/7) in which the Alcona South Secondary Plan is located. Figure A-8-1 presents the existing conditions for Innisfil Creeks.

Alcona South Secondary Plan

The landuse designations outlined in the updated Draft Alcona South Secondary Plan dated 2011 July 22 are shown below in **Table A-8-3** and **Figure A-8-2 and A-8-3**. As shown in **Table A-8-4**, without the use of BMPs the Alcona Secondary Plan will reduce existing phosphorus loads by an estimated 6% through change in land use and removal of septic systems, livestock populations and tile drain. However, a 12% reduction in existing phosphorus loads can be achieved with the further implementation of BMPs including:

- storm water management facilities for all new urban development;
- enhanced infiltration for the portion of the development areas west of the rail line within the secondary plan (which is recommended in the MDP and hydrogeologic studies); and
- re-direction of a portion of storm flows from upstream agricultural areas in Watercourse 7 into a pre-treatment system and then the Little Cedar Point Wetland and ultimately into Watercourse 6.

If further reduction in phosphorus loads is required, there will be a need to find opportunities outside of the Alcona South Secondary Plan or explore additional on-site source controls that can help supplement the SWM facilities, enhanced infiltration and wetland.

The analysis assumed a 35% septic system failure rate in the existing conditions model and that all septic systems are removed within the footprint of the secondary plan in the post-development scenario. Similarly, the population of livestock was proportionally reduced and tile drains were removed in the post-development scenario.

For the treatment of agricultural runoff, it was assumed that only storm flows in excess of the 25mm storm and up to and including the 25-year storm event would be re-directed through the Little Cedar Point Wetland resulting in approximately 20% of annual flows from Watercourse 7 being diverted (i.e. approximately 80% of rainfall events have a depth less than 25 mm). Fisher and Acreman (2004) reported total phosphorus reduction efficiency by wetlands of 65% however, with the addition of a fore-bay and hence, pre-treatment upstream of the wetland, an efficiency of 83% was used in the modelling. TRCA (2004) reported up to an 83% reduction in total phosphorus achieved for storm water management ponds. Wilson (2008) identified the potential of wetlands in the Lake Simcoe Watershed to absorb phosphorus from upstream drainage areas up to 80 kg/ha of wetland. Nearly all of the agricultural runoff from the catchment containing water courses 6 and 7 will be intercepted at the applicable flow rates.

For the areas deemed suitable for implementing enhanced infiltration it was assumed that 80% of stormwater (i.e. infiltration of the 25 mm storm) would be infiltrated with 100% phosphorus removal efficiency and that the remaining 20% would be treated by stormwater management facilities.

It is recommended that the stormwater management ponds be designed for enhanced level treatment and properly maintained with appropriate vegetation and regular cleanout. It should be noted that the data used to derive reduction factors is only for ice-free periods (i.e. summer/fall) and do not speak to the uncertainty of actual reduction factors. SWM ponds and wetlands should be routinely monitored. Additional technological enhancements may be required to ensure that these removal rates are achieved consistently over the long-term.

Point Source Considerations

The analysis of point source phosphorus loading assumes an additional population of 15,700 from the Draft Alcona South Secondary Plan (July 2011) at a per capita water consumption rate of 350 L/cap/day and an upgraded WPCP effluent concentration of 0.01 mg/L. This yields an annual phosphorus load from the WPCP of approximately 20 kg/yr.

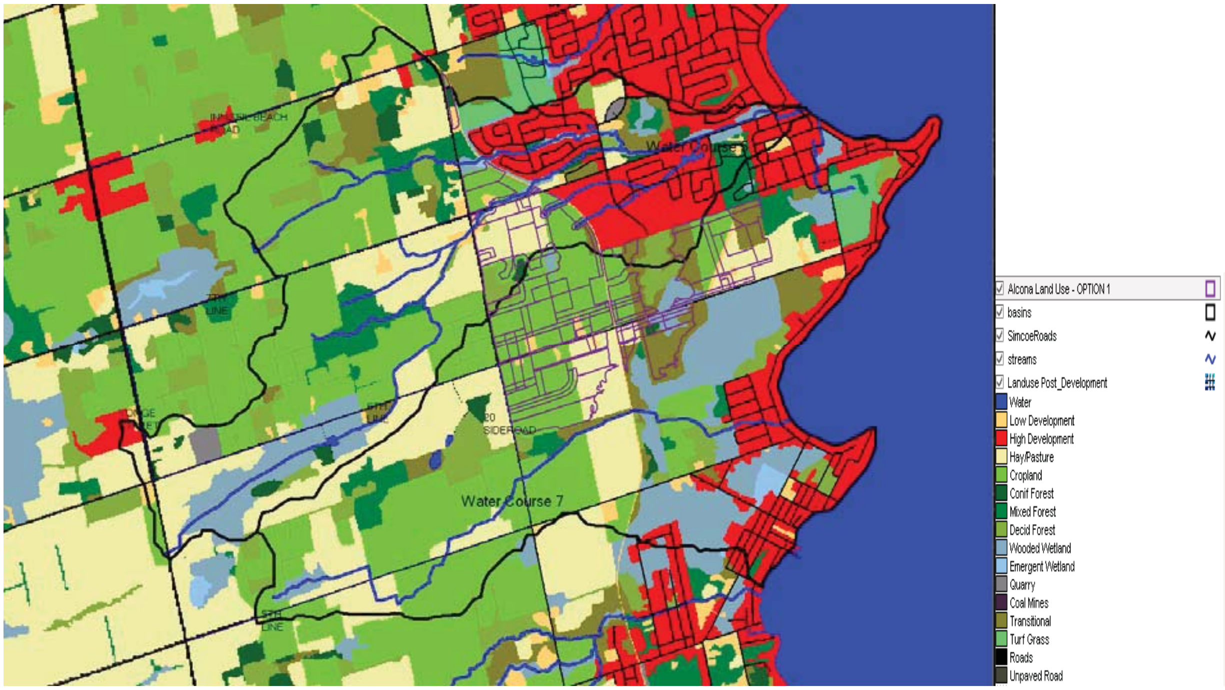

Figure A-8-2: Existing Land Use and Location of Proposed Secondary Plan Development

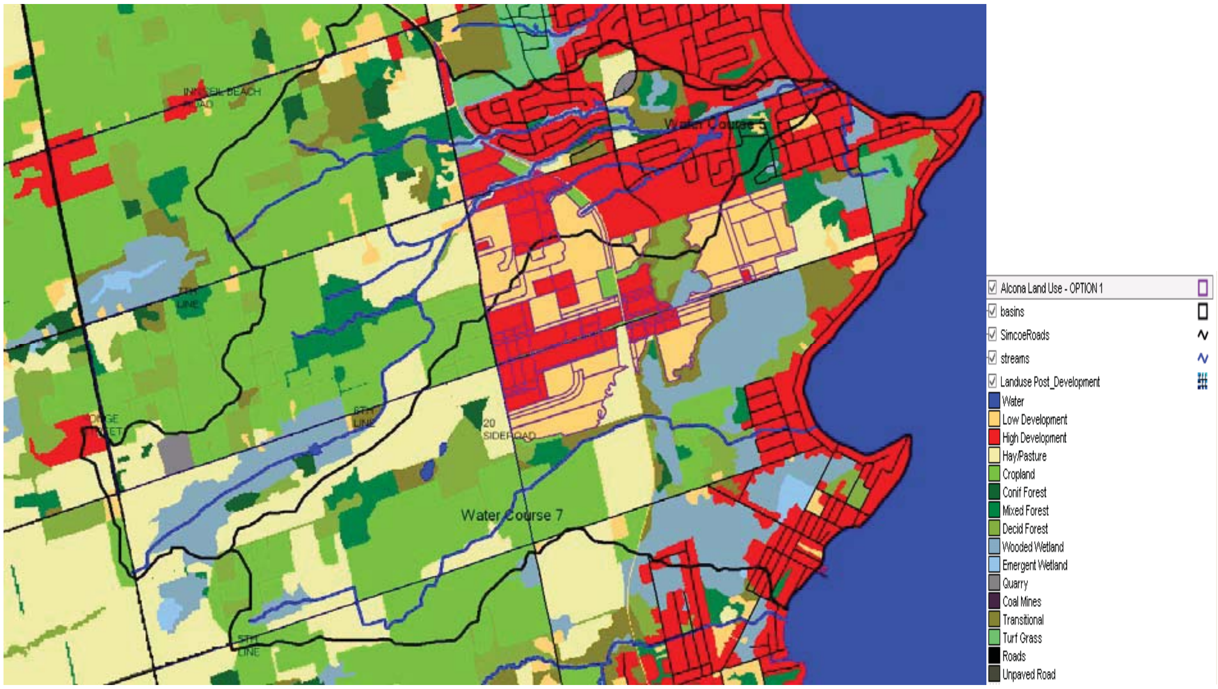

Figure A-8-3: Proposed Land Use

Table A-8-3: Land Use Designations (Watercourse 5 and 6/7 Catchments)

Source	Existing Area (ha)	Future Area (ha)	Difference (ha)
Crops	592	450	-142
Hay / Pasture	391	336	-55
Wetlands / Forest / Transitional Lands	649	592	-57
Low-Intensity Development	53	209	+156
High-Intensity Development	356	454	+97
Turf / Sod / Quarries	34	34	0
TOTALS	**2075**	**2075**	**0**

Table A-8-4: Comparison of Nutrient Loading for Watercourse 5 and 6/7 Catchments

Source	Existing Scenario (kg)	Alcona South Secondary Plan (kg)
Point Source Increase	0	20
NPS Water Course 5 Catchment	295	289
NPS Water Course 6/7 Catchment	297	248
BMP Reduction WC5	0	(9)
BMP Reduction WC6/7	0	(30)
Net Total	592	518
Percent Reduction from Existing Scenario		**12%**

Water Quality Objective

The intent was to achieve a phosphorus reduction level consistent with the watershed-wide reduction levels needed to achieve the latest loading rate target in advance of the results of the updated target setting process, which are expected to define targets by subwatershed.

Louis Berger Group (2010) reports that Innisfil Creeks currently produces approximately 3,490 kg of the 57,215 kg of average annual total phosphorus load from the larger Lake Simcoe watershed. Of the amount from Innisfil Creeks they estimated that more than 25% is the result of failing septic systems.

The Innisfil Creeks contribution represents approximately 6% of the total point and non-point source loadings to the lake from land based (non-atmospheric deposition) sources. If the estimated contribution from failing septic systems can be verified, a maintenance program would go a long way toward reducing the subwatershed load. The proposed Secondary Plan represents a further reduction of more than 2% from the subwatershed total. The LSRCA has also identified a series of agricultural BMPs and urban stormwater retrofits that could further reduce loads if implemented. The combined reductions should align Innisfil Creeks with the reductions needed to achieve the Lake based loading target.

The LSRCA requires storm water quality control for the subject lands at a level consistent with enhanced (Level 1) criteria as per the 2003 MOE *Storm water Management Manual* for discharges to the receiving watercourses from developed areas. This is achieved by providing the required permanent pool and extended detention volume in end of pipe SWM facilities (SWMFs).

Nottawasaga River Phosphorus Loading Analysis

Existing Conditions Model

An existing condition model was developed for the Nottawasaga River to simulate stream flow, in-stream total phosphorus concentration and phosphorus loading. The results of the phosphorus model were summarized by catchment and stream reach as average daily in-stream concentration (mg/L) and average annual loading (kg/year) over the period of simulation from 1983 through 2003. Results of the existing conditions (or base) model are presented in Table A-8-5 and Figure A-8-4.

Two (2) alternate scenarios were developed by changing aspects of the existing conditions model setup. The first (Scenario 3) increases WWTP loading and the second (Scenario #4 a, b and c) looks at implementing a centralized WWTP.

Alternate Scenario #3 Additional Angus and Borden WWTP Flows

Populations and resulting wastewater treatment plant flow increases were added to both of the Base Borden and Town of Angus Plants. Although there is also an expected impact from urban non-point source loading as well, the modeled scenario assumed that adequate stormwater management controls and low impact development technologies would be used to produce a net zero change in load from non-point sources.

An equivalent 2031 serviced population of 12,371 at the current per capita rate of 357 L/cap/day gives a 2031 flow rate of 4,417 m^3/day from the Angus WWTP. The 2031 serviced population for the Borden WWTP is 8,000. Using the same per capita flow rate gives a 2031 flow of 2,962 m^3/day.

Under the scenario that these facilities will also treat future populations of New Lowell, Evertt and Baxter the total serviced volume by these WWTPs is 9,438 m^3/day. Since the combined capacity of these facilities is 9,571 m^3/day (Angus and Borden have 5,511 m^3/day and 4,060 m^3/d, capacities, respectively), the scenario was modeled with Borden and Angus WWTPs operating at full capacity and existing average effluent concentrations.

Table A-8-5 Community population and flow projections

Community	Township	2031 Population	Estimated Sewage Flow (m^3/day) – using Angus average 357 L/cap/day
New Lowell	Clearview	3335	1190
Everett	Adjala Tosorontio	1558	556
Baxter	Essa	878	313
Borden		8,000	2,962
Angus		12,371	4,417
Total		**26,142**	**9,438**

Alternate Scenario #4 Divert WWTP Flows to Central Facility

The second scenario for the Nottawasaga model has three (3) options and assumed that treatment plants were taken off-line and flows diverted to a centralized facility that discharges directly to Georgian Bay. This scenario also explores the difference in water quality impact associated with removal of different combinations of WWTPs and also with the servicing of some currently privately serviced properties.

Option 4a saw the following WWTPs taken off-line to show the result of centralized facility option:

- Tottenham (169 kg/year)
- Sir F Banting (115 kg/year)
- Regional WPCP, New Tecumseth (310 kg/year)
- Borden (5 kg/year)
- Angus (381 kg/year)
- Cookstown (48 kg/year)

Option 4b was the same as Option 4a except that the Cookstown WWTP was retained operating at existing conditions.

Option 4c was the same as Option 4b but the following subsurface disposal systems were removed and connected to sanitary servicing. This included the removal of both properly operating and failing septic systems.

Table A-8-6 Community populations and expected per capita flow rates

Community	Township	Existing Population (Persons)	Persons Per Unit or Septic	Expected Septic Flow (L/cap/day)
Everett	Adjala Tosorontio	1929	3	Assume 375
Colgan	Adjala Tosorontio	213	3	Assume 375
Loretto	Adjala Tosorontio	328	3	Assume 375
Rosemount	Adjala Tosorontio	141	3	Assume 375
Baxter	Essa	149	2.7	Assume 375 Lpcd
New Lowell	Clearview	955	2.8	Assume 375 Lpcd

Table A-8-7 Septic systems taken off-line in Scenario #4c

Community	Total Estimated Septic Systems	Normal Septic Systems Removed in Scenario	Failing Septic Systems Removed in Scenario
Everett	643	579	64
Colgan	71	64	7
Loretto	109	98	11
Rosemount	47	42	5
Baxter	55	50	6
New Lowell	341	307	34
TOTAL	**1266**	**1140**	**127**

Results and Discussion

Alternate Scenario #3

Modeled reaches 27 and 13 receive effluent from Angus and Borden WWTPs, respectively. As illustrated by Figure A-8-5 and Table A-8-9, loads in these two (2) reaches increase by approximately 504 kg/yr and 175 kg/yr, respectively under this scenario. Increased loads from Angus and Borden result in a decayed load increase of 521 kg/year at the mouth of the Nottawasaga River.

Computed annual loads at the downstream ends of reaches 29, 30, 31, 32 and 33 located downstream between the confluence of the reach 13 (Pine River) with the main Nottawasaga River show load increases that decline with time and distance as they move downstream from Angus and Borden WWTPs where the increased load was added. This is the expected response as model applies an exponential decay in order to consider net uptake from plants and settling of particulate phosphorus to the stream bed.

From an in-stream water quality perspective, concentrations in downstream reaches are predicted to increase between 0.001 mg/L and 0.002 mg/L with the exception of the outlet of reach 13 where the concentration is predicted to be reduced by 0.004 mg/L due to the increased flow diluting non-point source loading.

Alternate Scenario #4 a, b, c

In contrast to Scenario #3, Scenario #4 reduces the loading within the stream network and at the mouth of the Nottawasaga River by taking a number of wastewater treatment plants off-line under the assumption of a centralized treatment facility discharging directly to Georgian Bay.

The total reduction in upstream loading at the locations of the existing WWTPs is 1028 kg/year, including 48 kg/year from the Cookstown WWTP. Figures A-8-6 through A-8-8 and Table A-8-9 illustrate the change in loading at the end of each stream reach in the system.

While the upstream treatment plant load taken off-line is 1028 kg/year the downstream reduction in loading is only 671 kg/year due to the assimilative uptake in the stream network between the point sources and Georgian Bay that reduce the current load at the mouth of the Nottawasaga River. If the centralized facility were to discharge into Georgian Bay at the same average concentration and flow rate of the combined treatment facilities under existing conditions, there would be a net increase of 357 kg/year due to the loss of assimilative uptake in the Nottawasaga River system. A net increase of 381 kg/year is predicted if the Cookstown WWTP remains on-line.

It should also be considered that these estimates are based on existing flows and concentrations rather than the 2031 serviced population projection. If Scenarios 3 and 4 are combined, the direct discharge to Georgian Bay in 2031 would be 1558 kg/year (with Cookstown off-line and without servicing existing septic users) representing a net increase of 891 kg/year compared to existing conditions.

From an in-stream water quality perspective, concentration reductions are on the order of 0.001 mg/L to 0.002 mg/L with only reach 190 showing a reduction of 0.010 mg/L. Several reaches are predicted to show increases in concentration due to the reduction in flow available to dilute un-changed non-point source loading.

Provision of municipal sanitary servicing to communities currently using private septic systems via a central treatment facility further reduces the predicted load at the mouth of the Nottawasaga to 857 kg/year less than existing conditions assuming a 10% failure rate of existing private septic systems. This represents an additional expected load reduction at the outlet and in reaches between the sources and the outlet. In-stream water quality is predicted to see average phosphorus concentrations reduced in downstream reaches by 0.002 mg/L.

Although on the surface, this appears to be a gain, it must be further considered that many of the septic systems that would be removed and serviced by a centralized facility are working properly and release little or no phosphorus into nearby water courses. These properly operating systems represent load that is being assimilated into the natural system. By replacing septic systems with a central facility, it is likely that the net result will be a higher load directly discharged to Georgian Bay than current conditions because a portion of all existing septic loads (failing or not) would be discharged to Georgian Bay.

Table A-8-8 Simulation results by stream reach

	Model Scenario Phosphorus Concentration (mg/L) at Downstream End of Reach					Model Scenario Phosphorus Loads (kg/year) at Downstream End of Reach				
Reach	Base	3	4a	4b	4c	Base	3	4a	4b	4c
1	0.045	0.046	0.045	0.045	0.044	49171	49692	48500	48524	48314
2	0.148	0.148	0.148	0.148	0.148	2551	2551	2551	2551	2551
3	0.123	0.123	0.123	0.123	0.123	1601	1601	1601	1601	1601
4	0.119	0.119	0.119	0.119	0.119	3707	3707	3707	3707	3707
5	0.051	0.051	0.051	0.051	0.051	5173	5173	5173	5173	5173
6	0.085	0.085	0.085	0.085	0.085	4797	4797	4797	4797	4797
7	0.111	0.111	0.111	0.111	0.100	1714	1714	1714	1714	1636
8	0.100	0.100	0.100	0.100	0.100	1681	1681	1681	1681	1681
9	0.333	0.333	0.333	0.333	0.333	4310	4310	4310	4310	4310
10	0.177	0.177	0.177	0.177	0.177	3136	3136	3136	3136	3136
11	0.039	0.039	0.039	0.039	0.039	6470	6470	6470	6470	6470
12	0.081	0.081	0.084	0.081	0.081	3184	3184	3136	3184	3184
13	0.069	0.066	0.069	0.069	0.064	5049	5224	5044	5044	4898
14	0.087	0.087	0.087	0.087	0.087	2368	2368	2368	2368	2368
15	0.074	0.074	0.075	0.074	0.074	7112	7112	7066	7112	7112
16	0.038	0.038	0.405	0.405	0.405	4975	4975	4856	4856	4845
17	0.110	0.110	0.110	0.110	0.110	1771	1771	1771	1771	1771
18	0.129	0.129	0.129	0.129	0.124	2213	2213	2213	2213	2172
19	0.043	0.043	0.043	0.043	0.043	1845	1845	1731	1731	1731
20	0.093	0.093	0.104	0.104	0.101	4124	4124	4070	4070	4028
21	0.073	0.073	0.075	0.079	0.078	11244	11244	11173	11307	11268
22	0.052	0.052	0.052	0.052	0.052	1068	1068	1068	1068	1068
23	0.057	0.057	0.057	0.057	0.057	932	932	932	932	932
24	0.029	0.029	0.029	0.029	0.029	2715	2715	2715	2715	2715
25	0.044	0.044	0.044	0.044	0.044	4467	4467	4467	4467	4467
26	0.059	0.059	0.060	0.062	0.061	16335	16335	15910	16025	15988
27	0.043	0.045	0.041	0.041	0.041	22525	23029	21718	21748	21703
29	0.052	0.055	0.051	0.051	0.050	29287	29939	28499	28529	28345
30	0.051	0.053	0.050	0.050	0.049	35893	36539	35110	35139	34956
31	0.052	0.053	0.051	0.051	0.050	37309	37945	36535	36563	36308
32	0.051	0.052	0.050	0.050	0.049	42485	43105	41725	41752	41503
33	0.043	0.044	0.043	0.043	0.042	44894	45428	44210	44234	44020
160	0.118	0.118	0.118	0.118	0.118	1319	1319	1319	1319	1319
190	0.057	0.057	0.047	0.047	0.047	624	624	455	455	455

Table A-8-9 Comparison of scenario simulations by load and concentration

	Load Difference Between Scenario and Base Models at Downstream End of Reach (kg/year)				Concentration Difference Between Scenario and Base Models at Downstream End of Reach (mg/L)			
Stream Reach	3-base	4a-base	4b-base	4c-base	3-base	4a-base	4b-base	4c-base
1	521	-671	-647	-857	0.001	-0.001	-0.001	-0.001
2	0	0	0	0	0.000	0.000	0.000	0.000
3	0	0	0	0	0.000	0.000	0.000	0.000
4	0	0	0	0	0.000	0.000	0.000	0.000
5	0	0	0	0	0.000	0.000	0.000	0.000
6	0	0	0	0	0.000	0.000	0.000	0.000
7	0	0	0	-78	0.000	0.000	0.000	-0.010
8	0	0	0	0	0.000	0.000	0.000	0.000
9	0	0	0	0	0.000	0.000	0.000	0.000
10	0	0	0	0	0.000	0.000	0.000	0.000
11	0	0	0	0	0.000	0.000	0.000	0.000
12	0	-48	0	0	0.000	0.003	0.000	0.000
13	175	-5	-5	-151	-0.004	0.000	0.000	-0.005
14	0	0	0	0	0.000	0.000	0.000	0.000
15	0	-46	0	0	0.000	0.001	0.000	0.000
16	0	-118	-118	-130	0.000	0.367	0.367	0.366
17	0	0	0	0	0.000	0.000	0.000	0.000
18	0	0	0	-41	0.000	0.000	0.000	-0.004
19	0	-114	-114	-114	0.000	0.001	0.001	0.001
20	0	-53	-53	-96	0.000	0.010	0.010	0.008
21	0	-71	-31	-39	0.000	0.002	0.006	0.005
22	0	0	0	0	0.000	0.000	0.000	0.000
23	0	0	0	0	0.000	0.000	0.000	0.000
24	0	0	0	0	0.000	0.000	0.000	0.000
25	0	0	0	0	0.000	0.000	0.000	0.000
26	0	-425	-310	-346	0.000	0.001	0.003	0.002
27	504	-807	-777	-822	0.002	-0.002	-0.002	-0.002
29	652	-788	-758	-942	0.002	-0.002	-0.002	-0.003
30	646	-783	-754	-936	0.002	-0.001	-0.001	-0.002
31	636	-774	-745	-1001	0.002	-0.001	-0.001	-0.002
32	620	-760	-732	-982	0.001	-0.001	-0.001	-0.002
33	534	-684	-660	-874	0.001	-0.001	-0.001	-0.001
160	0	0	0	0	0.000	0.000	0.000	0.000
190	0	-169	-169	-169	0.000	-0.010	-0.010	-0.010

Coldwater and Sturgeon Rivers Phosphorus Loading Analysis

There were no alternate scenarios simulated for the Severn Sound model. Figure A-8-9 depicts catchment loading rates and in-stream delivered loads and concentrations of phosphorus under existing conditions. The model predicts an average annual load from the Coldwater River of 8,445 kg/year and 1,341 kg/year from the Sturgeon River with average annual in-stream concentrations of 0.07 mg/L and 0.09 mg/L, respectively.

Limited Validation and Recommendations

The scope, budget and schedule for this study did not permit the calibration of the water quality models. However, in order to provide some minimum level of confidence, a series of summary validations were carried out to assess whether the models were at least performing within a range consistent with a limited period of flow and water quality monitoring. No adjustments were made to the models to enhance the level of agreement between the model and data used in the validation. Although the validations confirmed that the models were performing reasonably well given that no calibration was done, they also confirmed the potential for improvement with proper adjustments.

Nottawasaga and Coldwater Rivers

Water Survey of Canada stations in the Coldwater and Nottawasaga rivers were used in the limited validation. Stations used were in catchment 33 of the Nottawasaga River model and catchment 26 of the Coldwater River model.

Select data from the Provincial Water Quality Monitoring Network database and location shape file were downloaded from the Ministry of Environment website for the years 2002-2003 and used in the limited model validation for the Coldwater and Nottawasaga rivers.

From this limited validation, it appears that the models tended to simulate the continuous hydrograph reasonably well on a daily time step in both models. There was some over simulation of the spring hydrograph and under prediction of the summer portion of the hydrograph. The simulations tended to over-estimate phosphorus concentration in portions of the simulation. This could be attributed in part to the absence of consideration given to the existing use of urban and rural stormwater management practices and agricultural beneficial management practices. Future updates to these models should consider identifying where these practices are in use and adding them into the model.

It has also been observed that there is some instability in the hydraulic routing routine that can create an oscillating response in the hydrograph in some portions of the simulation. This can also impact predicted concentrations on a given day in the simulation. This could likely be corrected as part of a calibration procedure that would make adjustments to the Mannings roughness coefficients and further verification of the stream geometry settings and travel times.

Innisfil Creeks

For Innisfil Creeks the validation was against results reported in Louis Berger Group (2010) where CANWET v.3 was calibrated against “estimated” total phosphorus loading and “synthesized” stream flow from LSRCA and MOE. As there are no stream flow gauges or water quality monitoring stations in the Innisfil Creeks subwatershed, estimated flows and synthesized loads were determined based on other monitored subwatersheds in the Lake Simcoe watershed that were considered most similar to the Innisfil Creeks subwatershed.

The summary validation against the results of the Louis Berger (2010) modeling and calibration found good agreement between estimated long term annual phosphorus loads under existing (pre-development) conditions. Excluding septic system failure rates, the updated CANWET^{TM} 4 model is within 12% of the annual total phosphorus loading estimated by Louis Berger Group (2010) using a model calibrated to synthesized flow and loading data.

Table A-8-10 Total phosphorus (kg/yr) existing conditions, non-point sources

CANWET 4 model	**Louis Berger (2010) CANWET 3 model**
2,710 (excluding loading due to septic failure)	2,416 (excluding loading due to septic failure)
2,848 (assuming 10% direct discharge of all septic systems). Note: a 35% failure rate was used for the catchments containing the Alcona South Secondary Plan.	3,232 (assuming direct discharge of all septics within 100 m of Lake)

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Updated Draft Alcona South Secondary Plan dated 2011 July 22

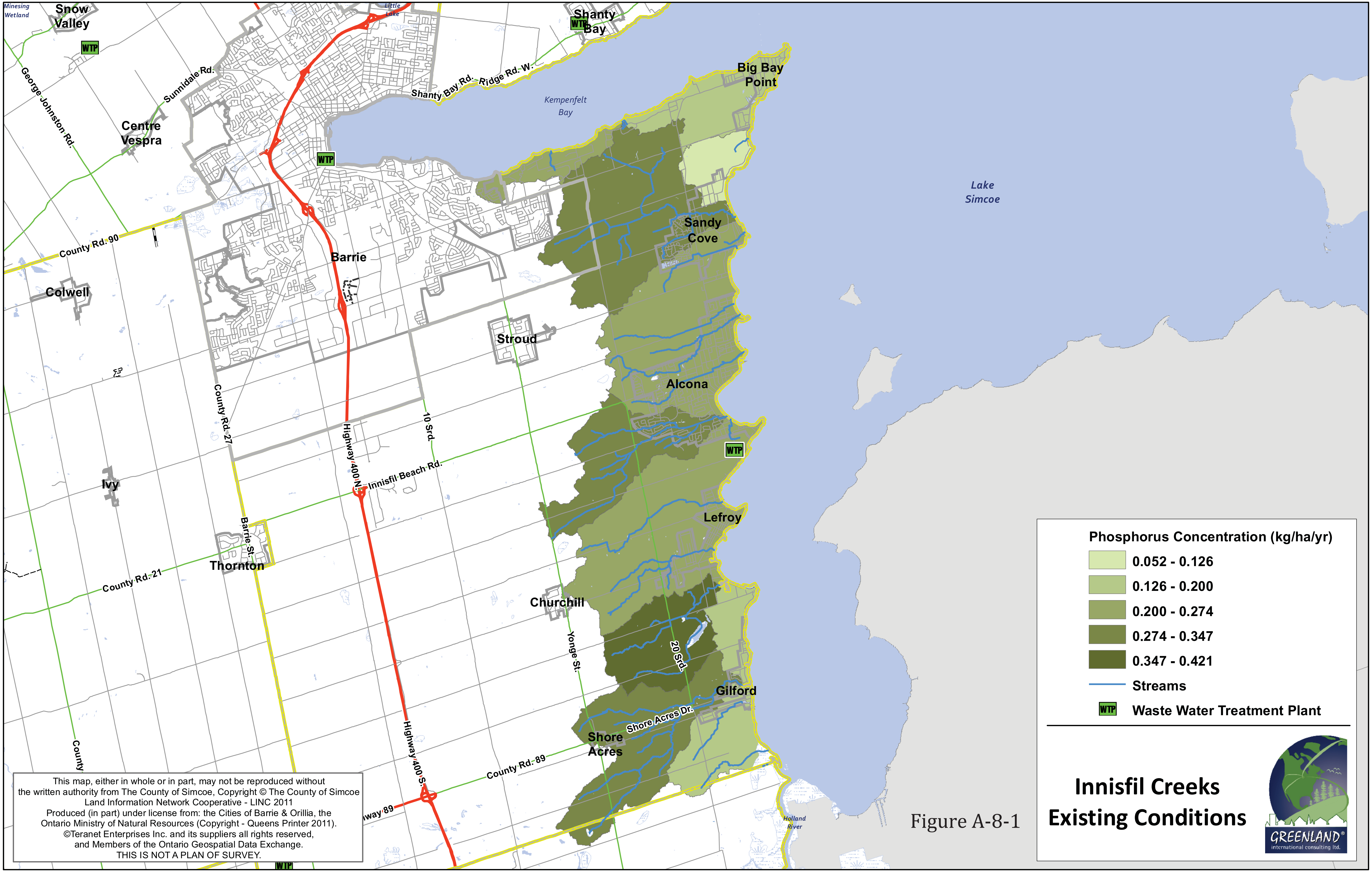
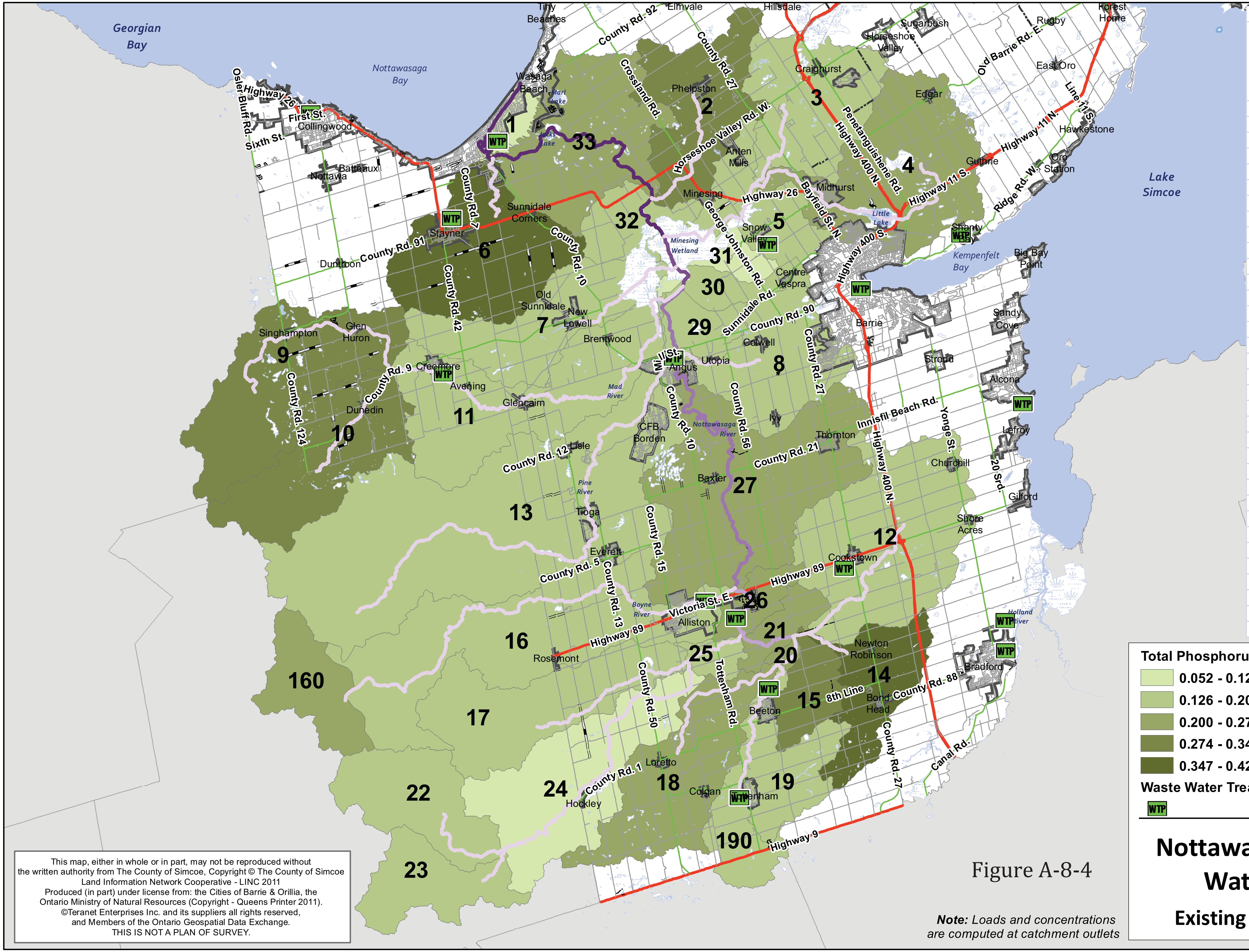


Figure A-8-1

Innisfil Creeks
Existing Conditions



In Stream Phosphorus

ID	Phosphorus Load (Kg/yr)	Phosphorus Concentration (mg/l)
1	49171	0.045
2	2551	0.148
3	1601	0.123
4	3707	0.119
5	5173	0.051
6	4797	0.085
7	1714	0.111
8	1681	0.100
9	4310	0.333
10	3136	0.177
11	6470	0.039
12	3184	0.081
13	5049	0.069
14	2368	0.087
15	7112	0.074
16	4975	0.038
17	1771	0.110
18	2213	0.129
19	1845	0.043
20	4124	0.093
21	11244	0.073
22	1068	0.052
23	932	0.057
24	2715	0.029
25	4467	0.044
26	16335	0.059
27	22525	0.043
29	29287	0.052
30	35893	0.051
31	37309	0.052
32	42485	0.051
33	44894	0.043
160	1319	0.118
190	624	0.057

Total Phosphorus (kg/ha/yr)	Streams Load (Kg/yr)
0.052 - 0.126	624 - 9834
0.126 - 0.200	9834 - 19668
0.200 - 0.274	19668 - 29502
0.274 - 0.347	29502 - 39336
0.347 - 0.421	39336 - 49171

Waste Water Treatment Plant

WTP

Nottawasaga River Watershed

Existing Conditions

Figure A-8-4

***Note:** Loads and concentrations are computed at catchment outlets*

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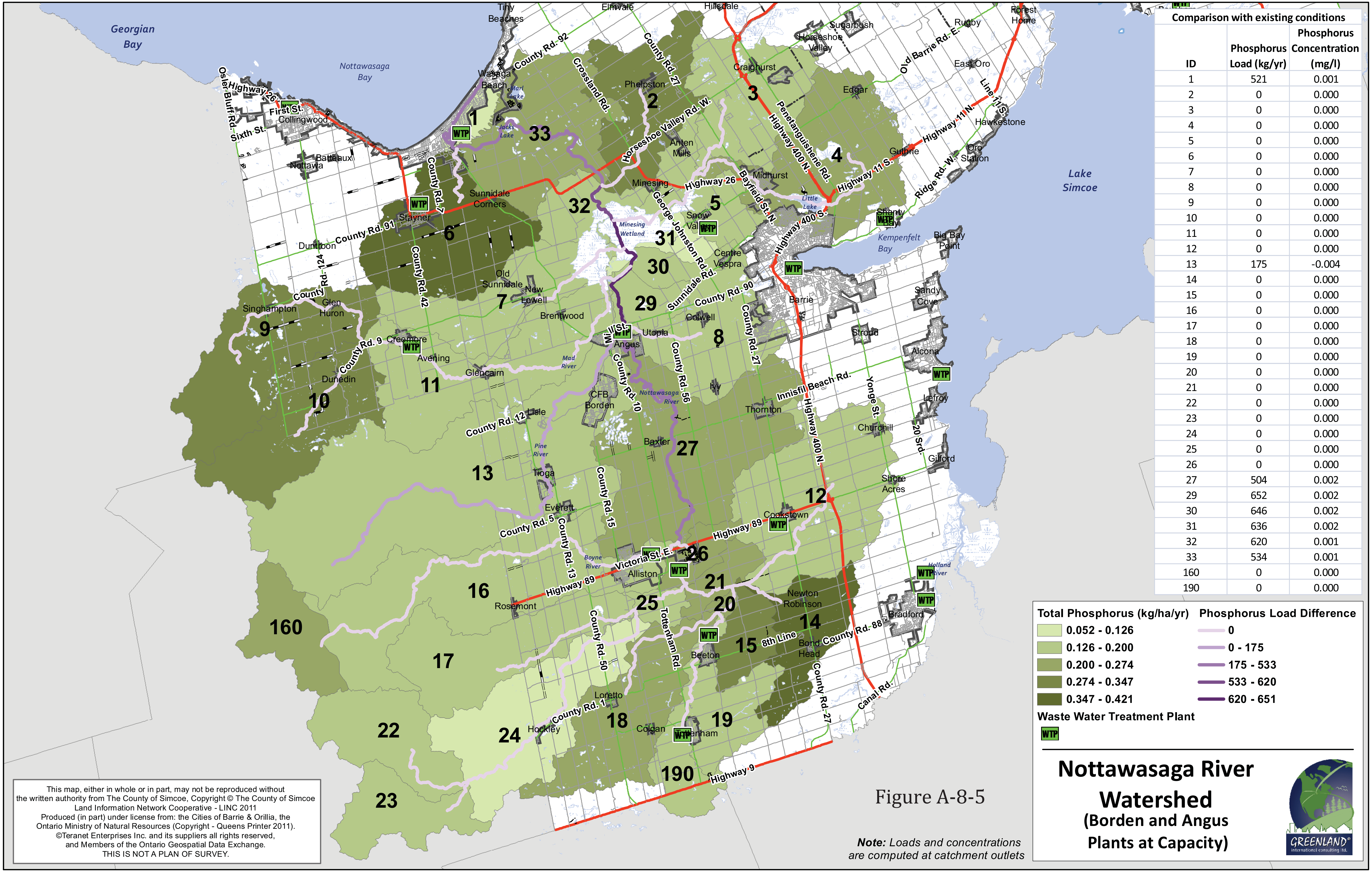

Comparison with existing conditions

ID	Phosphorus Load (kg/yr)	Phosphorus Concentration (mg/l)
1	521	0.001
2	0	0.000
3	0	0.000
4	0	0.000
5	0	0.000
6	0	0.000
7	0	0.000
8	0	0.000
9	0	0.000
10	0	0.000
11	0	0.000
12	0	0.000
13	175	-0.004
14	0	0.000
15	0	0.000
16	0	0.000
17	0	0.000
18	0	0.000
19	0	0.000
20	0	0.000
21	0	0.000
22	0	0.000
23	0	0.000
24	0	0.000
25	0	0.000
26	0	0.000
27	504	0.002
29	652	0.002
30	646	0.002
31	636	0.002
32	620	0.001
33	534	0.001
160	0	0.000
190	0	0.000

Total Phosphorus (kg/ha/yr)

- 🟩 0.052 - 0.126
- 🟩 0.126 - 0.200
- 🟩 0.200 - 0.274
- 🟩 0.274 - 0.347
- 🟩 0.347 - 0.421

Phosphorus Load Difference

- — 0
- — 0 - 175
- — 175 - 533
- — 533 - 620
- — 620 - 651

Waste Water Treatment Plant

WTP

Nottawasaga River Watershed
(Borden and Angus Plants at Capacity)

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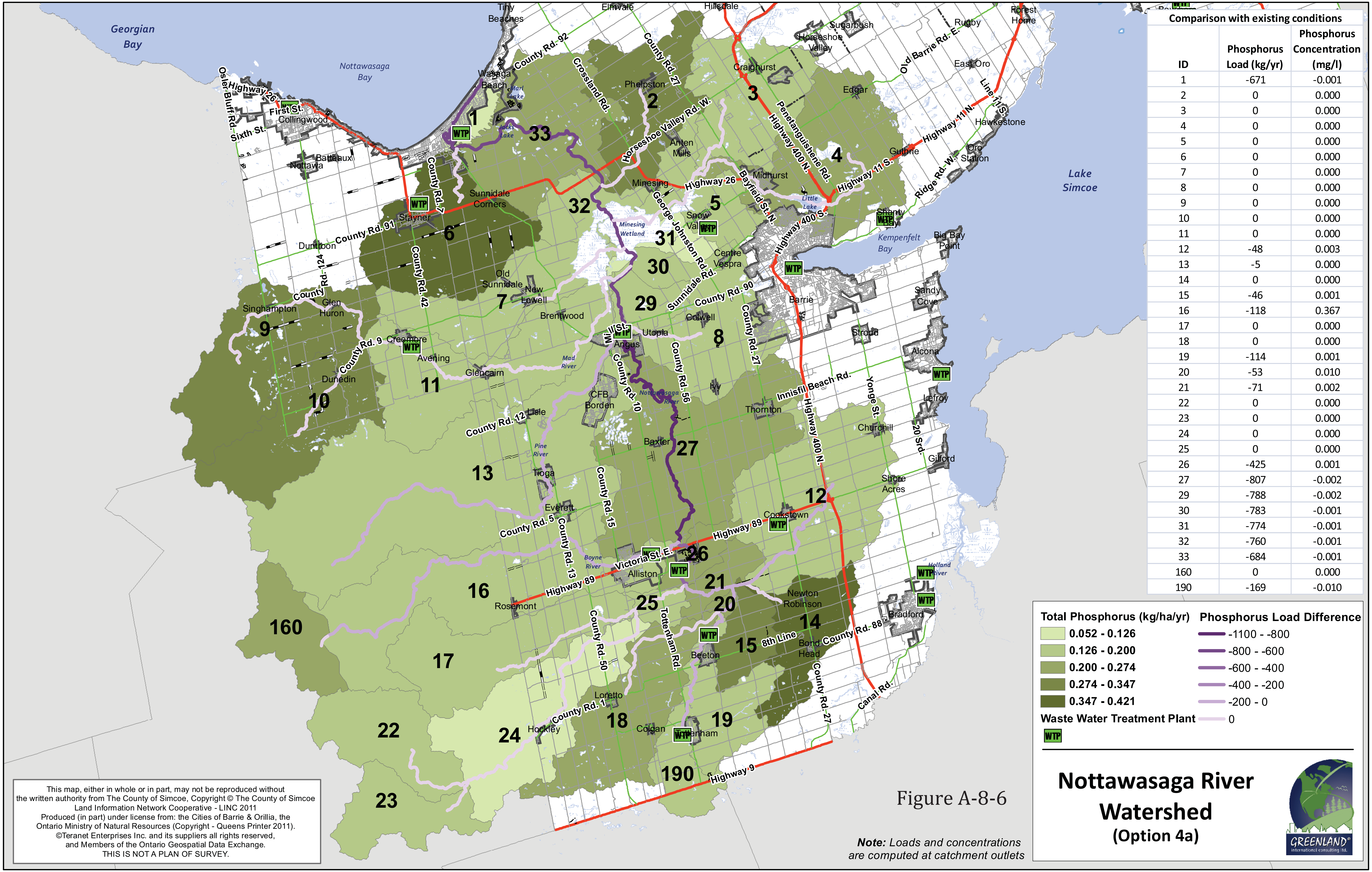
Figure A-8-5

Note: *Loads and concentrations are computed at catchment outlets*



Comparison with existing conditions

ID	Phosphorus Load (kg/yr)	Phosphorus Concentration (mg/l)
1	-671	-0.001
2	0	0.000
3	0	0.000
4	0	0.000
5	0	0.000
6	0	0.000
7	0	0.000
8	0	0.000
9	0	0.000
10	0	0.000
11	0	0.000
12	-48	0.003
13	-5	0.000
14	0	0.000
15	-46	0.001
16	-118	0.367
17	0	0.000
18	0	0.000
19	-114	0.001
20	-53	0.010
21	-71	0.002
22	0	0.000
23	0	0.000
24	0	0.000
25	0	0.000
26	-425	0.001
27	-807	-0.002
29	-788	-0.002
30	-783	-0.001
31	-774	-0.001
32	-760	-0.001
33	-684	-0.001
160	0	0.000
190	-169	-0.010

Total Phosphorus (kg/ha/yr)

- 🟩 0.052 - 0.126
- 🟩 0.126 - 0.200
- 🟩 0.200 - 0.274
- 🟩 0.274 - 0.347
- 🟩 0.347 - 0.421

Waste Water Treatment Plant

WTP

Phosphorus Load Difference

- ▬ -1100 - -800
- ▬ -800 - -600
- ▬ -600 - -400
- ▬ -400 - -200
- ▬ -200 - 0
- ▬ 0

Nottawasaga River Watershed
(Option 4a)

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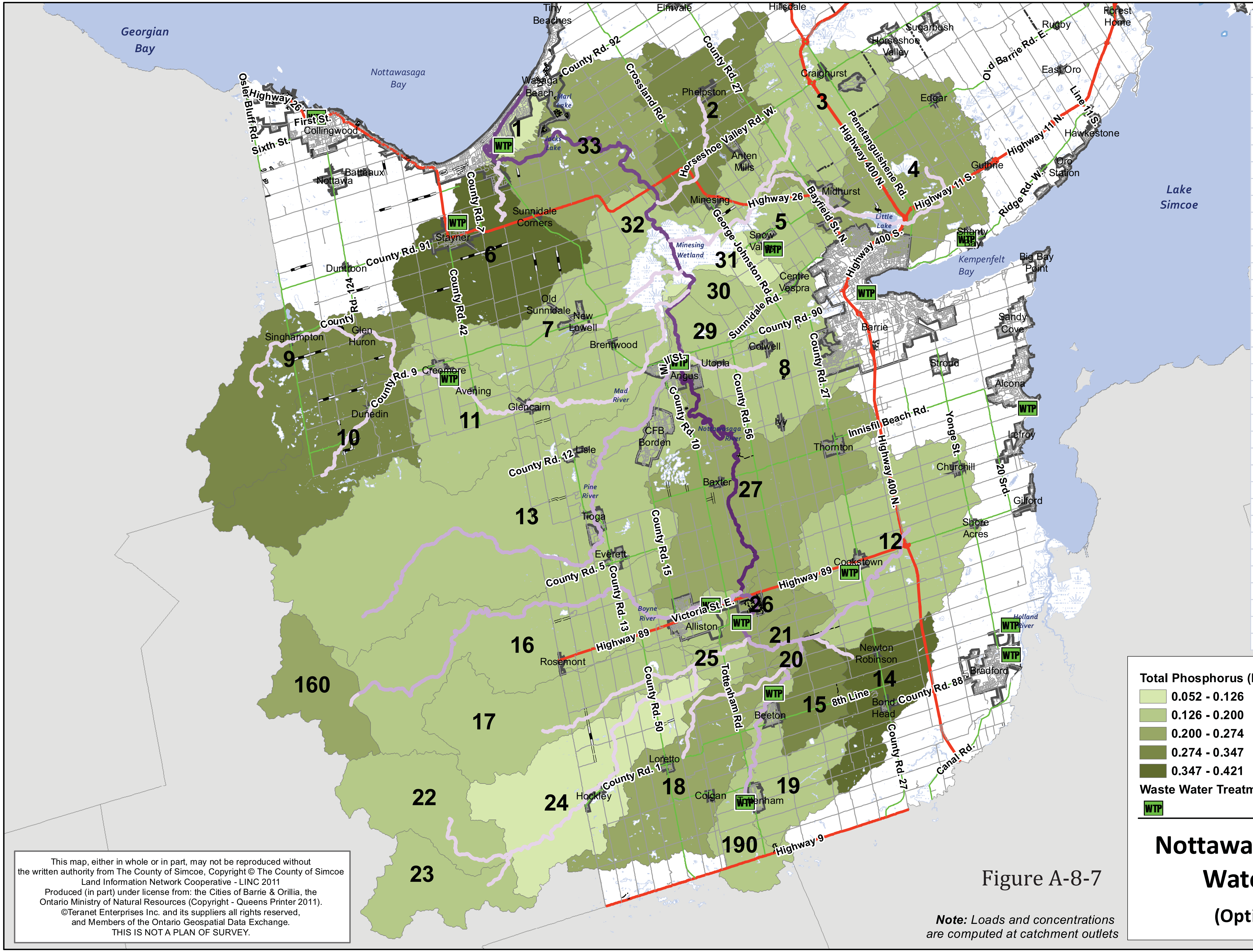
Figure A-8-6

Note: *Loads and concentrations are computed at catchment outlets*



Comparison with existing conditions		
ID	Phosphorus Load (kg/yr)	Phosphorus Concentration (mg/l)
1	-647	-0.001
2	0	0.000
3	0	0.000
4	0	0.000
5	0	0.000
6	0	0.000
7	0	0.000
8	0	0.000
9	0	0.000
10	0	0.000
11	0	0.000
12	0	0.000
13	-5	0.000
14	0	0.000
15	0	0.000
16	-118	0.367
17	0	0.000
18	0	0.000
19	-114	0.001
20	-53	0.010
21	-31	0.006
22	0	0.000
23	0	0.000
24	0	0.000
25	0	0.000
26	-310	0.003
27	-777	-0.002
29	-758	-0.002
30	-754	-0.001
31	-745	-0.001
32	-732	-0.001
33	-660	-0.001
160	0	0.000
190	-169	-0.010

Total Phosphorus (kg/ha/yr)	Phosphorus Load Difference
0.052 - 0.126	-1100 - -800
0.126 - 0.200	-800 - -600
0.200 - 0.274	-600 - -400
0.274 - 0.347	-400 - -200
0.347 - 0.421	-200 - 0
Waste Water Treatment Plant	0
WTP	

Nottawasaga River Watershed

(Option 4b)

Figure A-8-7

Note: *Loads and concentrations are computed at catchment outlets*

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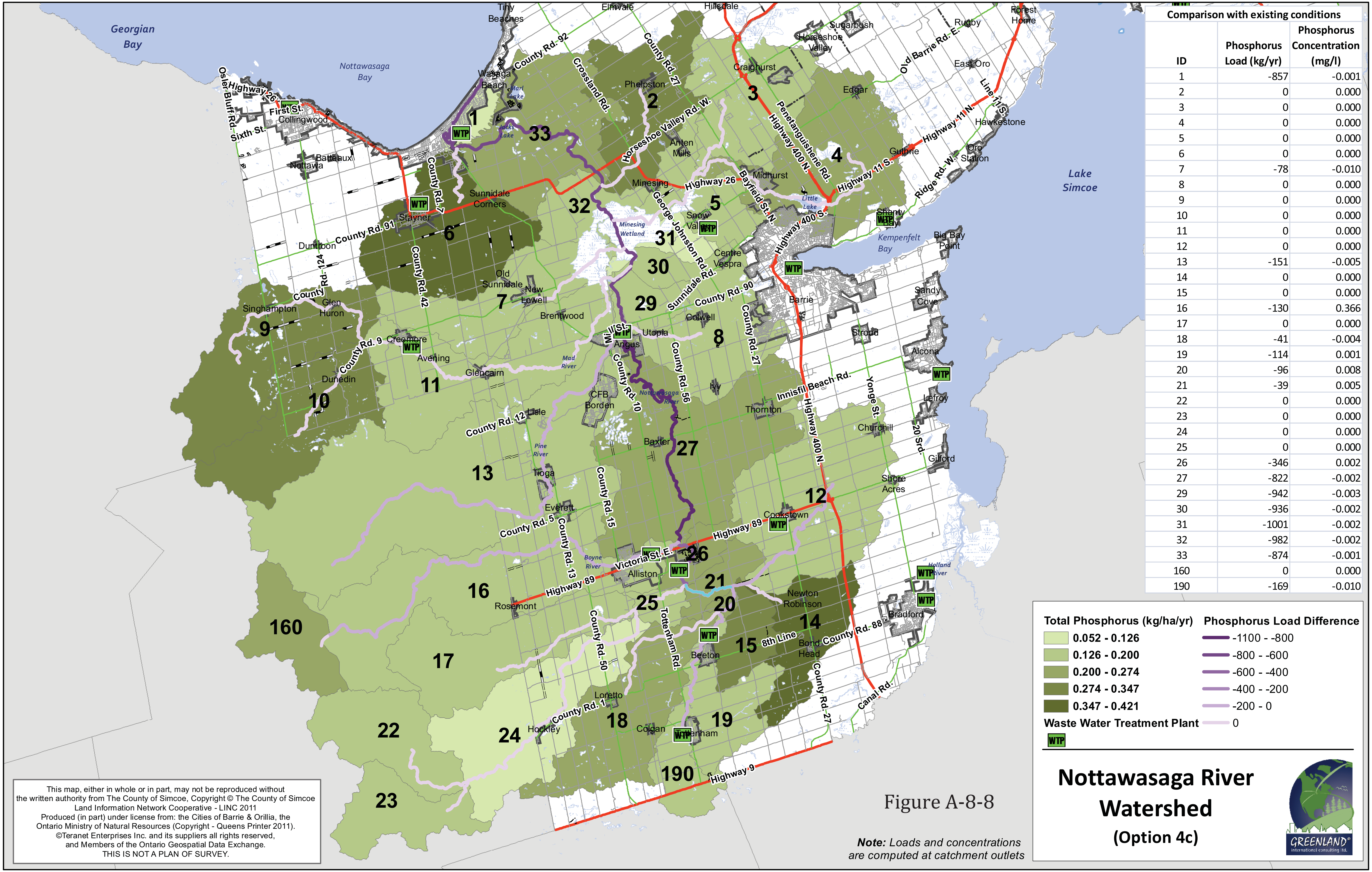


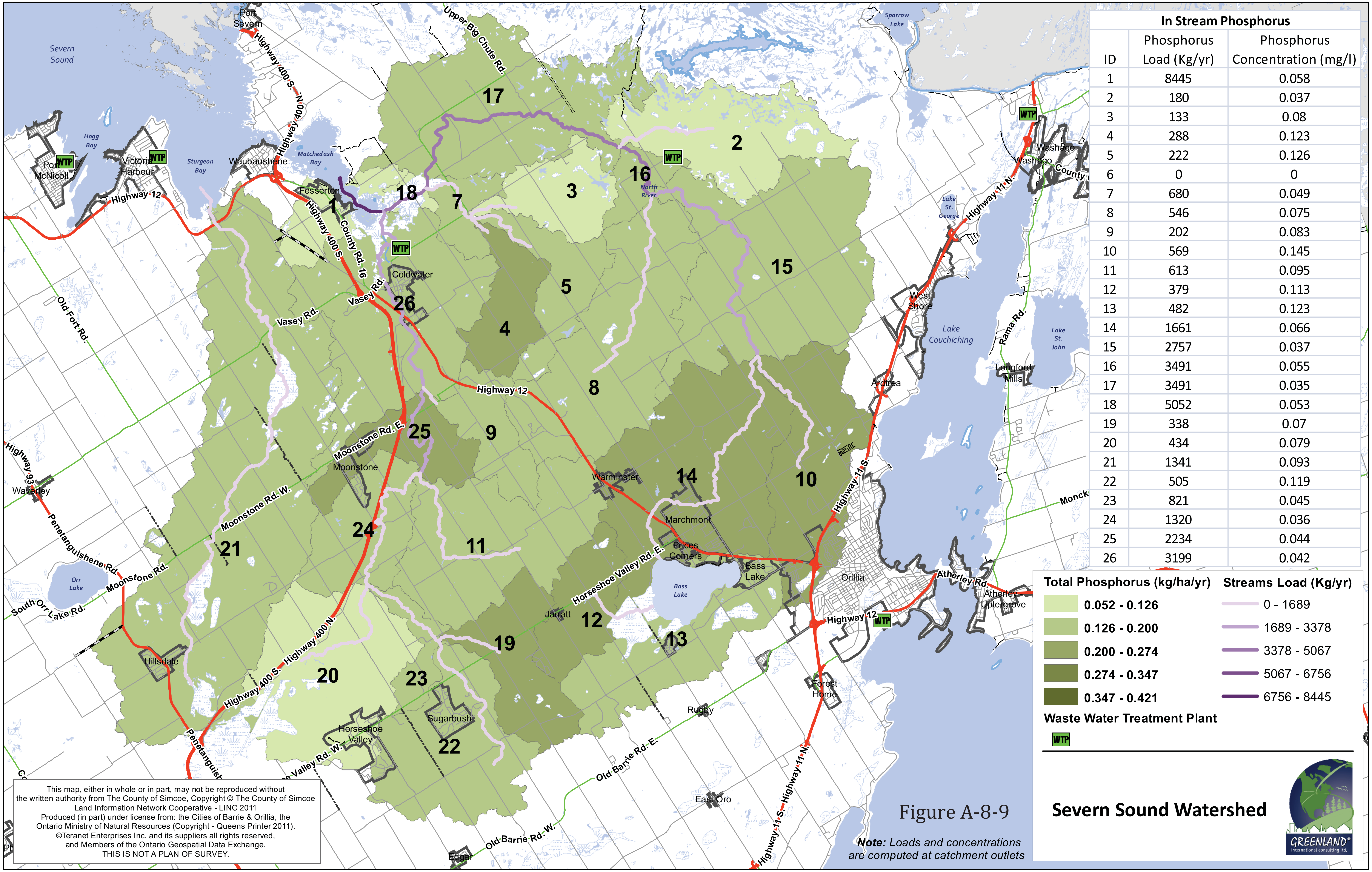
Comparison with existing conditions		
ID	Phosphorus Load (kg/yr)	Phosphorus Concentration (mg/l)
1	-857	-0.001
2	0	0.000
3	0	0.000
4	0	0.000
5	0	0.000
6	0	0.000
7	-78	-0.010
8	0	0.000
9	0	0.000
10	0	0.000
11	0	0.000
12	0	0.000
13	-151	-0.005
14	0	0.000
15	0	0.000
16	-130	0.366
17	0	0.000
18	-41	-0.004
19	-114	0.001
20	-96	0.008
21	-39	0.005
22	0	0.000
23	0	0.000
24	0	0.000
25	0	0.000
26	-346	0.002
27	-822	-0.002
29	-942	-0.003
30	-936	-0.002
31	-1001	-0.002
32	-982	-0.002
33	-874	-0.001
160	0	0.000
190	-169	-0.010

Figure A-8-8

Nottawasaga River Watershed

(Option 4c)

Note: *Loads and concentrations are computed at catchment outlets*



In Stream Phosphorus

ID	Phosphorus Load (Kg/yr)	Phosphorus Concentration (mg/l)
1	8445	0.058
2	180	0.037
3	133	0.08
4	288	0.123
5	222	0.126
6	0	0
7	680	0.049
8	546	0.075
9	202	0.083
10	569	0.145
11	613	0.095
12	379	0.113
13	482	0.123
14	1661	0.066
15	2757	0.037
16	3491	0.055
17	3491	0.035
18	5052	0.053
19	338	0.07
20	434	0.079
21	1341	0.093
22	505	0.119
23	821	0.045
24	1320	0.036
25	2234	0.044
26	3199	0.042

Total Phosphorus (kg/ha/yr)	**Streams Load (Kg/yr)**
▨ **0.052 - 0.126**	― 0 - 1689
▨ **0.126 - 0.200**	― 1689 - 3378
▨ **0.200 - 0.274**	― 3378 - 5067
▨ **0.274 - 0.347**	― 5067 - 6756
▨ **0.347 - 0.421**	― 6756 - 8445

Waste Water Treatment Plant

WTP

Figure A-8-9

Note: *Loads and concentrations are computed at catchment outlets*

Severn Sound Watershed

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