

This article was downloaded by:[McMaster University Library]  
[McMaster University Library]

On: 27 March 2007

Access Details: [subscription number 769426004]

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954

Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



## Aquatic Ecosystem Health & Management

Publication details, including instructions for authors and subscription information:  
<http://www.informaworld.com/smpp/title-content=t713393886>

### Restrictions on dredging as an impaired beneficial use under the Great Lakes Water Quality Agreement

To cite this Article: , 'Restrictions on dredging as an impaired beneficial use under the Great Lakes Water Quality Agreement', Aquatic Ecosystem Health & Management, 10:1, 117 - 124

xxxx:journal To link to this article: DOI: 10.1080/14634980701223701

URL: <http://dx.doi.org/10.1080/14634980701223701>

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article maybe used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

© Taylor and Francis 2007

# Restrictions on dredging as an impaired beneficial use under the Great Lakes Water Quality Agreement

Gail Krantzberg<sup>1\*</sup> and Kelly Montgomery<sup>2</sup>

<sup>1</sup>Centre for Engineering and Public Policy, McMaster University, 1280 Main St. W., Hamilton, ON, L2S1K4, Canada

<sup>2</sup>Toronto and Region Conservation Authority, 5 Shoreham Drive, Downsview, Ontario, M3N 1S4, Canada

\*Corresponding author: krantz@mcmaster.ca

---

*As part of the commitments made by the governments of Canada and the United States in the Great Lakes Water Quality Agreement, Remedial Action Plans (RAPs) are being developed and implemented at Great Lakes Areas of Concern. The Areas of Concern are specific places around the Great Lakes basin ecosystem where environmental quality is degraded to the point that certain beneficial uses (the ability of fish, wildlife and humans to thrive) are impaired. Many communities are struggling to determine at what point in time ecological conditions are such that the geographic Area of Concern can be considered no longer degraded. Due to semantics and lack of clarity, one example of which is called "restrictions on dredging," many communities continue to debate approaches without learning from the discussions in other communities. This paper outlines how to develop a delisting target for this particular Great Lakes Water Quality Agreement impairment.*

**Keywords:** Great Lakes, Remedial Action Plan, dredging restrictions, sediment management

---

## Introduction

The 1909 Boundary Waters Treaty between Canada and the United States established the International Joint Commission (IJC). The Commission's purpose under the Treaty is to prevent or resolve disputes surrounding environmental quality between the two countries and act impartially, rather than representing the views of their respective governments.

Under the treaty, questions or matters of difference arising between the two countries involving the rights, obligations, or interests of either nation in relation to the other along the common border between the United States and Canada, can be referred to the IJC for examination and report, whenever either the Government of the United States or the Government of Canada request that such questions, or matters of difference, be so referred (Boundary Water Treaty, 1909). In 1972, the Governments of Canada and United States created the Great Lakes Water Quality Agreement (GLWQA)

as a permanent reference for the IJC under the Boundary Water Treaty. The Agreement was signed by Prime Minister Trudeau of Canada and President Nixon of the United States (Canada and United States, 1972). In November 22, 1978, a revision to the 1972 Agreement provided new programs and more goals directed predominantly towards "virtually eliminating inputs of persistent toxic substances to the Great Lakes" (Canada and United States, 1978). In November 1987, the Governments signed a Protocol that included Remedial Action Plans (RAPs) under Annex 2 of the Agreement. The United States and Canada revision in 1987 of the GLWQA commits the two governments to develop RAPs at Areas of Concern (42 in total at that time) where ecosystem deterioration is particularly pronounced (Canada and the United States, 1987).

RAPs are instruments that enable governments and concerned citizens to restore and protect "beneficial uses" once they become impaired. According to Annex 2, the two federal governments are to work in

cooperation with state and provincial governments and with local communities to jointly develop and implement the RAPs. Krantzberg (2003) and Gurtner-Zimmermann, (1995) discuss the process for developing and implementing RAPs in greater detail.

## Beneficial Use Impairments

Impairment of beneficial use is defined as: “a change in the chemical, physical, or biological integrity of the Great Lakes system sufficient to cause any of the 14 use impairments” or obstruction other related uses covered by Article IV such as the microbial objective for waters used for body contact recreational activities (Canada and United States, 1987). The 14 impairments specified in the GLWQA are:

- Restrictions on Fish and Wildlife Consumption
- Tainting of Fish and Wildlife Flavor
- Degraded Fish and Wildlife Populations
- Fish Tumors or Other Deformities
- Bird or Animal Deformities or Reproductive Problems
- Degradation of Benthos
- Restrictions on Dredging Activities
- Eutrophication or Undesirable Algae
- Restrictions on Drinking Water Consumption or Taste and Odor Problems
- Beach Closings
- Degradation of Aesthetics
- Added Costs to Agriculture or Industry
- Degradation of Phytoplankton and Zooplankton Populations
- Loss of Fish and Wildlife Habitat

## Dredging restrictions

According to the International Joint Commission (IJC), restrictions on dredging activities are implemented when contaminants in sediment exceed standards, criteria, or guidelines such that there are added costs associated with dredging or disposal activities (IJC, 1989).

There are no Canadian Federal regulations/criteria or guidelines restricting dredging activities or restricting the disposal of dredged material for the Great Lakes. Public Works Canada follows the provincial guidelines, as is the case for Ontario (Letterhos and Kohler, 1997). The guidelines for disposal of dredged sediment are outlined in Persaud et al. (1992). The Ontario Ministry of Environment requires analysis of both the material to be dredged and the existing sediment at the proposed

open lake disposal site. Each parameter is compared to the Provincial Sediment Quality Guidelines (PSQG). The dredged material is matched to the disposal area that is classified into one of the following three groups.

### Group 1

1. The concentrations of contaminants in sediment in the disposal area are below the No Effect Level. If the concentrations in the dredged material are also below the No Effect Level, the material is suitable for disposal at this site.
2. If the concentrations in the dredged sediment are above the No Effect Level then this material is not suitable for disposal at the above-described site, since this would result in contamination of a clean site with sediment of a lesser quality. However, if the concentrations in the dredged materials are below the Lowest Effect Level, it may be suitable for disposal at another site where existing sediment concentrations are above the No Effect Level.
3. Material that exceeds the Lowest Effect Level (LEL) for any parameter is not suitable for open water disposal at this site.

### Group 2

1. The contaminants in sediment in the disposal area are above the No Effect Level but still below the LEL. If the concentrations in the dredged material are below the No Effect Level then the material is suitable for open water disposal at this site.
2. Similarly, if the dredged material is above the No Effect Level but below the LEL, the material is also suitable for disposal at this site. Material that exceeds the LEL is not suitable for open water disposal at this site.

### Group 3

1. If the sediment in the disposal area is contaminated to a level above the Lowest Effect Level, material that is below the LEL is suitable for open water disposal at this site.
2. Material that exceeds the LEL for organic compounds and mercury is not suitable for open water disposal. Material that exceeds the LEL for metals other than mercury is suitable for open water disposal under certain conditions. If the material is at or below the Great Lakes background and does not exceed ambient sediment levels then the material is suitable for open water disposal at this site.

If no dredging of sediment is required, these guidelines are used to trigger bioassessment of sediment contamination when the concentrations of contaminants are above the LEL. The bioassessment results determine whether or not active intervention in sediment remediation is required, but are not required to determine whether open water disposal is permissible.

In the U.S., the National Environmental Policy Act (NEPA) of 1969 (EPA, 1969) applies to major Federal actions (e.g., proposals, permits, and legislation)

that may significantly affect the environment. United States Army Corps of Engineer activities in the areas of dredging and disposal, including regulatory actions, come under the NEPA jurisdiction. It is through the NEPA process that the dredged material disposal alternatives including no action, open-water disposal, or confined disposal of dredged material are evaluated, documented, and publicly disclosed. Section 404 of the Clean Water Act designates the United States Army Corps of Engineers as the lead federal agency in the

**Table 1.** Sediment quality guidelines that reflect probable effect concentrations (PECs; i.e., above which harmful effects are likely to be observed). An “\*\*\*” designates a reliable PEC (>20 samples and >75% correct classification as toxic).

Metals (in mg kg <sup>-1</sup> DW)	PEL	SEL	TET	ERM	PEL-HA28	Consensus-Based PEC
Arsenic	17	33	17	85	48	33.0*
Cadmium	3.53	10	3	9	3.2	4.98*
Chromium	90	110	100	145	120	111*
Copper	197	110	86	390	100	149*
Lead	91.3	250	170	110	82	128*
Mercury	0.486	2	1	1.3	NG	1.06
Nickel	36	75	61	50	33	48.6*
Zinc	315	820	540	270	540	459*
Polycyclic aromatic hydrocarbons (in μg kg <sup>-1</sup> DW)						
Anthracene	NG	3700	NG	960	170	845
Fluorene	NG	1600	NG	640	150	536
Naphthalene	NG	NG	600	2100	140	561*
Phenanthrene	515	9500	800	1380	410	1170*
Benz[a]anthracene	385	14800	500	1600	280	1050*
Benzo(a)pyrene	782	14400	700	2500	320	1450*
Chrysene	862	4600	800	2800	410	1290*
Fluoranthene	2355	10200	2000	3600	320	2230
Pyrene	875	8500	1000	2200	490	1520*
Total PAHs	NG	100000	NG	35000	3400	22800*
Polychlorinated Biphenyls (in μg kg <sup>-1</sup> DW)						
Total PCBs	277	5300	1000	400	240	676*
Organochlorine Pesticides (in μg kg <sup>-1</sup> DW)						
Chlordane	8.9	60	30	6	NG	17.6
Dieldrin	6.67	910	300	8	NG	61.8
Sum DDD	8.51	60	60	20	NG	28.0
Sum DDE	6.75	190	50	15	NG	31.3*
Sum DDT	NG	710	50	7	NG	62.9
Total DDTs	4450	120	NG	350	NG	572
Endrin	62.4	1300	500	45	NG	207
Heptachlor Epoxide	2.74	50	30	NG	NG	16.0
Lindane (gamma-BHC)	1.38	10	9	NG	NG	4.99

PEL = Probable effect level; dry weight. SEL = Severe effect level, dry weight (Persaud et al., 1992). TET = Toxic effect threshold; dry weight. ERM = Effects range median; dry weight. PEL-HA28 = Probable effect level for *Hyalella azteca*; 28-day test; dry weight NG = No guideline.

From Ingersoll et al. (2000).

**Table 2.** Delisting targets to identify when restrictions on dredging are no longer an impaired beneficial use**Collingwood Harbour, Ontario**

Concentrations of contaminants do not exceed the open water disposal guidelines in localized areas.

**Detroit River, Ontario**

Contaminants in sediments do not exceed applicable standards, criteria, or guidelines. As such, there are no restrictions on dredging or disposal activities. The issue of dredging is closely related to benthic degradation. For both uses to be unimpaired, sediment quality must be uncontaminated. Due to this interconnection, as well as to the fact that dredging does not ordinarily provide direct benefits to the ecosystem, it is considered a secondary use impairment. In some cases dredging can negatively impact other beneficial uses, especially if contaminated sediments that are otherwise not bioavailable are disturbed and released into the waterway. Efforts focusing on this impairment should not be put forth until the more critical primary impairments have been addressed. In the interim, dredging of the riverbed continues, with some restrictions imposed regarding the disposal of removed materials.

**St. Clair River, Ontario**

No limitations on disposal of dredging spoils.

**Wheatley Harbour, Ontario**

\*Metal concentrations in sediments do not exceed the PSQG-LEL, except where background concentrations exceed this level.

\*Nutrient levels (phosphorus, nitrogen and carbon) in sediments do not exceed the PSQG-LEL, except where background concentrations exceed this level.

\*PCB concentrations in sediments meet the PSQG-LEL.

**Severn Sound, Ontario**

\*To meet biological and chemical guidelines for sediment quality such that there are no restrictions on dredging or disposal activities attributable to polluted sediments.

**Hamilton Harbour, Ontario**

\*When contaminants in sediments do not exceed biological and chemical standards, criteria, or guidelines such that there are restrictions on disposal activities associated with navigational dredging.

**Toronto & Region, Ontario**

\*Suspended, transported, and in-place sediments contain levels of contaminants at or below the Provincial Sediment Quality Guidelines.

\*Dredged sediments meet Provincial Sediment Quality Guidelines.

\*Materials used in lakefilling meet the Fill Quality Guidelines for Lakefilling in Ontario.

\*Lakefilling produces no net loss of aquatic habitat.

\* Lakefill structures do not have adverse effects on water circulation.

**Port Hope, Ontario**

The Port Hope Initiative is working to develop a long-term remediation plan for this AOC.

**Bay of Quinte, Ontario**

Prevent degradation of sediments and protect benthic organisms by accomplishing the virtual elimination of persistent toxic contaminants inputs to the bay/and prevent potentially harmful disturbances of in-place contaminants by regulating the methods of dredging, transportation and disposal of bay sediments.

**St. Lawrence River, Ontario**

When appropriate technologies have been identified that will protect against contamination of the river during dredging, transport and disposal of sediment contaminated above the LEL.

**Niagara River, Ontario**

Suspended, transported and in-place sediments contain levels of contaminants at or below LEL. Where no LEL standard exists, use LC50 (incl. Welland River and tribs).

**St. Mary's River, Ontario**

\*Considered restored when contaminants in dredged sediment do not exceed the standards, criteria, or guidelines that permit open water disposal. These levels are based on sediment concentrations associated with compounds identified within this AOC from local point or non point sources, and not based on contributions of new atmospheric depositions of compounds.

**Peninsula Harbour, Ontario**

Continued use of harbour for discharge if under environmentally controlled conditions.

(Continued)

**Table 2.** Delisting targets to identify when restrictions on dredging are no longer an impaired beneficial use (Continued)

---

U.S.A.
Clinton River, Michigan
No information
Detroit River, Michigan
When contaminants in sediments do not exceed the most stringent standards, objectives or guidelines such that there are restrictions on (navigational) dredging or disposal activities.
Oswego River, New York
No Army Corp of Engineers dredge restriction
Rouge River, Michigan
No restrictions on dredging.
River Raisin, Michigan
Eliminate unusual restrictions on dredge spoil disposal due to contamination.
St. Clair River, Michigan
No limitations on disposal of dredging spoils.
Buffalo River, New York
No limitations on disposal of dredge spoils
Rochester Embayment, New York
1. A formal long-term agreement between Monroe County and the U.S. Army Corps of Engineers (COE) is in place to prohibit overflow dredging in the Rochester harbor (the NYSDEC may also be included in the agreement); AND
2. The quality of the material to be dredged meets the standards for open-lake disposal.
St. Mary's River, Michigan
When contaminants in dredged sediment do not exceed the standards, criteria or guidelines that permit open water disposal. These levels are based on sediment concentrations associated with compounds identified within this AOC from local point or nonpoint sources, and not based on contributions of new atmospheric deposition of compounds.
Saginaw River & Bay, Michigan
The level of contaminants in Saginaw River/Bay sediments no longer imposes additional costs due to requirements for the removal, confinement, and remediation of dredge spoils.
Kalamazoo River, Michigan
Reduce levels of PCBs in sediments to eliminate restrictions on disposal of dredged material
Muskegon Lake, Michigan
1. Additional costs for sampling sediments for heavy metals, hydrocarbons and/or other contaminants will no longer be necessary in the MDNR Land and Water Permit process because all contaminated sediment sites will be fully characterized
2. the level of contaminants in the Muskegon Lake AOC watershed sediments no longer impose additional costs due to requirements for the removal, disposal, confinement or remediation of dredge spoils.
3. Aquatic habitats impacts are mitigated (within immediate area/zone) where development/dredging occurs.
Waukegan Harbor, Illinois
1. Remove, treat and dispose of highly contaminated sediments (PCB concentrations greater than 50 mg kg <sup>-1</sup> ) from Waukegan Harbor which currently prevents dredging activities.
2. Promote the development of a responsible dredging and disposal plan for moderately polluted sediments which may collect in the harbor in the future.
3. Maintain quality sediment in outer harbor.
4. Maintain channel depths throughout the harbor which allow passage of fully loaded commercial vessels.
White Lake, Michigan
No information
Milwaukee Estuary, Wisconsin
Same as IJC guideline: when contaminants in sediment do not exceed standards, criteria or guidelines such that they are restrictions on dredging or disposal activities.
Manistique River, Michigan
1. When contaminants in sediments do not exceed standards, criteria, or guidelines, such that there are restrictions on dredging disposal activities.
2. When there are no restrictions on dredging to the authorised 12.5' commercial navigation channel depth.

---

regulation and enforcement of dredge and fill discharge activities in all navigable waters of the U.S. The Corps is also responsible for maintenance of federal navigation channels. Guidelines and criteria developed jointly by the Corps and U.S. EPA are used to administer this program.

Potential water-column contaminant effects of open water disposed sediment are evaluated by comparing contaminant release in an elutriate of the material to be disposed with applicable water-quality criteria or standards as appropriate. A chemical comparison of the material to be disposed with that of a reference sed-

iment is conducted. If contaminant concentrations in the dredged material and concentrations at an adjacent disposal site are substantially similar and contaminants will not leave the adjacent disposal site, or if controls are available to reduce contamination to acceptable levels within the disposal site, no further evaluation may be required. If this is not the case, bioassays and bioaccumulation tests are required to complete the evaluation (EPA, 1992) and determine whether active intervention in sediment remediation is warranted.

Ingersoll et al. (2000) provide sediment quality guidelines that reflect probable effect concentrations

**Table 3.** A summary of use impairments potentially associated with contaminated sediment and the numbers of Areas of Concern with such use impairments (taken from SedPAC 1997).

Use impairment	How contaminated sediment may affect use impairment	Number of areas of concern with the impaired use (N = 42; % in parentheses)
Restrictions on fish and wildlife consumption	Contaminant uptake via contact with sediment or through food web	36 (86%)
Degradation of fish and wildlife populations	Contaminant degradation of habitat; contaminant impacts through direct sediment contact; food web uptake	30 (71%)
Fish tumors or other deformities	Contaminant transfer via contact with sediment or through food web; possible metabolism to carcinogenic or more carcinogenic compounds	20 (48%)
Bird or animal deformities or reproduction problems	Contaminant degradation of habitat; contaminant impacts through direct sediment contact; food web uptake	14 (33%)
Degradation of benthos	Contact; ingestion of toxic contaminants; nutrient enrichment leading to a shift in species composition and structure, due to oxygen depletion	35 (83%)
Restrictions on dredging activities	Restrictions on disposal in open water due to contaminants and nutrients, and their potential impacts on biota	36 (86%)
Eutrophication or undesirable algae	Nutrient recycling from temporary sediment sink	21 (50%)
Degradation of aesthetics	Resuspension of solids and increased turbidity; odors associated with anoxia	25 (60%)
Added costs to agriculture or industry	Resuspended solids; presence of toxic substances and nutrients	7 (17%)
Degradation of phytoplankton or zooplankton populations	Toxic contaminant release; resuspension of solids and adsorbed contaminants, and subsequent ingestion	10 (24%)
Loss of fish and wildlife habitat	Toxicity to critical life history stages; degradation of spawning and nursery grounds due to siltation	34 (81%)

(PECs); i.e., above which harmful effects are likely to be observed (Table 1) derived from a review of a range of agencies.

In 1991, the International Joint Commission approved guidelines for listing and delisting Areas of Concern in the Great Lakes Basin Ecosystem. The intent of these early listing/delisting guidelines was to serve as an initial reference point from which the Parties could base the development of appropriate restoration criteria on. Delisting criteria are recommended in order to provide direction and focus for the Remedial Actions Plans (RAPs) developed for each Area of Concern (AOC). Since 1991, many government agencies, local RAPs groups and others have been attempting to develop systematic and comprehensive restoration targets for their Areas of Concern (Table 2).

Using the open water disposal guidelines of either country, one can determine whether the costs of dredging in a navigational channel will rise due to the need for some form of confined disposal; thereby constituting a beneficial use impairment. The presence of contaminated sediment per se does not result in this beneficial use being impaired if there is no need for navigational dredging. George et al. (2004) conclude that if contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities this beneficial use will be considered impaired. Their view is that this beneficial use impairment applies solely to those zones within AOCs where dredging is required for navigational purposes.

This does not mean that the presence of contaminants in sediment is ignored should there be no need for navigational dredging. Many of the other beneficial uses can be impaired by the presence of contaminated sediment, and dealt with appropriately within the plans to restore those beneficial uses. SedPAC (1997) summarize the use impairments potentially associated with contaminated sediment (Table 3).

## **Other types of dredging restrictions, that do not constitute a beneficial use impairment under Annex 2 of the Great Lakes Water Quality Agreement**

Restrictions on dredging operations are used to protect various types of aquatic resources. It is necessary to restrict or suspend dredging operations during a defined period of time to prevent real or potential detrimental impacts on important species of invertebrates,

fish, and birds. The magnitudes of these potential impacts are often speculative but are imposed nonetheless in the context of the precautionary principle.

Environmental windows are periods in which regulators have determined that the adverse impacts associated with dredging and disposal can be reduced below critical thresholds, and dredging is therefore permitted. Conversely, seasonal restrictions are applied and dredging and disposal activities are prohibited when the perceived increase in potential harm to aquatic resources is above critical thresholds. Since passage of the National Environmental Policy Act in 1969, resource agencies have requested environmental restrictions on dredging and disposal activities with increasing frequency. More than 80 percent of the federal contract-dredging program is now subject to some type of restriction (CEWDP, 2001).

Environmental Windows are an intuitively simple means of reducing risk to biological resources from stressors generated during dredging and disposal activities, including entrainment of fish eggs and larvae, resuspension of buried contaminated sediment, habitat loss, and collisions with marine mammals (CEWDP, 2001).

## **Conclusions**

In regard to Areas of Concern, the ultimate conclusion is that the presence of contaminated sediment by itself does not result in the beneficial use of the areas being impaired unless dredging is needed. In areas where contaminants in sediment exceed standards, criteria, or guidelines, such that restrictions are put on dredging or disposal activities, the beneficial use will be considered impaired only in regions within AOCs where dredging is required for navigational purposes.

This does not mean that the presence of contaminants in sediment is ignored if there is no need for navigational dredging. Many of the beneficial uses other than dredging can be impaired by the presence of contaminated sediment, and these are dealt with appropriately within the RAPs to restore those beneficial uses.

## **Acknowledgements**

The authors thank Lori Boughton of the Pennsylvania Department of Environmental Quality for her encouragement to disseminate this material for the benefit of Remedial Action Plan practitioners in Canada and the United States.

## References

- Boundary Waters Treaty, 1909. Treaty between The United States and Great Britain relating to boundary waters, and questions arising between The United States and Canada.
- Canada and United States, 1972. Great Lakes Water Quality Agreement. <http://www.ijc.org/rel/agree/quality.html>
- Canada and United States, 1978. Great Lakes Water Quality Agreement. <http://www.ijc.org/rel/agree/quality.html>
- Canada and United States, 1987. Revised Great Lakes Water Quality Agreement of 1978.
- CEWDP (Committee for Environmental Windows for Dredging Projects), 2001. A Process for Setting, Managing, and Monitoring Environmental Windows for Dredging Projects. Special Report 262 National Academy Press Washington, D.C. ISBN 0-3-9-07244-1.
- EPA, 1969. National Environmental Policy Act. Pub. L. No. 91-190, 42 U. S. C. 4321 et seq. Published by the United States Environmental Protection Agency. <http://www.nepa.gov/nepa/regs/nepa/nepaeqia.htm>
- EPA, 1992. Framework for Dredged Material Management. In: E. Southerland, M. Kravitz, T. Wall (Eds.), *Sediment Toxicity Assessment*, pp. 341–370. Lewis Publishers, Boca Raton, Florida.
- George, T., Boyd, D. Diep, N., 2004. Canada-Ontario Agreement Area of Concern Monitoring Discussion Identifying Sediment, Water, and Biological Monitoring Required to Track Progress Towards Restoration of Beneficial Use Impairments. Ontario Ministry of Environment, Toronto, Ontario.
- Gurtner-Zimmermann, A., 1995. A mid-term review of Remedial Action Plans: Difficulties with translating comprehensive planning into comprehensive actions. *J. Great Lakes Res.* 21, 234–247.
- IJC, 1989. Proposed Listing/Delisting Criteria for Great Lakes Areas of Concern. Focus on International Joint Commission Activities. Volume 14, Issue 1, insert.
- Ingersoll, C. G., MacDonald, D. D., Wang, N., Crane, J. L., Field, L. J., Haverland, P. S., Kemble, N. E., Lindskoog, R. A., Severn, C., Smorong, D. E., 2000. Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines United States Geological Survey (USGS). Final report for the U.S. Environmental Protection Agency Great Lakes National Program Office. EPA 905/R-00/007 June 2000.
- Krantzberg, G., 2003. Keeping Remedial Action Plans on target: lessons learned from Collingwood Harbour. *J. Great Lakes Research* 29, 641–651.
- Letterhos, J., Kohler, K., 1997. Lake Erie Lakewide Management Plan (LaMP). Impairment Assessment of Beneficial Uses: Restrictions on Dredging Activity. Lake Erie LaMP Technical Report No. 9. Environment Canada and the U.S. Environmental Protection Agency.
- Persaud, D., Jaagumagi, R., Hayton, A., 1992. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, Ontario Ministry of the Environment, Queen's Printer for Ontario, Toronto.
- SedPAC. 1997. Overcoming Obstacles to Sediment in the Great Lakes Basin. Report to the Water Quality Board of the International Joint Commission publication, Windsor, Ontario.