Water Quality Management Issues in Montreal's Bouchard Creek

BREE 533: Water Quality Management - Group 9 Final Report

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Abstract

This report provides a preliminary investigation of water quality management and restoration issues related to Montreal's Bouchard Creek. The urban context of the creek is explained, showing how historical developments in the city of Montreal have shaped the creek's hydrology and physicochemical characteristics. Water quality data from 2011-2017 is analyzed and instances of exceedance of standards for coliforms, phosphorus, total organic carbon, and copper are highlighted. Context-appropriate water quality management and creek restoration strategies are suggested according to best practices.

Introduction & Site Description

Bouchard Creek, located primarily in the city of Dorval on the island of Montreal, runs north-south for approximately 2.8 km from its beginnings on the property of Montréal-Pierre Elliott Trudeau International Airport to Lac Saint-Louis (See figure 1). On its route, it passes through industrial zones in Dorval, under Autoroute 20, and then through mixed commercial and residential areas. For much of its length, the creek has been covered by buildings and parking lots or diverted to the city sewer system. However, the sections of the creek south of Autoroute 20 remain at least partially open and show high potential for water quality and habitat improvement.

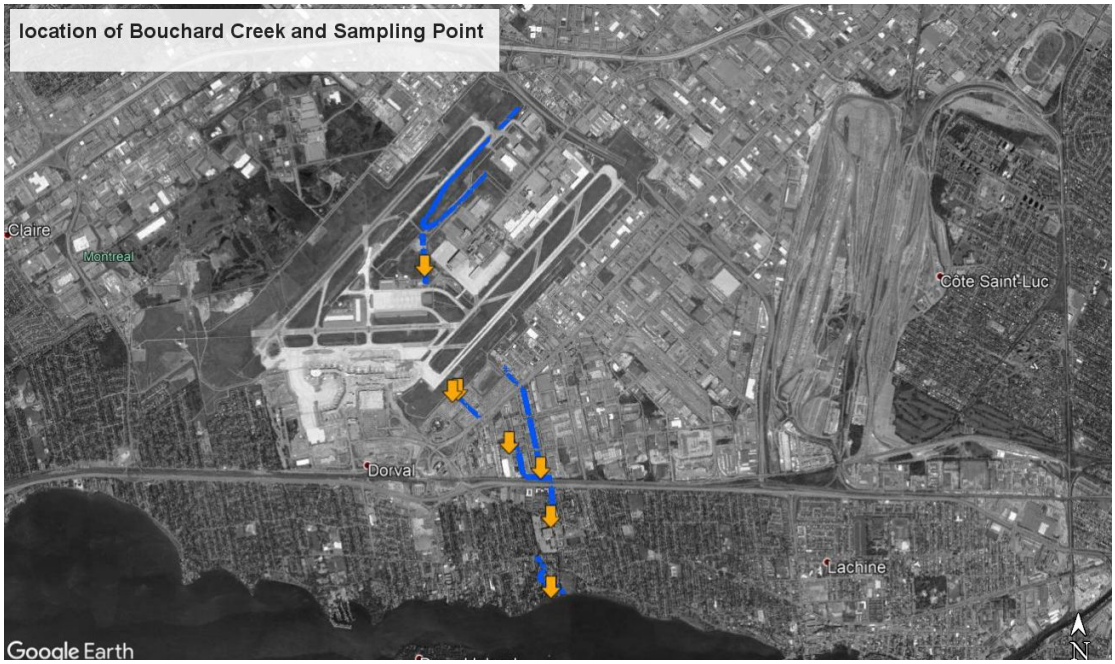

Figure 1: Route of Bouchard Creek (highlighted).

Although various informal cleanup initiatives have been organized in recent years, to our knowledge, no rigorous studies have been conducted to date regarding the health of

the creek or prospects for its renewal. The goal of this report is to give a clearer view of the creek's current state from a water quality and urban ecosystem standpoint, and to serve as a guide in further research, restoration, and conservation work.

History & Urban Context

The landscape of the city of Montreal, as in most modern metropolises, has been substantially altered by human influences. This includes the widespread smoothing of surface topography and hydrological changes. In particular, many creeks and streams that previously flowed on the island have been diverted, covered, or rerouted into the city sewer network. Based on the dates of construction of local infrastructure, Bouchard Creek seems to have flowed in its historical course until about the beginning of the 20th century, when horse racing tracks were built at what is now Pierre Elliott Trudeau International Airport. The airport itself was built in 1941 due to increased air traffic related to WWII, followed by further industrial development, airport expansion, and highway construction in the next decades. The airport and industrial area north of Autoroute 20 are especially relevant to the ecological state of Bouchard Creek for several reasons:

1. Airport and industrial construction resulted in the leveling of local topography and the rerouting, straightening, and covering of large sections of the creek, thereby significantly altering its drainage characteristics and hydrology.
2. Both the airport and surrounding industries are responsible for substantial quantities of Bouchard Creek's pollutant load, including aircraft deicing fluid (primarily ethylene glycol), sediments, organic compounds, and heavy metals.

Identification of Water Quality Issues: Results, Analysis, and Interpretation

Data Collection & Methodology

The city of Montreal's *Réseau de suivi du milieu aquatique* (Environmental Monitoring Network or RSMA), part of the city Environment Department, monitors water quality on and around the island of Montreal. Bouchard Creek is among the 20 or so water bodies whose physicochemical and bacteriological status is monitored and reported to the public. Samples were taken at 7 predetermined locations along the creek at 7 times between May and October of 2011-2017, which are then analyzed for a variety of water quality parameters, including fecal coliforms, dissolved oxygen (DO), suspended solids (TSS), total phosphorus, total organic carbon (TOC), ammonia nitrogen (NH_3-N), and heavy metals.

Although this sampling regime does not provide specific data regarding pollution with ethylene glycol, pesticides, solvents, or other organic chemicals, TOC can be used as a proxy measurement for organic pollutants in general (Ni et al., 2008; Spruill et al., 1988). Additionally, the available data do not provide information on creek sediments, which may act as a significant pool of accumulated pollutants considering the industrial nature of the surroundings. Depending on the compound in question, pollutants may be sequestered in the sediment with varying degrees of mobility. The question of pollutant

mobility is a complex one and will require sampling of sediments and water at finer spatial and temporal scales for a complete picture to emerge.

Figures 2 and 3 show the water sampling points and land use in the area surrounding Bouchard Creek, respectively. These graphics help contextualize the city of Montreal's water quality dataset by linking water quality observations to specific areas and industries. This relationship will be key in further restoration work of Bouchard Creek.

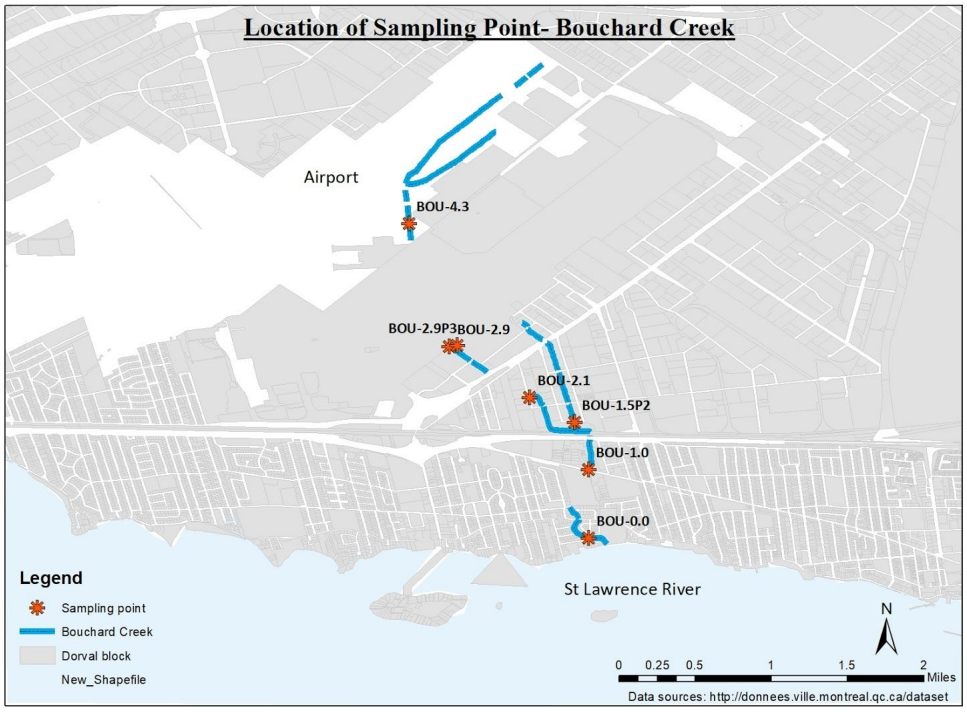

Figure 2: Map showing the locations of Bouchard Creek water sampling points

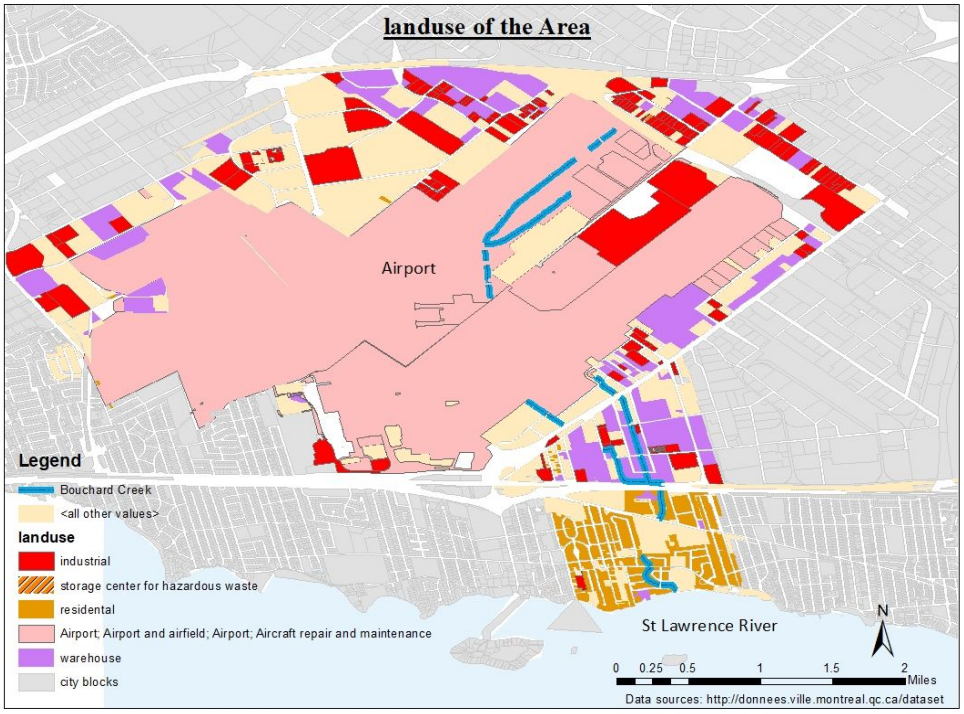

Figure 3: Land use map of the area surrounding Bouchard Creek

As noted previously, the available dataset provided values for a number of different parameters. We focus here on 4 specific water quality indicators that are particularly relevant in light of Bouchard Creek's urban setting and from which it would be reasonable to establish pollution sources and possible remedial techniques.

Coliforms

Figure 4 shows average coliform levels over the study period. As can be seen from the graph, these values are far in exceedance of applicable standards, with some individual readings showing more than 10,000 CFU/100 mL. These likely indicate leakage of untreated sewage into the Bouchard Creek watershed. Whether this is due to combined sewer overflows or illegal pipe connections or discharges must be determined in charting a path forward.

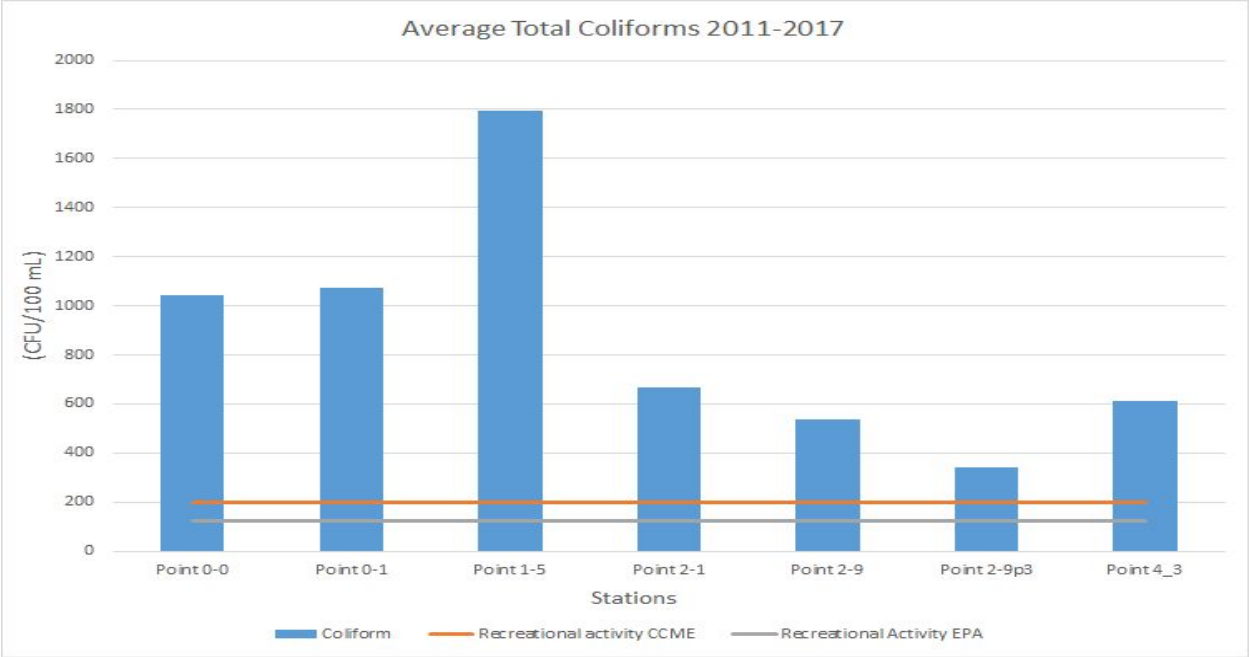

Figure 4: Average Observed Total Coliform Levels

Phosphorus

Figure 5 shows the average total phosphorus (P) levels over the study period. The data show that Bouchard Creek has a high P load that exceeds environmental standards. The Canadian Council of Ministers of the Environment (CCME) classifies waters with total P levels above 35 µg/L as eutrophic, a designation which applies to all sampling points in Bouchard Creek. The P data also suggest a correlation between P loading and extensively grassed areas, such as the airport and residential parts of Dorval, which may indicate excessive fertilizer runoff.

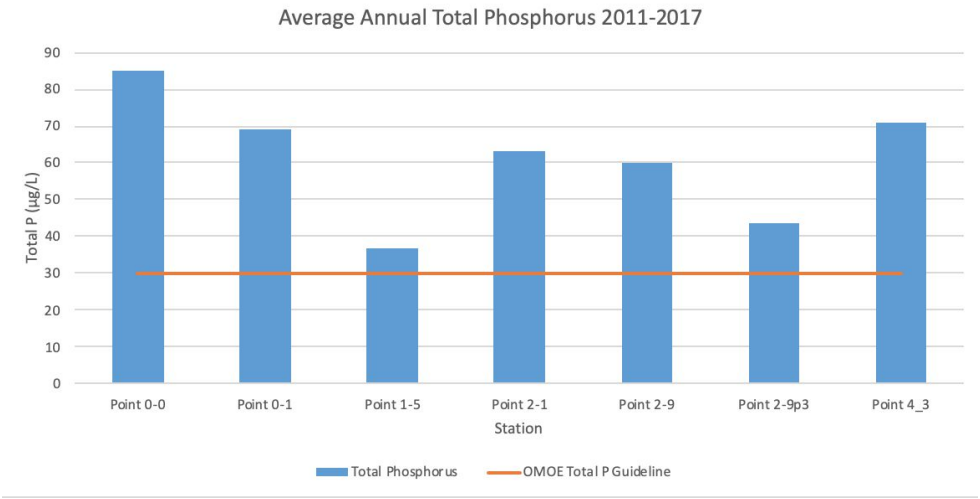

Figure 5: Average Observed Total Phosphorus

Total Organic Carbon (TOC)

Figures 6 shows TOC in exceedance of standards based on CCME guidelines at all test points. Note the dramatically higher TOC load in station 2-9, located near the airport. We hypothesize that this is related to aircraft de-icing operations that utilize ethylene glycol and other organic compounds, which subsequently drain to Bouchard Creek near this point. Further analysis is required to evaluate this possibility.

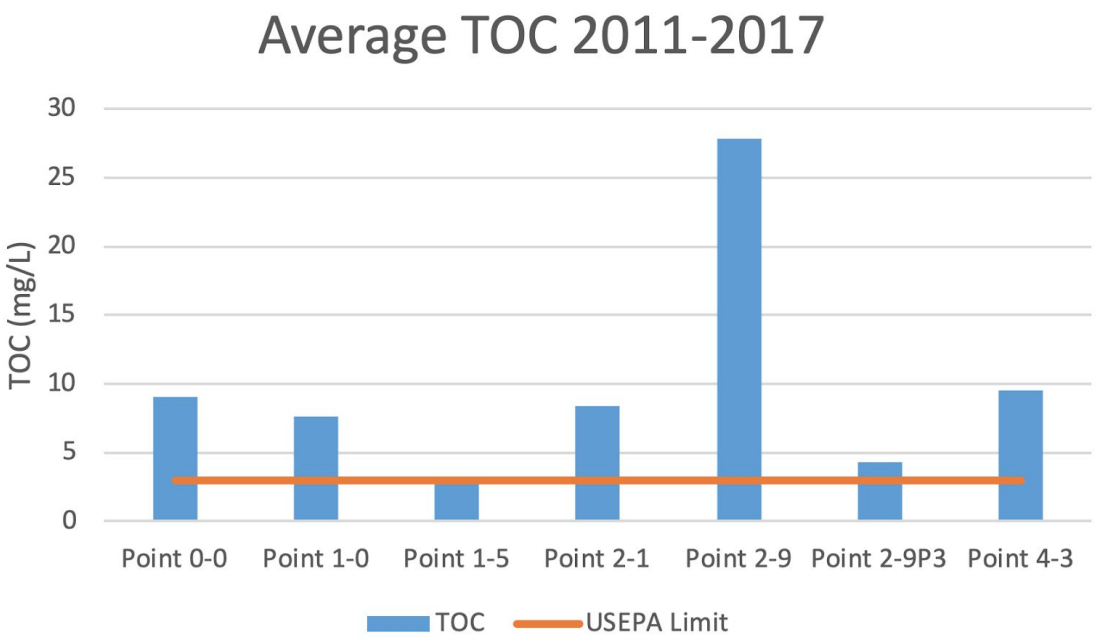

Figure 6: Average Observed Total Organic Carbon

Copper (example metal)

Figure 7 shows a time series graph of copper levels at all test points. We show this graph as one example of the many metals surveyed in the available water quality data. All metals sampled showed temporal variation, but few were as dramatic as with copper, which was regularly well above USEPA acute exposure guidelines until late 2012, when it dropped rapidly to acceptable levels. We hypothesize that this corresponds to a cessation of industrial discharge from a small number of sources. These were likely located in the northern section of the study area, since all test points showed elevated copper levels. This illustrates the potential effectiveness of anti-pollution technologies and regulations in quickly ameliorating water quality issues and their associated human- and environmental health consequences.

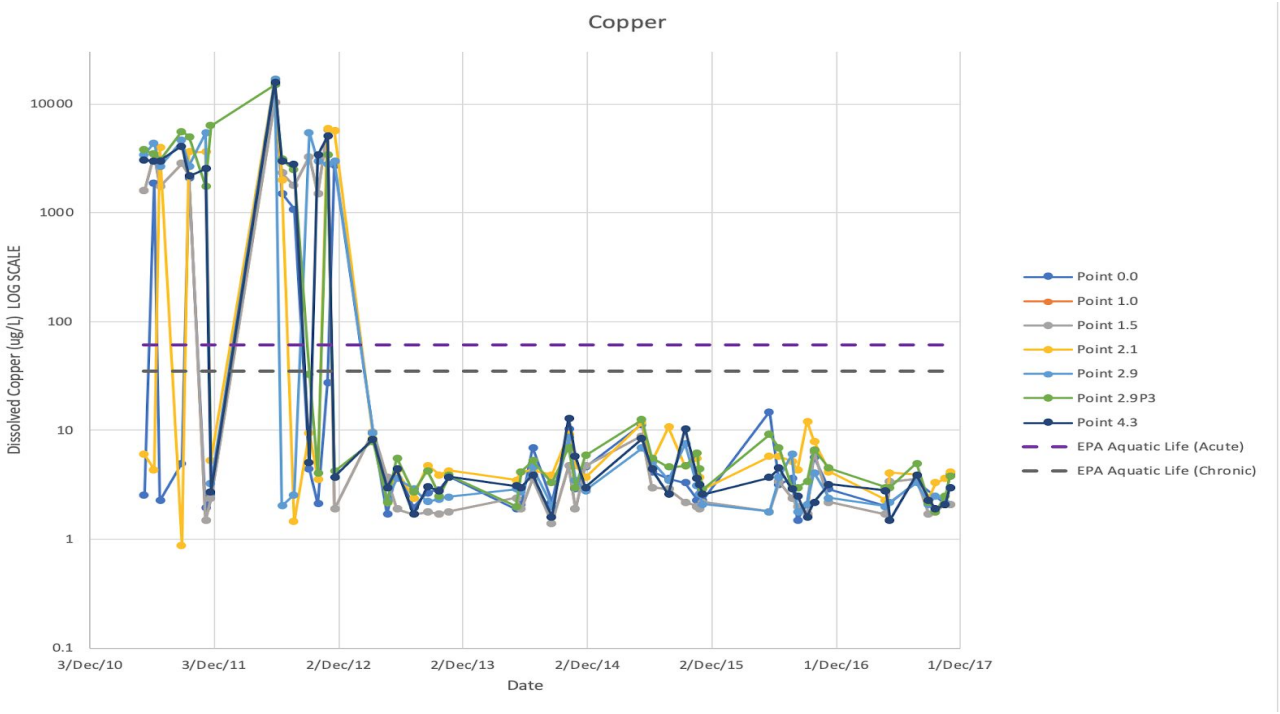

Figure 7: Average Observed Copper

Recommendations and Conclusions: Roadmap for Improvement

Water quality is an important metric for quantifying environmental health, as it affects both humans and non-human species. Maintenance of water quality can, therefore, have wide-ranging impacts on plants, animals, and people, all of whom utilize it for basic physiological needs, aesthetic value, recreation, and other uses. Water quality data from Bouchard Creek indicates that it receives a substantial pollutant load, which may come from commercial/industrial or residential sources. In the section that follows, we introduce several methods that may be used to improve the overall environmental

quality of the creek. It is, however, important to note that the process of ecological restoration is multi-faceted and will necessarily be an extended process due to the multiple complex environmental and political factors involved.

Daylighting

Bouchard Creek is bordered by urban areas, airport operations, and numerous buildings and parking lots. One method for restoring Bouchard Creek to a state more similar to its historical appearance is a process known as daylighting. This entails uncovering and re-routing sections of the creek that have been diverted into drains and straightened so that it becomes more open and meandering. When this process is well designed and executed, it is possible to increase the stormwater absorption capacity of the creek, thereby reducing peak flows during storms and bolstering the flood resiliency of the surrounding areas. Slowing the flow of stormwater also helps remove pollutants by allowing them to settle or by filtering them through plants and sediments (http://nrcsolutions.org/). Daylighting is beneficial to both human and aquatic life. The process is economically and ecologically efficient: ecologically, it allows the stream to return to a less disturbed state. From an economic perspective, daylighting can also improve property values and businesses around the creek by turning into a more aesthetically pleasing space.

One particularly long stretch of Bouchard Creek that has been diverted underground and that could be the focus of a daylighting project is underneath the property of a Bell

Canada call center in Dorval (See figure 16), which is currently surrounded by a large parking lot. The construction of a multi-level parking garage with a smaller area or elimination of some parking spots could create the space necessary for the restoration of Bouchard Creek in this area and could serve as a model for similar stream restoration projects, in addition to generating positive publicity for the landowner and increasing abutting property values.

Figure 8: Possible site to establish a daylighting structure

Buffer Strips

Buffer strips are also a plausible solution to the improvement of Bouchard Creek's ecosystem health. Buffer strips are typically used to mitigate the infiltration of nitrogen, phosphorus, and sediments during stormwater events, but are useful in stemming the flow of other pollutants as well. The most common type of buffer strips used are contour

buffer strips, filter strips, and grassed waterways, and they are usually located on both sides of a waterbody (John F Hebblethwaite, Carol N. Somody, in The Triazine Herbicides, 2008). The design enables the interception of runoff by creating permanent vegetation between a waterbody and the polluting entity (J.E. Gilley, in Encyclopedia of Soils in the Environment, 2005) (See figure 9). In the case of Bouchard Creek, the goal would be to intercept runoff from the airport, nearby roads, industrial activities, and lawn fertilization. Vegetation buffers around Bouchard Creek will also aid in the creek's restoration by providing small but significant areas of habitat for plants and small animals, contributing to the overall ecosystem health of the area.

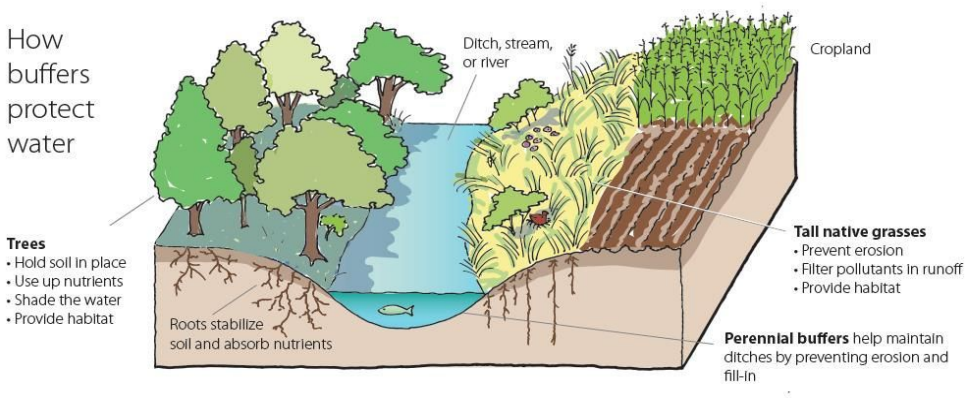

Figure 9: How Buffer Strips Works (https://www.mankatofreepress.com/)

Figure 10: Example of vegetation buffer (https://thejamesriver.org/)

Enforcement of discharge regulations around Bouchard Creek would also be an efficient way to limit pollution of the water body. This is a particularly attractive solution because it stems pollution at its source rather than removing it after it has entered the creek, which is a more technically and economically burdensome project. Additionally, an important part of the implementation of an integrated water management plan is the involvement of stakeholders at all levers of the affected communities. In this case, airport and industrial executives and the affected residential owners should all have opportunities for input and decision-making.

Conclusions: Prospects for Remediation of Bouchard Creek

Ultimately, the available data on water quality help to create a preliminary understanding of the health of Bouchard Creek as an ecosystem, as the biological and physicochemical states of the creek are fundamentally interrelated. Further data

collection and restoration efforts should go beyond water sampling to include sediment analyses and surveys of the plant and animal life of the creek. Particular attention should be paid to sensitive species that can serve as indicators of overall ecosystem health and to rare or threatened species who may require particular care in order to be preserved. It should be noted, however, that the urban context of Bouchard Creek places inherent limits on its rehabilitation potential. The creek was originally part of a broader ecosystem on the island that no longer exists - the original route of the creek was leveled and re-channeled long ago and surrounding tracts of land are now mostly part of the airport or industrial or residential areas. There is important restoration work to be done both with the aforementioned technical solutions (buffer strips, daylighting) and through regulatory work in limiting pollutant discharges from various sources, such as ethylene glycol used for de-icing of aircraft, industrial wastes, and residential fertilizer applications. In order to be effective, these solutions must be integrated and utilize best practices for stakeholder and community engagement and education. Ultimately, the scope of such work must be viewed in the broader context of the creek's urban setting and the interrelations between human and non-human factors.

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