

The Qu'Appelle Mass Balance Report

Summary:

- The Qu'Appelle Mass Balance Report was completed because of the significant cultural, environmental and resource importance of the Qu'Appelle watershed to Saskatchewan.
- The Qu'Appelle Mass Balance Report examined the concentration and load (total amount over time) of nutrients entering, being retained and leaving the Qu'Appelle River and tributaries within the watershed.
- Similar to other prairie ecosystems with naturally rich soils, the Qu'Appelle Watershed is a naturally nutrient-rich system. The report identified some key load sources for nutrients and highlighted some significant steps taken to reduce phosphorus and nitrogen loads entering Pasqua Lake. It also provides important scientific information on the formation of algal blooms to assist with managing their relative risk.
- The Water Security Agency (WSA) will continue to gather and evaluate information to inform decisions regarding options to manage nutrient inputs in the Qu'Appelle Watershed. WSA's work includes regulating sewage effluents, moving forward with the Agricultural Water Management Strategy, and continuing collaborative work with researchers, local watershed authorities and municipalities.
- The study did not specifically evaluate agricultural contributions to overall non-point source (diffuse) nutrient loading to the Qu'Appelle River or its tributaries. Nor did the study consider the quality of water as it relates to a raw source water used to produce potable drinking water supplies. Drinking supplies are already regulated for safety by WSA in cooperation with municipalities through the watershed.



*Qu'Appelle River, southern Saskatchewan, Canada
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Key Findings

- The Water Security Agency (WSA) undertook the Qu'Appelle Nutrient Mass Balance study to better understand nutrient levels in the Qu'Appelle River and in its major tributaries. The study included the river reach from the headwaters at the Qu'Appelle Dam on Lake Diefenbaker to the outflow of Round Lake.
- The Qu'Appelle Nutrient Mass Balance study is a component of a larger project to update the notional water quality objectives for the Lower Qu'Appelle lakes that were proposed as part of the Lower Qu'Appelle Watershed Plan (<https://www.wsask.ca/Water-Info/Watershed-Planning/Lower-QuAppelle-River-Watershed/>)
- The Qu'Appelle Nutrient Mass Balance study found that the Moose Jaw River and Wascana Creek were the largest individual tributary sources of nutrients to the Qu'Appelle River.

- The Regina wastewater treatment plant was found to contribute 9.3% of the phosphorus and 52% of the nitrogen load entering Pasqua Lake. After the wastewater treatment plant upgrade in 2017, this is estimated to have decreased to 6% of the phosphorus and 15% of the nitrogen load entering Pasqua Lake. Ongoing monitoring will better quantify the improvements arising from the Regina wastewater treatment plant upgrade.
- Smaller creeks entering the Qu'Appelle River were individually less important nutrient sources. However, collectively all other creeks were an important source of nutrients to the river.
- The study occurred during a period of higher than average runoff. During years with lower runoff, and therefore lower tributary flows than observed during the study, the loading from these tributaries would also be lower.
- The difference between the natural load and agricultural contributions to non-point source load is not simple to evaluate and was not done as part of the study given the number of contribution and transport pathways. The prairie landscape would naturally contribute comparatively high amounts nutrients, particularly during periods of high flow, to the river relative to other geographic areas.
- The report provides an assessment of nutrient concentrations and loads along the Qu'Appelle River and its tributaries. The report cannot assess whether the observed nutrient levels are above acceptable levels as these have not yet been defined for the Qu'Appelle River.
- The study also found that lakes within the Qu'Appelle River (i.e. Buffalo Pound, Pasqua to Katepwa, Crooked and Round) receive more nutrients in their inflows than they have in their outflows. This trapping of nutrients by lakes is known and was an expected finding.

Questions and answers

1. Why is WSA interested in nutrients within the Qu'Appelle Watershed?

The Qu'Appelle Watershed is an important watershed in the province. The provincial capital city, and many other cities and communities are located within the watershed. The watershed is important for cultural, environmental and economic reasons. The Watershed is a managed system, with augmented flows from Lake Diefenbaker and multiple water control structures, at or near lake outlets, along the length of the river.

2. Have there always been algal blooms on the Qu'Appelle lakes?

Yes. Multiple sources have confirmed the presence of algal blooms in the Qu'Appelle Lakes. This includes historic mention of blooms by European explorers in the mid 1850's and a comment in the federal fisheries inspector's diary from the 1890's about "green scum" present on the Qu'Appelle lakes.

Scientific reconstruction of the number of algae present in the lakes over time has been done by evaluating algal remains in the sediment at the bottom of the lakes, with older periods represented by deeper sediment layers.

This study confirmed the historic and natural high algal content of these lakes. It also found increased total algae in the furthest upstream lake, Pasqua, which was attributed to human activities in the watershed. To address these changes, there have been more stringent controls placed on nutrients from wastewater treatment plants.

3. Why are nutrients important to the formation of algal blooms?

Nutrients are an essential building block for all organisms, including algae that live in lakes. Various scientific studies have found that certain nutrients, notably phosphorus and nitrogen, can indicate the amount and type of algae present. Generally, this means that when more nutrients are present there are more algae present.

There are other factors critical to the growth of algae including the physical nature of the lake and other organisms present in the lake. Lakes naturally have different amounts of algae, which is often linked to the geographical features of that area. Nutrients do not always limit algal growth or algal bloom formation; however, understanding their dynamics is an important component to understanding algal growth.

4. Have nutrient levels in the Qu'Appelle River and its lakes changed over time?

Nutrient concentrations in the Lower Qu'Appelle lakes are known to have increased from historical background levels up to the mid to late 1970's as a result of various human activities in the watershed, including from wastewater effluent. The upgrade of Regina's wastewater treatment plant in the mid to late 1970's decreased the nutrient load to the Lower Qu'Appelle lakes. The nutrient load from the city of Regina has further decreased with the recent (2017) upgrade to the wastewater treatment plant.

5. What is meant by "nutrient mass balance"?

This study measured both the concentration and the load of nutrients in the Qu'Appelle River. Load is a measure of the mass of nutrients transported over a given time. Load is calculated from concentration and flow. A mass balance approach looks at how nutrient load changes through time and space to better understand sources and sinks (losses) of nutrients transferred within the watershed.

6. What are the sources of nutrients to the watershed?

Sources of nutrients to the watershed can be divided into point and non-point sources. Point sources are discrete additions of nutrients, such as would be found at the end of a pipe, for example effluent from a wastewater treatment plant. Non-point sources are contributions from a diffuse area.

This study did not undertake assessment to understand different types of non-point sources but rather assumed that non-point sources represent the total load minus those from point sources.

7. Do all nutrients that enter the Qu'Appelle River stay within the water of the Qu'Appelle watershed?

No. Ecosystems, through a variety of processes, remove nutrients from water. This includes burial and in the case of nitrogen, removal through a process called denitrification.

8. What are non-point sources of nutrients?

Non-point sources of nutrients include all those nutrients from diffuse sources. This includes overland flow, which in the Qu'Appelle watershed, naturally contains higher level of nutrients. These are derived from soils and dead plants. Nutrients also can be added within the river channel, for example through bed or bank erosion. Other sources of non-point nutrients include those arising from a variety of human activities in the watershed, including various agricultural activities.

9. What does the report say about the contribution of agricultural activities to nutrients in the Qu'Appelle River?

The study did not specifically evaluate agricultural nutrient contributions. Water entering the Qu'Appelle River through its tributaries flows over a landscape where agriculture is the dominant land use. However, the prairie landscape would naturally contribute comparatively high amounts nutrients, more so during periods of high flow, to the river relative to other geographic areas. The difference between the natural load and an agriculturally contributed load is not simple to evaluate and was not done in the study.

10. What are some of the ways that the WSA engages with stakeholders within the Qu'Appelle Watershed?

The Water Security Agency supported the creation of watershed plans, supports ongoing implementation of these plans and is engaged in a technical manner with stakeholder groups in the Qu'Appelle Watershed. The province regulates wastewater treatment systems and has been instrumental in the upgrades and assessment of effects to understand the influence of these activities on the watershed. The provincial Agricultural Water Management Strategy is administered by the WSA, which is working to balance the benefits with the impacts related to agricultural drainage.

11. What are the next steps to inform management of water quality in the Qu'Appelle?

WSA continues to monitor for nutrient concentrations and loads from the outflow of Buffalo Pound Lake to the outflow of Katepwa Lake. This monitoring will provide data to quantify nutrient reductions associated with the recent (2017) upgrades to the Regina wastewater treatment plant. The WSA is working with researchers to better understand the potential reductions in non-point nutrient loading associated with various beneficial management projects.

The WSA is engaged with the Qu'Appelle Basin Research and Monitoring Committee, a committee comprised of watershed planning groups and other provincial stakeholders in the Qu'Appelle Watershed. The WSA is also collaborating with university researchers addressing specific questions related to nutrient dynamics in the Qu'Appelle Watershed. These studies will improve understanding of achievable nutrient reductions and the expected effect of nutrient reductions on size and formation of algal blooms.

12. Does the report indicate that the observed nutrient levels are above acceptable levels?

No, that is not the focus of this particular report. The report assesses nutrient concentrations and loads along the Qu'Appelle River and its tributaries. The Qu'Appelle River, including lakes along the river, are known to be naturally nutrient rich, or in more technical terms, hypereutrophic. While this particular report does not explore "acceptable levels", it is the intention of ongoing studies to set nutrient objectives in the downstream Qu'Appelle lakes based in part on the information from this report and WSA's ongoing water quality monitoring program of those lakes.

13. Does the report indicate that the water quality of the Qu'Appelle system is bad?

No, this was not the intention of this study. Water quality encompasses a large range of variables associated with water, with nutrients being one of them. This report was focused on understanding nutrient sources to the Qu'Appelle Watershed as part of a larger study of updating notional nutrient objectives in the downstream Qu'Appelle lakes. The provincial government undertakes water quality monitoring of provincial beaches within the Qu'Appelle Watershed to ensure the safety for recreational activities.

14. Is the province controlling nutrients to reduce algae blooms which can be problematic under extreme conditions?

Yes, the provincial government issues permits to limit the discharge of point source nutrients within the Qu'Appelle Watershed. These permits, notably the current nutrient targets for Regina's wastewater treatment plant, are amongst the most stringent on the prairies. The provincial government also undertakes various programs to promote and subsidise implementation of beneficial management practices to reduce non-point nutrient loading from human landscape activities.

15. Does the report show that it isn't safe to use water in the Qu'Appelle system?

The intention of the report was to quantify nutrients to better understand the sources, not to evaluate the safety of water within the Qu'Appelle system. Safety for human activities, aquatic life and water suitability for other uses are evaluated/regulated by other monitoring.

16. How low do the nutrients have to go to stop algal blooms?

All lakes have algae growing in them, and at times algae become more abundant. Some algal blooms are clearly visible because they form surface scums, whereas other algal blooms are less visibly apparent because they occur within the water column. This difference is largely a function of the types of algae that are blooming. For example, there is typically a large spring bloom of algae that occurs within the water column of the Qu'Appelle lakes.

These algae form an important part of the food web in the lakes and the productive nature of the lakes is important for the lakes' fisheries. Algal blooms, including summer and autumn blooms with surface scums, are a natural condition of the Qu'Appelle lakes. Lakes with nutrient levels much lower than is practically achievable in the Qu'Appelle system experience these types of blooms. Reducing nutrients may; however, reduce the size and severity of the blooms.

17. Do industrial water withdrawals make the nutrient load worse?

Any water withdrawals remove nutrients along with water from lakes and rivers. This removal of nutrients generally has a small effect on nutrient concentrations.

18. What is a "good" nutrient level for the Qu'Appelle?

Nutrient levels vary along the length of the Qu'Appelle River and in lakes within the watershed. Generally, nutrients are at hypereutrophic levels. The nutrient rich nature of the lakes makes them productive, including a productive fishery. One of the consequences of high nutrient levels; however, is that blue-green algae (cyanobacteria) blooms occur with greater size and frequency. There is no ideal nutrient level for the Qu'Appelle lakes, although the longer-term goal is to reduce the amount of nutrients added to the Qu'Appelle from human activities.

19. What does this report indicate about the safety of the water supply for Regina and Moose Jaw?

The report does not evaluate the quality of water as it relates to a source water for drinking water supplies. Under separate programs the WSA regulates water treatment facilities, including the Buffalo Pound Water Treatment Plant, to ensure it meets drinking water standards.