Toronto & Region Remedial Action Plan

BUI Status Re-designation Document:

Degradation of Benthos

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The Toronto and Region Remedial Action Plan is managed by representatives from Environment Canada, Ontario Ministry of the Environment, Ontario Ministry of Natural Resources and Toronto and Region Conservation Authority.

Introduction

In 1985, based on recommendations from U.S. and Canadian Federal, Great Lakes states and provincial governments, the International Joint Commission (IJC) identified 42 (later 43) areas in the Great Lakes where severe environmental concerns existed. These "Areas of Concern" (AOCs) formed the priority sites for environmental actions. The original listing of AOCs was based on a list of 14 designated beneficial use impairments (BUIs). The BUIs noted the major environmental impairments in each of the AOCs, and identified the issues that would need to be addressed for the area to be delisted as an AOC. In many of these areas, contaminated sediments were identified as one of the causes of the use impairments and there are a number of the BUIs related directly to contaminated sediment issues:

- Degradation of benthos;
- Restrictions on fish and wildlife consumption;
- Fish tumours or other deformities;
- Bird or animal deformities or reproduction problems; and
- Restrictions on dredging activities.

Criteria for Re-designation of “Degradation to Benthos”

The Toronto and Region Remedial Action Plan Stage 2 Report (1994) stated the Degradation of Benthos Beneficial Use would be declared not impaired when:

- Suspended, transported, and in-place sediment contain levels of contaminants at or below the Provincial Sediment Quality Guidelines; and,
- The quality of stormwater run-off is protected and enhanced.

Newer effects based approaches are now used to better determine whether contaminated sediment poses an environmental risk to aquatic life, non-aquatic wildlife (e.g. fish eating animals, birds, etc) and humans. This new approach clearly shows the use of sediment chemistry alone is insufficient evidence to conclude whether sediment-

bound chemicals are toxic. Instead a weight of evidence approach (here after called the COA Sediment Framework) that incorporates four lines of evidence (sediment chemistry, laboratory toxicity testing, *in situ* assessment of the health of the benthic community and assessment of food chain effects through bioaccumulation) provides a more accurate assessment of the environmental risk posed by contaminated sediment (Environment Canada and Ontario Ministry of the Environment 2007). The first three of these lines of evidence of the COA Sediment Framework are the most appropriate for determining the effects of sediment contaminants on benthic organisms and provides a better basis for deciding on the status of the "degradation of benthos" Beneficial Use (BU). For this reason the criterion proposed in the Toronto and Region Stage 2 Report (1994) is considered outdated. The International Joint Commission's (1991) guideline for re-designating benthos provides guidance that is consistent with the COA Sediment Framework and is a more appropriate criterion to assess this BU for the Toronto and Region AOC.

The International Joint Commission's guideline for determining the status of "degradation of benthos" (International Joint Commission, 1991) as un-impaired states:

> *When the benthic macroinvertebrate community structure does not significantly diverge from un-impacted control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use will be considered restored when toxicity of sediment associated contaminants is not significantly higher than controls.*

This report examines the weight of evidence gathered to support re-designating the "degradation of benthos" BU for the Toronto and Region AOC as <u>not impaired</u>.

Weight of Evidence

Sediment Chemistry

Studies undertaken in the Toronto and Region AOC in the 1970s showed that sediments in the Toronto Inner Harbour and Humber Bay were contaminated with a number of metals and organic compounds, while sediments in the Outer Harbour and the eastern waterfront had low concentrations of contaminants and generally did not contribute to biological effects. Concentrations of many of the metals in the Inner Harbour and Humber Bay during the 1970s exceeded the Ontario Ministry of Environment's Provincial Sediment Quality Guidelines Severe Effect Levels (SEL)[1]The sediments also had a high nutrient content, indicating organic enrichment of the sediments, due mainly to runoff (storm-water, snowmelt, combined sewer overflows, etc.) from the largely urbanized areas of the two main watersheds draining to the AOC: the Humber River and the Don River.

More recent surveys (Figures 1 and 2) have shown that concentrations of metals and organic compounds have decreased significantly in the Inner Harbour and Humber Bay, and there are now only a few contaminants that exceed the SELs in a limited number of sampling locations. Elevated concentrations of some metals are noted only in the slips along the Toronto Waterfront. These areas receive direct stormwater runoff and combined sewer overflow discharges, and this urban runoff is likely the main source of these higher concentrations. While long-term plans have been developed to address stormwater management and combined sewer overflows in the Toronto area, loadings to the slips from stormwater drainage are expected to continue until these plans are implemented.

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[1] The Severe Effect Level (SEL): indicates a level of contamination that is expected to be detrimental to the majority of sediment-dwelling organisms and sediments exceeding the level are considered heavily contaminated. *Guidelines for Indentifying, Assessing and Managing Contaminated Sediments in Ontario: An Integrated Approach* (Ontario Ministry of the Environment, 2008). The fact that contaminant levels exceed the SEL does not always indicate the sediment is toxic to sediment dwelling organisms. Instead the SEL is used as a trigger for implementing further biological assessment of sediment to determine if ecological effects associated with high contaminant levels exist.

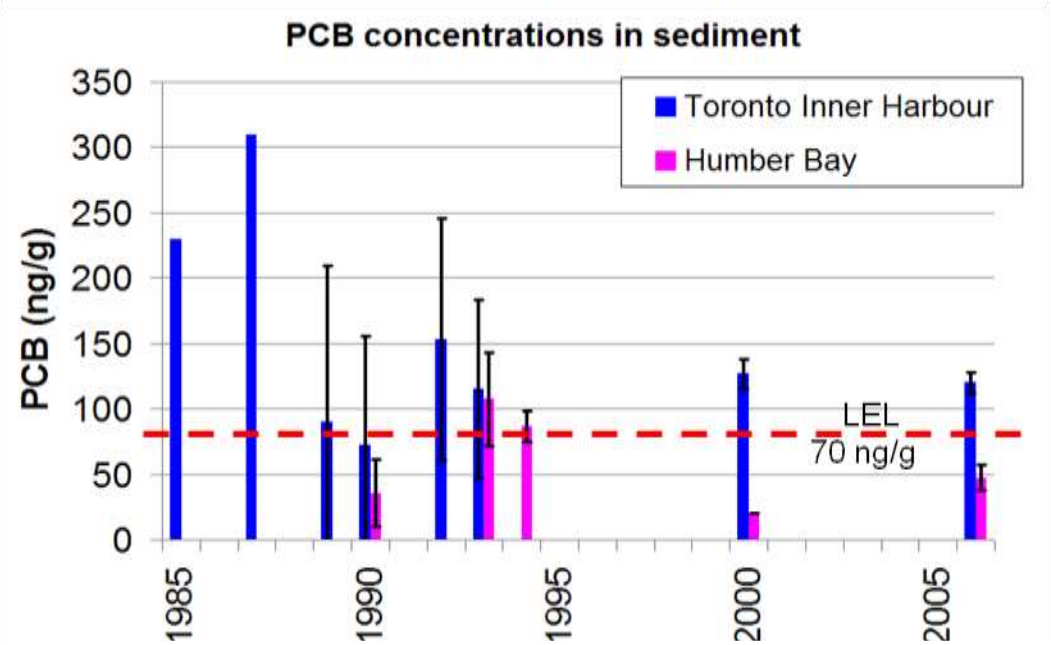

Figure 1. Graph showing PCB concentrations in sediment in Toronto Inner Harbour and Humber Bay from 1985 – 2006 (Ontario Ministry of the Environment, 2013)

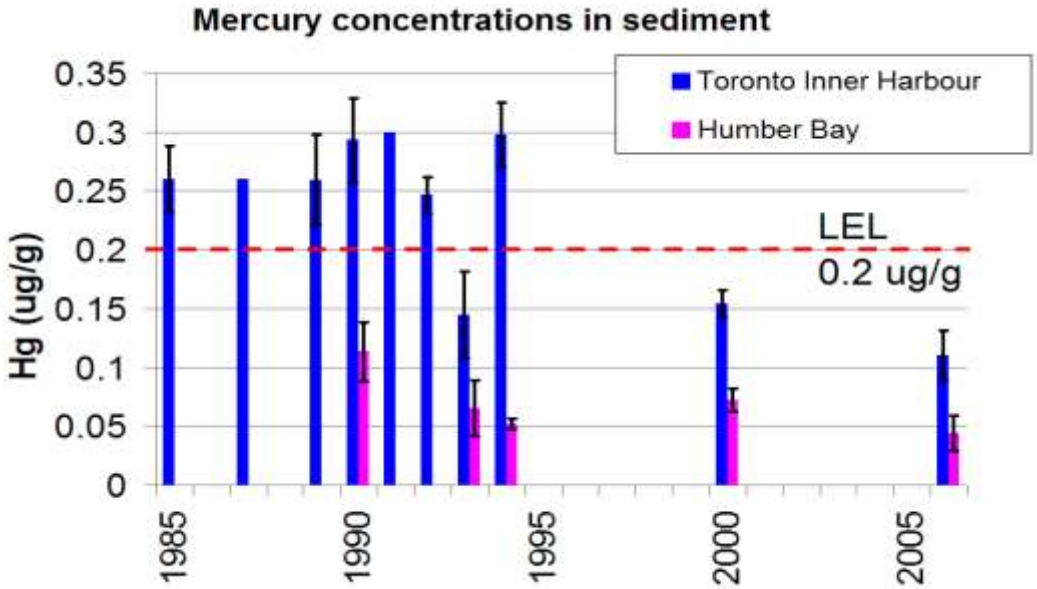

Figure 2. Graph showing mercury concentrations in sediment in Toronto Inner Harbour and Humber Bay from 1985 – 2006 (Ontario Ministry of the Environment, 2013)

Toxicity Testing

Testing for sediment toxicity from areas along the waterfront has shown that, despite concentrations of some metals in excess of the Severe Effect Levels (SEL), there were no substantial effects on benthic organisms. Previous studies have also shown that uptake of metals and organic substances by benthic organisms is low, and that biological availability of these substances from sediment is also low.

In 1995, nine locations in the Inner Harbour identified with sediment contaminant concerns were subjected to laboratory toxicity tests using mayfly (*Hexagenia limbata*) growth and survival test, the midge (*Chironomus tentans*) growth and survival test, and the fathead minnow (*Pimephales promelas*) survival test. Sediment concentrations of the metals of concern in these samples were high and ranged up to 257 µg/g lead, 111 µg/g copper, and 95 µg/g chromium. The test results showed that none of the samples resulted in mortality for any of the test organisms. Elevated levels of copper and lead in the sediments did not result in increased mortality in the mayflies, chironomids or fathead minnows, despite sediment lead concentrations that in one case exceeded the SEL. There was no reduction in growth in the chironomids (midge) at any of the locations tested. Mayflies exhibited reduced growth relative to control sediments at all stations in the Inner Harbour, with lowest growth recorded from off the Keating channel and in the deeper central section of the open harbour.

Mayflies are sensitive to sediment type and the high silt content of the Inner Harbour sediments (>80%), could also limit mayfly burrowing activity, placing additional stress on the test organisms, and may account for the slight reduction in growth. The lack of a response in the chironomids suggests that those species adapted to silty sediments in depositional areas were not influenced by the metals concentrations and, that the reduction in growth in the mayfly tests was mainly a response to the physical conditions of the sediment, to which this species is less well adapted.

Benthic Invertebrate Community Assessment

The most compelling evidence in determining whether benthos is affected by sediment-bound contaminants is the application of benthic community assessments. By studying the abundance and diversity of sediment dwelling organisms in sediment of concern compared to similar sediment from clean areas, scientists are able to determine whether the sediment of concern is toxic.

Benthic invertebrate community assessments have been conducted within the Toronto waterfront sporadically from 1971 to 2008. These biological tests show that effects due to contaminants in sediments are largely absent in habitats along the Toronto waterfront, and the main factors affecting biota are related to the physical nature of the sediments, which in many areas are largely comprised of silts. The higher nutrient levels of these silts favour benthic communities which are adapted to these conditions.

Increases over time in the diversity of the major groups of organisms present in depositional environments along the waterfront demonstrate improvement. In particular, the increased number of species of oligochaetes and chironomids, are clear indicators of this improvement and show that the chemical contaminant levels are no longer toxic to benthos.

Conclusions

Together benthic community studies and laboratory sediment toxicity testing indicate that the changes in the benthic communities in most areas of the AOC are a result of physical alterations of the substrate which favour species well adapted to depositional areas, and that evidence of toxic effects due to contaminants in sediments is generally lacking.

Biological assessment of watercourses within the AOC has identified the physical effects of urbanization (e.g., loss of forest cover which affects stream water temperatures, results in increased peak flows) as having the greatest influence on

benthic communities. That is, the benthic communities have adapted to the physical conditions of a densely urbanized area.

Status of AOC Against BUI Criteria

Comparison of AOC conditions to BUI Criteria

It is recommended that the Degradation of Benthos BU be considered not impaired as supported by the following evidence:

- the benthic community has demonstrated improvements over time (increase in diversity);
- concentrations of various metals and organic contaminants have been reduced over time and are generally below the guidelines, and are consistent with what might be expected in a large urban area;
- sediment bound contaminants are not acutely or chronically toxic to test organisms;
- diversification of the benthic community is limited by the physical aspects of the habitats , which are not expected to change over time as it is a reflection of the urban environment.

Has the BUI Delisting Criterion been met?

Yes. Concentrations of various metals and organic contaminants in sediment are generally below guidelines, and are consistent with conditions expected in a large urban area; and the benthic community has demonstrated improvements over time (increase in diversity).

Recommended Status of the Beneficial Use:

Not Impaired

Ongoing Actions

While the benthic community at the mouth of the Don River has shown improvements over time, with a larger number of species present, the high organic matter and nutrient

levels in the water and sediment (as indicated by Total Organic Carbon concentrations) indicate that effects in these areas are due to physical conditions of the sediment and eutrophication rather than contaminants (e.g. metals, Polycyclic Aromatic Hydrocarbons, etc.). For this reason it is recommended that the Don River continue to be monitored through the Remedial Action Plan to address the beneficial use impairment (BUI 8) *Eutrophication and Undesirable Algae.*

Recommendations: Future Monitoring or Actions Required

- The Toronto and Region Conservation Authority, Environment Canada and Ontario Ministry of the Environment continue to coordinate their sediment and water monitoring programs for contaminants and the diversity of the benthic community in the Toronto and Region AOC.
- The Toronto and Region Conservation Authority Continue to implement the Regional Watershed Monitoring Network to provide long-term data to track improvement of water quality and to ensure no backsliding.
- All partners continue to support Toronto and Region Conservation Authority Sustainable Technology Evaluation Program (STEP) or other programs with similar goals/outcomes and initiatives to control erosion, stormwater, restoration of more natural stream hydrology and encourage sustainable, Low Impact Development (LID) within the Toronto and Region AOC.
- The three levels of government work together to support and implement the City of Toronto's Wet Weather Flow Master Plan to eliminate discharges from combined sewer overflows and improve stream and waterfront water quality.
- All partners continue to work together to implement watershed management plans to address the causes of urban impacts, improve the stream benthic community through stormwater management, improve stream hydrology and habitat restoration. Implement the Terrestrial Natural Heritage Strategy to restore riparian vegetation and wetlands and the Toronto Waterfront Aquatic Habitat Strategy to create and restore aquatic habitat and coastal wetlands, improving the health and diversity of the benthic communities.

Research Results

Please see the attached reports for details on the summarized findings.