ENVIRONMENTAL ASSESSMENT: MARATHON MINE

CONTAMINATION OF THE LAKE SUPERIOR BASIN

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CONTENTS

INTRODUCTION

The Lake Superior Basin, composed of the lake and its tributaries, is rich in minerals, and mining has played a key role in its settlement over the last century (Northwatch 2001). On the Ontario side of the Basin, there are currently 10 abandoned mines with tailings, 12 closed/under closure, 4 operating and 3 mines under development including the Marathon mine (Ripley 2011). In February 2010 Marathon PGM Corporation, later in the year acquired by Stillwater Mining Company, submitted a proposal to the Canadian Environmental Assessment Agency to develop a mine 10 miles north of Marathon to extract platinum group metals and copper (CEAA 2011). The proposed mine development is to include the construct, operation and decommissioning of three open pits, an ore processing plant, tailings & mine rock storage facilities, site access roads, a 7-km power transmission line, explosives factory & magazines, water management facilities, and ancillary mine infrastructure and associated activities. It is estimated that the mine will produce 22 000 tonnes/day with a mine life of approximately 11 ½ years (CEAA 2010).

Exploration remains very attractive in the Basin, primarily for gold, palladium group metals, and, increasingly, for diamonds. Mining has both benefits and costs. Communities like Marathon and the Ojibways of Pic River First Nation, situated near the StillWater copper and platinum mine, experience major economic benefits from the mines while they are in operation, including employment and local spending, but such communities also bear the brunt of environmental contamination. Mines must inevitably close, either when reserves are exhausted or markets fall.

The industry is ever changing. It is now estimated that 3.4 employees are required to generate $1 million of metals production (Northwatch 2001). As mechanization in mining increases, so too does the scale of its operations and its impacts.

Many of the difficult issues and impacts identified in this report on mining in the Lake Superior Basin are also relevant in other jurisdictions globally. This report provides information on mining issues and impacts in the Lake Superior Basin to increase public understanding to maximize benefits and minimize costs, particularly environmental and social. Currently the proponent for the Marathon mine does not include a plan in case toxins enter the Lake Superior ecosystem. A better understanding of the issues pertaining to toxins in such a large ecosystem need to be understood and mitigation efforts need to be brought forward in case such an event happens. Coverage of toxin entry points into the Lake Superior Basin, toxins produced from the Marathon mine, and case studies pertaining to the use of mines around watersheds will all be discussed. Once a general understanding of the mine's effect on large water bodies is understood, mitigation efforts will be demonstrated to fill the gap in the proponent's proposal for protection of the Lake Superior Basin.

WATER SYSTEMS ENTERING LAKE SUPERIOR

There are many locations in which any toxins coming from the Marathon mine could enter the Lake Super Basin. One of the main concerns is the Pic River, a large water body that could easily carry down any excess toxins into the Lake Superior Basin, shown to the east of the mine site in Figure 1.

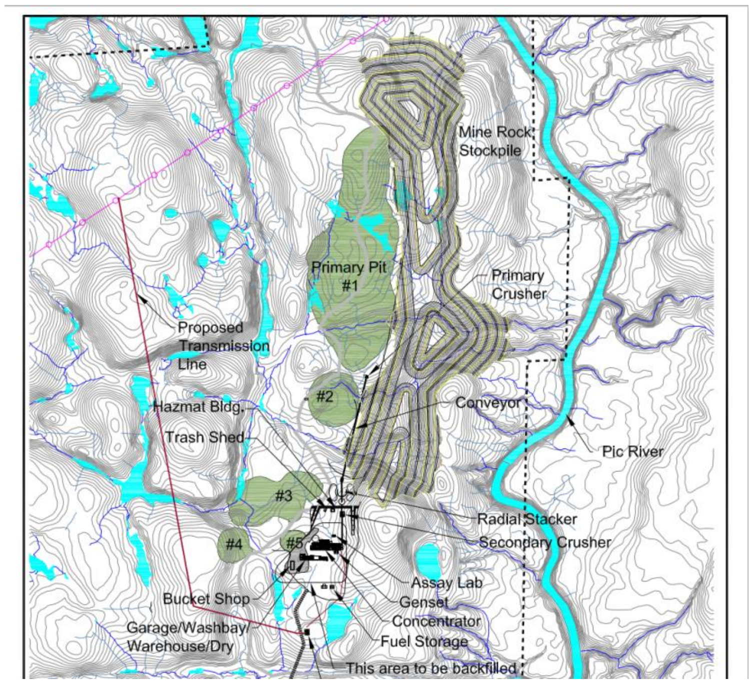


Figure 1. Enlarged site layout with water bodies which have a possibility of being contaminated (Stillwater Canada Inc.).

Other areas of concern are stream 5 (Hare Creek) which drains a relatively large area including Hare and Bamoos Lakes. Stream 5 flows westward, draining the northwestern portion of the Project area and discharging into the eastern end of Hare Lake. Bamoos Lake outlets from its western end enter into Bamoos Creek, which discharges into the eastern end of Hare Lake. The outlet at the southwestern end of Hare Lake forms Hare Creek, which flows westward towards Lake Superior. Hare

Creek discharges to Lake Superior at Port Munroe (Figure 2). The Stream 5 sub-watershed includes lakes 4, 17, 23, 25 and 27, as well as Hare and Bamoos (Marathon PGM 2010). Within the Stream 6 (north tributary) watershed, water flows westward, draining the southwestern portion of the Project area. Stream 6 discharges to Lake Superior at Sturdee Cove (Figure 3). The stream 7 (Shack Creek) watershed drains a relatively small portion of the Project area along the southwest border. This watershed includes the Rag Lakes and Shack Lake and discharges to Lake Superior at Peninsula Harbour. Hare Creek (Stream 5) flows to a nearshore embayment of Lake Superior known as Port Munroe (Figure 2). The creek discharges along the northeast corner of the bay. Within the embayment, maximum depth was approximately 18 m. Habitat is primarily open deep water, as the lake bed is generally steeply sloped from shore, with exception of a shallow sand bar shelf off the creek mouth and in the northwest corner of the bay, behind a small island. A sand beach is present along the northern shore of the embayment, while the remaining shoreline is rocky. The creek discharges along the southeast corner of the bay. A sand beach is present along the eastern shore of the embayment, while the northern and southern shorelines are rocky. Near shore substrates included sand, bedrock, cobble and boulder. Shack Creek outlets to a near shore embayment of Lake Superior known as Peninsula Harbour. Peninsula Harbour includes two embayments, Carden Cove situated to the west and Jellicoe Cove located in the east.

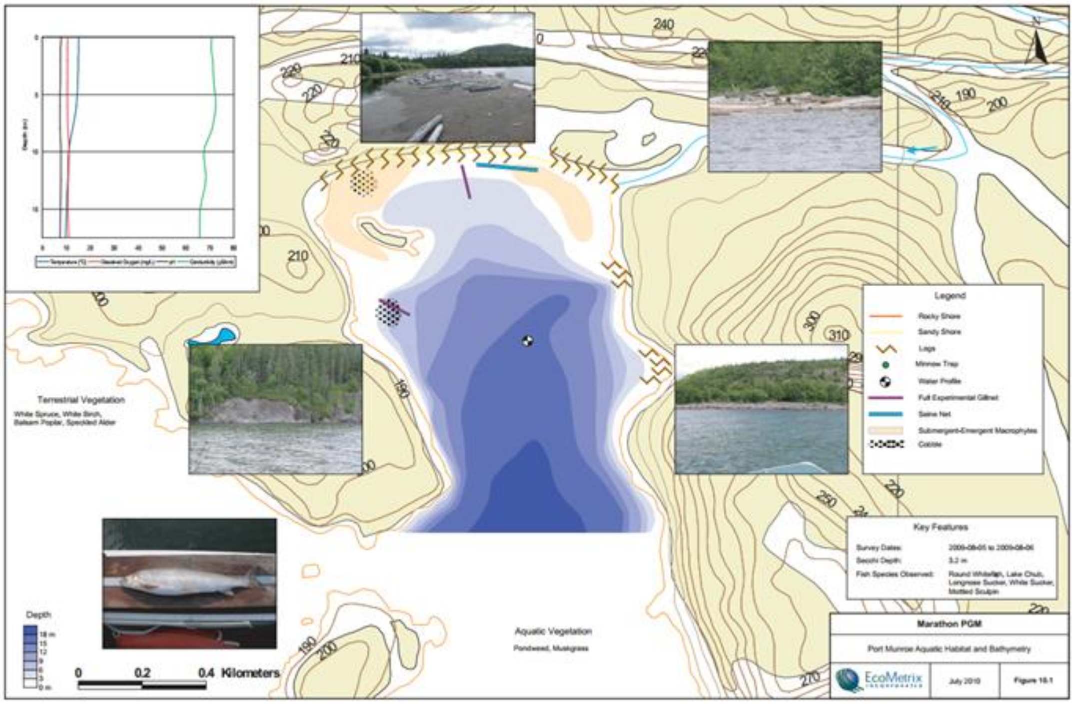


Figure 2. Port Monroe aquatic habitat (Stillwater Canada Inc.)

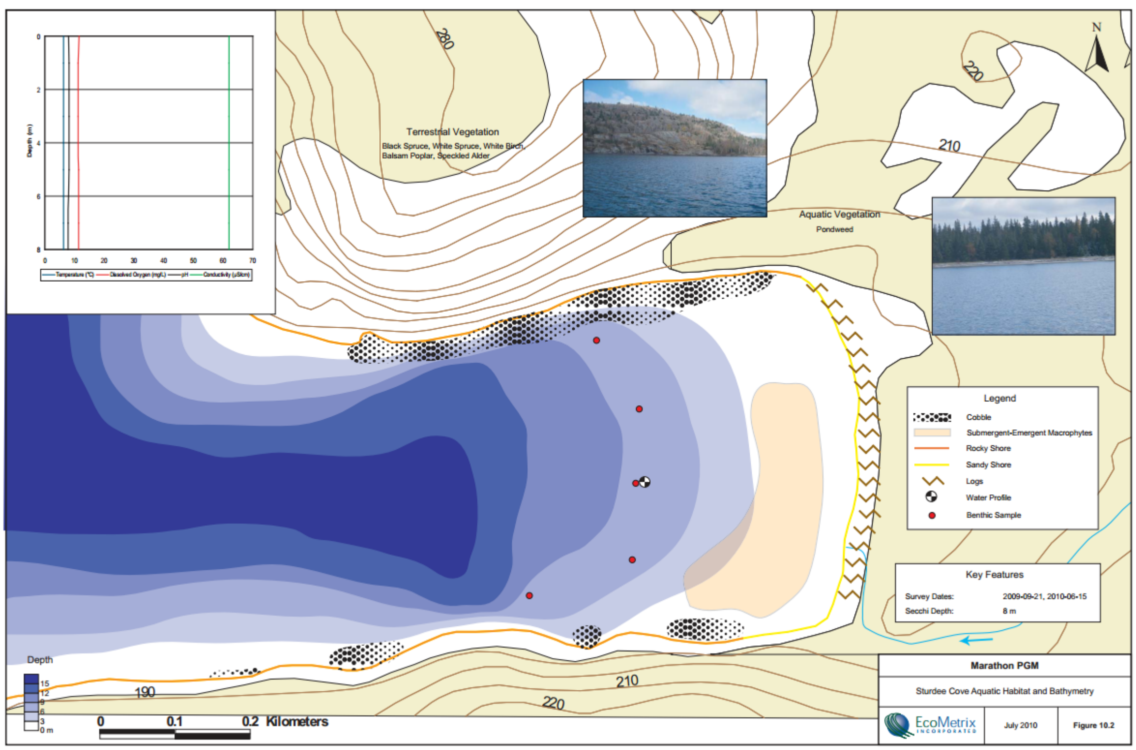


Figure 3. Sturdee Cove aquatic habitat (Stillwater Canada Inc.)

Knowing the areas where the toxins could enter the basin is a good starting point to assist the proponent in mitigation efforts.

METAL CONTAMINATION

Stillwater Canada Inc. plans to develop, operate, and decommission an open pit mine. The main extractive mineral from the open pit mine will be copper (Cu); however, other platinum group minerals, gold (Au), platinum (Pt), and palladium (Pd) are to be extracted as well. Marathon PGM did extensive work preparing a project overview, which outlines the existing biophysical conditions at the proposed site. Marathon PGM proposed, and in some situations, such as air and water quality, already enacted controls to measure the difference in pre-mining and active-mining contaminant levels. This section of the paper explores the specific metal contaminants, which carried through water or air, are expected to be released through copper and platinum group metals mining. This paper will not discuss any health affects to human or other biota. Research of that depth is beyond the scope of this paper. The purpose of this section is to aid interveners, the people of Marathon, and Stillwater Canada in scoping their analysis of effluent and air contaminants.

Metal contaminants may enter the atmosphere or water system through a number of methods. Metal contaminants seeping into waterways may appear from dams, tailings ponds, release of process water, and storm water. Previously in this paper, control points where there is a potential for metal contaminants to enter the

Lake Superior Basin were discussed. Contaminants may enter the air through blasting operations, construction activities, ore processing (crushing), and/or smelter dust.

Mining operations have significant influence on atmospheric pollution because of the direct exposure of metal to the atmosphere. Mines produce large amounts of waste because the used ore and concentrates are only a small fraction of the total volume of the mined material (Dudka and Adriano 1997, Salomons 1995). Marathon PGM failed in the project outline to state the metal contaminants which hold the greatest risk of accumulation in the atmosphere. A study was carried out measuring accumulation of airborne contaminants as a result of a copper and platinum group metal mine in the Republic of Macedonia. The study found that four elements—arsenic (As), cadmium (Cd), copper (Cu), and lead (Pb)—were statistically related to active mining operations (Balabanova et al. 2010). Samples for this study were obtained by collecting dust deposited in buildings attics. From this data the authors were able to create a spatial distribution of the four identified contaminants as shown in Figure 4.

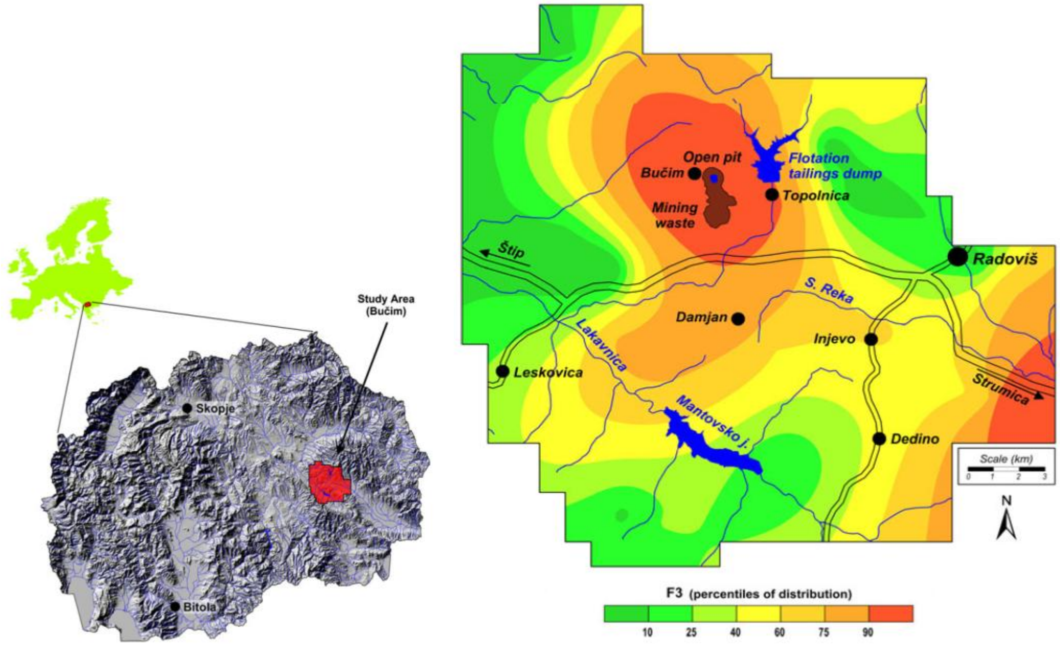


Figure 4: Location of Republic of Macedonia and study area, and the special distribution of As, Cd, Cu, and Pb (Balabanova et al. 2010).

The airborne chemicals can travel far through the atmosphere, which is worth noting as the town of Marathon is approximately 11 km away from the proposed mine site. More than the four elements here have been reported as a result of copper mining. A study in Ireland found iron (Fe), zinc (Zn), copper (Cu) and cadmium (Cd) levels in soil and vegetation had been altered due to mining operations and windblown particles (Herr et al. 1996).

Just as metal contaminants are carried through the air, they can also be carried through water. Marathon PGM supported their analysis that copper mining in the proposed location poses no threat to adverse affects within Lake Superior. Marathon PGM was very diligent in enacting measures to ensure that major tributaries feeding Lake Superior will not be disturbed. The creations of dams, as well as establishing mine rock storage areas, are proposed to protect the Lake Superior watershed. Dams are to be created in areas of natural waterways. These dam and mine rock storage area locations create control points which must be targeted as areas with the greatest potential for metal contaminants to enter the watershed.

Copper mining effluents will have an effect on water quality and associated biota within the affected area. Specific amounts of copper mining effluent required to have a measurable adverse affect on the area will vary greatly. A study of adverse effects caused from copper mining effluents was conducted in Chanaral Bay in northern Chile. The study found that copper mine effluents had an adverse effect on the intertidal sea community in the area of effluent release (Ramos-Jiliberto et al. 2011). Species studied expressed higher mortality, slower development, and lower reproduction fitness (Ramos-Jiliberto et al. 2011). Studies on the production and extraction process of gold (Au) and other platinum group metals have been widely examined. Gold (Au) extraction requires the use of cyanide which has been shown to have cumulative adverse affects on watersheds (Hilson 2006).

Risks to human health, safety, and the environment must be carefully assessed. Identification and monitoring of the metals present, as well as measurement of contaminant concentrations at individual sites with analytical techniques suiting the typical levels, must be programmed and fulfilled. When individual sites of inspection are within a given watershed or airshed zone, their cumulative effects must be taken into consideration. Any effect of other primary parameters such as climate, precipitation regime, hydrogeology, acid rain expectations, migrating animals and bird flocks, renewable local forests and vegetation cover and endangered species must also be recorded and quantified in relation to the monitoring of toxic contaminants (Muezzinoglu 2003).

LAKE SUPERIOR WATER BASIN: A CASE STUDY OF THE MARATHON AREA

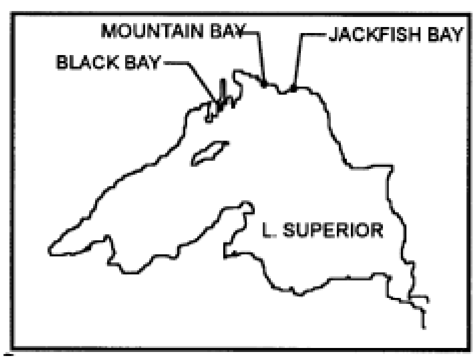
Stillwater Canada continues to support Marathon PGM's analysis that the proposed copper mine near Marathon will not have any affect or influence on the Lake Superior Basin. The proposed mine site is approximately 12 kilometres from Lake Superior; additionally, many rivers (some whose natural flow will be interrupted due to mine development) and one major tributary into Lake Superior, the Pic River, are close to the proposed mine site. This section explores the probability, possible effects, and history of Lake Superior effluent release, providing strategies to mitigate the potential affect of copper effluent release into Lake Superior.

Lake Superior is the most northern of all the Great Lakes; it serves as a major tributary and starting point of the entire St. Lawrence waterway. Lake Superior has been idealised as the largest, cleanest, coldest, deepest, most beautiful lake within the great lake system by many Canadians and Americans (Linder 2006). It serves as an icon of the great northern wilderness, free of the industrial influences and pollution that many other Great Lakes are associated with. There are many environmental policies directly related to pollution control and conservation of Lake Superior. Policies regarding Great Lakes, specifically Lake Superior, have become more proactive and restrictive through time as clean water continues to become a controversial issue. However, it must be acknowledged that Lake Superior has historically suffered industrial pollution. In the past, Lake Superior has been viewed as large and vast enough that it could never be influenced by pollution. Degradation of the more southern Great Lakes served as a catalyst in supporting pollution control within Lake Superior.

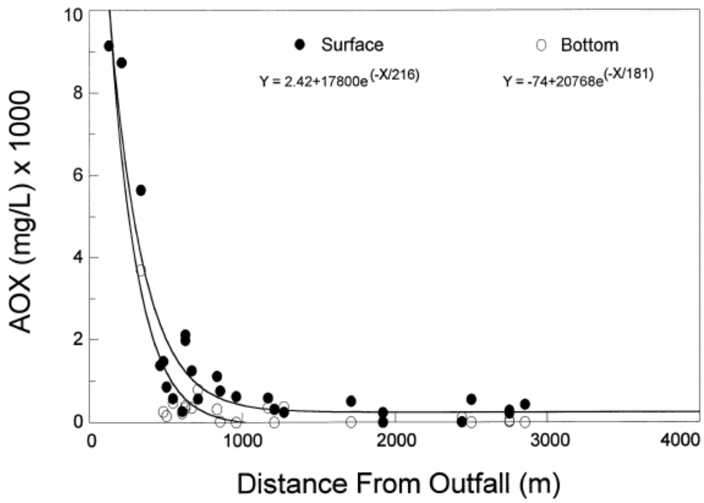
Historically, industrial pollution has been released into Lake Superior. The Murphy Oil refinery was located approximately three miles southwest of Lake Superior in Superior, Wisconsin. Released treated wastewater from the refinery entered indirectly into Superior Bay via a drainage way called Newton Creek for over 30 years before permits were issued in the early 1990s by the Wisconsin Dept. of Natural Resources requiring water quality limits reflective of the U.S. Great Lakes Initiative that enacted more stringent pollution control (Vail 2000). Pollution has not solely been released in America; Canada too has released many effluents into Lake Superior.

A contributor to historic Lake Superior pollution has been pulp mills. Pulp and paper mills line the Lake Superior coast, typically close to or at major tributary river outlets where log drives would have occurred. Since the discovery of dioxins and furans in the mid-1980’s, public and scientific concern over the discharge of toxic compounds in pulp and paper mill effluents has escalated significantly (Sibley 1997). It has been estimated that over one thousand compounds may occur in bleach effluents (Suntio 1988). Historically, research studies have attempted to assess the risks posed by these compounds in aquatic environments. Initially the focus was toward mills that included pulp bleaching; however, more recent studies have revealed similar impacts in waters receiving effluent from mills that do not incorporate bleaching, suggesting that compounds associated with pulping may also be responsible for environmental effects (Sibley 1997). Marathon was a town whose economy was principally based around a pulp mill, which began operating in 1946. This staple in Marathon lasted until February 12, 2009 when Marathon Pulp Inc. announced its shutdown, eliminating many jobs and the forest industry in the town.

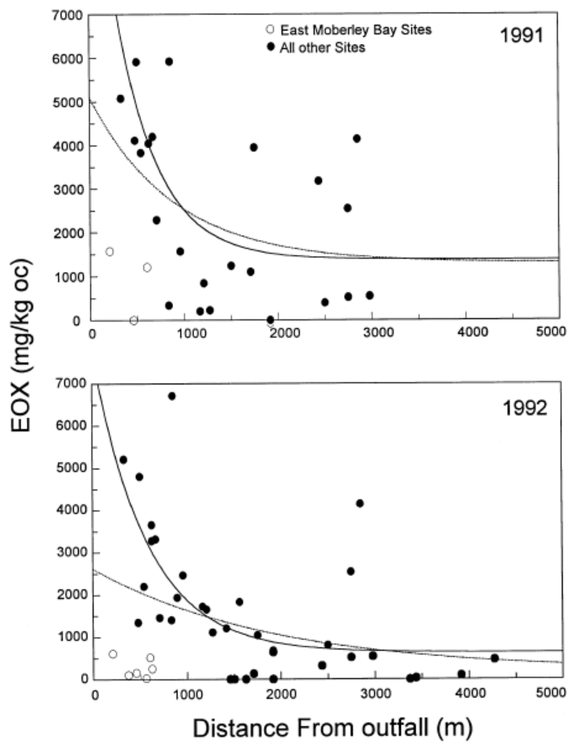
The Marathon pulp mill would have released effluent into the Lake Superior Basin for many years while in operation. A study was carried out on the effluents from the Terrace Bay Pulp Mill (located approximately 50 kilometres due east of Marathon Ontario) into the Lake Superior Basin. The following figures (Figure 5) detail the finding of the study.



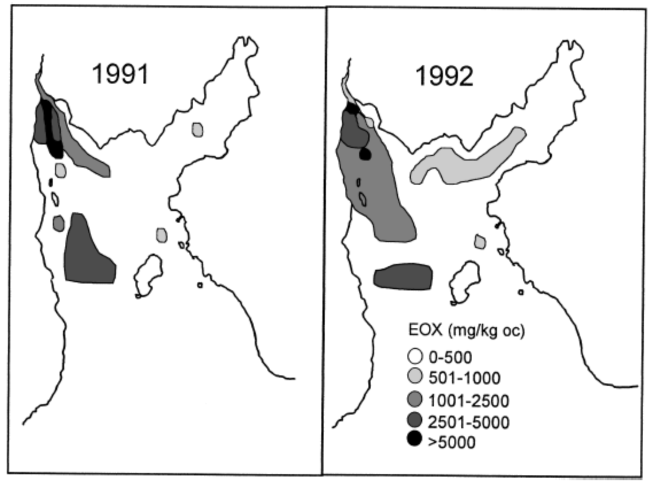
i)


Surface
Bottom
Y = 2.42+17800e(-X/216)
Y = -74+20768e(-X/181)
AOX (mg/L) x 1000
Distance From Outfall (m)

ii)


East Moberley Bay Sites
All other Sites
1991
1992
EOX (mg/kg oc)
Distance From outfall (m)

iii)



iv)

Figure 5: i) Location of Jack Fish Bay in relation to Lake Superior; ii) Absorbable organic halides (AOX) in relation to distance from effluent outlet; iii) Extractable organic halides (EOX) in relation to distance from effluent outlet; iv) A spatial view of concentrations of Extractable organic halides (EOX) throughout Jackfish Bay in 1991 and 1992 (Sibley 1997).

For the purposes of this paper it is not relevant to describe the exact toxicological makeup of the study. However, it is worth noting that the results displayed here indicate that pulp mill effluents decrease dramatically with increasing distance from the outlet. This would indicate that any effects caused from effluents would be concentrated within the area closest to discharge. This information is relevant to this paper by suggesting that effects caused by the proposed copper mine on the Lake Superior Basin must be studied in relation to contaminant impacts occurring from past industry. The Marathon harbour has been influenced by industrial effluents, which promotes the question as to whether the Marathon harbour can ecologically buffer more potential effluent as a result of copper mining.

The absence of effects of the proposed copper mine on the Lake Superior Basin within the Marathon PGM project description would suggest that effects to the basin would not have any negative effect. However, the proximity and connectedness of the project site to Lake Superior should warrant a closer inspection of control methods.

Mining activities can potentially have disastrous human and environmental impacts (Stenson 2006). The enormity of detrimental impacts caused from past mining accidents supports the need to further explore the potential for mine effluent to reach Lake Superior. Stillwater Canada plans to construct dams which will create waste rock holding areas. Dams will follow traditional waterways on route to Lake Superior. The number of tailings dam failures worldwide has steadily increased from 10 in the decade 1969-1979 to 21 in the decade 1989-1999 (Stenson 2006). A failure in one of the dams would potentially result in mine tailings leaching or spilling into Lake Superior.

There have been strategies created to mitigate the effects of mining accidents leading to environmental degradation. Disaster management is a strategy where both the community and the proponent agree to the responsibilities and actions to be taken in the event of an accident. It is unreasonable for a community to place sole responsibility of disaster management and planning on the mining company. Communities, mining industry, and government must work together to create a disaster management plan which examines the control points and possibilities of effects to the Lake Superior Basin. All Disaster Management Plans are ineffective if they are unable to be readily and properly implemented. A holistic approach is essential so that the additive effects of each individual process and system is understood and appreciated. To be effective, Disaster Management Plans must be constructed in such a way that they can constantly be adapted. They must evolve as each variable evolves. Lastly, programs must be put in place to monitor plans to ensure constant readiness (Stenson 2006). Through implementation of a disaster management plan the community of Marathon will be better prepared to stem potential accidents, which will result in negative affects to Lake Superior.

MONITORING AND MITIGATION THROUGH TRACERS

There seem to be large areas in which toxins could travel downstream into the Lake Superior Basin. Understanding the impacts and inclusion of mitigation efforts should be addressed by the proponent. If toxins did reach the Basin, it would affect biological, social, and economic values for Marathon, the Ojibways of Pic River First Nation and adjoining townships. If large amounts of chemicals are added to the native ground water, it will alter the flow patterns and the ion exchange and secondary chemical precipitation will alter the aquifer permeability (Davis et al. 1980).

We suggest using water tracers before the mine is in place, and then use similar tracers again each year to see if anything has changed in the flow and aquifer systems. The criteria for selecting a suitable tracer organism for ground water contamination depend on the time of survival, as well as their retention in soil-water systems. There are twelve different types of water tracers available: salts, dyes, solid tracers, radioactive tracers, neutron activation analysis, lead isotopes, zinc variations, temperature, conductivity, carbon dioxide, tritium, and stable isotopes, all with positives and negative aspects (Keswick et al. 1982).

We recommend using dyes initially to judge how far the transport rates are occurring. If the contaminants are showing little distance before being diluted into the water system, then the proponent would not have to include mitigation efforts in stopping the contaminants reaching the Lake Superior Basin. The downfall to dyes is they cannot be used to travel long distances, therefore using solid tracers might be a second choice in demonstrating the distance travelled by the toxins (Davis et al. 1980). Solid tracers are solid material in suspension water flows in large conduits such as in some basalt, limestone, and dolomite aquifers (Davis et al. 1980). Separate numbers printed on small pieces of paper can be placed into the different sink holes and recovered by sieving water as it emerges from springs. In this way, simultaneous tests can be made of the interconnections among several sink holes and springs. Owing to the relatively large sizes of the pieces of paper however, the method can be successful only where ground-water flow is within large open passages such as the outlets leading into the Lake Superior Basin from smaller tributaries.

CONCLUSION

Overall understanding the distance travelled by the contaminants is an effort that the Marathon mine should put into place to show water quality impacts. Mitigation efforts will all depend on the data the tracers produce. If there is an obvious contaminant travelling from the mine to the Lake Superior Basin, the proponent would have to include alternative pathways to stop the toxins if they are in high enough capacity. A small amount of contaminants travelling into the Basin would not be enough to account for the alteration of the water table to stop the toxins from reaching the basin. We recommend that Marathon Mine include tracers into their obligations to ensure that the contaminants that they are producing will not reach the Lake Superior Basin.

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