

DEGRADATION OF BENTHOS (BUI #6)



BACKGROUND

Benthos are the community of invertebrate organisms (e.g., crayfish, insects, worms) which live in or near the bottom of freshwater systems such as lakes, rivers and streams—at least for a part of their life cycle. Benthic invertebrates (or “benthos”) are an important part of the food chain as a source of food for fish and aquatic birds. These bottom-dwelling organisms are also excellent indicators of local sediment and water quality conditions, because their limited mobility means they are continuously subjected to pollutants and environmental stream conditions within a small area. Benthos are used as ecosystem health indicators through a scientific sampling technique referred to as biomonitoring. Toxic chemicals such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and metals found in sediments can accumulate in benthos, and move up through the food chain as the organisms are eaten by fish and wildlife. Certain benthos species can tolerate living in polluted sediment (e.g., aquatic worms, midge larvae) while others are very sensitive to pollution (e.g., caddisflies, stoneflies, and mayflies). The presence of more sensitive benthos is generally indicative of good water and sediment quality.

Specific to the Niagara River Area of Concern, the status of the *Degradation of Benthos* ecosystem indicator has been ‘Impaired’ since the completion of the Niagara River Remedial Action Plan (RAP) Stage 1 Report, mainly because of contaminated sediments in the Welland River and other small tributaries near the Niagara River (NRRAP 1993). The 1993 report indicated that benthos in the Niagara River itself were relatively sparse due to lack of suitable substrate related to the high-velocity water flow but, in backwater areas, benthos abundance and diversity were not impaired. In 1995, a RAP Stage 1 Update Report provided scientific evidence that identified the impaired status of benthos in the Niagara River watershed was due to contaminated sediments at 14 potential sites identified for further investigation (NRRAP 1995a). Based on the sediment conditions, the sites were prioritized into three categories (Level 1, 2, 3) (Figure 1). The Level 1 sites were those with known contamination requiring remediation, while all of the Level 2 and 3 sites were shown to have little to no risk to living organisms (humans and wildlife) and no further action required. In April 1995, recommendations to address specific sources at contaminated sites were identified in the RAP Stage 2 Report (NRRAP 1995b) and remediation activities began shortly thereafter.

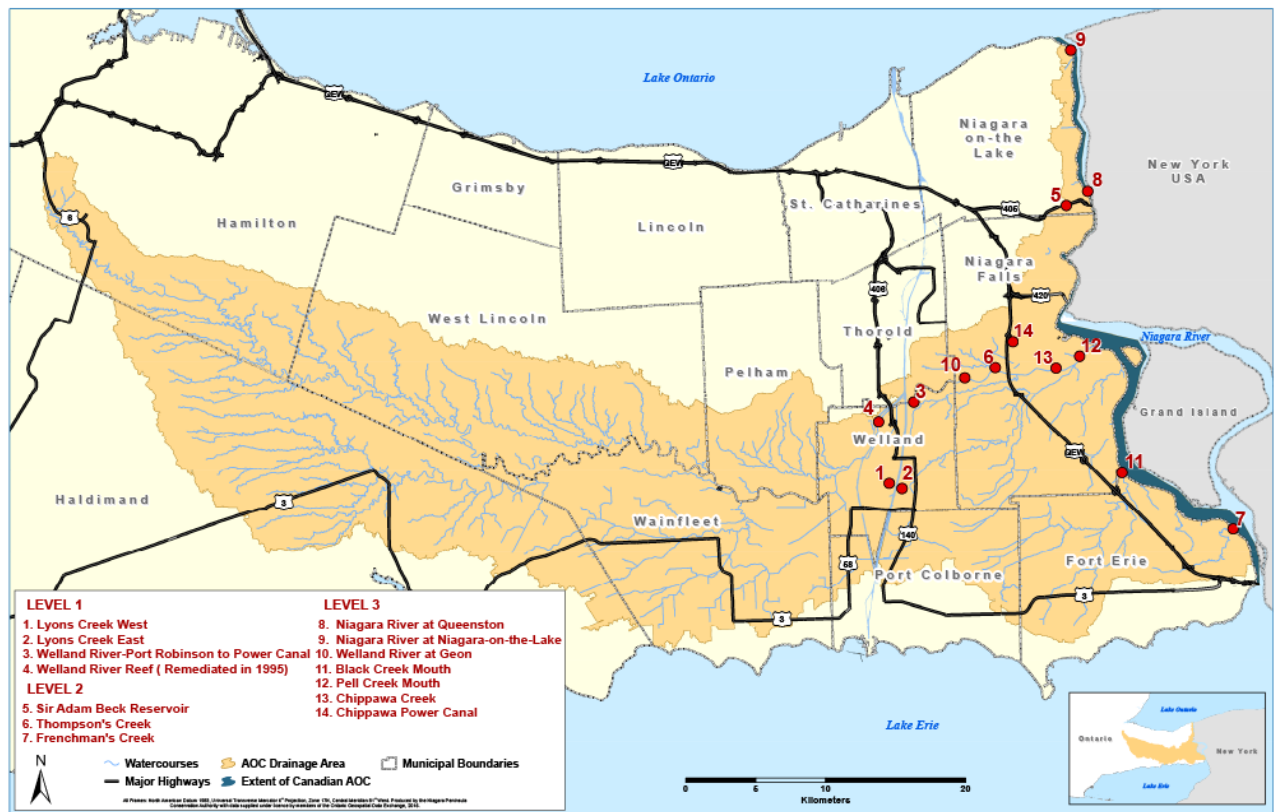


Figure 1. Map of contaminated sediment sites (level 1, 2, 3) in the Niagara River Area of Concern watershed. The level 1 sites were those with known contamination requiring remediation. The level 2 and 3 sites were shown to have little to no risk to living organisms (humans and wildlife) and no further action required.

Of the four sites identified as Level 1 (i.e., Welland River Reef, Welland River at Port Robinson, Lyons Creek West, and Lyons Creek East), only the Welland River Reef required remediation due to high levels of chromium, copper, nickel, and PAHs. The site was dredged in 1995 and post-remediation monitoring concluded that the benthic communities were becoming re-established at levels similar to the remainder of the Welland River (Golder 2013). The Welland River at Port Robinson site was shown to be impacted by the nearby Welland River Reef site, but a follow-up assessment in 2003 showed that further remedial actions would have little impact on fish or benthos; therefore, no further action was required (Golder 2013). The Lyons Creek West site was contaminated with PCBs and arsenic which were removed in 2007. In 2014, a natural recovery strategy was implemented by Transport Canada for the Lyons Creek West site (NRRAP 2015). The fourth site is Lyons Creek East, in which sediments are contaminated with PCBs. The site is made up of a series of Provincially-Significant Wetlands and contain rare species. After several studies – including an ecological risk assessment and human health risk assessment – and following public consultation, Monitored Natural Recovery was selected as the option to minimize the disruption and mobilization of PCB-contaminated sediments at Lyons Creek East. This decision followed the 2008 Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment. In 2011, a multi-agency Administrative Controls Protocol was developed

and is in place that commit signatory agencies to collaborate on the long-term protection, monitoring, and awareness efforts regarding the contaminated sediments at Lyons Creek East (NRRAP 2011).

In 2013, a technical assessment of the status of benthos was conducted for 13 of the 14 contaminated sites in the Niagara River Area of Concern's watershed originally noted in the RAP Stage 1 Update (NRRAP 1995a). The 14th site, Welland River Reef, was not included in the assessment because the site was remediated in 1995 and shown to have re-established benthos (Golder 2013). The technical assessment indicated that 11 of the 13 sites met the delisting criteria and the BUI was 'Not Impaired' for those sites (Golder 2013). In addition, the BUI was shown to be 'Not Impaired' at the other two remaining sites, Lyons Creek East and West, because there was minimal risk to wildlife and management strategies (e.g., Lyons Creek East Monitored Natural Recovery Administrative Controls Protocol) were in place to mitigate potential risks (Golder 2013). A beneficial use impairment (BUI) Status Assessment was prepared in April 2015 but was never finalized; thus, the *Degradation of Benthos* BUI remains 'Impaired'.

Monitoring at Lyons Creek East continues through coordinated efforts between Environment and Climate Change Canada (ECCC) and Ministry of the Environment, Conservation and Parks (MECP) to confirm the progress of natural recovery and burial of contaminated sediment by cleaner sediments, as well as determine/measure the reduction of risk to organisms. As part of this ongoing long-term monitoring, sediment cores and fish samples from the Lyons Creek East site were collected by MECP researchers in the fall of 2015. Results indicated that mean PCB concentrations at specific zones did not meet the RAP targets and recommended that further sampling be conducted to better understand the spatial extent of the contaminated sediment and the ecological risk assessment targets (Richman 2018). In 2019, scientists from ECCC and MECP collected sediment and benthos samples from specific locations along Lyons Creek East in order to contrast and compare with past results to determine changes over time. Furthermore, as a means of validating the scientific biomagnification model and provide evidence about actual PCB bioaccumulation in organisms higher up in the food chain, scientists from MECP have collected and are analyzing concentrations of PCBs in young-of-the-year fish from Lyons Creek East. ECCC scientists are currently analyzing contaminant levels in snapping turtle eggs for similar reasons. The results from these updated studies will inform future direction of the long-term monitoring plan for Lyons Creek East.

For more information about the recent monitoring efforts at Lyons Creek East, please visit www.ourniagarariver.ca/lyonscreek-monitoring2019. You may also download all of the reports and technical documents related to the Degradation of Benthos indication from our online document library: www.ourniagarariver.ca/document-library.

BUI DELISTING CRITERIA REVIEW & RECOMMENDATIONS

The delisting criteria for the *Degradation of Benthos* beneficial use impairment (BUI) were revised in 2009 in consultation with a range of stakeholders and a Public Advisory Committee, and then endorsed by the RAP Science Committee that existed at the time. In 2017, a Canada-Ontario Agreement Task Team (made up of staff from ECCC and MECP) reviewed the delisting criteria across all of the Canadian Areas of Concern (AOC). The Task Team did not suggest revisions for the *Degradation of Benthos* BUI for the Niagara River AOC; however, members of the Coordinating Committee reviewed the *Degradation of Benthos* BUI delisting criteria for consistency and as part of the review of delisting criteria for all remaining BUIs for the Niagara River Area of Concern. The *Degradation of Benthos* BUI criteria were found to be relevant and still applicable, but required minor revisions for clarity and readability.

The *Degradation of Benthos* BUI will no longer be impaired when...

	Proposed Delisting Criteria (2020)	RAP Stage 2 Update Report (2009)
1a	acute and chronic toxicity, community composition, and abundance in the benthic community are similar to non-AOC reference sites	acute and chronic toxicity, community composition, and abundance in the benthic community are similar to non-AOC reference sites.
<u>AND</u> 1b	concentrations of biomagnifying contaminants (e.g., PCBs and dioxin-like PCBs) within benthic invertebrate tissues are comparable between contaminated sites ¹ and a suitable non-AOC reference site	benthic invertebrate tissue contaminant (PCBs and dioxin-like PCBs) concentrations are comparable in the AOC to those at a suitable non-AOC reference sites for contaminants that biomagnifies in the aquatic food chain and/or
<u>OR</u> 2	if a contaminated site ¹ fails to meet criteria 1a and 1b, then benthic invertebrate tissue contaminant concentrations are greater than reference sites but below concentrations considered to impair the beneficial uses associated with the consumption of fish and wildlife.	in cases where benthic invertebrate tissue contaminant concentrations are greater than reference sites but are below concentrations considered to impair the beneficial uses associated with the consumption of fish and wildlife.
<u>OR</u> 3	if a contaminated site ¹ fails to meet the criteria above, then a risk based contaminated sediment management approach/strategy must be in place with appropriate monitoring and mitigation measures and/or administrative controls.	if a contaminated site (as designated by the Niagara River Contaminated Sediment Technical Advisory Group*) fails to meet the criteria described above in regard to fish and wildlife consumption, then a risk based Contaminated Sediment Management Strategy must be in place with appropriate monitoring and mitigation measures and/or administrative controls.

¹ Refers to the original 14 contaminated sediment sites identified in the Niagara River AOC watershed (NRRAP 1995a).

Description of delisting criteria and application guidance

The proposed revisions to the delisting criteria are minor and only meant to provide clarity and understanding for the interpretation and application of the BUI Assessment Framework (Fig. 2).

The delisting criteria require that the abundance, toxicity and composition of benthic species in the 14 contaminated sediment sites be comparable to that of healthy reference sites not within the Area of Concern or its watershed. Contaminated tissues in benthos must also be comparable to those at the healthy sites or must be below concentrations that would harm fish and wildlife. If a contaminated site does not meet these criteria, then a Contaminated Sediment Management Strategy must be put in place to monitor and mitigate any movement of contaminants at the site (see Figure 2 for a graphical representation of the assessment framework application). The BUI delisting criteria incorporates components of the sediment assessment framework and applies the framework to specific contaminated sites in the Niagara River AOC watershed. The Niagara River RAP approach to assessing these contaminated sites is similar to the Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (ECCC/MECP 2008). The approach with details provided below are as described in Golder (2013).

Criterion 1a: Acute/Chronic Toxicity

If an assessment shows no acute and/or chronic toxicity in the majority of the test organisms, then the criterion is deemed to be met. Similarly, if benthic community composition and abundance are similar to reference sites, or at those sites where no direct benthic community assessment was undertaken if there is no acute or chronic toxicity to benthic species, then the benthic community composition and abundance is considered to be unaffected by contaminants, and the criterion is deemed to be met.

- If the contaminants did not include those that could biomagnify, then further assessment is not considered necessary and the general conditions for Criterion 1a are met and the benthic community is considered to be unimpaired.
- If the contaminants present included those that could biomagnify, then the benthic community assessment proceeds to assess the ability of the benthic community to meet Criterion 1b.

Criterion 1b: Biomagnifying contaminants

Benthic invertebrate tissue concentrations in reference areas are expected to be below detection limits for industrial compounds (e.g., PCBs) since these substances do not occur natural or would be expected to be low in the case of naturally occurring metals like mercury. The presence of detectable concentrations of these contaminants in benthic organism tissues shows that this condition has not been met regardless of whether reference site data are available, and the assessment would proceed to evaluating the ability to meet Criterion 2 (below).

Criterion 2: Predicted risk

This criterion is met if tissue residues are within ranges that do not result in predicted risk to fish or terrestrial consumers of benthic organisms (e.g., mallard ducks, snapping turtles, etc.). If unacceptable risks are predicted, then the assessment proceeds to evaluating the ability to meet Criterion 3.

If Criterion 1a and b or Criterion 2 criterion are met, then the RAP Team may suggest proceeding with the BUI's status re-designation to 'Not Impaired' and Criterion 3 is not assessed.

Criterion 3: Sediment Management Approach/Strategy

The 14 sites were evaluated with respect to the above criteria and it was determined that 12 of them met the above criteria. Therefore, this criterion only applies to the Lyons Creek East and Lyons Creek West contaminated sediment sites. If an assessment fails criterion 1a and 1b or 2, then there must be a plan to manage sediment contaminants to minimize risks to aquatic and terrestrial species. If there is a plan in place, then the criterion is met and the BUI can be deemed 'Not Impaired' for the purpose of the RAP. The RAP Team may proceed with the BUI re-designation process. The Canada-Ontario Agreement Sediment Management Framework was applied and is in place for both Lyons Creek East and West sites. Monitored Natural Recovery was selected as the appropriate sediment management option in both Lyons Creek West and Lyons Creek East.

In 2011, the Niagara River RAP team developed an administrative controls protocol for the Lyons Creek East contaminated sediment site (NRRAP 2011) as the appropriate sediment management approach. The Niagara Peninsula Conservation Authority acts as the lead agency for the protocol along with the following signatory agencies: Environment and Climate Change Canada, Fisheries and Oceans Canada, Ministry of the Environment, Conservation and Parks, Ministry of Natural Resources and Forestry, City of Welland, Niagara Region and the St. Lawrence Seaway Management Corporation. All agencies indicated their support in applying the Lyons Creek East Administrative Controls Protocol to plan or review any projects or activities in the contaminated sediment and drainage areas.

In addition to the Lyons Creek East Administrative Controls Protocol (2011), there is support from both Environment and Climate Change Canada and the Ministry of the Environment, Conservation and Parks for the development and implementation of a long-term sediment monitoring plan for the Lyons Creek East contaminated sediment site.

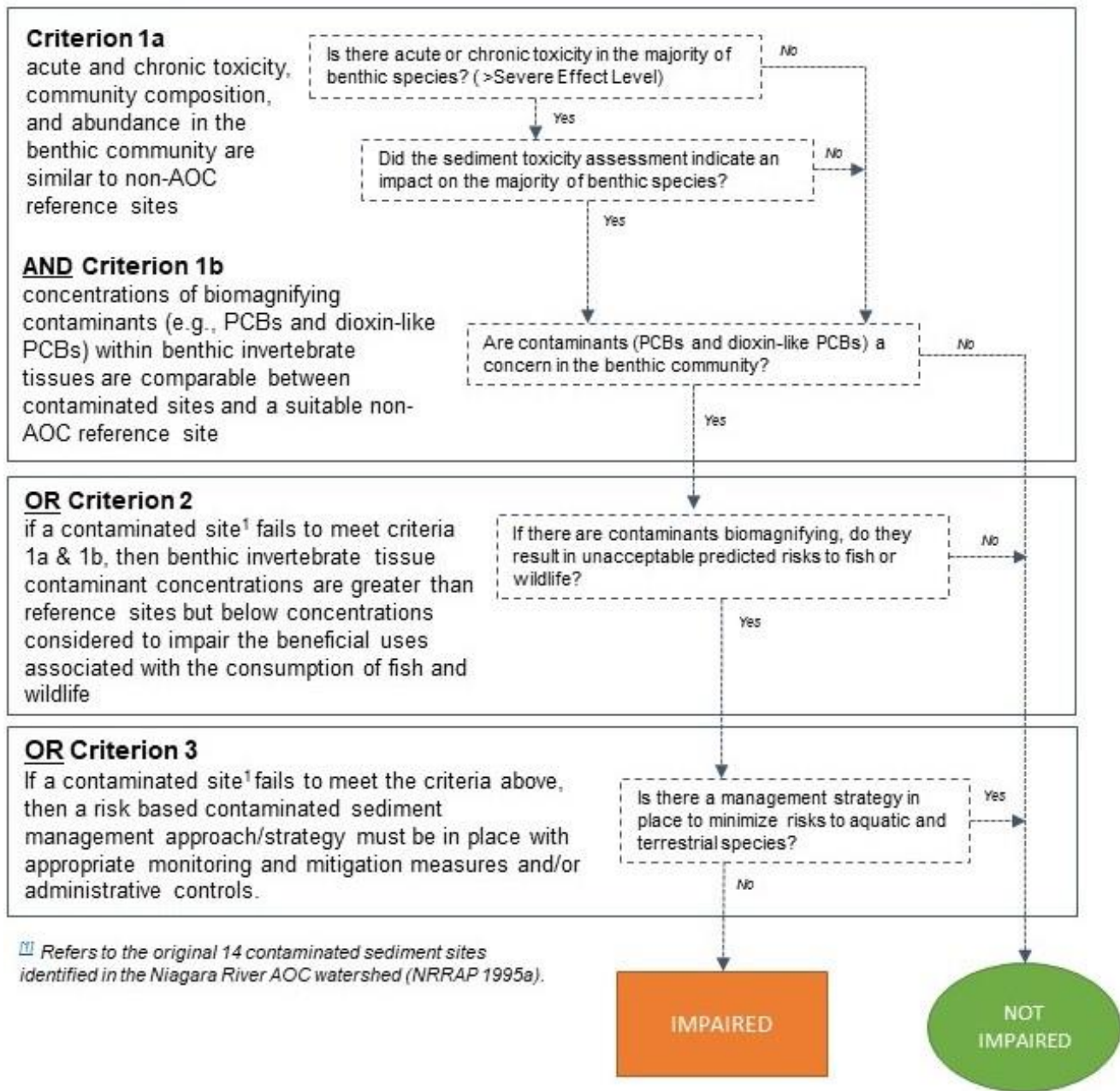


Figure 2. Methodology for assessing contaminated sediment sites against the delisting criteria. Adapted from NRRAP (2015) to update with proposed revised delisting criteria language.

REFERENCES

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