Policy Analysis and an Overview of Technologies to Manage Agricultural Tile Runoff in Southern Ontario

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Abstract

Runoff from agricultural tiles contains phosphorus and nitrogen particulate, potentially contributing to the issue of algal blooms downstream. The nutrients from agricultural runoff can lead to downstream problems in the Great Lakes, such as harmful cyanobacterial blooms and hypoxia, a zone of oxygen-depleted water devoid of multicellular life. Other issues caused by excess nutrient loading are turbidity in the water which lowers the quality of drinking water, changes in the geomorphology of the stream, disruption of fish migration, and damage to fish gills and organs.

Phosphorus and nitrogen pollution from agricultural runoff is a serious issue in lakes and streams; currently, concentrations in some parts of Lake Erie and Lake Ontario and their tributaries are higher than the acceptable levels. It is clear that by not protecting lakes and streams in Ontario from excessive inputs of sediments, fish habitat, and human and animal health can be affected.

The relationship between agricultural tile drainage and the runoff containing nutrients, and whether best management practices (BMP) measures in Ontario can work efficiently to mitigate this issue are discussed in this paper.

The methods used to determine the effectiveness of the existing policy are an extensive examination of Provincial and Federal legislation, and stakeholder interviews. Five people from four stakeholders were interviewed - municipalities, conservation authorities, farmers and First Nations. The results of this research show that there is a legislative gap where no policy or standards exist to clearly define who is responsible for the capital costs of BMP implementation or the ecological planning for new and existing farms to mitigate runoff.

Foreword

Directly related to my area of concentration, this major paper explores the complex issues relating to policy and enforcement of standards in watershed management as it relates specifically to agricultural tile runoff in Ontario. The learning objectives in my Plan of Study (POS) were the starting point to begin gathering data and information to form the basis of the research. Listed below are the learning objectives:

To gain a working knowledge of the development of agricultural land from the lens of an environmental planner

To obtain a working knowledge of environmental law with respect to enforcement.

To become an expert in the current policy framework on agricultural tiles.

The major research paper addresses fundamental questions and identified gaps in the current policy for agricultural tile runoff. Participants for the major research study were chosen based on their relationship to the land, and their ability to enforce current sediment/nutrient runoff control policies, on a municipal, provincial and federal level.

1. To what extent do agricultural drains contribute to nutrient export?

2. What effective best management practices exist to mitigate export of sediments and nutrients from agricultural fields? Are they cost effective? What maintenance is required? How are capital and maintenance costs financed?

3. How are agricultural drains regulated in Ontario? What regulations are the exemptions? Are there gaps in existing legislation which, if filled, would improve the quality of agricultural drainage?

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Introduction

Description of the Current Issue

Access to clean drinking water is essential to human health. Lakes, rivers, and streams represent 1% of the world's water. (EWB, 2016) Canada possesses 1/5th of the world's fresh water. (WWF Canada, 2016) The Government of Canada bears the responsibility to ensure the protection of this vast natural resource that lies within its borders. Currently, there are many threats to the health of the watersheds in Ontario – one of these threats is nutrient pollution. Several industries contribute to nutrient contamination of source water including farms, gravel pits and mines, urban developments, poorly constructed or uncapped wells, pavement, logging, air pollutants, sewage treatment plants and factories. The focus of this research is to examine farm pollution runoff from agricultural tiles into Ontario watersheds.

Agricultural tile drains are typically plastic or ceramic perforated pipes that remove excess water from the fields where crops are planted. It is the opposite concept of irrigation where water is added; tile drainage removes the excess water leaving crops damp but not flooded. They also allow the field to dry, especially in spring when farmers need to prepare their fields for planting as early as possible. Drainage tiles are installed on farm fields to prevent sheet erosion from occurring. Particulate of nitrogen and phosphorus, but other nutrients and pesticides are also exported into water bodies.

Figure 1. Diagram of agricultural tile drainage system

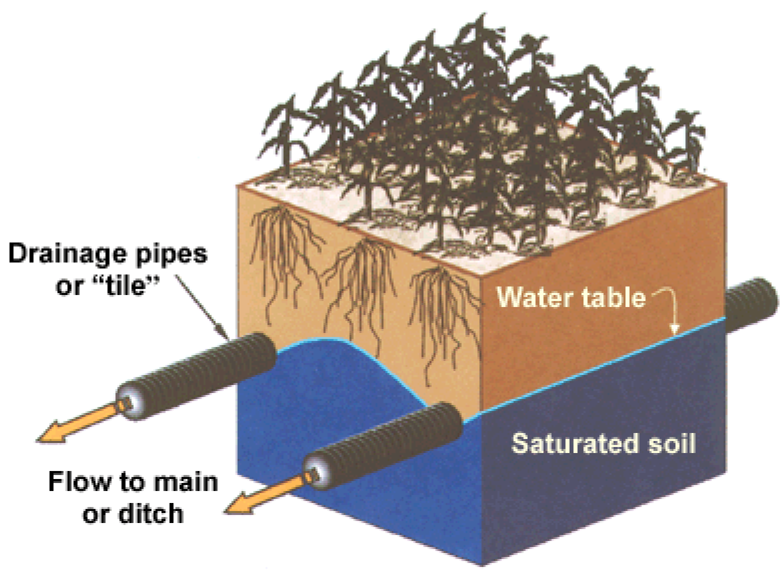
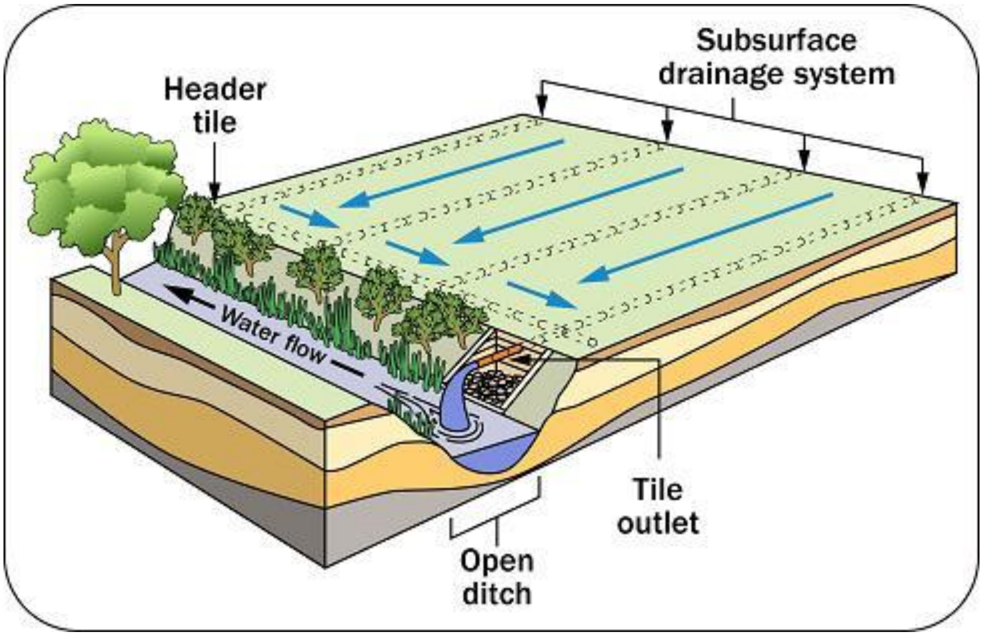


Figure 2. Tile drainage outlet with a vegetated buffer strip to an open ditch



A major cause of pollution of surface waters in southern Ontario is pollution which can deliver nutrients, P (phosphorus) and N (nitrogen), to lakes and rivers that promote blooms of cyanobacteria (a type of algae). Cyanobacterial algal blooms are problematic for drinking water sources because toxins produced by dense populations of some strains can harm animals, humans and aquatic life.

In a recent article published by the New York Times, Tim Davis, an ecologist at the National Oceanic and Atmospheric Agency's Great Lakes Environmental Research Laboratory in Ann Arbor, Mich. was interviewed to discuss the effects of the 33 square mile algal bloom that covered Lake Okeechobee in the State of Florida (Figure 3). One of the final comments that Dr. Davis made in the interview was "A lot of this has to do with legislation, all the way from the watershed down into the lake. It needs to be a mutual effort on all sides…" (Neuhaus, NYT 2016) Similar issues have arisen in the Great Lakes. In 2014, near Pelee Island in western Lake Erie, the largest ever cyanobacterial algal bloom recorded. It was 700 km^2! The algal bloom was so severe that it closed beaches and prevented access to safe drinking water for several days. As a result, there have been collaborative actions taken on both sides of the border under the Great Lakes Water Quality Agreement committing Federal and Provincial governments to an action plan to reduce phosphorus pollution to safe levels. The number one cause of algal blooms in the Great Lakes is nutrient loss from agricultural fertilizer. As a result, the Ontario Great Lakes

Protection Act S.O. 2015 was enacted to address some of these issues on the Canadian side of the border.

It would appear that the same applies to the algal bloom in Florida. "The bloom itself is the visual manifestation of nutrient over-enrichment in lakes," said Tim Davis, an ecologist at the National Oceanic and Atmospheric Agency's Great Lakes Environmental Research Laboratory in Ann Arbor, Mich. "In freshwater systems, both nitrogen and phosphorus are the main nutrients." The effects of the bloom can be devastating to the residents and economy of the region. In coastal towns where residents rely on fishing and tourism, an algal bloom that kills fish and makes people sick depresses a region. It can take months and years to recover from this setback.

Figure 3. Lake Okeechobee Algal Bloom

However, there are other ways that sediment pollution can wreak havoc on source water, including wells and groundwater. Between May 8th and 12th 2000, there was a heavy rainfall in Walkerton, Ontario. As a result, the surface runoff that came from a nearby farm where manure containing *E. coli* and *Campylobacter jejuni* had been spread migrated to a well that supplied drinking water. Seven people died, and thousands of people became ill. Although the well was chlorinated, the amount used was routinely less than the amount required; the bacteria and organic matter overwhelmed the system. (Salvadori et al., 2009) One the key issues was lack of enforcement; the public utility commissioners were making false entries in their daily operating sheets. Some of these deficiencies were attributed to cuts to the Ministry of Environment and climate change (MOECC). In Ontario, the MOECC and the Ontario Clean Water Agency are responsible for enforcing regulation and policy relating to municipal water systems and waste water treatment maintenance. (Salvadori et al., 2009). While tile drains were not implicated in the Walkerton tragedy, it illustrates how heavy rainfall and runoff can transport pollutants into shallow ground waters.

As a result of the Walkerton tragedy, several new pieces of legislation were enacted by the Ontario government including the Safe Drinking Water Act S.O. 2002 and the Nutrient Management Act S.O. 2002. The Great Lakes Protection Act was passed in 2015 but these statutes do not address the tile drainage issue. In spite of these legislative improvements, my review shows that legislation specifically highlighting erosion and sediment control enforcement for agricultural watercourses is lacking.

A survey conducted by Sierra Legal Defense Fund (now Ecojustice) found that none of the provinces were doing a particularly exceptional job across the broad range of issues covered. (Christensen, Parfitt, 2001) There were several issues examined. First the stringency of testing: which contaminants were tested, and how frequently they tested. Second, water treatment: protecting water sources, filtering water, chemically or otherwise disinfecting water with the evaluation based on what the jurisdiction required regarding water treatment. Lastly, operator training and certification: jurisdictions were judged on whether the people and agencies responsible for delivering water to the public were trained up to the proper standards, and if the labs doing the testing were certified. Ontario received the highest score along with Alberta (B grade). One of the notable weaknesses was that there is no statutory provision for watershed or wellfield protection. Erosion and sediment control and discharge from drainage tiles fall under watershed protection.

It is clear that agriculture is a source of physical, chemical and biological pollutants and tile drains facilitate movement of pollutants to surface and ground waters. The objective of this research paper is to examine the current state of practice for mitigating agricultural tile runoff in southern Ontario, and whether the existing legislation is adequate to provide protection to source water. It begins with a description of tile drains and their impacts (Chapter 1). Chapter 2 examines best management practices and costs, and chapter 3 reports interviews with knowledgeable stakeholders, chapter 4 examines policies and identifies policy gaps.

<u>Chapter 1:</u> Snapshot of the Current Research on the Contribution of Nutrient Export due to Tile Drainage.

To what extent do agricultural drains contribute to sediment and nutrient export?

<u>Agricultural Tile Drainage Function and Purpose:</u>

Agricultural tile drainage is artificial drainage, typically in the form of perforated plastic or ceramic pipes used for agricultural management in humid regions. Their function is to ensure that the removal of excess water, as many fields can quickly become flooded causing sheet erosion. Flooded fields can limit a farmer's ability to travel across the fields with heavy equipment and can impair crop production. Even in dryer more arid climates, tile drainage can be necessary as it can route "return flows" away from irrigated lands. (Kleinman et. al 2015)

<u>Nitrogen and Phosphorus Runoff:</u>

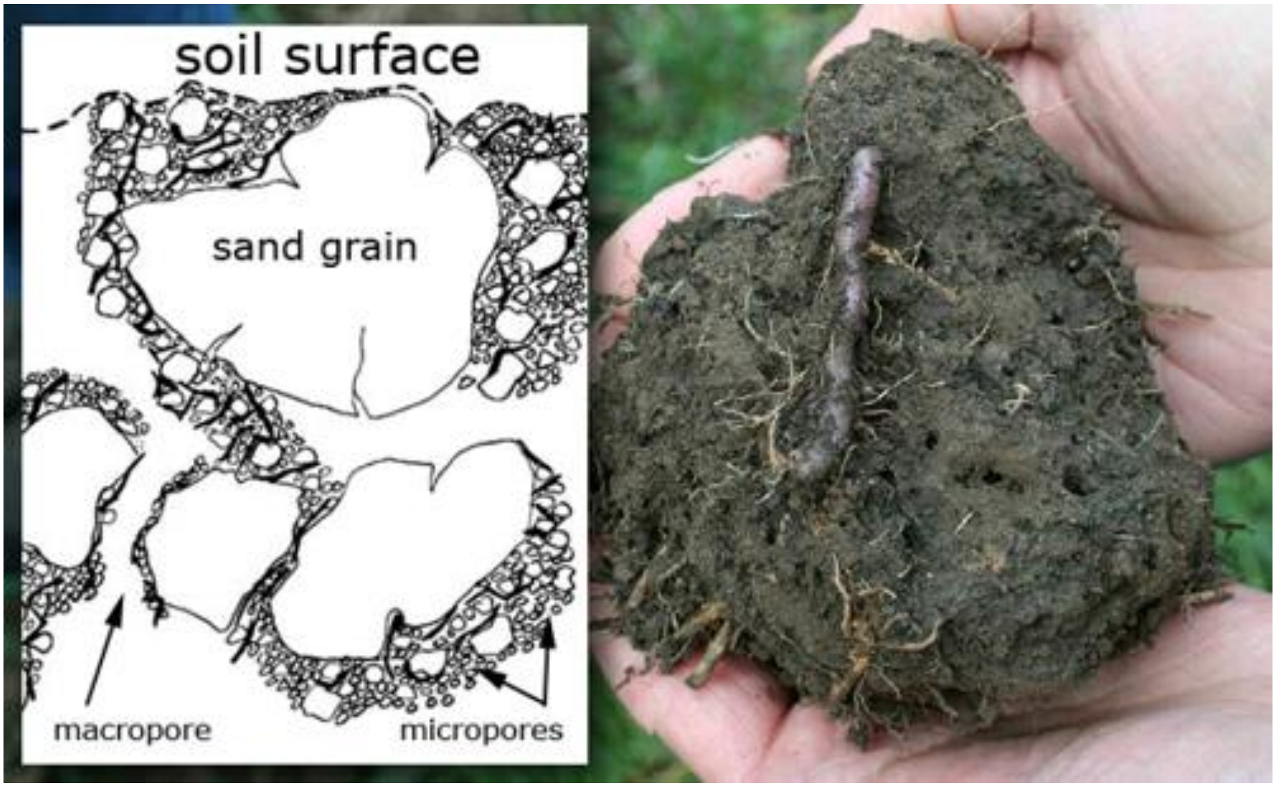
Tile drainage systems are very effective at their task of removing excess water and increasing crop yields. However, the water that is discharged into ditches and streams can be polluted with nitrogen, pathogens, phosphorus, and organic matter (measured as biochemical oxygen demand). (Fleming, Ford 2004). Installing tile drains is better than allowing sheet erosion to occur, but runoff from tile drains causes problems. "Natural, undrained land behaves differently - for example, peak runoff rates as well as sediment and pollutant loading are lower in natural systems than agricultural systems (Skaggs et al. 1994)." "Wall et al. (1982) determined that 0 to 30% of suspended sediment in streams comes from bank erosion, and 70 to 100% comes from cropland sheet erosion." (Fraser, Fleming 2001) Sheet erosion typically occurs when thin layers of soil are removed from fields due to the forces of raindrops and overland flow.

Figure 4. Sheet Erosion

The delivery of sediment to receiving waters is a concern with the use of tile drains. A study completed in 1997 examined transport characteristics of sediment from an agricultural watershed of the Thames River near Kinore using a 5m circular flume, to replicate the use of an agricultural tile drain. (Stone, Krishnappen 1997) "The results show that the tile drain sediments have a tendency to flocculate when subjected to a range of shear stresses." (Stone, Krishnappen) Sediment flocculation is important because it affects particle size and hence their capacity for transport downstream in receiving waters along with pollutants adhering to particle surfaces.

"Xue et al. (1998) reported that tile drains made significant contributions of dissolved phosphorus to the total river load. They also showed that the tile drain load was storm event-driven, with the highest loads corresponding to heavy rain events. Stamm et al. (1998) demonstrated that preferential flow through macropores was contributing to high soluble phosphorus levels in tile drain water under manured grasslands. Phosphorus leaching by preferential flow was also shown by Jensen et al. (1998) in laboratory soil column tests."(Howard et al. 2006) Macropores are defined as earthworm burrows and root channels where P and N can escape to groundwater or be transported to watersheds. "It's difficult for hydrologists, hydraulic engineers, and biogeochemists to determine and quantify the importance of bypass flows (including macropores) on non-point source loss of P from agricultural fields." (Kleinman et al. 2015) Artificial drainage tiles increase flow velocity and create more concentrated pathways of P rather than if left in its natural state, P is dispersed diffusely across the field. (Kleinman et al. 2015, King et al., 2015a; Smith et al., 2015).

Figure 5. Macropores



Another interesting tension reviewed in a scientific journal, "The Journal of Environmental Quality," is whether the benefit of reduced surface runoff of P outweighs the cost of increased P loss in drainage surcharge. (Kleinman et. al 2015) In an intensely cropped area in Indiana and Ohio, a major problem emerged in the drinking water treatment facility in Toledo, Ohio in the summer of 2014. There were cyanobacterium microystis algal blooms that temporarily overwhelmed the water treatment plant. The significant P losses came from glacial till soils drained by surface inlets, drain tiles and ditches. (Smith et al., 2015; King et al., 2015a). "Smith et al. (2015) conclude that as much as 50% of the P loads in a tributary of Indiana's St. Joe's watershed may be derived from tile drainage." (Kleinman et at. 2015) There is also a difference in the quantity of how much P will be transported based on the type of crops grown in the drainage tiled agricultural field. For example, "in Ontario, a study of a long-term (>40yr) cropping systems summarized that dissolved forms of P comprised the majority of total P (72%) in tile drainage." Zhang et al. (2015a) "Grassed systems have the potential to lose up to three times more P through tile drainage systems than a cropped system.”(e.g. continuous corn). (Kleinman et al. 2015)

Quantifying the Loss of P and N through Defined Parameters:

The counter argument to the argument that tile drainage causes P pollution is that the nitrogen runoff is significantly less in tile drainage in comparison to sheet erosion. It depends on the type of soil where the water discharges. For sandy loam soils, the use of tile drains caused a reduction in nitrogen loss. However with clay soils, tile drainage increased P runoff in a study completed for the Vermont Department of Environmental Conservation (Craven et al., 2014) In addition, some chemicals and nutrients, such as pesticides (mostly herbicides) and phosphate are strongly adsorbed to soil constituents. By reducing the number of sediments lost from a watershed by using tile drains, there is a reduction of chemical and nutrient losses. In older literature, tile drainage is an effective method of reducing non-point source pollution in areas where sediment and phosphorus are concerns. Skaggs et al. (1982) Gaynor et al. (1995) Loudon et al. (1986)

Chapter 2 Standards, Best Management Practices, and Capital Costs

What effective best management practices exist to mitigate export of sediments and nutrients from agricultural fields? Are they cost effective? What maintenance is required? How are capital and maintenance costs financed?

What are Best Management Practices (BMP) and how are they financed?

A Best Management Practice or BMP is adopted by government agencies to either prescribe or suggest as an acceptable method of mitigation. There are many different BMPs available for managing tile drains and there is no universal approach. It requires a systems-level approach to managing tile drainage successfully. (Strock et al., 2010) There are several considerations for the management of P loss. Balancing P inputs and outputs at catchment managing applied sources of P to fields is one way to manage P loss, as is (King et al., 2015) agronomic management, (Bergstrom et. al; Han et al., 2015), farm and field scales to minimize legacy sources of P is another method of management (Kleinman et al., 2011) in addition to drainage water management and filtration. (Buda et al., 2013; Nash et al., Zhang et al., 2015a, Kleinman et al., 2015)

BMP Evaluation and Drainage Water

Extensive studies on BMP effectiveness are available for erosion and sediment control and drainage tiles. An article written by R.J. Rickson reviews the scientific evidence of the effectiveness of erosion control measures used in the United Kingdom to reduce sediment loads originating from hill slopes. (Rickson, 2014). Although over 73 soil erosion mitigation steps are identified from the literature, empirical data on erosion control effectiveness are limited. Baseline comparisons for the 18 measures where data do exist reveal erosion control effectiveness are highly variable over time and between study locations (Rickson, 2014). It would appear that it's hard to determine what types of erosion mitigation methods are appropriate to protect watersheds and how to qualify their use given the variability of the empirical data that exists. Although it is an important piece, soil erosion is only a small part of how P can be transported into receiving waters.

One method of dealing with poor water quality in tile drainage is by treating the water at the end of the pipe. An evaluation of many of the practices suggested for the discharge of end of pipe solutions and varied in cost and complication. "There is a general lack of information on hot spots where a BMP's application would prove to be effective." (Stang et al. 2016; Mostaghimi et al. 1997; Bracmort et al. 2004; Nietch et al. 2005; Prokopy et al. 2008; Arabi et al. 2007; Karamouz et al. 2010; Yang et al. 2012; Grady et al. 2013; Jang et al. 2013; Giri et al. 2014; Sattar and Gharabaghi 2015). Examples of best management practices are: drain inlet inserts, bio-filters, media filters, infiltration, and extended detention basins. A limitation of these methods is that they perform well under low flow conditions in removing pollutants; however few had a satisfactory performance under elevated flow conditions. (Fleming, Ford 2004) Hence, agricultural tile systems that can control the water flow entering the watershed to prevent high-velocity flow would be desirable.

Changes in the seasonal distribution and amounts of precipitation levels have an effect on nutrient export. "Various researchers have studied the seasonal impact on tile water nutrient levels. Bjorneberg et al. (1996) found that 45 to 85% of the annual nitrate-N losses through subsurface drainage occurred in the spring and fall, corresponding with times when crops were not growing, as well as with changes in rainfall and drain flow.

Tillage

Legacy P is P from previous fertilizer applications that has left P deposited in sinks and stored within the soil. One proposed method of addressing legacy P is through tillage. The thought is that tilling helps to dilute high P concentrations at the surface of the ground, breaking macropores that connect the elevated levels of P at the surface with drainage channels and bringing sources of P sorption capacity from the subsoil to surface. (Sharpley, 2003; Shipitalo et al., 2000) In heavily P saturated soils with legacy sources of P in the subsoil (>20 cm), deeper forms of tillage may be required to see a benefit from this practice. (Han et al., Kleinman et al., 2015)

Figure 6. Tillage as a BMP

Figure 7. Controlled Drainage

Mitigating P in Return Flows in Irrigated Fields with Drainage Tiles

Return flows from irrigated fields can be sources of P to downstream water bodies. "In the Upper Snake Rock watershed (Idaho) case study done by Bjorneberg et al. (2015), water diverted from the Snake River annually supplied 1.1 kg per ha – 1 of total P to the 82 000 ha irrigation tract, while return flows contributed only 0.71 kg per ha-1 of total back to the Snake River. This reduction in P shows the potential for conservation practices to improve quality – specifically for highly irrigated systems." (Kleinman et al., 2015) One of the methods that have been shown to be effective for conservation is changing "furrow irrigation to sprinkler irrigation. Furrow irrigation contributes high concentrations of P-laden sediment in the return flow."(Bjorneberg et al., 2006) Dispersing the water using sprinkler irrigation does not allow any area to become overly saturated, and therefore does not allow sediment containing P to migrate to the return flow. "Water quality ponds designed to mitigate sediment and P losses from the watershed are also effective at reducing P losses from 25% to 75% from the watershed, although they little effect on dissolved P."(Kleinman et al., 2015)

Two methods are used to estimate reductions in P runoff: monitoring and modelling. The limitations of field monitoring are: expense, time consumption, and it only provides information based on the specific parameters of the experiment, i.e., extrapolation can be problematic. Models can predict the outcome of different scenarios that would be near impossible to simulate in field monitoring. (Stang et al. 2016)

Controlled Drainage

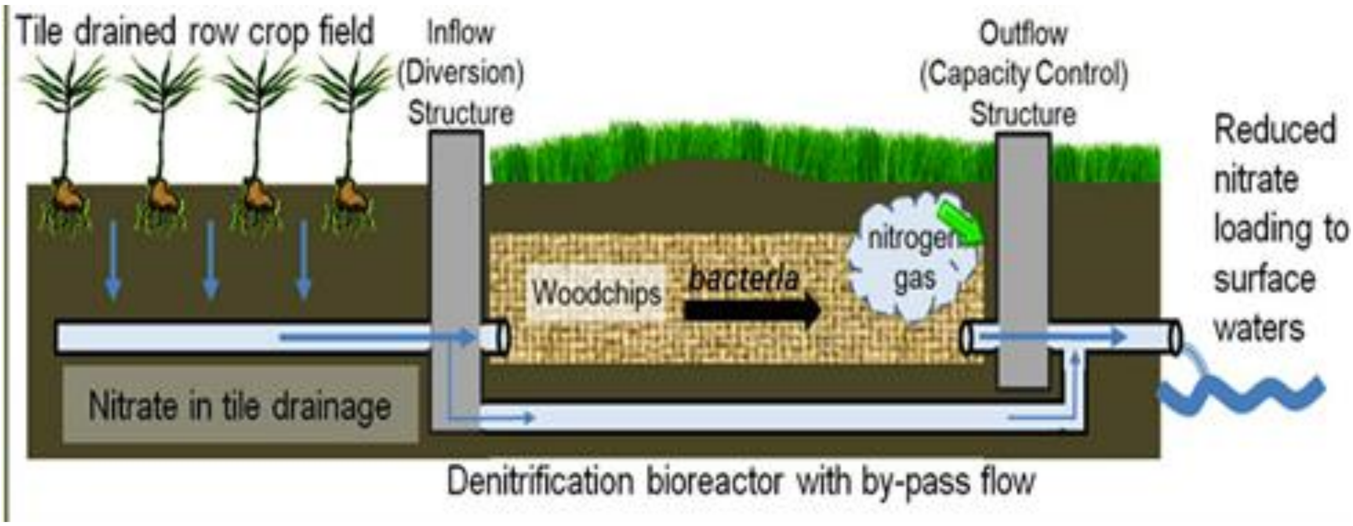
Some forms of controlled drainage use coffer dams to regulate the velocity of water. A coffer dam is a structure that retains water and soil, allowing the enclosed area to be pumped out and excavated dry. Coffer dams have been shown to reduce annual drainage losses of N, due to less volume of discharged water from the fields. However controlled drainage is less effective at decreasing dissolved P due to the microbially "reductive dissolution of particulate iron hydroxides during periods of water stagnation." (Kleinman et al., 2015) A downside of this form of mitigation of controlled drainage is the risk of "elevated water tables which could increase dissolved P loss in subsurface drainage." (Kleinman et al., 2015) There was a study completed of this phenomenon where elevated water tables produced by drainage water management increased P export in subsurface drainage following the reductive dissolution of iron-bound P in waterlogged soils. (Kleinman et al., 2015, Sanches Valero et al., 2007) The key issue with the effectiveness of controlled drainage is typically when drains are free flowing in the spring, however in field trials there are some significant benefits documented, including reduced P loss and improved yields. (Kleinman et al., 2015)

Another interesting BMP is the combination of controlled drainage with sub-irrigation and free drainage. A study completed by Zhang et al. (2015b) determined that this combination could be an effective means of preventing all forms of P loss (dissolved and particulate) from tile drainage. However, "swine compost added to the fields overwhelmed the benefits."(Kleinman et al., 2015) Nutrient management must be considered in conjunction with controlled drainage. (Kleinman et al., 2015) Sub-irrigation on its own is not a BMP; in fact, a study monitoring tile drains in Quebec by Stampfli and Madramootoo (2006) suggests that "sub-irrigation can substantially increase dissolved P concentrations in tile discharge." (Kleinman et al., 2015) Sub-irrigation and tile drainage should be combined only with careful consideration. (Kleinman et al., 2015)

Bioreactors

A new method of BMP that has garnered attention is the use of denitrifying bioreactors to remove nitrate from tile drainage. There has been some research completed to evaluate different bioreactor designs to partner with P removal. (Kleinman et. al., 2015, Bock et al. 2015) The study included nine laboratory-scale bioreactors with and without biochar originating from hardwood and pine materials. (Kleinman et al., 2015) The results showed that the use of biochars in the bioreactors "lowered dissolved P concentrations by 65% over 18h compared to 8% increase in dissolved P levels within the bioreactor with no biochar after 72 hours." (Kleinman et al. 2015) These biochars "decreased nitrate concentrations, by 86% after 18 h and 97% after 72 h, on average, compared with only 13% at 18 h and 75% at 72 h in the control study." (Kleinman et al., 2015, Bock et al., 2015) The results are significant: Bock et al. (2015) showed that using biochar is an attractive and effective method to reduce N and P concurrently from the discharge from drainage tiles. (Kleinman et al., 2015)

Figure 8. Bioreactor with Woodchips



Conveyance Structures

Another BMP that has been used traditionally in the past to reduce nutrient contamination from runoff entering the watersheds are ditches. The type of ditch and geometry are the main determinants of how effectively it will function to convey water, sediment, P and N. One design used is a two-stage ditch which is trapezoidal to support a stable bench within the ditch. As a result, widening the ditch reduces velocity of drainage flows and promotes sedimentation on the bench. (Powell et al., 2007, Strock et al., 2010) Another consideration is vegetation in the ditch which serves a double function: bank stabilization and trapping sediment. (Moore et. al., 2010) However, vegetation has its drawbacks also, as it can affect the hydraulic function of a ditch by creating impoundments during peak flows, causing a reduction in drainage flows. (Kleinman et al., 2015) Some researchers argue that there is potential for the impoundments in drainage ditches to promote sedimentation and hyporheic exchange that may reduce particulate and dissolved P losses. (Pierce, R.Kroger, 2011). This practice can also fall under the category of constructed wetlands, and could be considered "entrained wetlands."

Figure 9. Conveyance Structures

Capital Costs, Maintenance and Responsibility

The use of BMP's can be effective, however, without the right framework, their potential benefit can be mitigated. "Installation of structures without the adoption of associated management behaviors may produce no net benefit to watershed goals." (Jackson-Smith et al. 2010) Even with incentives where there are benefits to the end user, it doesn't always result in a positive result. "The use of cost-sharing does improve the rate of implementation and maintenance but to a smaller degree than we initially expected. In this watershed, practices targeted at crop production practices and irrigation systems had lower implementation rates than some of the practices aimed at livestock systems and riparian area protection." (Jackson-Smith et al. 2010)

The structure of funding in Ontario is a loan program for agricultural tiles, which allows farmers to purchase the necessary infrastructure for crop production over a long term period. Farmers are eligible for a 10-year loan up to 75% of the expense of the agricultural tile drainage system through OMAFRA (Ontario Ministry of Agricultural, Food and Rural Affairs) Farmers are also eligible to receive a full HST rebate. However, there are no such loans available for BMPs relating to tile drainage and it is unclear who is responsible, the farmers or the municipality or the conservation authority to provide the funding for the BMPs.

In Ontario it is the municipalities who are responsible for the creation and maintenance of drainage channels for agricultural fields. For new ditches or repairs, the Drainage Act makes grants to municipalities on agriculturally assessed lands for one third of the costs in Southern Ontario, and two thirds of the costs in Northern Ontario. (OFA, 2017) However, BMPs are not addressed in the existing legislation and it is unclear if municipalities and the provincial government are willing to pay for BMPs like coffer dams, bioreactors and conveyance structures. In the next chapter, the stakeholders are interviewed and the discussion continues from four different perspectives.

Chapter 3

Study of Stakeholders in Southern Ontario Watersheds

A structured questionnaire was used to determine if the existing legislative framework for agricultural runoff in southern Ontario watersheds is effective. First Nations and farmers were given identical questions. Municipalities and conservation authorities were also given identical questions. The persons interviewed were found through cold calling, conferences, and referrals with each organization. Although the questionnaire was structured it allowed for discussion with each of the interviewee's, this information was used for further analysis and discussion.

Methods

All of the interviews have been recorded and transcribed. The analysis of the material was completed by sorting the responses to questions about existing and potential legislation into a systematic matrix. The matrix includes responses grouped into 5 general questions labelled A to E:

A. It/they is/are clear/accessible/responsive.
B. It/they is/are mostly clear/accessible/responsive
C. It/they is/are somewhat clear/accessible/responsive
D. It/they is/are not entirely clear/accessible/responsive
E. It/they is/are not clear/accessible/responsive

The wording of each question differed slightly depending on which of two categories the interviewee was in.

The questions for Farmers and First Nations were:

A. Is it clear what your responsibilities are for ensuring erosion and sediment controls around drainage tiles?
B. Is it easy to access the information?
C. How responsive is the Conservation Authority to inquiries?
D. How responsive is the Municipality to inquiries?
E. Do you understand the implications of nutrient transport into the receiving waters?

The questions for Municipalities and Conservation Authorities were:

A. Is it clear what your responsibilities are for enforcing legislation with respect to erosion and sediment control surrounding agricultural tiles are?
B. How responsive are private land owners to requests to improve erosion/sediment controls around watercourses?
C. Are there by-laws to address any gaps in legislation that could lead to unwanted sediment pollution into sensitive watercourses?
D. What are the enforcement mechanisms available? Do you have inspectors?

E. How is your interaction with the conservation authority/municipality? Are there gaps in legislation that require a collaborative approach?

Description of the Municipalities being interviewed:

- Municipalities with a population over 100 000 people. The ideal candidates were inspectors or contract administrators who have drainage and erosion control included in their responsibilities. This could include water resources engineers, inspectors, and potentially environmental planners.

Description of the Conservation Authorities being interviewed:

- Conservation authorities with a population over 100 000 people. The ideal candidates were water resources engineers, planners and inspectors who have a vested interest in understanding agricultural runoff and the implications of sediment and total suspended solids (TSS) into watercourses.

Description of the Agricultural Land Owners being interviewed:

- Farms with significant watersheds on their property. Agricultural land owners who have installed tile drainage for their crops. The ideal candidate was the owner or their staff or tenants who work the land, and maintain the drainage tiles.

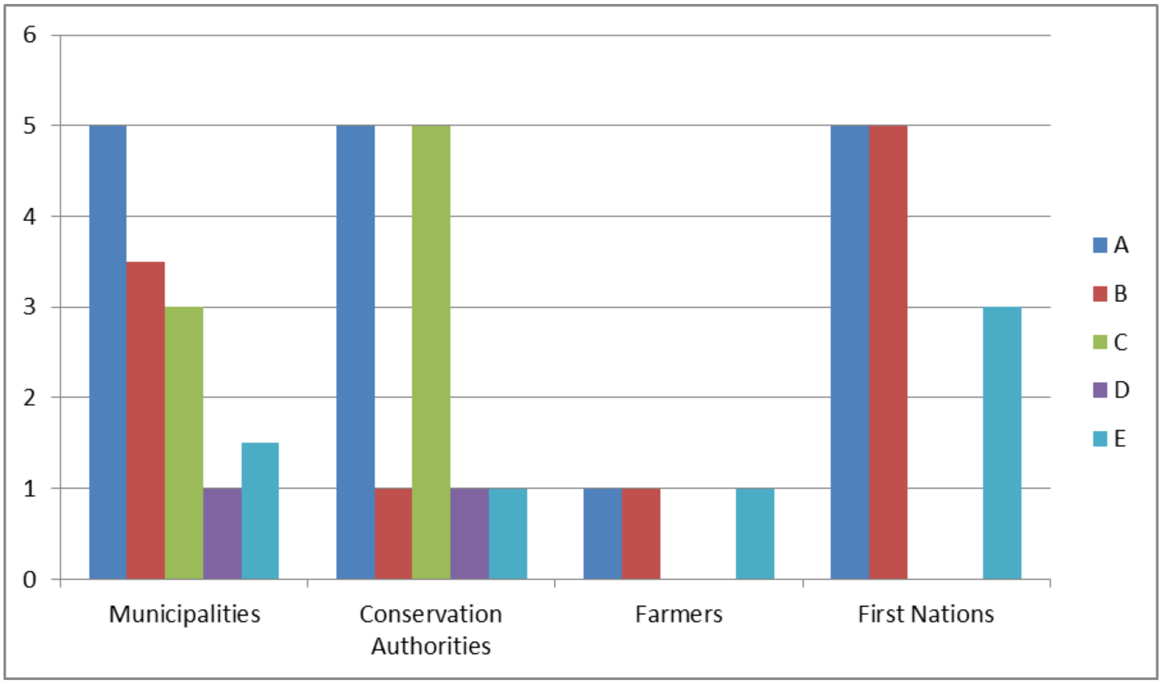
Description of the First Nations persons being interviewed:

- Communities with significant watersheds on their reserves. Chiefs or First Nations people who work the land, and maintain the drainage.

<u>Results:</u>

Five respondents agreed to be interviewed for this study (2 municipalities), 1 Conservation Authority, 1 farmer and 1 First Nations person It is important to note that while the small number of respondents is not adequate to be conclusive or to base decisions, it does provide a basis for further research and identify trends that warrant further exploration.

Figure 10 – A Graphic Analysis of Answers



The averages of the two municipality's answers were used in the data in order to chart the results. For answers that were not applicable to the interviewee, they were not recorded as data.

Municipalities

The municipalities had some variances in their responses; however the one answer that they both agreed on was that it was unclear what their responsibilities were for enforcing erosion and sediment controls surrounding agricultural drainage. Their answers with regards to the responsibilities of the landowners varied as well, although not by much. They used different methods to deal with the landowners, in some cases the municipality takes it upon themselves to install the BMPs at their cost to ensure that the installation is completed correctly, citing that it is cheaper for taxpayers and protects their infrastructure in the longer term. Another experience described was that some landowners are resistant to certain solutions, such as adding a riparian strip as it can remove land from agricultural production. The municipalities agreed that if a permit is required then the landowners must comply. When it comes to by-laws, site alteration by-laws were one area that a municipality could provide some provisions for unwanted sediment pollution. Another option was to partner with the local conservation authority and use their guidelines for ESC. Both municipalities were knowledgeable about what the enforcement mechanisms are, and had access to inspectors. In one case, a dedicated staff member went and did inspections solely for erosion and sediment control. The interactions with the local conservation authorities were described as amicable and collaborative.

Conservation Authority

Similar to the response from the municipalities, it was not clear what their responsibilities are when it comes to enforcement of erosion and sediment controls surrounding agricultural tiles. For the question about the responsiveness of private landowners, the answer was that most are responsive as it is a day to day routine permitting exercise. A by-law would be made when a connection is triggered, for example if a tile drain was draining into a wetland or watercourse, however the conservation authority interviewed did not see many permits for this application. The **Conservation Authorities Act R.S.O. 1990** describes the responsibilities of the conservation authority under s.28 with regards to site alterations, regulated areas, areas of interest, river and stream valley's, watercourses, protecting property and life, wetlands, and shorelines of the great lakes. A full time enforcement team works for the conservation authority and they are there to ensure that work is being done in compliance with the permits. However, they are limited by the current legislation as they do not have the ability to issue stop work orders, and going to court is very costly. The maximum fine is $10,000 which is not a big deterrent for some private landowners. The typical relationship between the conservation authority and the municipality for a Planning Act application is that they will circulate to the conservation authority the ones that fall within area`s that are regulated by the conservation authority, such as flood plains, wetlands, lands adjacent to watercourses, because the conservation authority is a public commenting body under the **Planning Act R.S.O. 1990** and a service provider to municipalities for meeting Provincial policies. Comments are made on the applications and always have the test of the Conservation Authority Act regulation in mind. At the same time, the development in principle will be commented on. If it looks like they will need a permit in order to do the work after it gets approved by the municipality it would be flagged that regulation activities proposed may require a permit under the CA regulations.

Farmers

It is clear that the interviewee knew what was required by the province and stated that it is in their best interests to follow the guidelines. This particular farm has an environmental farm plan and vegetated grass strips that are installed in next to the drainage tiles, berms and catch basins and are added as needed. Information was easy to find, both on the phone and on the internet. The province is the governing body, so they do not interact with the CA and Municipality. There has been a lot of education and outreach about nutrient runoff to the farming community, and the interviewee had been to three different sessions where the subject had been discussed.

First Nations

The interviewee stated that it is not clear what their responsibilities are and there is a lack of environmental legislation, a regulatory gap, hence there is no guidance. Everything is done voluntarily by First Nations farmers with the standards and information that they can find through networking with other agricultural groups that are beyond the reserve. For example, they attend meetings and share the information when they return. The interaction with the conservation authority (CA) is somewhat collaborative, and CA's will provide advice, however they can't do any work on the reserve as the CA's are not mandated to do so. As for the municipalities, there is not much involvement; however they can provide letters of support if requested. There is some education happening internally on this particular reserve, in fact they were hoping to go forward with a phosphorus reduction pilot project to see if there was some new technology that could help but, unfortunately they were not successful in receiving the funding. The farmers on the reserve are aware of the issues of nutrient runoff and want to know what they can do to prevent it.

Discussion

The results of the interviews provided some information with respect to the current state of practice with five interviewees from four different stakeholders. It appears that for all of the stakeholders with the exception of the farmer, their responsibilities for enforcing or following legislation with respect to agricultural runoff from drainage tiles were somewhat unclear.

It also seems that there are differences between private landowners when it comes to accepting the guidelines and ESC recommendations. Permits seemed to be a motivating factor for some landowners. By-laws can be created by a municipality – not by conservation authorities, however they didn't seem to need them in most cases. It was mentioned that the penalties are not much of a deterrent to some landowners perhaps because they are not large enough.

The municipalities and CA's were all adequately equipped with inspectors and knew their responsibilities. All of the participants reported a collaborative effort with the other stakeholders, and there did not seem to be any unease in their interactions.

On First Nations lands it appears that they are making the best possible effort to address tile drainage as effectively as they can with minimal support. This is an area that can be researched and further explored, as it does not seem equitable that they are not able to access the same resources as the rest of the province. The streams and rivers that run through First Nations lands drain into the Great Lakes, the same Great Lakes that experience cyanobacterial algal blooms. To be clear, First Nations lands are governed under federal legislation. However, the existing federal legislation is woefully inadequate and it warrants further review outside of the confines of this research paper.

It was encouraging to see that there has been educational outreach to farmers to share information about nutrient runoff and the deleterious effects. It was also encouraging to see the municipalities who took nutrient and chemical runoff seriously and hired a full time inspector to monitor construction sites as well as agricultural fields.

Chapter 4 – Policies and Management Tools

How are agricultural drains regulated in Ontario? What regulations are the exemptions? Are there gaps in existing legislation which, if filled, would improve the quality of agricultural drainage?

How are agricultural drains regulated in Ontario? What are the exceptions?

There are three major groups of legislation that affect agricultural drainage, federal, provincial and municipal. The governing bodies for water regulation in Ontario are the Ministry of the Environment and Climate Change (MOECC), and the Ministry of Natural Resources and Forestry (MNRF). The local conservation authority in each region and the municipality are given powers to make by-laws and to uphold them. Conservation Ontario is the governing body that oversees all of the conservation authorities in Ontario. For farmers the Ministry of Agriculture, Food and Rural Affairs is the governing body. In some cases, an inspector is hired to check the properties to ensure that farms are compliant with the regulations. However, in many understaffed municipalities and conservation authorities, if it is not implicitly regulated an inspector will not be discharged to the field.

One of the tensions observed is the power dynamic between the municipalities and the conservation authorities when it comes to the enforcement of following guidelines for erosion and sediment controls, storm sewers and agricultural drainage tile runoff into sensitive watercourses. Often there is a lack of continuity from the recommendations made by the conservation authorities to the end user. An example, such as a farmer or developer making changes to their land and the local municipality given the powers of enforcement versus the conservation authority can create tension. An example of this tension recorded in a recent planning document from the Town of Milton, where there is thinly veiled criticism over the roles that the conservation authority plays in some of the permitting and cost implications of the inspection and maintenance of stormwater facilities. (Koopmans, 2015)

"However, opportunities exist, as part of this review, to improve CA processes and programs, as well to clarify the roles and responsibilities of CAs in land use planning and development. Town staff acknowledges that there have been moments of conflict among public agencies in terms of areas of jurisdiction, and clearer direction through the CA Act may alleviate some frustrations. This would also lead to an improved relationship between municipalities and local CAs, as it would increase efficiency, reduce/eliminate duplication of efforts, and reduce the potential for conflict." (Koopmans, 2015

Types of regulations, effectiveness, and implementation

There are many kinds of regulations that are used for environmental controls around watercourses in Ontario. Several of the Acts that are analyzed further in this chapter use different variations of these types of regulations.

Performance Based Regulations

This is a popular type of regulation that allows the end user to be creative in meeting the requirements for the desired outcome stipulated by the regulation. This could involve a technology that produces the desired outcome to be met while reducing costs to the user. It also allows for innovation to take place that does not compromise the standard set forth. An example of this type of regulation would be the minimum acceptable concentrations for various chemicals in Canadian Federal guidelines. (Kete, 1994)

Incentive-based regulation (Market-based Instruments)

These types of regulation place a cap on the amount of pollution that is accepted and can limit the permitting. It also provides an economic incentive for achieving reductions in pollutions to the end user. One of the arguments against this type of regulation is that it gives the public a license to pollute. (Guerin, 2003) This type of regulation has been implemented in Quebec under a Cap and Trade system, and is being proposed in Ontario.

Command and control (CAC) regulation strongly relies on the use of standards to uphold the quality of the environment. Command represents the standards that the government sets as an expectation for industry to meet. Control represents the negative consequences that may result in prosecution if the standards are not met. (Guerin, 2003) It is a prescriptive type of regulatory instrument in nature and does not leave itself open to alternatives. The Montreal Protocol is an example of the use of CAC regulation internationally being used successfully to eliminate CFC's in order to stop the depletion of the ozone layer. This form of regulation has been criticized for restricting technology, since the lack of incentive does not motivate the end user to innovate. (Guerin, 2003)

Tax

This type of instrument is used to dissuade users from using a pollutant by adding a maximum tax rate to the maximum amount. There is no cap on users, but financially there is a big tax imposed for using excess amounts of a pollutant. The gas tax in British Columbia is a good example of a tax being used to control the use of a polluting substance.

Gaps in Current Legislation

The method of analysis to learn if there was a legislative gap in this area of research was done by first, reviewing all of the current provincial and federal acts pertaining to drainage or sediment control. Next, a stakeholder interview to learn if the existing legislation was functioning in protecting source water from nutrient runoff originating from agricultural tiles.

There was no legislation identified specifically highlighting erosion or sediment control enforcement for agricultural operations in Ontario. Many policies dedicated to addressing erosion and sediment control are directed at the development industry, for example, but are not applied towards the agricultural sector. Farms are not subjected to the same by-laws that other industries are in many Ontario municipalities. An example would be having and erosion and sediment control plan for a new development for the developer to receive their permit from the municipality to build, whereas when a farmer is disturbing the soil through tilling their fields no such permit or plan is required (understandably). An important difference between the development industry and farming is that developments are a onetime project, as opposed to a repeated activity.

A relevant piece of legislation concerning farm runoff is The Drainage Act R.S.O. 1990. Currently under The Drainage Act R.S.O. 1990, drains can still be constructed in wetlands under the Provincial Policy Statement in Ontario. If the wetlands are full of runoff from tile drains they will be full of pollution from nitrogen and phosphorus. Consequently, if the wetlands are inadequately protected using erosion and sediment control measures, the nutrients from these wetlands can migrate to streams, leading to the lakes.

Agricultural operations are also exempt from some provisions requiring notification of activities with the Environmental Registry under Ontario's Environmental Bill of Rights (EBR). "The EBR allows the public certain rights such as the right for notification, right to review and comment, right to appeal a ministry decision, right to apply for a review, right to apply for an investigation, right to sue and whistleblower protection. Under the NMA (Nutrient Management Act) citizens are not allowed to apply for investigations, nor do they have right to sue farm operations (Holtslander, 2010)."

Even if command and control legislation to control runoff from tile fields were enacted, it would probably require a large increase in staff to inspect and enforce.

New legislation recently ratified, The Great Lakes Protection Act R.S.O. 2015, addresses some of the concerns left out of the Drainage Act, yet there are still gaps. For example, wetlands are an area that needs further protection. The Great Lakes Protection Act R.S.O. 2015 requires the Ministry of Environment to set at least one target per year to support the reduction of algal blooms; it also provides the Ministry of Natural Resources the power to establish a target with respect to preventing the net loss of wetlands. All of these goals will require a plan outlining actions. The Ministry can appoint a public board to provide information and determine whether the actions are appropriate to meet the target. Much of the legislative emphasis has been on studying the effects of cyanobacterial algal blooms in freshwater systems; however, less research has been conducted to examine agricultural runoff and how it may contribute to the growth of algal blooms.

Another area that has received minimal examination is the streams, rivers, and lakes contained within First Nations owned lands. Based on the poor drinking water quality in many reserves, it will be interesting to learn what the factors are leading to contamination. Are there are other sources upstream that are contributing to the pollution, potentially from lack of funding for BMPs with regards to nutrient runoff? There is a process that the conservation authorities adhere to when undertaking flood control measures on First Nations lands by environmental assessments. However, it is not clear whether the same Ontario standards for source water protection apply to their lands.

Even if existing policies appear adequate, the effectiveness of enforcement of erosion and sediment controls is not guaranteed. A recent study conducted an examination of the quality of stormwater in the Lake Simcoe watershed during construction activities and current regulatory policies put in place to mitigate the effects of total suspended solids in the basin due to sediment pollution containing phosphorus. (Eric, Li, 2015) Many municipalities and cities in Ontario and British Columbia have enacted by-laws through either site alteration regulations or erosion and sediment control plan submissions to protect their watersheds, yet many watersheds remain vulnerable phosphorus and other contaminants as sufficient policies do not exist. (Eric, Li, 2015). Currently, there is no formal legislation specifically prescribing BMP's to treat the runoff from agricultural tiles. Although not directly related to source water protection or agricultural runoff, noteworthy is that farmers are not obligated to protect endangered species on their lands per O.Reg 248/08 of the Endangered Species Act in Ontario. Included is the destruction or damaging habitat for the endangered species. It is curious that farmers are provided these exemptions while other industries are not.

Levels of Legislation

Federal Legislation:

Department of Fisheries and Oceans – The Fisheries Act. 1985 (with changes in 2012/13) Although erosion and sediment control are not stated as a prescriptive measure, the Fisheries Act has the power to regulate deleterious substances (including sediment) in water bodies. "Through the Act, DFO has the authority to develop regulations prescribing quantities or concentration of substances, classes of substances permitted in water or water treatments, and processes and changes in water that support the management of deleterious substances within watersheds (S. 34[2]). Should any individual become aware that a deleterious substance has or may reasonably be expected to be deposited into a water body that inspectors or fisheries officers must be notified. (S. 38[5])

Provincial Legislation – Critical Analysis:

Provincial legislation relevant to erosion, sediment control and tile drainage, and source water protection in Ontario is listed below with pertinent excerpts from each piece of legislation. Under each Act, there are comments and an analysis of how each may pertain to managing agricultural sediment runoff from tile drainage.

Environmental Protection Act R.S.O. 1990

Spill prevention and spill contingency plans

91.1 Every person who belongs to a class of persons prescribed by the regulations shall, in accordance with the regulations, develop and implement plans to,

(a) prevent or reduce the risk of spills of pollutants; and

(b) prevent, eliminate or ameliorate any adverse effects that result or may result from spills of pollutants, including,

(i) plans to notify the Ministry, other public authorities and members of the public who may be affected by a spill, and

(ii) plans to ensure that appropriate equipment, material and personnel are available to respond to a spill. 2005, c. 12, s. 1 (14).

<u>Analysis:</u>

The Environmental Protection Act does not specify types of pollutants per 91.1 (b). Pollutants could include nutrients from farm fields although they are not considered 'spills' under the Act. Sediment discharged into streams can contain heavy metals and could lead to unsafe levels of TSS (total suspended solids).

Ontario Water Resources Act. R.S.O. 1990

Supervision of waters

s. 30 (2); 2006, c. 19, Sched. K, s. 3 (2). 29. (1) For the purposes of this Act, the Minister has the supervision of all surface waters and ground waters in Ontario. R.S.O. 1990, c. O.40, s. 29 (1).

Examination for pollution

(2) The Minister may examine any surface waters or ground waters in Ontario from time to time to determine what, if any, pollution exists and the causes thereof. R.S.O. 1990, c. O.40, s. 29 (2).

Injunction to prevent pollution of water

(3) Where any person is discharging or causing or permitting the discharge of any material of any kind into or in or near any waters that, in the opinion of the Minister, may impair the quality

of the water in such waters, the Minister may apply without notice to the Superior Court of Justice for an order prohibiting such discharge for such period not exceeding twenty-one days and on such terms and conditions as a judge considers proper, and such order may, on application to the Court, be continued for such period and on such terms and conditions as a judge considers proper. R.S.O. 1990, c. O.40, s. 29 (3); 2001, c. 9, Sched. G, s. 6 (50).

Discharge of polluting material prohibited

30. (1) Every person that discharges or causes or permits the discharge of any material of any kind into or in any waters or on any shore or bank thereof or into or in any place that may impair the quality of the water of any waters is guilty of an offence. R.S.O. 1990, c. O.40, s. 30 (1).

Ministry to be notified when polluting material is discharged or escapes

(2) Every person that discharges or causes or permits the discharge of any material of any kind, and such discharge is not in the normal course of events, or from whose control material of any kind escapes into or in any waters or on any shore or bank thereof or into or in any place that may impair the quality of the water of any waters, shall forthwith notify the Ministry of the discharge or escape, as the case may be. R.S.O. 1990, c. O.40

Analysis:

The Minister is given powers to supervise all surface water and ground water. This statement is left broadly defined per s. 30 (2); 2006, c. 19, Sched. K, s. 3 (2). 29. (1). The next clause goes into further detail by stating that from time to time the Minister may examine surface waters and groundwater for pollution. s. 30 (2); 2006, c. 19, Sched. K, s. 3 (2). 29. (2) P and N laden sediment particles or dissolved P could fall under the category of discharge escaping into receiving waters that could cause the water quality to become impaired. If a farm field runs off into a watershed leading to streams and lakes, it could then lead to a contravention of this Act.

Planning Act R.S.O. 1990

Regulations concerning the development permit system

70.2 (1) The Lieutenant Governor in Council may, by regulation,

(a) establish a development permit system that local municipalities may by by-law adopt to control land use development in the municipality; or

(b) delegate to local municipalities the power to establish a development permit system upon such conditions as may be set out in the regulation. 1994, c. 23, s. 46.

Analysis:

This legislation is important as it establishes that a local municipality can have the powers to create a permit system for development, which often includes an erosion and sediment control plan for the construction phase. The Planning Act does not currently apply to agriculture.

Conservation Authorities Act R.S.O 1990

Regulatory power of the Office in respect of its area of jurisdiction

28. (1) Subject to the approval of the Minister, the board may make regulations for the area over which it exercises jurisdiction,

(A) restrict and regulate the use of water in rivers, streams, inland lakes, ponds, marshes and natural or artificial depressions in rivers or streams;

(B) prohibit or regulate the rectification, alteration or diversion of an existing channel of a river, stream or other watercourse, or change of marshy land, or any interference with that channel Or marshland, or require the permission of the Office for any of these purposes;

(C) prohibit or regulate a development or require the authority of the board to make a development if, in the opinion of the board, the development may have an impact on the control of flooding, erosion, the dynamism of beaches or pollution or the protection of the land;

(D) providing for the appointment of officers to enforce regulations made under this section or section 29;

And (e) respecting the appointment of persons to act as agents and with all the powers and duties of agents to enforce the regulations made under this section. 1998, chap. 18, annex I, art. 12.

Analysis:

S.28.(1)(C) clearly states that the conservation authority can prohibit or regulate development that may have an impact on erosion or pollution within its jurisdiction areas. Pollution is left open to interpretation, and sediment pollution with P and N nutrient loading can fall under this clause. Also, inspectors or agents to enforce regulations are empowered by S.28 (1) (D)

Lakes and River Improvement Protection Act. R.S.O. 1990

Throwing matter into lake or river in conflict with purposes of Act

36. (1) No person shall throw, deposit, discharge or permit the throwing, depositing or discharging of any substance or matter in a lake or river, whether or not the lake or river is covered by ice, or on the shores or banks of a lake or river under circumstances that conflict with the purposes of this Act. 1998, c. 18, Sched. I, s. 36; 2009, c. 33, Sched. 22, s. 5 (2).

Order to remove

(2) If any substance or matter is deposited, thrown or discharged in a lake or river or on the shore or banks of a lake or river in circumstances that the Minister considers conflict with the purposes of this Act, the Minister may order the person who did the act or caused it to be done to take such steps, within the time specified in the order, as the Minister considers necessary to remove the substance or matter from the lake or river or the shore or bank, as the case may be. 1998, c. 18, Sched. I, s. 36; 2009, c. 33, Sched. 22, s. 5 (2).

Where failure to comply

(3) After the expiration of the time specified in an order, the Minister may remove whatever the person to whom the order was directed did not remove. 1998, c. 18, Sched. I, s. 36.

Analysis:

Under s.36 (1) depositing of any substance into the lake is a direct contravention of this Act. There is nothing in the above stated Act that would exclude sediment or P & N particulate runoff. However it would be difficult to remove the sediment or nutrients once discharged into the lake, and the Act does not specify a penalty for such a violation with the exception that the minister will then step and remedy the situation s.36. (3)

Canadian Environmental Assessment Act R.S.O. 2012

Factors

19 (1) The environmental assessment of a designated project must take into account the following factors:

(a) the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project and any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or, will be carried out;

(b) the significance of the effects referred to in paragraph (a);

(c) comments from the public — or, with respect to a designated project that requires that a certificate be issued in accordance with an order made under section 54 of the National Energy Board Act, any interested party — that are received in accordance with this Act;

(d) mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;

(e) the requirements of the follow-up program in respect of the designated project;

(f) the purpose of the designated project;

(g) alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means;

(h) any change to the designated project that may be caused by the environment;

(i) the results of any relevant study conducted by a committee established under section 73 or 74; and

(j) any other matter relevant to the environmental assessment that the responsible authority, or — if the environmental assessment is referred to a review panel — the Minister, requires to be taken into account.

Analysis:

19(d) addresses any mitigation measures needed to protect the environment, and that could be extended to erosion and sediment control measures, particularly if the lands had previously been used for agriculture, and drain tiles had been removed.

Public Lands Act R.S.O. 1990

Regulations re work permits

14. (1) The Lieutenant Governor in Council may make regulations,

(a) governing activities that may be carried out on public lands and on shore lands, including requiring that such activities be carried out in accordance with the regulations and prohibiting certain activities on public lands or shore lands unless the activity is carried out in accordance with the terms and conditions of a work permit;

(b) defining "shore lands" for the purpose of clause (a);

(c) governing the issue, refusal, renewal and cancellation of work permits and prescribing their terms and conditions;

(d) providing for and governing appeals from a refusal to issue or renew a work permit, from the cancellation of a work permit or from the imposition of terms and conditions in a work permit;

(e) exempting any person or class of person from the requirement of obtaining a work permit to carry out an activity on public lands or shore lands. 1996, c. 1, Sched. N, s. 4; 2006, c. 19, Sched. P, s. 5 (1); 2012, c. 8, Sched. 49, s. 2.

Penalty for unlawfully taking possession of public lands and erecting buildings, etc.

26. (1) Any person who enters into possession of public lands without lawful authority and erects any building or structure or makes any improvements thereon is liable to a penalty of an amount equal to twice the market value of the public land so entered as determined by the Minister. R.S.O. 1990, c. P.43, s. 26 (1).

Removal of material, etc.

(2) The Minister may remove any material, substance or thing deposited contrary to subsection (1), and any cost or expense incurred thereby is a debt due the Crown and may be recovered by the Minister in a court of competent jurisdiction in an action against the person who deposited the material, substance or thing or the person who caused it to be deposited. R.S.O. 1990, c. P.43, s. 27 (2). (3) Repealed: 2016, c. 8, Sched. 5, s. 3.

Analysis:

In S.14 (1) the clause defines the level of powers given to the Lieutenant Governor to make regulations as it pertains to shorelines. In this respect, any waters draining into shorelines with any works that could increase the risk of groundwater or tributaries to become polluted can contravene the Act. This type of activity is directly related to construction or development practices that require permits to alter the lands. In Section 26 (2) it refers to any material, substance or thing, it is a gray area whether runoff from upstream areas would apply to this clause.

Endangered Species Act. R.S.O. 2007

Habitat protection order

28. (1) The Minister may make an order described in subsection (2) if he or she has reasonable grounds to believe that a person is engaging in or is about to engage in an activity that is destroying or seriously damaging or is about to destroy or seriously damage an important feature of an area described in clause (b) of the definition of "habitat" in subsection 2 (1) for a species and one or more of the following criteria are satisfied:

Contents of order

(2) The order may include any one or more of the following orders:

1. An order requiring the person to stop engaging in or not to engage in the activity.

2. An order prohibiting the person from engaging in the activity except in accordance with directions set out in the order.

3. An order directing the person to take steps set out in the order to rehabilitate any area damaged or destroyed by the activity. 2007, c. 6, s. 28 (2).

Analysis:

S.28 (1) could pertain to aquatic habitat in cases where sediment is considered a deleterious substance that could harm a species at risk. Tile drainage runoff containing sediment and other nutrients could be considered damaging to aquatic habitat.

Drainage Act R.S.O. 1990

Improving, upon examination and report of engineer

78. (1) If a drainage works has been constructed under a by-law passed under this Act or any predecessor of this Act, and the council of the municipality that is responsible for maintaining and repairing the drainage works considers it appropriate to undertake one or more of the projects listed in subsection (1.1) for the better use, maintenance or repair of the drainage works or of lands or roads, the municipality may undertake and complete the project in accordance with the report of an engineer appointed by it and without the petition required by section 4. 2010, c. 16, Sched. 1, s. 2 (27).

Projects

(1.1) The projects referred to in subsection (1) are:

1. Changing the course of the drainage works.

2. Making a new outlet for the whole or any part of the drainage works.

3. Constructing a tile drain under the bed of the whole or any part of the drainage works.

4. Constructing, reconstructing or extending embankments, walls, dykes, dams, reservoirs, bridges, pumping stations or other protective works in connection with the drainage works.

5. Otherwise improving, extending to an outlet or altering the drainage works.

6. Covering all or part of the drainage works.

7. Consolidating two or more drainage works. 2010, c. 16, Sched. 1, s. 2 (27).

Notice to conservation authority

(2) An engineer shall not be appointed under subsection (1) until thirty days after a notice advising of the proposed drainage works has been sent to the secretary-treasurer of each conservation authority that has jurisdiction over any of the lands that would be affected. R.S.O. 1990, c. D.17, s. 78 (2); 2010, c. 16, Sched. 1, s. 2 (28).

Analysis:

S.78 (1.1) 3 directly discusses the installation of tile drains under the bed or touching any part of the drainage works. This clause is intended to deal with maintenance and capital costs rather than runoff. However, it is interesting to note that immediately afterward in S.78 (2) there is a notice to the conservation authority an engineer will only be appointed after 30 days when a notice has been sent to the secretary-treasurer of the conservation authority affected. It would appear that the conservation authority is responsible for the capital costs for drainage works completed on their lands, however the conservation authority is not given approval rights.

Lake Simcoe Protection Act. R.S.O. 2008

Regulations under s. 28 of Conservation Authorities Act

24. (1) Despite subsection 28 (7) of the Conservation Authorities Act, a regulation made by the Lake Simcoe Region Conservation Authority under section 28 of that Act may provide that all or part of the regulation applies to an area that is outside the area over which the Authority would otherwise have jurisdiction under that Act but that is within the Lake Simcoe watershed. 2008, c. 23, s. 24 (1).

Application of cls. (1) (a) and (b)

(3) A regulation under clause (1) (a) may apply only to activities that are carried out in, and a regulation under clause (1) (b) may apply only in respect of things to be done in, the Lake Simcoe watershed in areas specified in the Lake Simcoe Protection Plan that are,

(a) areas of land or water adjacent or close to the shoreline of Lake Simcoe or any other lake in the Lake Simcoe watershed;

(b) areas of land or water within, adjacent or close to a permanent or intermittent tributary of Lake Simcoe; or

(c) areas of land or water within, adjacent or close to wetlands. 2008, c. 23, s. 26 (3).

Penalty, individual

(28) An individual who is guilty of an offence under this section is liable, on conviction,

(a) in the case of a first conviction, to a fine of not more than $25,000 for each day or part of a day on which the offence occurs or continues; and

(b) in the case of a subsequent conviction, to a fine of not more than $50,000 for each day or part of a day on which the offence occurs or continues. 2008, c. 23, s. 26 (28).

Same, corporation

(29) A corporation that is guilty of an offence under this section is liable, on conviction,

(a) in the case of a first conviction, to a fine of not more than $50,000 for each day or part of a day on which the offence occurs or continues; and

(b) in the case of a subsequent conviction, to a fine of not more than $100,000 for each day or part of a day on which the offence occurs or continues. 2008, c. 23, s. 26 (29).

Analysis:

This Act is similar to the Conservation Authorities Act in some ways, but there are some notable differences. In S.24 (1) the limits of jurisdiction are extended outside of S.28 in the Conservation Authorities Act R.S.O. 1990 to reach anywhere within the Lake Simcoe watershed detailed in the Lake Simcoe Protection Plan. The penalty clause is also much higher than outlined in the Conservation Authorities Act R.S.O. 1990 which only goes up to a maximum of $1000 per person S.29.(2) and S.24 specifies a $10,000 penalty for an individual who obstructs an authority.

The Nutrient Management Act R.S.O. 2002

Section 6.(2) R. requires that studies be conducted in relation to the use of materials containing nutrients on lands, including topographical studies and studies to determine soil types on those lands and studies to determine the depth, volume, direction of flow and risk of contamination of water located on, in and under those lands;

Analysis:

This Act is self-explanatory. Care and consideration of the nutrients put on the fields and other areas, and the risk factors must be determined. This legislation was developed after the Walkerton crisis and has remained an important guideline for source water protection in southern Ontario.

Clean Water Act S.O. 2006

4. (1) The area over which a conservation authority has jurisdiction under the Conservation Authorities Act is established as a drinking water source protection area for the purposes of this Act. 2006, c. 22, s. 4 (1).

Source Protection Authority

(2) The conservation authority shall exercise and perform the powers and duties of a drinking water source protection authority under this Act for the source protection area established by subsection (1). 2006, c. 22, s. 4 (2).

Analysis:

This act gives powers to the conservation authorities to have the powers and duties of a drinking water source protection authority.

Safe Drinking Water Act S.O. 2002

Section 2. "drinking-water health hazard" means, in respect of a drinking-water system,

(a) a condition of the system or a condition associated with the system's waters, including anything found in the waters,

(i) that adversely affects, or is likely to adversely affect, the health of the users of the system,

(ii) that deters or hinders, or is likely to deter or hinder, the prevention or suppression of disease, or

(iii) that endangers or is likely to endanger public health,

Analysis:

Depending on the fertilizers used on the fields, tile drainage runoff would generally not be considered a health risk to the end users of the system unless it contained ammonia or nitrates. In that case then the water quality should be monitored to ensure the MAC (maximum available concentrations) are not exceeded before entering a watercourse.

Tile Drainage Act R.S.O. 1990 c. T.8

Appointment of Inspector

4. The council of a local municipality borrowing money under this Act shall employ an inspector of drainage who shall inspect the drainage work and file with the clerk an inspection and completion certificate in the prescribed form, together with a sketch indicating the location, spacing, direction and depth of the tile as laid, and the cost of such services by the inspector shall be charged against the drainage work inspected and shall be paid out of the money borrowed and deducted from the amount loaned under section 7. R.S.O. 1990, c. T.8, s. 4; 2002, c. 17, Sched. F, Table.

Analysis:

This clause is an interesting stipulation to hold municipalities accountable to a plan using an inspector to qualify for a loan for the tile drainage.

Geographic Regions in Ontario. Are there differences in enforcement?

Ontario is a large Province with a population of 13 982 984. There are also different levels of penalties depending on the watershed. For example the Lake Simcoe Protection Act R.S.O. 2008 has a maximum of $25,000 per day for any corporation in contravention for a first offence versus a maximum of $10,000 per day as a maximum penalty for any person or corporation in contravention of the Conservation Authorities Act R.S.O. 1990. One other difference to note is that the amount of water in an area does not necessarily mean there will be more enforcement officers in the conservation authority for that region. The larger the region, the more resources are available for staff, and the reverse is true for smaller areas.

In contrast to the rest of watersheds and lands in Ontario, First Nations lands are exempt from formal legislation from the Province of Ontario or any municipality. There are under federal jurisdiction of their lands. This poses a few issues, the first being that there is a lack of funding infrastructure for watersheds in First Nations territory. For example, if there is a need for BMP placement, or tile drainage, it is unclear whether the same loan program from the Province of Ontario would apply. If there are tributaries or streams in upstream towns, cities or municipalities that cross through First Nations lands that are not following BMP measures, it could impact water quality without funding mechanisms for remediation or mitigation. There is also the consideration that if nutrient runoff from tile drainage in First Nations lands watersheds runs downstream, it is unclear if the existing Provincial legislation extends into these areas.

Comparative Analysis of US standards vs. Ontario Standards for Erosion and Sediment Control

There are several differences in standards in the United States of America vs. Southern Ontario with respect to ESC measures including agricultural runoff. The first example would be the monetary differences between contraventions of statutes. Recently in a case in US (State of Maryland, Tennessee, Missouri, Colorado, Utah and Nevada vs. US Centex Homes), a settled penalty of $1.485Million USD was issued along with several conditions to improve their mitigation methods for erosion and sediment control. In Ontario, the maximum punishment through the Conservation Authorities Act R.S.O. 1990 is $10 000, and $25 000 (for a first offence) for the Lake Simcoe Protection Act. R.S.O. 2008. The Environmental Protection Agency in the USA recently passed an Act in 2014, Harmful Algal Bloom and Hypoxia Research and Control Amendments Act. (HABHRCA) The National Oceanic and Atmospheric Administration (NOAA) and USEPA are the governing bodies. Their responsibility is to ensure further scientific research and detection, monitoring, assessment, and prediction of HAB and hypoxia events in marine and fresh waters in the U.S. They are also responsible for overseeing a task force (Interagency Working Group) to develop reports and plans to reduce the risk of HABs forming and to mitigate their damage. (EPA, 2017)

In Canada, the regulations are written differently. There is an established MAC (maximum acceptable concentration) and federal guidelines for cyanobacterial toxins (0.0015mg/L). In the USA the EPA has published guidelines. However, it is up to each State to create water quality standards. Also, they have a web page dedicated to nutrient pollution policy and data. There is a description of the EPA's current activities, numeric nutrient water quality criteria, tools to assist states and tribes, and nutrient data. Also, it provides reports, research, and resources to explore. It appears that there has been dedicated funding and resources put towards this issue in the USA although the legislative framework is still being developed. Currently, in Ontario, the MOECC (Ministry of Environment and Climate Change) has not published this type of resource. All of the Acts listed above pertain to agricultural runoff.

Conclusions

An Analysis of the Current State of Practice in Ontario

It is clear from the research that agricultural tile drainage is a contributor of sediments and nutrients to surface waters and a systems level approach is needed to effectively mitigate the impacts of tile drains on erosion and surface water quality.

Ecological systems level approaches for managing water on a farm field are a good starting point, and in some cases eliminate the need for agricultural tiles. This method would be preferred as it deals with the water issues at their source, not at the end of pipe. However, the ecological approach can be capital intensive in some cases and take many years of careful planning. Although there is much written on the subject, the focus of this research was on the technological practices available for dealing with the end of pipe runoff from agricultural tiles. For the shorter term on existing farm fields using agricultural tiles, there are options of BMPs that can mitigate the export of nutrients from tile drainage, and each method requires an individual evaluation. Innovative methods such as bioreactors, coffer dams and conveyance structures need further evaluation in Ontario.

The costs of BMP vary, and some costs may include loss of productive land for farmers which are a disincentive for farmers. There are many programs available to farmers and OMAFRA is providing support the agricultural community.

It seems that the municipality bears the capital costs of drain installation, whereas the farmer bears the cost of the tiles. However, drainage ditches and tile fields need maintenance. It is not specified in any current legislation who is responsible for these costs.

The legislative gap for agricultural tiles drains is a policy that clarifies what the role of the municipality, conservation authority, farmers and first nations are responsible for with regards to the cost for BMPs to manage and maintain agricultural runoff. Furthermore, it is noted that funding is needed for BMPs to ensure that P & N particles stay out of source water.

The **Conservation Authorities Act R.S.O. 1990** could be improved by providing stiffer fines for violations and clearly defined responsibilities with respect to water draining into their jurisdiction from upstream, including agricultural drainage runoff.

Lakes and River Improvement Act R.S.O 1990 could also use more clear definitions on what is considered “pollution” and fines to individuals or corporations found “polluting”.

However, it is encouraging to see some new legislation with some of these changes in the **Lake Simcoe Protection Act S.O. 2008,** where there are greater penalties and defined parameters.

A collaborative discussion is necessary with First Nations communities to help them obtain the tools they need in their communities to protect the water within their lands. This is a systemic issue that leads into a deeper discussion about the drinking water crisis.

Currently in First Nations communities across Canada, there is a drinking water crisis. The problem stems from a lack of adequate binding legislation for water on First Nations reserves. First Nations lands are governed federally, without a form of provincial or municipal legislation. 90% of the water advisory alerts are in Ontario. There is a total of 134. Lack of source water protection and waste water and systems also contribute to the issue. Source water is affected by commercial and industrial runoff from land outside of the reserve that contaminates waters downstream, including First Nation's reserves. (HRW, 2016)

There is an urgent need for the Federal government to assist with funding for critical infrastructure such as waste water treatment. Private water companies have been pressing the federal government to permit P3 (public, private partnerships) style projects to address the needs of the First Nations communities; however, there are risks of privatizing water. Some of the risks include accountability to the community, employment, local costs, and health and environmental concerns. There is not a current solution that addresses the needs of the First Nations communities that can provide the infrastructure desperately needed without compromising the water rights of those members of the community.

Although this paper uncovered a policy gap, there are many more area's to consider in future studies.

Further research questions:

- What is the amount of P & N runoff coming from each watershed in Ontario, and from which geographic areas? Is it possible to track?
- Exploration as to why there is no clear legislation for agricultural tile runoff, and if it has ever been proposed in any of the current policy instruments.
- Why are First Nations lands kept out of the conversation when it comes to watershed management, also why are they not given the same resources as other Canadian municipalities?
- What has been done in the past and what can be done in the future with respect to First Nations access to resources for source water protection?

Recommendations

Based on the existing policy gap, it is recommended that policy and standards writers at the provincial and federal level add in a clear and comprehensive policy to address agricultural tile runoff. I would also note that it is important to have a similar quality assurance, and quality control (QA/QC) check implemented into any new legislation, similar to what is prescribed in the **Tile Drainage Act R.S.O. 1990** that a professional engineer must certify that the installation has been done in accordance with a plan. A plan should be completed and approved by the agency that is given the funding, and installation procedures must be followed accurately to ensure resources are not wasted on an improperly functioning BMP. Price should not be the governing factor on which system should be chosen.

The next recommendation is for the both the federal and provincial government to allocate funding for either to the end user, or in the form of a tender through a municipality or conservation authority for materials and installation of BMP's to prevent excessive nutrient runoff from agricultural tiles. Another recommendation is to give an incentive either in the form of a grant, or tax break to farmers who show an ecological plan whereby they either reduce or eliminate the need for agricultural tiles, and find alternate ways to manage the water on the crop fields. Funding, education and outreach should be made available to First Nations communities through federally funded programs distributed by the Province of Ontario, municipalities or conservation authorities with regards to runoff from farm fields. Lastly, the conservation authorities are only given a meager fine to work with when it comes to fines for corporations polluting watersheds. An increased fine limit on par with the United States of America is suggested.

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