DRAFT TMDL Support Document for PCBs in Lake Ontario

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USEPA Region 2

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1. INTRODUCTION

Section 303(d) of the 1972 Clean Water Act requires States to define impaired waters and identify them on a list, which is referred to as the 303(d) list. Section 303(d) of the Clean Water Act and the United States Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (40 Code of Federal Regulations [CFR] Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and waterbody conditions. This allowable loading represents the maximum quantity of the pollutant that the waterbody can receive without exceeding water quality standards. The TMDL also takes into account a margin of safety, which reflects scientific uncertainty, as well as the effects of seasonal variation. By following the TMDL process, States can establish water quality-based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of their water resources (USEPA, 1991).

The 2008 New York State Section 303(d) List of Impaired Waters (New York State Department of Environmental Conservation [NYSDEC], 2008) identifies twenty-six Class A or C[1] shoreline segments of Lake Ontario, as well as ninety one tributaries, bays and ponded waters. Class A, B and C, including trout and trout spawning as not meeting their designated fish consumption use due to high concentrations of polychlorinated biphenyls (PCBs). These assessments, for portions of the Lake Ontario shoreline, are used to represent the assessment for Lake Ontario itself (NYSDEC, 2007).

The scope of this TMDL covers the Lake Ontario shoreline segments, which are described further in Section 2 and Appendix A as well as an additional ninety one tributaries, bays or ponded waters that were identified in a footnote in the 303(d) list as being impaired for fish consumption due to fish migration from the open waters of Lake Ontario. These segments are assumed to represent Lake Ontario and this document presents the TMDL designed to allow Lake Ontario and its tributaries to fully support their designated uses. The report covers each step of the TMDL process and is organized as follows:

- Problem Identification
- Required TMDL Elements
- Water Quality and Watershed Characterization
- Description of Applicable Standards and Numeric Targets
- Water Quality Model Development
- TMDL Development

[1] Class A and C are fresh surface waters. The best usages of Class A waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The best usage of Class C waters is fishing. See New York State Codes, Rules, and Regulations (NYCRR) Title 6, Chapter X, §701.

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2. PROBLEM IDENTIFICATION

All of the impaired segments addressed in this TMDL are located within the Lake Ontario (Minor Tributaries) Drainage Basin in New York, and the pollutant of concern for all of these segments is total PCBs. This section provides a description of the Lake Ontario (Minor Tributaries) Drainage Basin and background information on the PCB impairment. This section also identifies pollutant sources and the priority ranking of Lake Ontario on the New York State 303(d) list.

2.1 BACKGROUND

Lake Ontario is a large, complex multi-jurisdictional waterbody that is impaired by legacy PCBs. It is the most downstream of the Great Lakes, which together drain approximately 300,000 square miles (NYSDEC, 2007). Excluding the drainage area of the other Great Lakes, the Lake Ontario Basin (Figure 2-1) is 24,720 square miles and roughly 55% of this lies within New York State. The entire south shore of the lake from the Niagara River to the outlet at the St. Lawrence River is contained entirely within New York. The remaining Lake Ontario shoreline is Canadian.

Management of Lake Ontario and its main tributary, the Niagara River, is under the jurisdiction of the Four Parties (NYSDEC, USEPA, Ontario Ministry of the Environment (OME) and Environment Canada (EC)), which account for both state (provincial) and federal agencies from both Canada and the United States.

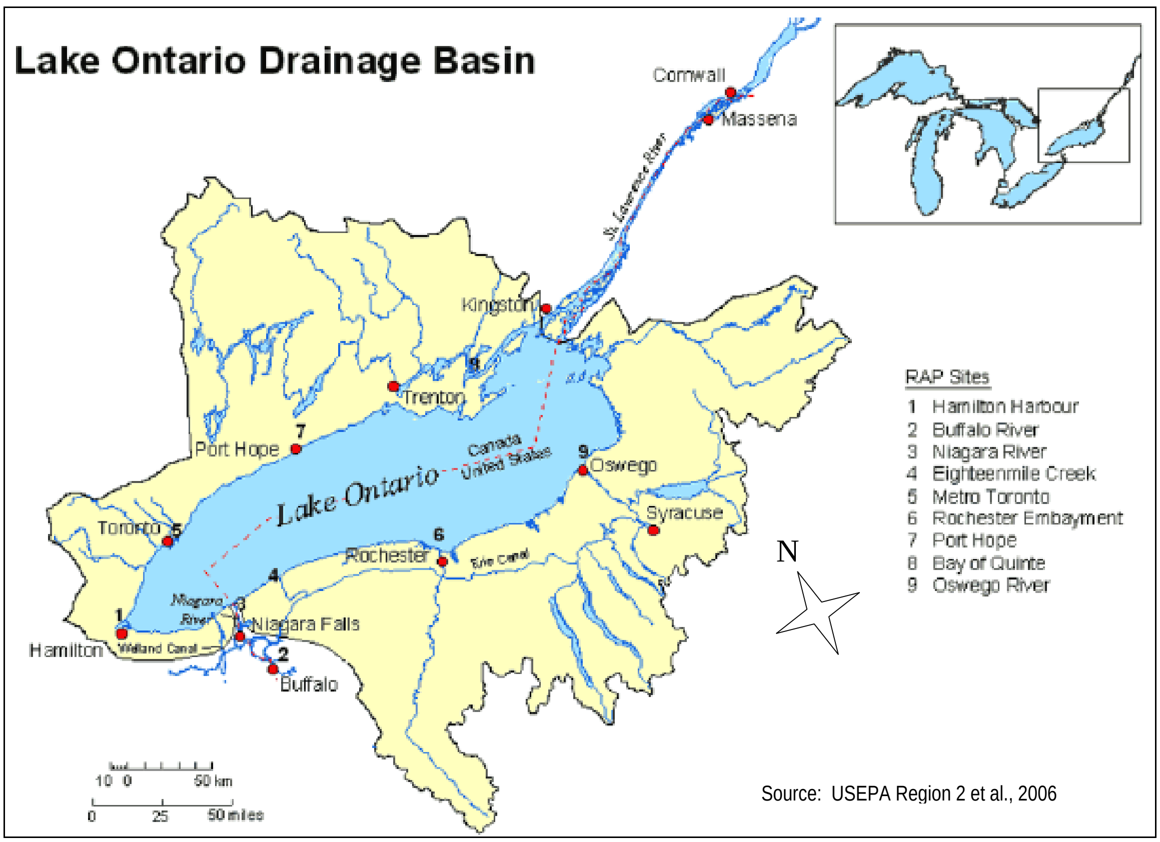
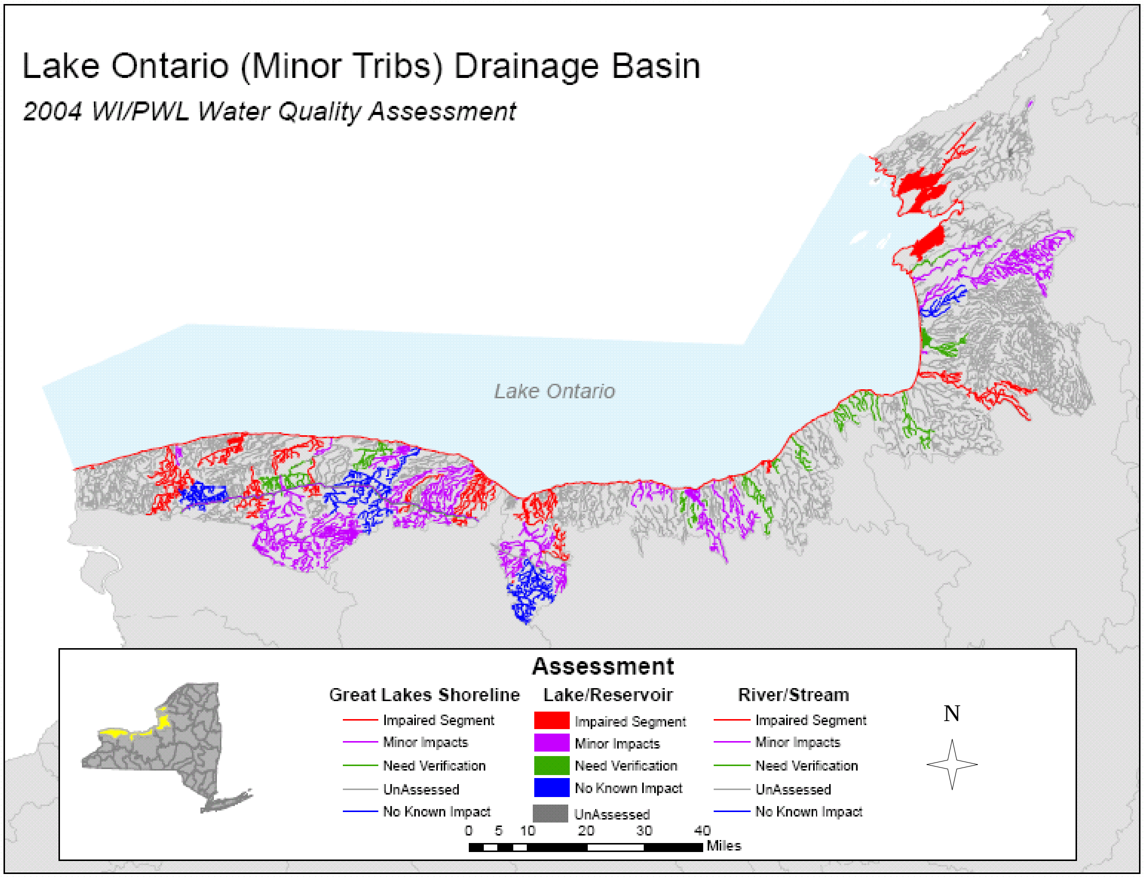


Figure 2-1. Lake Ontario Drainage Basin

NYSDEC has assessed the portion of Lake Ontario within New York State, and represents the lake as separate assessments for twenty-six Lake Ontario shoreline segments. These segments all lie within NYSDEC's Lake Ontario (Minor Tributaries) Basin which is shown in Figure 2-2. According to NYSDEC (2007), "The primary water quality impacts in this basin are largely associated with water quality in Lake Ontario itself and in the nearshore waters and embayments of the lake. The past/historic discharge of contaminants to Lake Ontario and upstream waters resulted in a fish consumption advisory that impacts waters across the entire basin." The twenty-six PCB-impaired shoreline segments will be addressed together within this TMDL, and a single loading capacity and allocation will be determined for Lake Ontario using a model that relates the whole-lake annual average PCB concentration to the total PCB loading to the lake. The TMDL allocates the loading capacity among all of the following sources of PCBs to Lake Ontario:

- Atmospheric deposition to the lake
- Niagara River
- Canadian sources:
    - Tributaries (includes Canadian tributaries, direct drainage and permitted dischargers that do not directly discharge to Lake Ontario)
- New York sources:
    - Direct point sources (discharge directly to Lake Ontario)
    - Tributaries (includes New York tributaries, direct drainage and permitted dischargers that do not directly discharge to Lake Ontario)



Source: NYSDEC, 2007

Figure 2-2. Lake Ontario (Minor Tributaries) Drainage Basin

The Lake Ontario ecosystem has experienced significant changes over the last century from the effects of toxic pollution and habitat loss, in addition to other stressors. In 1972, Canada and the United States took actions to ban and control contaminants entering the Great Lakes, and in 1987 renewed the Great Lakes Water Quality Agreement with the goal of restoring the overall health of the Great Lakes ecosystem, including the initiation of the Lakewide Management Plant (LaMP) process for the whole lake and the Remedial Action Plan (RAP) process for designated Areas of Concern. Today, as a result of these actions, levels of toxic contaminants in the Lake Ontario ecosystem have decreased significantly.

2.2 IDENTIFICATION OF THE WATERBODY, POLLUTANT OF CONCERN, POLLUTANT SOURCES AND PRIORITY RANKING

Within the Lake Ontario (Minor Tributaries) Drainage Basin, there are twenty-six Lake Ontario shoreline segments that are identified on the New York State 2008 Section 303(d) list of impaired waters (NYSDEC, 2008) due to high concentrations of PCBs. The impaired shoreline segments listed in Table 2-1 will be addressed through the development of a PCB TMDL and allocations for Lake Ontario. In addition to the 26 shoreline segments footnote #65 to the Lake Ontario listed segments states:

> “For Lake Erie and Lake Ontario Shoreline segments included on the Section 303(d) List due to fish consumption restrictions, the primary source of

> contamination is the open lake rather than the near-shore waters. Due to fish migration the advisories apply to tributary waters up to the first impassable barrier."

The tributary waters described in the above footnote include segments with the Water Index Numbers (WIN) Ont 1 through 157, except for Ont 53 (Salmon River), Ont 108 (Irondequoit Bay), and Ont 118 (Eighteen Mile Creek) and a corresponding unique Priority Waterbody List (PWL) index number. Ont 1- Ont 157, excluding the exceptions, do not have sources of PCBs and are included as impaired waters, via footnote #65 because of fish consumption advisories. Fish which inhabit these tributaries accumulate PCBs from Lake Ontario and then migrate to these waters. By addressing the PCB impairment in Lake Ontario, the impairments in the tributaries will also be addressed.

Therefore, the Lake Ontario TMDL includes 26 shoreline segments and 91 segments identified as Ont 1 thru Ont 157, with unique PWL index numbers, (excluding Ont 53, Ont 108, and Ont 118), for a total of 117 segments. Segments Ont 53, Ont 108 and Ont 118 will remain on the 303(d) list.

While the TMDL was not directly calculated for these tributaries, meeting the TMDL target for Lake Ontario will result in restoring the fish consumption use in the tributaries. A brief description of these segments is provided in Appendix A.

The pollutant of concern for the Table 2-1 segments is total PCBs, which is identified in the 2004 Lake Ontario Basin Waterbody Inventory and Priority Waterbodies Listing (NYSDEC, 2007) as impairing the fish consumption use category. The primary source of the organics is contaminated lake sediments, the result of past/historic industrial discharges to the lake, the Niagara River, and the Upper Great Lakes (NYSDEC, 2007).

In previous research (LimnoTech, 2004; Atkinson, DePinto, Beljan, Verhamme and Larson., 2008) it is indicated that the bulk of the current external load of PCBs to Lake Ontario originates from background and/or sources that are not under regulatory control by the State of New York through this TMDL. PCB loads from the Niagara River, the Province of Ontario, New York non-point and indirect point sources, and from atmospheric deposition comprises approximately 98% of the 2005 external total PCB load to the lake (Atkinson *et al.*, 2008).

New York State prioritizes their 303(d) List of Impaired Waters Requiring a TMDL into two tiers: 1) high priority waters, scheduled for TMDL or restoration strategy development and submission for approval to USEPA within the next two years; and 2) all other waters requiring a TMDL (considered to be low-medium priority). The Lake Ontario segments considered here have a low to medium priority ranking.

Table 2-1. 303(d)-Listed Waterbodies Receiving Allocations within this TMDL Report

Water Index Number	Waterbody Name[1]	Priority Waterbody List ID	Hydro Unit Code	Waterbody Size (Shoreline miles/acres)	Type	Class	Year Listed
Ont (portion 1)	Lake Ontario Shoreline, Eastern	0303-0023	04150102	27.4 miles (mi.)	G.Lakes	A	1998
Ont (portion 2)	Lake Ontario Shoreline, Eastern	0303-0011*	04150102	53.1 mi.	G.Lakes	A	1998
Ont (portion 2a)	Chaumont Bay	0303-0024*	04150102	20 acres	G.Lakes	A*	1998
Ont (portion 2b)	Guffin Bay	0303-0025	04150102	20 acres	G.Lakes	A*	1998
Ont (portion 3)	Lake Ontario Shoreline, Eastern	0303-0026	04150102	25.2 mi.	G.Lakes	A*	1998
Ont (portion 3a)	Black River Bay	0303-0102	04150102	20 acres	Bay	C	1998
Ont (portion 4)	Lake Ontario Shoreline, Eastern	0303-0027	04140102	23.6 mi.	G.Lakes	A	1998
Ont (portion 4a)	Henderson Bay	0303-0022	04140102	20 acres	G.Lakes	A	1998
Ont (portion 5)	Lake Ontario Shoreline, Eastern	0303-0028	04140102	4.9 Mi.	G.Lakes	A	1998
Ont (portion 6)	Lake Ontario Shoreline, Eastern	0303-0029	04140102	10.4 mi.	G.Lakes	A	1998
Ont (portion 7)	Lake Ontario Shoreline, Eastern	0303-0030	04140102	8.3 mi.	G.Lakes	A	1998
Ont (portion 8)	Lake Ontario Shoreline, Eastern	0303-0031	04140102	5.1 mi.	G.Lakes	A	1998
Ont (portion 9)	Lake Ontario Shoreline, Eastern	0303-0032*	04140102	16.2 mi.	G.Lakes	A	1998
Ont (portion 10)	Lake Ontario Shoreline, Oswego	0302-0040	04140101	2.8 mi.	G.Lakes	A*	1998
Ont (portion 11)	Lake Ontario Shoreline, Central	0302-0041	04140101/080	9.8 mi.	G.Lakes	A	1998
Ont (portion 12)	Lake Ontario Shoreline, Central	0302-0042	04140101/070	17.1 mi.	G.Lakes	A	1998
Ont (portion 13)	Lake Ontario Shoreline, Central	0302-0043	04140101/060	4.7 mi.	G.Lakes	A	1998
Ont (portion 14)	Lake Ontario Shoreline, Central	0302-0044	04140101/040	12.4 mi.	G.Lakes	A	1998
Ont (portion 15)	Lake Ontario Shoreline, Central	0302-0045	04140101/030	14.2 mi.	G.Lakes	A	1998
Ont (portion 16)	Rochester Embayment - East	0302-0002	04140101	9.9 mi.	G.Lakes	A	1998
Ont (portion 17)	Rochester Embayment - West	0301-0068	04140101	7.7 mi.	G.Lakes	A	1998
Ont (portion 18)	Lake Ontario Shoreline, Western	0301-0069	04150200	9.8 mi.	G.Lakes	A	1998
Ont (portion 19)	Lake Ontario Shoreline, Western	0301-0070	04150200	16.4 mi.	G.Lakes	A	1998
Ont (portion 20)	Lake Ontario Shoreline, Western	0301-0071	04150200	28.1 mi.	G.Lakes	A	1998

Water Index Number	Waterbody Name[1]	Priority Waterbody List ID	Hydro Unit Code	Waterbody Size (Shoreline miles/acres)	Type	Class	Year Listed
Ont (portion 21)	Lake Ontario Shoreline, Western	0301-0072	04150200	7.3 mi.	G.Lakes	A	1998
Ont (portion 22)	Lake Ontario Shoreline, Western	0301-0053	04150200	11.3 mi.	G.Lakes	A	1998
Ont. Grenadier Island -1, 2, 3,4, Ont. Galloo Island-1, Ont. Stony Island 1	Tribs. of Lake Ontario on Grenadier Island, Galloo Island, and Stony Island	0303-0033	04150102	NA	Tributary	C	1998
Ont. a, b, c, d, e, f , g, 1a, 1b, 1c, 2, 2a, 2b, 2c, 2d, 2e, 2f, 2g, 2h, 2i, 2j , 2k, 2l, 2m, 2n, 2p, 2q, 3, 3a, 3b, 3c, 3d, 3e, 3f, 3g, 4, 5, 6a, 6b, 6c, 7, 7a	Tribs. of Lake Ontario	0303-0035	04150102	NA	Tributary	C, D	1998
Ont. 1 portion as described	Mud Creek	0303-0034	04150102	NA	Tributary	C	1998
Ont. 6	Three Mile Creek	0303-0036	04150102	NA	Tributary	C	1998
Ont. 8 portion as described	Chaumont River	0303-0010	04150102	NA	Tributary	C	1998
Ont. 8 portion as described	Chaumont River	0303-0037	04150102	NA	Tributary	C	1998
Ont. 9	Horse Creek	0303-0038	04150102	NA	Tributary	C	1998
Ont. 9a, 9b, 9c, 10, 11, 11a, 11b, 12, 12a, 14, 15, 15a, 17, 18a	Tribs. of Lake Ontario	0303-0039	04150102	NA	Tributary	C	1998
Ont. 18 portion as described	Perch River	0303-0040	04150102	NA	Tributary	C	1998
Ont. 19 (portion 1)	Black River	0801-0250	04150102	NA	Tributary	C	1998
Ont. 19a, 19b, 20, 21, 22, 22a, 22b, 24	Tribs. of Lake Ontario, including Muskalonge Creek (Ont. 21)	0303-0101	04150102	NA	Tributary	C	1998
Ont. 25 portion as described	Mill Creek	0303-0044	04150102	NA	Tributary	C, C(T)	1998
Ont. 25a, 25b,25c, 25d, 26 , 27, 28, 29,31, 32, 33, 34, 35, 35a, 37, 37a, 38, 39	Tribs. of Lake Ontario	0303-0045	04150102	NA	Tributary	C	1998
Ont. 40 portion as described	Stony Creek	0303-0009	04150102	NA	Tributary	C(T)	1998

Water Index Number	Waterbody Name[1]	Priority Waterbody List ID	Hydro Unit Code	Waterbody Size (Shoreline miles/acres)	Type	Class	Year Listed
Ont. 41 portion as described, excluding P 1030	Little Stony Creek	0303-0019	04150102	NA	Tributary	C	1998
Ont. 42, 43, 46, 49 portion as described, 51	Trib. of Lake Ontario, including Blind Creek (Ont. 49)	0303-0048	04150102	NA	Tributary	C	1998
Ont. 44 portion as described	Sandy Creek (upper section of Stebbins Creek)	0303-0005	04150102	NA	Tributary	C, C(T)	1998
Ont. 44 portion as described	Stebbins Creek (lower section of Sandy Creek)	0303-0020	04150102	NA	Tributary	C, C(T)	1998
Ont. 45 portion as described	South Sandy Creek (upper section is Pigeon Creek)	0303-0021	04150102	NA	Tributary	C(T)	1998
Ont. P 1041,including outlet channel	North Pond	0303-0002	04150102	NA	Ponded Water	B	1998
Ont. 47 portion as described	Skinner Creek	0303-0060	04150102	NA	Tributary	C(TS)	1998
Ont. 47 portion as described	Skinner Creek	0303-0061	04150102	NA	Tributary	A(TS)	1998
Ont. 47 portion as described	Skinner Creek	0303-0062	04150102	NA	Tributary	C(TS)	1998
Ont. 48 portion as described	Lindsey Creek	0303-0063	04150102	NA	Tributary	C, C(TS)	1998
Ont. 50 portion as described	Little Sandy Creek	0303-0013	04150102	NA	Tributary	C(T)	1998
Ont. 50 portion as described	Little Sandy Creek	0303-0064	04150102	NA	Tributary	C(TS)	1998
Ont. 51-P 1	South Pond	0303-0065	04150102	NA	Ponded Water	C	1998
Ont. 52 portion as described	Deer Creek, Little Deer Creek	0303-0066	04150102	NA	Tributary	C	1998
Ont. 54 portion as described	Grindstone Creek named North Branch Grindstone Creek above trib. 4	0303-0081	04150102	NA	Tributary	C(T)	1998
Ont. 54 portion as described	North Branch Grindstone Creek	0303-0082	04150102	NA	Tributary	C, C(T)	1998
Ont. 55 portion as described	Snake Creek	0303-0086	04150102	NA	Tributary	C	1998
Ont. 57	Sage Creek	0303-0087	04150102	NA	Tributary	C	1998

Water Index Number	Waterbody Name[1]	Priority Waterbody List ID	Hydro Unit Code	Waterbody Size (Shoreline miles/acres)	Type	Class	Year Listed
Ont. 58 portion as described	Little Salmon River to trib. 9, then South Branch Little Salmon River	0303-0015	04150102	NA	Tributary	C(T)	1998
Ont. 59	Butterfly Creek	0303-0098	04150102	NA	Tributary	C	1998
Ont. 60 portion as described	Catfish Creek	0303-0099	04140102	NA	Tributary	C(T)	1998
Ont. 61, 61a, 61b, 61c, 62 , 62a, 63 , 64, 64a, 65	Tribs of Lake Ontario including Otter Branch (Ont 61)	0303-0001	04140102	NA	Tributary	C	1998
Ont. 66 as described	Oswego River	0701-0022	04140203	NA	Tributary	C	1998
Ont. 66b, Ont. 68 , 69, 69a	Trib. of Lake Ontario	0302-0046	04140101	NA	Tributary	C	1998
Ont. 67 portion as described	Rice Creek	0302-0047	04140101	NA	Tributary	C(T), C	1998
Ont. 70	Eightmile Creek	0302-0049	04140101	NA	Tributary	C	1998
Ont. 71 portion as described	Ninemile Creek	0302-0005	04140101	NA	Tributary	C	1998
Ont. 71 portion as described	Ninemile Creek	0302-0050	04140101	NA	Tributary	C(T)	1998
Ont. 71 portion as described, Ont 76, 77, Ont. 78a, 79	Unnamed upstream of trib. 18	0302-0052	04140101	NA	Tributary	C	1998
Ont. 73 portion as described	Sterling Creek or Little Sodus Creek	0302-0018	04140101	NA	Tributary	B	1998
Ont. 74 and P 76	Trib. of Lake Ontario and Little Sodus Bay	0302-0017	04140101	NA	Tributary	B	1998
Ont. 75 excluding P 77	Blind Sodus Creek	0302-0059	04140101	NA	Tributary	C	1998
Ont. 75-P 77	Blind Sodus Bay	0302-0021	04140101	NA	Bay	B	1998
Ont. 78	Red Creek	0302-0014	04140101	NA	Tributary	C	1998
Ont. 80 and P 89	Port Bay and outlet	0302-0012	04140101	NA	Bay	B	1998
Ont. 81, 83	Trib. of Lake Ontario	0302-0060	04140101	NA	Tributary	C	1998
Ont. 82 portion as described, and P 93	Beaver Creek and East Bay	0302-0011	04140101	NA	Bay	B	1998
Ont. 82 portion as described	Beaver Creek	0302-0062	04140101	NA	Tributary	C	1998
Ont. 84	Trib. of Lake Ontario	0302-0008	04140101	NA	Tributary	B	1998
Ont. 84-P 96	Sodus Bay	0302-0020	04140101	NA	Bay	B	1998

Water Index Number	Waterbody Name[1]	Priority Waterbody List ID	Hydro Unit Code	Waterbody Size (Shoreline miles/acres)	Type	Class	Year Listed
Ont. 84-P 96-4 portion as described	Sodus Creek	0302-0007	04140101	NA	Tributary	C(T), C	1998
Ont. 85 portion as described, excluding P 100	Salmon Creek	0302-0064	04140101	NA	Tributary	C	1998
Ont. 86 , 87, 88, 89, 90 , 91, 92 , 92a	Tribs. of Lake Ontario	0302-0016	04140101	NA	Tributary	C	1998
Ont. 93 portion as described	Salmon Creek	0302-0068	04140101	NA	Tributary	B	1998
Ont. 93 portion as described	Salmon Creek	0302-0069	04140101	NA	Tributary	C	1998
Ont. 94, 94a, 95, 95a, 97	Tribs. of Lake Ontario	0302-0070	04140101	NA	Tributary	C	1998
Ont. 96	Bear Creek	0302-0071	04140101	NA	Tributary	C	1998
Ont. 98	Mill Creek	0302-0072	04140101	NA	Tributary	C	1998
Ont. 99 portion	Fourmile Creek	0302-0006	04140101	NA	Tributary	B, C	1998
0nt 100 portion as described	Mill Creek	0302-0025	04140101	NA	Tributary	B, C	1998
Ont. 101 , 102 , 103 , 104 , 106	Tribs. of Lake Ontario	0302-0028	04140101	NA	Tributary	C	1998
Ont. 107 portion as described	Shipbuilders Creek	0302-0026	04140101	NA	Tributary	B, C	1998
Ont. 109, 113, 114,115, 115a, 116	Tribs. of Lake Ontario	0302-0036	04140101	NA	Tributary	B	1998
Ont. 117 (portion 1)	Genesee River	0401-0001	04130003	NA	Tributary	B	1998
Ont. 120 portion as described	Slater Creek	0301-0020	0413001	NA	Tributary	C	1998
Ont. 121 portion as described	Round Pond Creek	0301-0022	0413001	NA	Tributary	C	1998
Ont. 122	Trib. of Lake Ontario	0301-0023	0413001	NA	Tributary	B	1998
Ont. 123	Outlet of Long Pond	0301-0015	0413001	NA	Ponded Water	B	1998
P 155a	Braddock Bay	0301-0010	0413001	NA	Bay	B	1998
Ont. 124 portion as described	Buttonwood Creek	0301-0024	0413001	NA	Tributary	B, C	1998
Ont. 125 portion as described	Salmon Creek	0301-0025	0413001	NA	Tributary	B, C	1998
Ont. 126	Trib. of Lake Ontario	0301-0030	0413001	NA	Tributary	B, C	1998

Water Index Number	Waterbody Name[1]	Priority Waterbody List ID	Hydro Unit Code	Waterbody Size (Shoreline miles/acres)	Type	Class	Year Listed
Ont. 130 portion as described	Sandy Creek	0301-0006	0413001	NA	Tributary	C	1998
Ont. 131 portion as described	Yanty Creek	0301-0032	0413001	NA	Tributary	B, C	1998
Ont. 132 and Ont. 132 a, Ont. 133, 133a, 134 , 135 , 136, 137, 137a, 137b, 137c, 137d, 137e	Tribs. of Lake Ontario	0301-0033	0413001	NA	Tributary	B, C	1998
Ont. 138 portion as described	Oak Orchard Creek	0301-0004	0413001	NA	Tributary	C	1998
Ont. 138 portion as described	Oak Orchard Creek	0301-0005	0413001	NA	Tributary	C	1998
Ont. 139 portion as described	Johnson Creek	0301-0007	0413001	NA	Tributary	C	1998
Ont. 141	Marsh Creek	0301-0049	0413001	NA	Tributary	C	1998
Ont. 144	Golden Hill Creek	0301-0050	0413001	NA	Tributary	C	1998
Ont. 140 through 146	Tribs. of Lake Ontario, including Ont 146, Keg Creek	0301-0048	0413001	NA	Tributary	C(T), C	1998
Ont. 149 portion as described	Hopkins Creek	0301-0060	0413001	NA	Tributary	C	1998
Ont. 150 , Ont. 151 , Ont.151a , Ont.151b , Ont.151c	Tribs. of Lake Ontario	0301-0059	0413001	NA	Tributary	C	1998
Ont. 152 portion as described	East Branch Twelvemile Creek, Tuscarora Bay	0301-0061	0413001	NA	Tributary	B(T)	1998
Ont. 152b , Ont. 152c , Ont. 152d, Ont. 153, Ont. 154a , Ont. 154b, Ont. 155 , Ont. 155a, Ont. 157	Tribs. of Lake Ontario	0301-0064	0413001	NA	Tributary	C	1998
Ont. 154 excluding P 191	Sixmile Creek	0301-0065	0413001	NA	Tributary	C	1998
Ont. 156 portion as described	Fourmile Creek	0301-0066	0413001	NA	Tributary	B	1998

[1] Fish consumption advisories/impairments for all waters listed in this table extend into and include tributary (and downstream) waters to the first impassable barrier.

* indicates entries that differ between the 2008 303(d) list and the NYSDEC (2007) Waterbody Inventory for the Lake Ontario Shoreline

NA indicates waterbody size has not been determined at this time.

3. REQUIRED TMDL ELEMENTS

USEPA guidance requires TMDLs to contain nine specific components. Each of these components is summarized below. It is assumed that the TMDL developed for Lake Ontario PCBs addresses the PCB impairments for the twenty-six segments listed in Table 2-1.

Lake Ontario (Minor Tributaries) Drainage Basin

1. **Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking:** Lake Ontario shoreline segments presented previously in Table 2-1 are the water bodies addressed in this TMDL and those to which the stated allocations apply. These are all located within the Lake Ontario (Minor Tributaries) Drainage Basin, and within the following Hydrologic Unit Code (HUCs): 04140101, 04140101/030, 04140101/040, 04140101/060, 04140101/070, 04140101/080, 04140102, 04150102, and 04150200 (NYSDEC, 2007). The pollutant of concern addressed in this TMDL is total PCBs. Potential sources contributing to the PCB impairment include contaminated lake sediments, upstream sources (via the Niagara River), tributaries (including non-point sources and indirect point sources), direct point sources, and atmospheric deposition. The impaired segments are reported on the 2008 303(d) list as low to medium (i.e., not high) priority.
2. **Description of Applicable Water Quality Standards and Numeric Water Quality Target:** The State of New York ambient water quality standard for total PCBs in the water column is 1 pg/l (NYSDEC, 1998). The standard is based on a human health cancerous endpoint to protect citizens from PCB contaminated fish. The TMDL target is therefore set as an annual, lake-wide water column concentration average of 1 pg/l.
3. **Loading Capacity – Linking Water Quality and Pollutant Sources:** The LOTOX2 model was applied to determine the maximum PCB load that will maintain compliance with the PCB target for Lake Ontario. The loading capacity of Lake Ontario is 0.75 kg/yr, or 2.054 g/day total PCBs. This represents a 99.7% reduction from the 2005 PCB load. Loads associated with atmospheric gas-phase exchange and sediment flux are excluded from this calculation, because the TMDL represents the steady-state conditions where these sources are in equilibrium with the water column PCB concentration. The lake will be 93% of the way to equilibrium within 20 years; however, equilibrium will not be reached for approximately100 years.
4. **Load Allocations (LA):** The LA designed to achieve compliance with the TMDL for PCBs is 0.747 kg/yr, or 2.047 g/day total PCBs. This LA applies to the waterbodies listed in Table 2-1 and all sources of PCBs to Lake Ontario not covered by the wasteload allocation.
5. **Wasteload Allocations (WLA):** The WLA for direct point sources to Lake Ontario within the state of New York is 0.003 kg/yr, or 0.007 g/d

total PCBs. Individual WLAs are presented within the TMDL in Table 7-3.

6. **Margin of Safety (MOS):** The TMDL for PCBs incorporates an implicit MOS. This implicit approach incorporates the MOS by using conservative estimates for the most uncertain and sensitive model inputs (i.e., those resulting in a more stringent TMDL). The magnitude of the implicit MOS is estimated as the difference in allowable load between that calculated using the conservative inputs and the load capacity using best estimates for the uncertain inputs. The MOS is estimated to be 0.20 kg/yr (0.55 g/day), which represents the difference in the loading capacity calculation with a 10% decrease in the TSS concentration, Henry's Law constant for PCBs, and the octanol-water partition coefficient for PCBs.
7. **Seasonal Variation and Critical Conditions:** The LOTOX2 model used to develop this TMDL is a time-variable model that provides continuous predictions of water quality over the course of many years, and is capable of considering any seasonal variation that may occur. Due to the extremely slow response time of Lake Ontario PCB concentrations to changes in loads, essentially no seasonal variation occurs in PCB concentrations in fish and the water column, and the resulting TMDL is based upon annual average conditions. Changes in lake volume as a result of year-to-year variability in net basin water supply or water level regulation will not cause a change in the annual, lake-wide total PCB concentration of more than 5 percent. Therefore, the environmental conditions assumed for this TMDL appropriately reflect critical conditions.
8. **Reasonable Assurances:** This TMDL is based upon the assumption that nonpoint source and background loads of PCBs to Lake Ontario will be reduced in the future. TMDLs that allow for reduction in sources for which an NPDES permit is not required should provide a reasonable assurance that the controls will be implemented and maintained. A number of programs are already in place designed to reduce PCB loads to Lake Ontario. These consist of:
   - Lake Erie (and other Great Lakes) LaMPs
   - Niagara River Toxics Management Plan
   - NYSDEC and USEPA contaminant trackdown efforts
   - Great Lakes Areas of Concern RAPs/Great Lakes Legacy Act
   - New York's Water Comprehensive Assessment Strategy
   - Canadian contaminant trackdown activities
   - Environment Canada's PCB regulations
9. **Index of Administrative Record:** An index of the administrative record will be included with the final TMDL document.

4. WATER QUALITY AND WATERSHED CHARACTERIZATION

As described in the Lake Ontario LaMP Lake Ontario is last in the chain of Great Lakes that straddle the border between Canada and the United States (USEPA Region 2, EC, NYSDEC, OME, Ontario Ministry of Natural Resources, Fisheries and Oceans Canada, and US Fish and Wildlife Service, 2006). The lake is bordered by the Province of Ontario on the Canadian side and New York State on the United States side. Lake Ontario is the smallest of the Great Lakes, with a surface area of 7,340 square miles, but it has the highest ratio of watershed area to lake surface area. It is relatively deep, with an average depth of 283 feet and a maximum depth of 802 feet, second only to Lake Superior. Approximately 79 percent of the water flowing into Lake Ontario comes from Lake Erie through the Niagara River (USEPA, EC, Brock University and Northwestern University, 1987). The remaining flow comes from other tributaries (14 percent) and precipitation (7 percent). About 93 percent of the water in Lake Ontario flows out through the St. Lawrence River; the remaining 7 percent evaporates from the surface. Since Lake Ontario is the most downstream Great Lake, it is affected by human activities occurring throughout the Lake Superior, Michigan, Huron, and Erie basins.

Lake Ontario's climate is classified as humid and temperate. All of the Great Lakes act as heat sinks by absorbing heat when the air is warm and releasing it when the air is cold. The result is more moderate air temperatures near shore compared to regions of equivalent latitude. Lake Ontario's summer climate is influenced by warm, humid air from the Gulf of Mexico. In the winter, the weather is influenced by Arctic and Pacific air masses (USEPA Region 2 *et al.*, 2006).

Land use in the Lake Ontario basin is predominantly rural (Table 4-1).

Table 4-1. Lake Ontario Basin Land Use Expressed in Percentages

Country	Agriculture	Residential	Forest	Other
Canada	49	6	42	3
US	33	8	53	6
Total	39	7	49	5

Adapted from USEPA Region 2 *et al.*, 2006

Subsequent to the nationwide ban on the production of PCBs in the United States in the late 1970s, various state and federal agencies began monitoring the concentrations of PCBs in air, water, and fish tissue. Presented below are monitoring data from various sources showing the air (Figure 4-1), water (Figure 4-2), and lake trout fish tissue total PCB concentrations (Figure 4-3). PCB concentrations in all media (air, water, and fish) have been declining over the last decade due to reductions in loadings as well as the degradation and burial of sediment bound PCBs. Figure 4-4 shows the mass balance of Lake Ontario PCBs for current (2005) conditions. This figure shows that absorption and volatilization of PCBs are not currently in equilibrium.

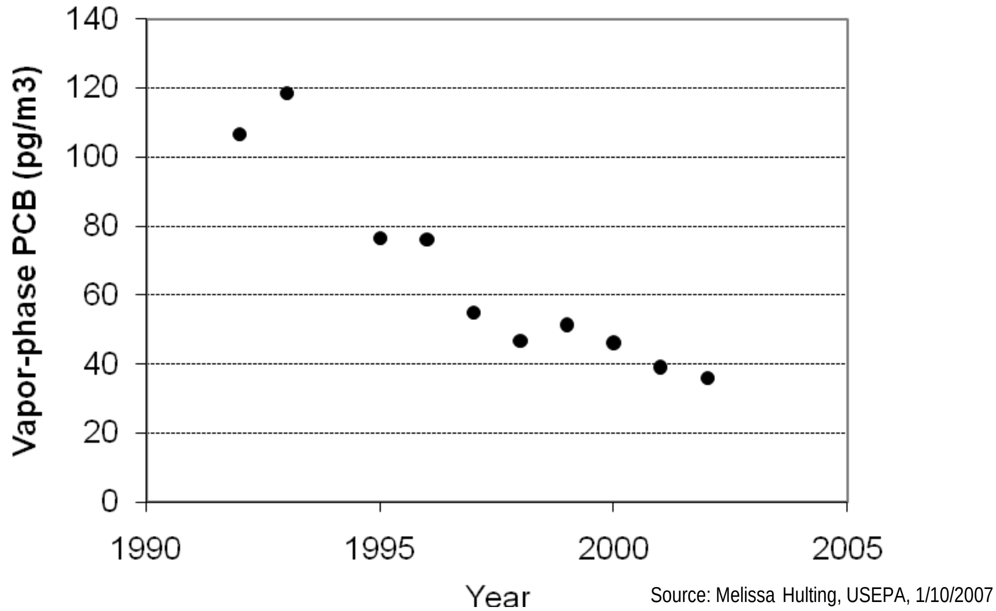


Figure 4-1. Average annual vapor-phase total PCB concentration measured at Point Petre, Ontario from 1992 to 2002

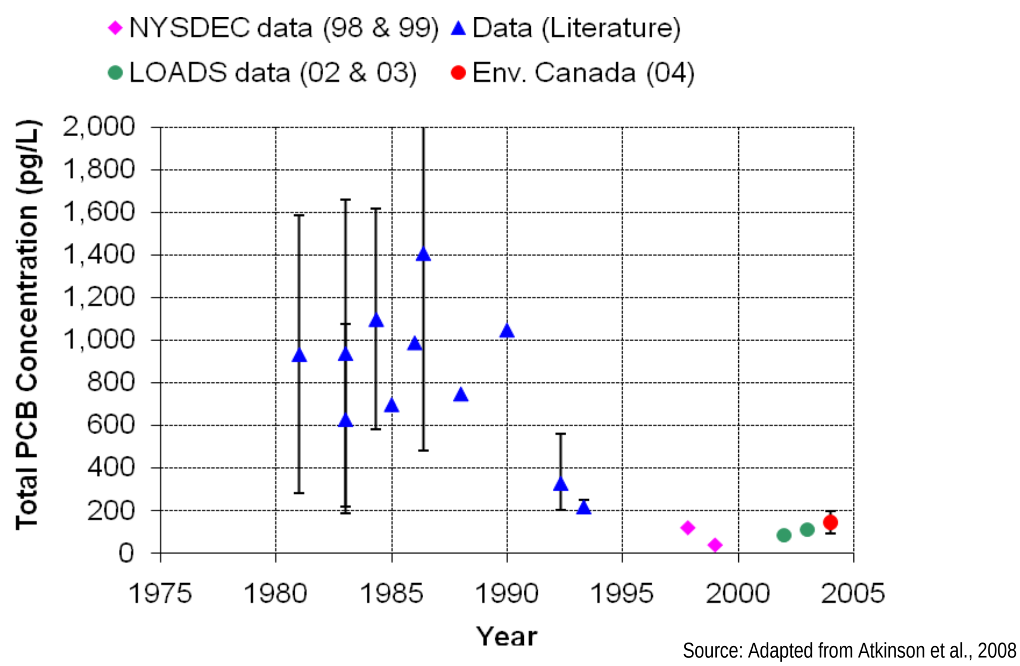


Figure 4-2. Average annual water column total PCB concentration measured by various sources from 1981 to 2004 in the open waters of Lake Ontario

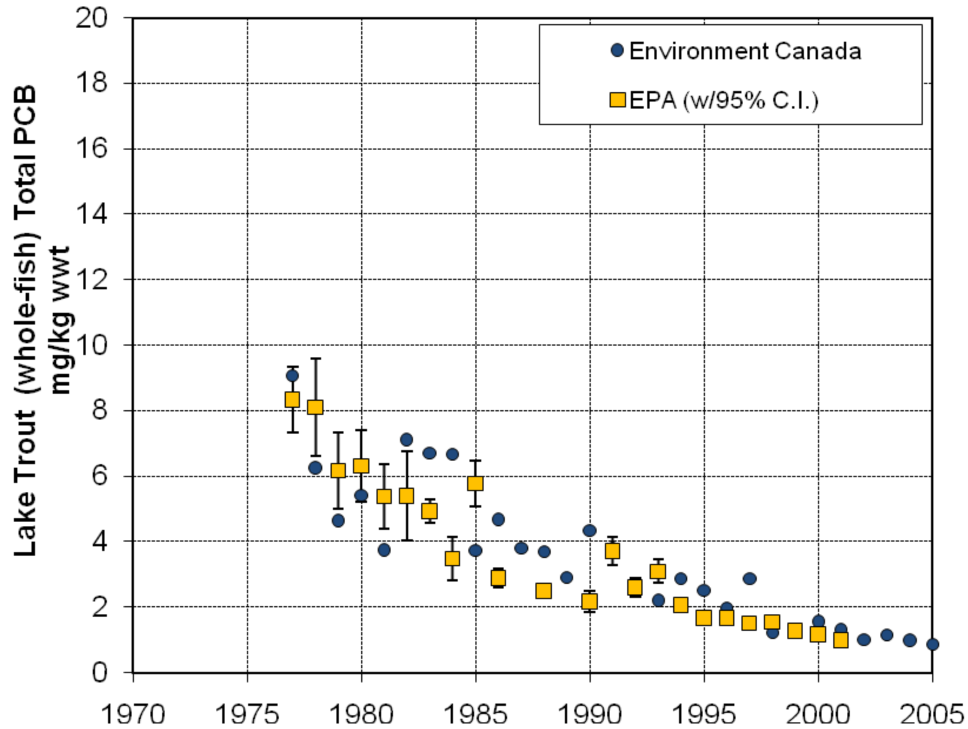


Figure 4-3. Average annual lake trout whole-fish total PCB concentration from 1977 to 2005 from USEPA (Elizabeth Murphy, USEPA, personal communication, November 7, 2006) and Environment Canada (Sean Backus, Environment Canada, personal communication, January 17, 2007)

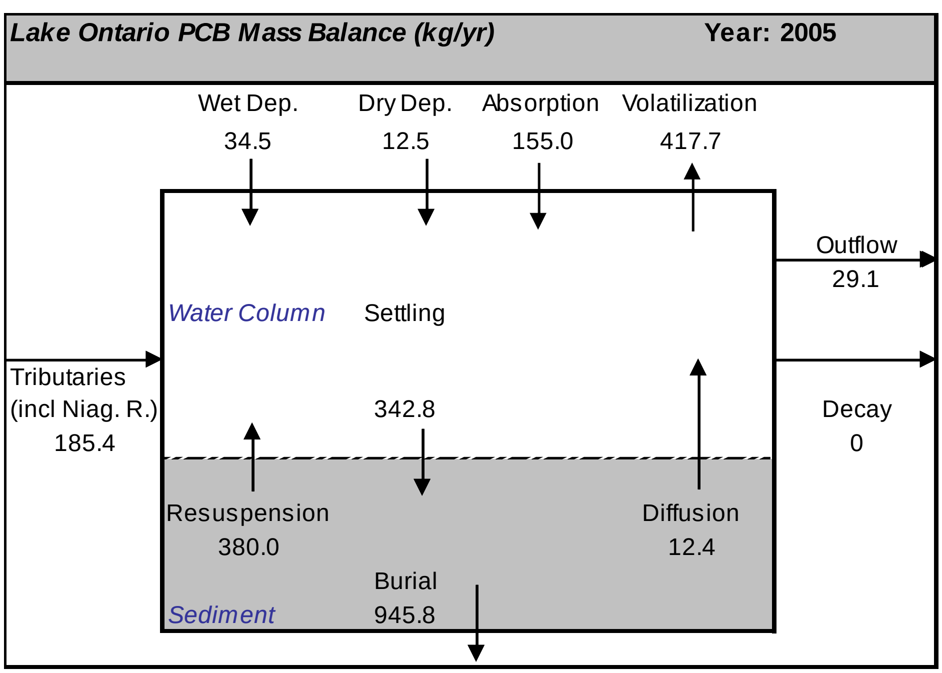


Figure 4-4. Lake Ontario PCB Mass Balance for 2005 (LOTOX2 model output)

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5. DESCRIPTION OF APPLICABLE STANDARDS AND NUMERIC TARGETS

A water quality standard consists of the designated uses of the waterbody, water quality criteria to protect designated uses, and an anti-degradation policy to maintain and protect existing uses and high quality waters. Water quality criteria are sometimes provided in a form that are not directly amenable for use in TMDL development and may need to be translated into a target value for TMDLs. This section discusses the applicable designated uses, use support, criteria and TMDL targets for water bodies in the Lake Ontario (Minor Tributaries) Drainage Basin that are addressed in this report.

5.1 DESIGNATED USES AND USE SUPPORT

Stream classifications were presented in Table 2-1 for each of the TMDL segments. General conditions that are applicable to all water classifications and three classifications (Class A, Class B and Class C) applicable for these impaired segments are described below.

General Conditions Applying to All Water Classifications

"The discharge of sewage, industrial waste or other wastes shall not cause impairment of the best usages of the receiving water as specified by the water classifications at the location of discharge and at other locations that may be affected by such discharge." (6 NYCRR Part 701.1)

Class A Fresh Surface Waters

"The best usages of Class A waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish, shellfish, and wildlife propagation and survival. This classification may be given to those waters that, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to reduce naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes." (6 NYCRR Part 701.6)

Class B Fresh Surface Waters

"The best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival." (6 NYCRR Part 701.7)

Class C Fresh Surface Waters

"The best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes." (6 NYCRR Part 701.8)

The New York State Department of Health (NYSDOH, 2009) issues annual fish consumption advisories for New York State waters which include specific and general advisories for Lake Ontario. NYSDEC collects and analyzes fish for contaminants. The

New York State Department of Health (NYSDOH, 2009) recommends that human consumption of fish from New York portions of Lake Ontario and its tributaries to the first impassable barrier be limited due to elevated levels of PCBs, dioxin and mirex. Women of childbearing age, infants and children under the age of 15 should not eat any fish from these waters. Additional recommendations for the rest of the population include:

- Eat no channel catfish, carp, larger lake trout (over 25 inches), larger brown trout (over 20 inches), and white perch (west of Point Breeze), and
- Eat no more than one meal per month of Chinook salmon, rainbow trout, white sucker, smaller lake trout, smaller brown trout, larger Coho salmon (over 25 inches) and white perch (east of Point Breeze).

A statewide advisory applies to all other fish not listed above, and recommends eating no more than one meal (one-half pound) per week of fish taken from the state's freshwaters.

Based on the NYSDOH health advisory, fish consumption in Lake Ontario (and all tributaries to the first impassable barrier) is impaired (NYSDEC, 2007). NYSDEC lists contaminated sediments as the source of PCBs (NYSDEC, 2008). These are the result of past/historic industrial discharges to the lake, the Niagara River and the Upper Great Lakes (NYSDEC, 2007).

5.2 WATER QUALITY CRITERIA

Management of Lake Ontario and its main tributary, the Niagara River, is under the jurisdiction of NYSDEC, USEPA, OME, and EC, which account for both state (provincial) and federal agencies from both Canada and the United States. While each jurisdiction has a different water quality standard for PCBs in surface waters, the only applicable standard for this TMDL is the New York State ambient water quality PCB standard. NYSDEC maintains water quality regulations for surface water and groundwater as 6 NYCRR Parts 700-706. The standard for human health (fish consumption) for PCBs in Class A, B and C water bodies is defined as 1 pg/l (6 NYCRR Part 703). This water quality standard is interpreted here to mean the average annual lake-wide total PCB concentration in Lake Ontario cannot exceed 1 pg/l.

5.3 DEVELOPMENT OF TMDL TARGETS

The TMDL target is a numeric endpoint specified to represent the level of acceptable water quality that is to be achieved by implementing the TMDL. The applicable numeric water quality standard for the pollutant of concern is generally used as the basis for the TMDL target.

New York State has water quality standards for PCBs in all classes of water based on human health (water supply), human health (fish consumption) and wildlife. The selected TMDL target of 1 pg/l PCBs measured on a lake-wide annual average basis is based on the New York State criteria for PCBs to protect human health (fish consumption).

This target represents an annual lake-wide average because it is based on a fish consumption exposure pathway and because the top predator fish (lake trout) that drive the target in Lake Ontario effectively integrate the lake conditions over the whole lake and over a decadal time period. Furthermore, changes in lake volume as a result of year-to-year variability in net basin water supply or water level regulation will not cause a change in the annual, lake-wide total PCB concentration of more than 5 percent. Therefore, the environmental conditions assumed for this TMDL appropriately reflect critical conditions.

Both USEPA and EC collect lake trout PCB samples on an annual basis, but do not routinely monitor PCBs in the water column. Fish tissue measurements are frequently used to assess TMDL target compliance for hydrophobic compounds, and the LOTOX2 model can be used to convert measured lake trout tissue concentration to water column concentration to assess compliance with the TMDL target. This calculation is based on 600-700 mm whole fish lake trout samples analyzed for total PCB congeners as reported by Great Lakes National Program Office's (GLNPO's) fish tissue monitoring program (http://epa.gov/glnpo/monitoring/fish/reports/quality.pdf).

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6. WATER QUALITY MODEL DEVELOPMENT

The LOTOX2 water quality model was used to define the relationship between PCB loads to Lake Ontario and the resulting concentrations in the water column. LOTOX2 is a time variable three-dimensional water quality model specifically developed for Lake Ontario. The model has been calibrated and validated against PCB data collected over several decades by many federal and state agencies (LimnoTech, 2004). The model allows for the input of tributary loads, point source loads, atmospheric loads and exchanges, as well as feedback from sediment sources. The selection and development of LOTOX2 is described in the following sections.

6.1 MODEL SELECTION

An advanced hydrodynamic and water quality model of Lake Ontario is required to link PCB loading inputs to water column concentrations of PCBs. In anticipation of developing a lake-wide TMDL for Lake Ontario, the State of New York and other agencies funded the development of a specialized water quality model that could model the fate and transport of PCBs throughout all compartments of Lake Ontario (water column, sediments, and biota). NYSDEC and USEPA have both accepted that the most appropriate model for this TMDL is LOTOX2 (Atkinson *et al.*, 2008). While other models were considered during the original model development process several years ago, all recent efforts to model PCBs in Lake Ontario have used the LOTOX2 model framework.

6.2 MODELING APPROACH

The LOTOX2 model has been documented previously (e.g., Domske, 1998; DePinto, Liu, Young and Booty, 1999a, 2000; LimnoTech, 2004; Atkinson *et al*., 2008), and only its basic framework is summarized here. The model was initially developed on behalf of the New York Great Lakes Research Consortium (GLRC), with support from USEPA Region 2 during the latter 1990s as a hydrophobic organic chemical mass balance and food chain bioaccumulation model (Domske, 1998; *DePinto et al.,* 1999b). This model was developed in conjunction with and in support of the Lake Ontario LaMP process. LOTOX2 has the capability to simulate the time-dependent response of water column, sediment, alewife, and lake trout concentrations of persistent bio-accumulative chemicals in Lake Ontario to external loads and boundary conditions. It has been developed and undergone extensive peer review specifically for PCBs (LimnoTech, 2004; Atkinson *et al.*, 2008).

The basic structure of LOTOX2 consists of a set of differential, time-dependent mass balance equations for solids (chemical sorbent) and total hydrophobic organic contaminants (HOCs) in the water column and sediments of the system. The state variables for the mass balance model are a single solids type and total chemical concentration (PCBs). Using a local equilibrium assumption, the total chemical concentration is partitioned into “dissolved” and sorbed phases so that processes acting only on a particular phase of the chemical can be applied appropriately. For example, settling and resuspension apply only to the particulate (sorbed) phase of the chemical. The model thus computes the concentration of solids and the HOC of interest in the water column and sediments of the system as a function of time and model forcing functions (flows, water column circulation, and loads of HOC from various categories including point sources, tributaries, atmospheric deposition, and gas phase boundary concentration).

The water column chemical concentration computed with the mass balance model is then used as input to a food chain bioaccumulation model, which computes the time-dependent concentration of the HOC of interest in adult top predator fish in the system. The bioaccumulation model predicts chemical concentration in biota as a function of chemical concentration in water. This linkage allows concentrations in biota to be quantitatively related to chemical loading to the lake. The formulation of the bioaccumulation model follows the development of Thomann and Mueller (1987), Thomann (1989), and Thomann, Connolly and Parkerton. (1992). It is the same formulation previously used by Endicott, Richardson, Parkerton and DiToro (1990) in their screening model for Lake Ontario, except they used a lipid-based concentration as the basis for state variables. In LOTOX2 the formulation is presented for wet-weight based biota concentration since that is the measure used in determining fish consumption advisories. Four trophic levels are used to represent a linear, pelagic food chain. The organisms chosen to represent the food chain in Lake Ontario are phytoplankton, mysis (zooplankton), alewife (small fish) and lake trout (large fish).

6.3 MODEL CONSTRUCTION

The water column and sediment mass balance model in LOTOX2 uses a finite segment modeling approach similar to the USEPA-supported Water Quality Analysis Simulation Program (WASP) model series (Ambrose, Wool and Martin, 1993; Thomann and Mueller, 1987) for all computations of horizontal and vertical gradients in the water column and sediments of the system. Within each water column segment, the model contains the following transport and transformation processes acting on the contaminant state variable:

- Equilibrium partitioning between the dissolved and the sorbed phase of the HOC;
- Volatilization of dissolved phase (for segments with an air-water interface);
- Settling of the particulate phase (for all water segments);
- Resuspension from surface bottom sediments (for segments with sediment-water interface);
- Porewater diffusion of dissolved phase (for segments with sediment-water interface);
- Advection across interfaces with adjacent water segments;
- Dispersion across interfaces with adjacent water segments; and
- Chemical/biochemical transformation or decay depending on contaminant of concern.

External loadings, via either direct point source, tributary, atmospheric wet and dry deposition, or atmospheric gas phase absorption, also are included in the mass balance equation for surface water column segments. Overall mass transport out of the system through outflow (in this case to the St. Lawrence River) occurs by advection from the model segment adjacent to the head of the St. Lawrence River.

Mass balance equations for sediment segments include the following processes:

- Equilibrium partitioning between the porewater phase and the sorbed phase of the HOC;
- Deposition from the water column (for segments with sediment-water interface);
- Resuspension into the water column (for segments with sediment-water interface);
- Net sedimentation (deposition – resuspension) flux into and out of sediment segment layers;
- Vertical particle mixing between adjacent sediment segment layers; and
- Porewater diffusion across upper and lower boundary of the sediment segment layers.

These processes are shown in Figure 6-1 for a typical water column and upper sediment segment. The assumption of local equilibrium partitioning allowed use of the total (particulate and dissolved) chemical concentration as the state variable. After each model time step, the phase distribution is recalculated and the appropriate transport or transformation kinetic process is applied to each phase during the next time step of the model.

Figure 6-1 also shows the various loading and boundary condition categories used by LOTOX2. Model inputs include loading rates for direct point sources, tributaries, the Niagara River, and atmospheric wet and dry deposition. The atmospheric gas phase boundary condition must also be specified in order for the model to calculate the loading rate through the absorption pathway. These various loading categories allow evaluation of system response to programs that would affect these individual loading categories.

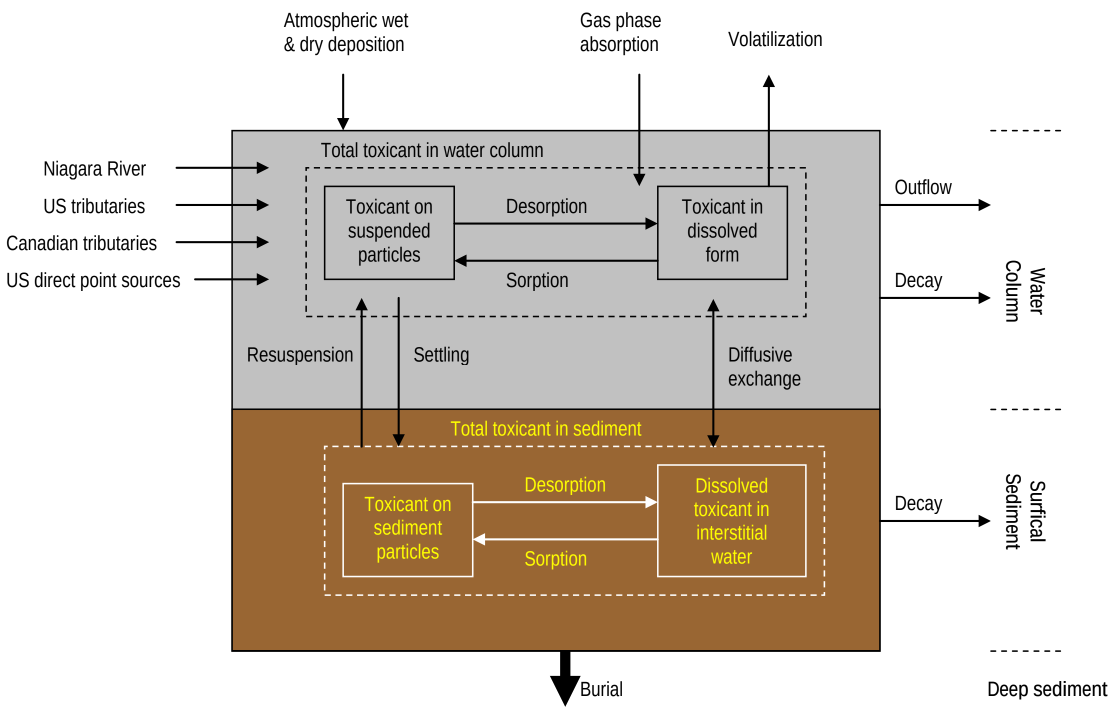


Figure 6-1. Transport and transformation processes and loading categories included in the mass balance model used by LOTOX2 for PCBs in Lake Ontario

The mass balance fate and transport model within LOTOX2 is constructed using the same finite segment modeling approach used in the USEPA-supported WASP model series (Ambrose *et al.*, 1993; Thomann and Mueller, 1987). The approach assumes that each segment in the system is a completely-mixed flow-through reactor that interacts with its adjacent segments by advection, dispersion, or other mass transfer processes such as settling or diffusion. Lake Ontario is divided into 22 water column segments covering nearshore and open water areas. The general time-dependent differential equation for the rate of change of chemical concentration in a given segment is written as:

$$V_j \frac{dC_j}{dt} = -\sum_i Q_{ij} C_{ij} + \sum_i R_{ij}(C_i - C_j) + W_j + I_{AW,j} + I_{SW,j} + I_{T,j}$$

Where:

V_j = volume of segment *j* [L^3]

C_j = total chemical concentration at the center of segment *j* [M/L^3]

C_{ij} = total chemical concentration at the interface between segments *i* and *j* [M/L^3]

Q_{ij} = volumetric flow across a segment boundary (defined as positive when leaving segment *j*, and negative when entering *j*) [L^3/T]

R_{ij} = dispersion/diffusion coefficient between segments *i* and *j* [L^3/T]

W_j = direct loading rate to segment *j* [M/T]

$I_{AW,j}$ = inventory mass change rate due to air/water exchange process between segment j and air (only for segments adjacent to air boundary) [M/T]

$I_{SW,j}$ = inventory mass change rate due to sediment/water exchange process between segment j and adjacent sediment segments (only for segments adjacent to sediments) [M/T]

$I_{T,j}$ = total kinetic transformation rate (a source is positive, a sink is negative) [M/T]

Further details of the mass balance modeling framework, including chemical partitioning (between sorbed and dissolved phases), air-water exchange, and sediment-related transport, are described in previous reports (Domske, 1998; DePinto *et al.* 1999a, 2000; LimnoTech, 2004; Atkinson *et al.*, 2008).

Four trophic levels are used to represent the food chain (Figure 6-2): phytoplankton, mysis (zooplankton), alewife (small fish) and lake trout (large fish). A generalized mass balance equation for each trophic level may be conceptualized as

Change in Concentration in Organism = Uptake + Consumption – Depuration

The equation for bioaccumulation in level "i" of the food chain above the plankton level (where subscript "i" refers to a predator, and i-1 refers to its prey, at the next lower trophic level) is:

$$\frac{dv_i}{dt} = k_{ui}c_d + \alpha_{i,i-1}C_{i,i-1}v_{i-1} - K_{Di}v_i$$

Where:

v_i = chemical concentration in organism ($\text{Mass}_{\text{chem}}/\text{Mass}_{\text{organism}}$)

k_{ui} = uptake rate ($L^3/T/\text{Mass}_{\text{organism}}$)

c_d = dissolved water concentration (M/L^3)

$\alpha_{i,i-1}$ = chemical assimilation coefficient across gut ($\text{Mass}_{\text{chem abs}}/\text{Mass}_{\text{chem ingested}}$)

$C_{i,i-1}$ = food consumption rate (M/M/D)

K_{Di} = apparent depuration rate (1/T)

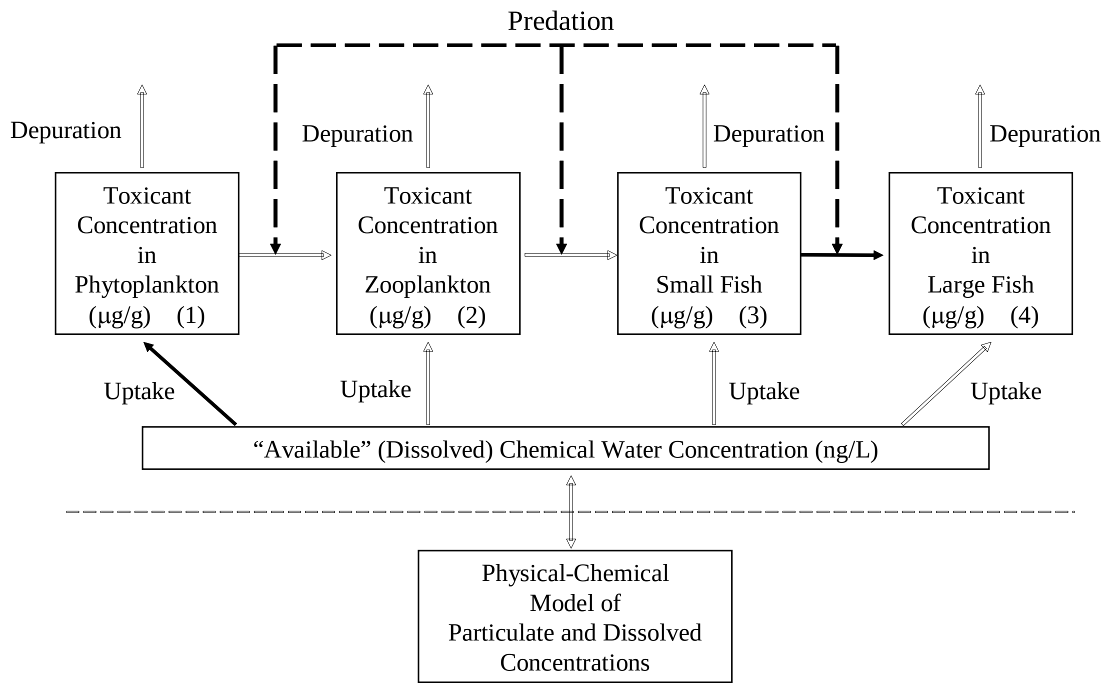


Figure 6-2. Conceptual diagram of four trophic level food chain and bioaccumulation model in LOTOX2

6.4 MODEL SEGMENTATION

The spatial segmentation of LOTOX2 is designed to differentiate between surface waters and bottom waters, between depositional and non-depositional sediment areas, and between horizontal locations of sediments relative to major sources such as the Niagara River (Figure 6-3). The water column is represented in two vertical layers (epilimnion and hypolimnion), to capture temperature stratification in the system. The top layer is twenty meters thick, which is the approximate depth of the summer thermocline in Lake Ontario. In total there are 22 water column segments (15 surface segments and 7 bottom water segments). Segments 1 through 8 represent the nearshore area of the lake. The outer boundary of each of these segments is defined by the intersection of the 20-meter contour with the bottom sediments. Therefore, these segments have an interface with the atmosphere at the top and with the surface sediments at the bottom. Segments 9 through 15 are the surface open-water segments, and segments 16 through 22 are the hypolimnetic segments, which are below each of the surface open-water segments.

The surface sediment segments in the system are designed to distinguish between depositional areas and non-depositional areas of the lake. Segments 28 and 31 through 36 represent the depositional areas of the lake. These segments are bounded on the outside by the 70-meter contour, determined by Thomas, Kemp and Lewis (1972) to be the depositional zone in the lake. These depositional basins – the Niagara, Missisauga, Oswego, and Kingston basins – comprise about one-half of the lake bottom area.

Sediment segments in water less than seventy meters deep (segments 23, 24, 25, 26, 27, 29, and 30) comprise the non-depositional zone of the lake. These sediments are shallow and are assumed to have zero net sedimentation over the course of a year. This sediment horizontal segmentation and sediment designated behavior allows LOTOX2 to simulate the sediment focusing behavior that has been observed in Lake Ontario.

LOTOX2 treats the sediments below each surface sediment segment depicted in Figure 6-3 as a multi-layer system. Vertical migration of chemicals in sediments is simulated by having each layer interact with adjacent vertical layers through specification of burial, erosion, particle mixing, and porewater diffusion processes. In the depositional zone sediment segments, each sediment segment contains twenty, 1-cm thick layers. In the near-shore non-depositional sediment segments, there are only five, 1-cm thick layers.

Volumes and interfacial areas of all segments in the model were determined by conducting a geographic information system (GIS) analysis of the system, using spatial bathymetric and shoreline data available from U.S. Geological Survey (USGS)-National Geophysical Data Center (NGDC).

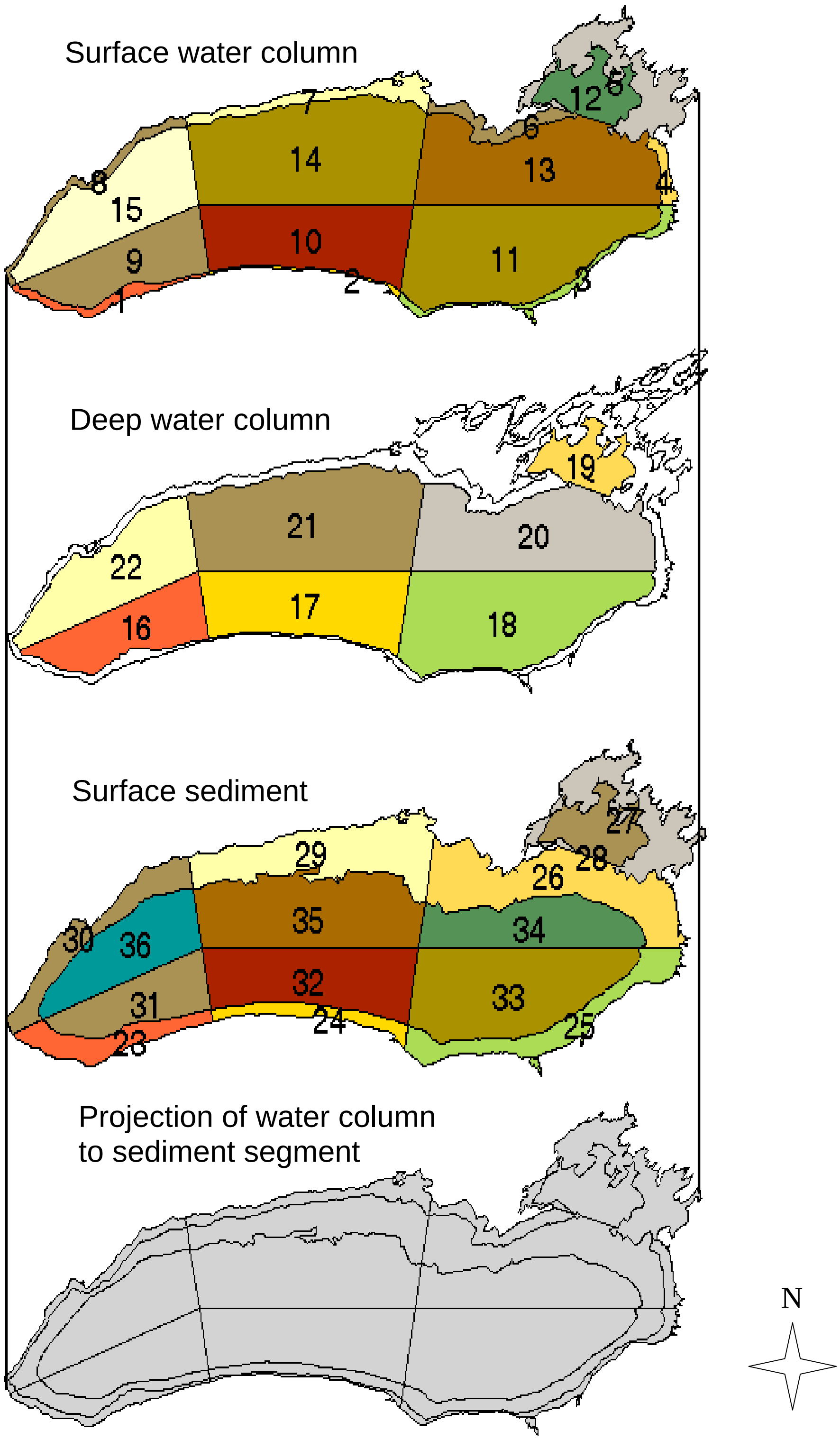


Figure 6-3. Spatial segmentation of the LOTOX2 model domain

6.5 MODEL FORCING FUNCTIONS

Within the LOTOX2 framework there are four categories of user-specified PCB loadings. The first two are time series loads and include tributary loadings and atmospheric deposition (wet and dry) directly into the lake. Direct point source loads are the third category. A fourth category, air-water exchange, can exist depending on vapor-phase PCB concentrations above the lake and water column concentrations.

Tributary and atmospheric deposition loadings were updated from previous estimates (LimnoTech, 2004; Atkinson *et al.*, 2008) to maintain the predictive capabilities of LOTOX2 and to confirm and/or update previous assumptions about PCB loadings when data were not available. Direct point source loads were estimated from information provided by NYSDEC. The assessment of air-water exchange was updated using measurements of vapor-phase PCB concentrations for Lake Ontario recorded on ship and on land. All data used to develop the forcing functions were either received directly from NYSDEC or USEPA or from publicly available reports and databases as cited throughout this report.

6.5.1 Tributary Loadings

Tributary loadings explicitly included in LOTOX2 include the Niagara River, 19 other major tributaries (8 U.S. and 11 Canadian) and direct drainage within the U.S. and Canada. For each of the US and Canadian tributaries, an annual load was estimated using monitoring data or an exponential loading function when data were not available. The exponential loading function was used to project measured loadings forward and/or backward to fill gaps in loading estimates. Annual loadings were estimated from 1930 to 2005 for all 19 tributaries, with only the 2005 load documented in detail below. Documentation of the historic PCB load is provided elsewhere (LimnoTech, 2004; Atkinson *et al.*, 2008).

Niagara River

Since 1986, annual loadings of PCBs into Lake Ontario from the Niagara River have been monitored by the Upstream/Downstream Program operated by Environment Canada. The program measures concentrations of priority pollutants at Fort Erie, Ontario and at Niagara-On-The-Lake, Ontario (NOTL) at weekly to bi-weekly intervals. Fort Erie is located at the upstream end of the Niagara River on Lake Erie and NOTL is located at the downstream end of the Niagara River on Lake Ontario. Annual load estimates for total PCBs from 1986 to 2004 were reported at both locations by Environment Canada (Brad Hill, Environment Canada, personal communication, November 2, 2007) and were estimated based on concentration and flow measurements. Between 1986 and 1997, the reported PCB load included both dissolved and particulate measurements of the total PCB load; however, since 1998 only a particulate PCB load has been reported. Lab and field blanks in the early 2000s showed that cross-contamination was occurring between samples and subsequently the dissolved PCB concentrations were being over reported by up to a factor of two (Brad Hill, Environment Canada, personal communication, November 2, 2007).

The annual dissolved PCB load from 1998 to 2005 was estimated using a first order exponential regression that was fit to dissolved PCB data from 1986 to 1997. The regression was fit to the annual average PCB load measured at Fort Erie and NOTL (both values were averaged to obtain a single value). This procedure assumes there is no change in the dissolved PCB load between the Fort Erie and NOTL sites. The exponential decline in the dissolved phase PCB load is consistent with trends observed in the atmospheric gas-phase PCB concentration. Figure 6-4 shows the annual average dissolved PCB loads for 1986 to 1996 and for 1997 to 2005 that were estimated from the trend line.

The particulate phase PCB load in the Niagara River is expected to be more dependent on tributary and point source PCB loads within the direct drainage area of the Niagara River watershed. Particulate phase PCB loading data from 1998 to 2004 at Fort Erie and NOTL (Figure 6-5) show no significant declining trend. For this reason, the average load from 1998 to 2004 at each location was used to estimate the 2005 load (31.41 kg/yr at Fort Erie and 81.74 kg/yr at NOTL). The difference is assumed to be from sources within the Niagara River.

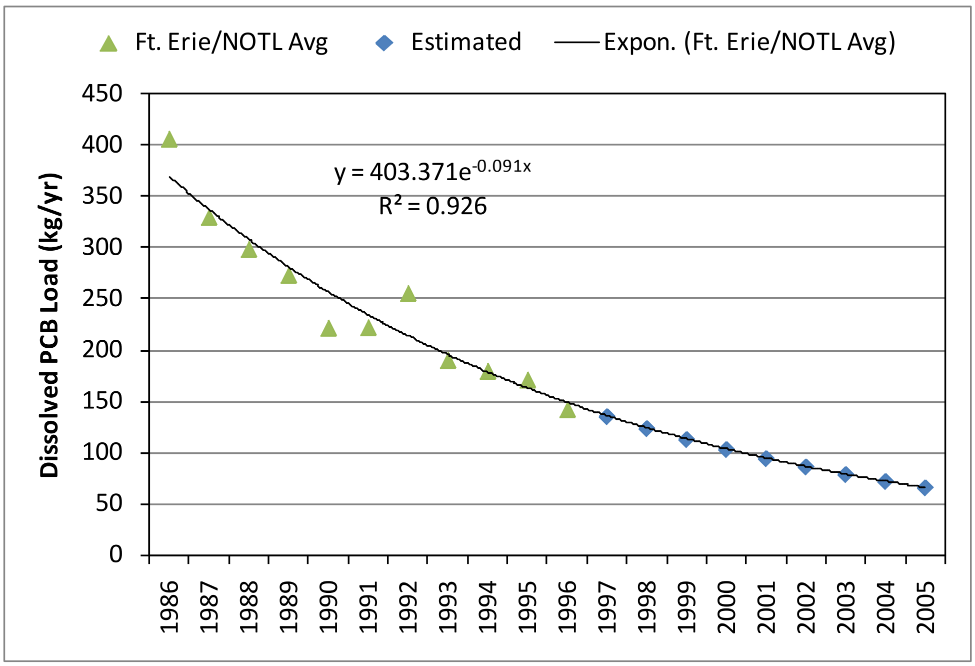


Figure 6-4. Average annual dissolved PCB load in the Niagara River (1986-1996) and predicted dissolved PCB load (1997-2005)

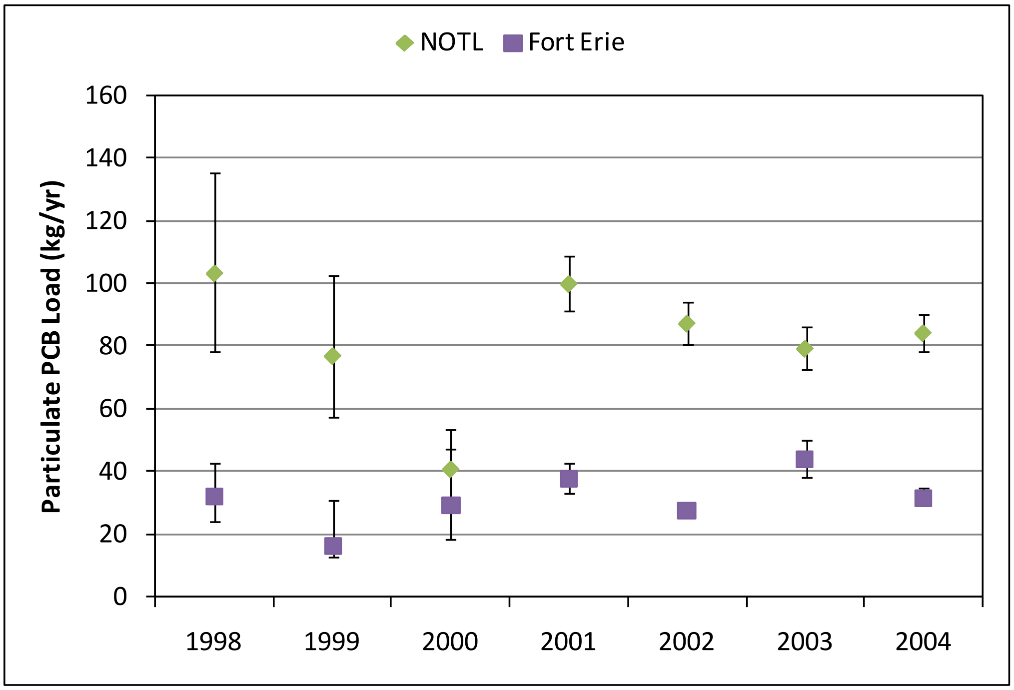


Figure 6-5. Annual average particulate phase PCB load at Fort Erie and Niagara-On-The-Lake, 1998-2004

The total PCB loads at Fort Erie and NOTL for 2005 were calculated as the sum of the dissolved and particulate PCB loads (Table 6-1). The 2005 Niagara River load to Lake Ontario is represented by the NOTL load (147.22 kg/yr). The largest source of uncertainty in this estimate is the dissolved PCB load. Environment Canada has not yet released updated dissolved PCB concentration data (Brad Hill, Environment Canada, personal communication, May 4, 2009), which could be used to validate this portion of the PCB load estimate.

Table 6-1. Estimated 2005 PCB load (kg/yr) at Fort Erie and Niagara-On-The-Lake

Phase	Fort Erie	NOTL
Particulate	31.41	81.74
Dissolved	65.49	65.49
Total	96.89	147.22

Other Tributaries

For all of the other major tributaries to Lake Ontario, available PCB monitoring data were used to develop an annual loading regression for each tributary. PCB monitoring data from USEPA (2002 to 2008), NYSDEC (2007 to 2008), and USGS (Black River for 2004 to 2005) (Litten, 2009; Coleates and Hale, 2009; Richards and Eckhardt, 2006) for major U.S. tributaries to Lake Ontario were used to update and validate the loading regressions reported in Atkinson *et al.* (2008). A summary of the 2005 PCB load from Canadian and U.S. tributaries is shown in Table 6-2. Annual PCB loads from Canadian tributaries were estimated using the same method as the US tributaries: monitoring data were used when available and an exponential regression was used to estimate PCB loads in years when data were not available. Unlike the US tributaries, recent data are not available for Canadian tributaries to provide confirmation of the accuracy of the loading regressions. Additional information on PCB load estimates is provided in LimnoTech, 2004 and Atkinson *et al.*, 2008. A discussion of the load estimates for the major U.S. tributaries follows below.

Eighteenmile Creek – In Atkinson *et al.* (2008), the 2005 PCB load (3.18 kg/yr) was estimated based on all recent (2002 to 2008) USEPA measurements (Coleates and Hale, 2009). The average concentration from this dataset for all samples from 2002 to 2005 is 39.62 ng/l (n=15; stdev = 8.55 ng/l). A constant flow of 90 cfs was used to calculate the load. NYSDEC also collected PCB data on 18-mile Creek in 2007 and 2008 (Litten, 2009). The average concentration for the NYSDEC data is 131.71 ng/l (n=7; stdev=116.65 ng/l), which is significantly higher than the USEPA data. Analysis by Litten (2009) estimated an annual PCB load of 10.9 kg/yr. These estimates are based on different PCB analysis methods and use data collected at different temporal scales. The actual flow in the creek is unknown. To be consistent with the approach used to estimate the PCB load for other U.S. tributaries, the USEPA dataset was used for the TMDL. The 2005 load is estimated at 3.18 kg/yr.

Genesee River – In Atkinson *et al.* (2008), the 2005 PCB load was estimated based on a projection of data collected by USEPA from 2002 to 2005 (Coleates and Hale, 2009). An analysis of all of the USEPA PCB data for the Genesee River (2002 to 2008) using the Beale’s ratio results in an annual 2005 load estimate of 0.66 kg/yr. Litten (2009) also analyzed data collected by NYSDEC from the Genesee River using a linear regression of the log of flow and the log of concentration and reported a PCB load estimate of 1.86 kg/yr. Litten states in his report that PCB values reported for the Genesee River may be artificially high due to the limitations of the analysis method. For this reason, the 2005 load is assumed to be equal to the Beale’s ratio estimate of 0.66 kg/yr.

Oswego River - In Atkinson *et al.* (2008), the 2005 PCB load (0.60 kg/yr) was estimated based on a projection of data collected by NYSDEC in 1993 and 1994 (Litten, 1997). An analysis of all of the USEPA PCB data for the Oswego River (2002 to 2008) using the Beale’s ratio results in an annual 2005 load estimate of 1.39 kg/yr. Litten (2009) also analyzed data collected by NYSDEC from the Oswego River using a linear regression of the log of flow and the log of concentration and reported a PCB load estimate of 2.70 kg/yr. Litten states in his report that PCB values reported for the Oswego River may be artificially high due to the limitations of the analysis method. For this reason, the 2005 load is assumed to be equal to the Beale’s ratio estimate of 1.39 kg/yr.

Black River - In Atkinson *et al.* (2008), the 2005 PCB load (7.30 kg/yr) was estimated based on an analysis done by Richards and Eckhardt (2006) using data collected in 2004 and 2005. An analysis of all of the USEPA PCB data for the Black River (2002 to 2008) using the Beale’s ratio results in an annual 2005 load estimate of 16.00 kg/yr. Applying the Beale’s ratio to the PCB collected by Richards and Eckhardt (2006) results in an annual load estimate is 9.39 kg/yr. This analysis excludes one outlier (7.50 ng/l) collected on May 5, 2005, which is an order of magnitude higher than any other sample collected during the study. Litten (2009) also analyzed data collected by NYSDEC from the Black

River using a linear regression of the log of flow and the log of concentration and reported a PCB load estimate of 8.40 kg/yr. Litten states in his report that PCB values reported for the Black River may be artificially high due to the limitations of the analysis method. For this reason, the 2005 load is assumed to be equal to the value reported by Richards and Eckhardt of 7.30 kg/yr.

Salmon River - In Atkinson *et al.* (2008), the 2005 PCB load for the Salmon River is not explicitly included in the model inputs, instead it is included in the U.S. direct drainage to Lake Ontario estimate, which was 0.10 kg/yr in 2005. An analysis of all of the USEPA PCB data for the Salmon River (2002 to 2008) using the Beale's ratio results in an annual 2005 load estimate of 0.27 kg/yr. Litten (2009) also analyzed data collected by NYSDEC from the Salmon River using a linear regression of the log of flow and the log of concentration and reported a PCB load estimate of 0.23 kg/yr. Litten states in his report that PCB values reported for the Salmon River may be artificially high due to the limitations of the linear regression method. However, the Beale's ratio is a more robust method to estimate annual loads when dealing with a limited dataset. For this reason, the 2005 load is assumed to be equal to the Beale's ratio estimate of 0.27 kg/yr.

Table 6-2. Estimated 2005 total PCB load (kg/yr) from U.S. and Canadian tributaries to Lake Ontario[1]

US Tributaries	Load (kg/yr)	Canadian Tributaries	Load (kg/yr)
Black River	7.3	Twelve Mile Creek	13.5
Eighteenmile Creek	3.18	Trent River	6.4
Oswego River	1.39	Hamilton Harbor	0.3
Sandy Creek	0.1	Credit River	0.3
Genesee River	0.66	Humber River	0.2
Irondequoit Creek	0.0003	Ganaraska River	0.1
Wine Creek	0.0001	Don River	0.1
Salmon River	0.27	Twenty Mile Creek	0.1
Direct Drainage	0.1	Etobicoke Creek	0.1
		Mimico Creek	0.02
		Rouge River	0.01
		Direct Drainage	0.9
Total	13.0	Total	22.0

1. The Niagara River load of 147.22 kg PCB/yr is presented separately in the previous text.

6.5.2 Direct Point Sources

Direct point sources are defined as permitted sources that discharge directly to Lake Ontario (i.e., their permits list Lake Ontario or an embayment of Lake Ontario as the receiving water). These include facilities and permitted Municipal Separate Stormwater Sewer Systems (MS4s). PCB loads from Canadian direct point sources are assumed to be small in comparison to other loads to the lake and were not calculated; these loads can be ignored since they are not getting an individual allocation in the TMDL. PCB loads from direct New York point sources are also calculated to be small, but are receiving an allocation in the TMDL because they are a regulated point source in the U.S. The calculation of these loads is described below. There is very little data regarding the existing PCB load from the point source dischargers to Lake Ontario. The assumption made to apply a 12.5 ng/l concentration to the POTWs is considered conservative and will be adjusted based on data collected as the first element of the implementation plan.

Information on direct New York point source facilities and their permitted effluent flows was extracted from the Integrated Compliance Information System (ICIS) with assistance from NYSDEC (Lorraine Gregory, NYSDEC, personal communication May 19, 2009).

Exclusions were made for discharges from power plants commissioned after the PCB ban went into effect since these facilities are unlikely to alter the PCB loads between the intake and discharge. Other point sources from these facilities are also not expected to contain PCBs.

Four power plants that discharge directly to Lake Ontario were commissioned prior to the PCB ban, therefore, it is possible that these sites could be potential sources of PCB discharges to Lake Ontario. Since there was no discharge data for PCBs from these facilities, and the POTW discharge concentration estimate of 12.5 ng/l would not be applicable, the potential current load from these facilities is unknown. Therefore these facilities were not considered in the development of the current load from point sources nor was a WLA established for these facilities. For these facilities, the concentration of PCB's in the non-contact cooling water at best will equal the concentration of PCBs in the intake water. This should not be considered a load to the lake since under that scenario no additional mass of PCB is being added to the lake and therefore it is not appropriate to assign a WLA for non-contact cooling water. It is appropriate to require a representative level of effort of monitoring to ensure no PCBs are being added to the background influent concentration. It may also be appropriate to implement a representative monitoring requirement at other discharges at these facilities. The DEC will, as part of the implementation plan determine which facilities and outfalls would be appropriate to have a short term monitoring requirement to assess their potential for contributing a PCB load to Lake Ontario.

There are 12 POTW's and one private waste water treatment plant that discharge directly into Lake Ontario. Six of these plants have a flow of greater than 1 MGD, with a combined flow of 175.1 MGD. This constitutes 98.55% of the total flow from POTW's discharging directly to Lake Ontario. These six facilities, plus the discharge from Novelis Corporation were considered for a WLA based upon the percentage of total flow that these facilities represent. A list of all direct dischargers to Lake Ontario and their flows is presented in Appendix B.

None of the direct New York point sources have effluent limits for PCBs and no recent effluent PCB data are available (Lorraine Gregory, NYSDEC, personal communication May 19, 2009). A flow-weighted mean PCB concentration of 12.5 ng/l for these facilities was therefore estimated from a 1996 NYSDEC investigation of POTWs in New York State (Litten, 1997) updated with revised concentrations (a personal communication from Simon Litten on May 19, 2009, through Lorraine Gregory, NYSDEC).

The total annual PCB load from the seven direct New York State permitted facilities that discharge directly to Lake Ontario is estimated using a PCB concentration of 12.5 ng/l and a flow of 194.06 MGD (Table 6-3). A complete discussion of the point source load estimate is included in Appendix C.

Table 6-3. Direct Point Source PCB Load Estimate (2005) for Facilities

Direct point sources (No.)	Total flow (MGD)	Effluent PCB concentration (ng/l)[1]	Direct point source PCB load (kg/yr)
7	194.06	12.5	3.35

[1] Facility-specific data were not available, and all dischargers were assumed to discharge the same effluent PCB concentration.

Permitted MS4 sources are also required to be treated as point sources for purposes of TMDL development. Direct MS4 loads of PCBs to Lake Ontario were calculated as follows:

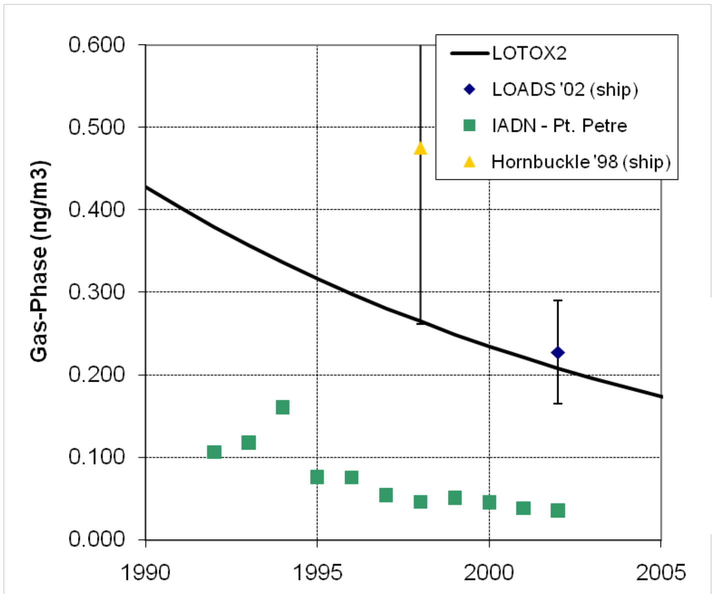
1. Define the surface area of MS4 permitted lands directly discharging to Lake Ontario
2. Multiply the above area by the areal atmospheric deposition rate of PCBs used in LOTOX2.
3. Assume that all PCBs deposited from the atmosphere are delivered to the lake.

GIS files provided by NYDEC indicate a total of 305 square miles (299 from the greater Rochester metropolitan area, 6 from the greater Buffalo metropolitan area) of MS4 sources contributing directly to Lake Ontario. This results in an estimated annual load of 0.7 kg/year. Direct MS4 contributions are much less than 1% of the total load and considered an insignificant contributor. Additionally, since the MS4 load is attributed to atmospheric deposition, reductions in the MS4 load will be expected to be achieved through reductions in atmospheric deposition of PCBs.

Due to the lack of PCB monitoring data for direct point sources in the watershed, the point source load estimates are highly uncertain and contribute to a high uncertainty in the TMDL WLA. As such, adaptive implementation will be critical to the success of achieving meaningful reductions from point sources per this TMDL.

6.5.3 Vapor-Phase PCB Concentration

The vapor-phase PCB concentration over Lake Ontario is used by LOTOX2 to compute the mass transfer of PCBs across the air-water interface. Available monitoring data from the Integrated Atmospheric Deposition Network (IADN) (1992 to 2002) at their Point Petre, Ontario site and from the Lake Ontario Atmospheric Deposition Study (LOADS) (2002 to 2004) at their Sterling, NY site were used to estimate a time trend of the vapor-phase PCB concentration (Blanchard, Audette, Hulting, Basu, Brice, Backus, Dryfhout-Clark, Froude, Hites, Neilson and Wu, 2008; Pagano, 2007). A time series plot of the annual concentration used by LOTOX2 is shown below (Figure 6-6). The 2005 concentration used during model calibration is 0.174 ng/m^3. Although these concentrations were used to calibrate the model, they will not be used during TMDL development. During the loading capacity calculations, the vapor-phase PCB concentration will be set such that equilibrium exists between the vapor-phase and water phase concentration.



Source: Pagano, 2007

Figure 6-6. Annual average vapor-phase PCB concentration from various data sources and the annual input into LOTOX2

6.5.4 Atmospheric Deposition

The deposition/settling of PCBs directly onto the lake surface is broken down by the method of deposition depending upon whether it is from precipitation (wet) or from particulate matter (dry).

Wet Deposition

The most recent estimate of wet deposition PCB rates is available from IADN for 2005 (Blanchard *et al.*, 2008). A second dataset was available from the LOADS project for a site at Sterling, NY. A comparison of PCB concentrations in precipitation across the Great Lakes (Figure 6-7) shows very similar results for the lower Great Lakes (Ontario, Michigan, and Erie). Wet deposition of PCBs across Lake Ontario is therefore not expected to vary significantly and the IADN measurements at Point Petre, Ontario are assumed to be representative of the annual lake-wide wet deposition flux. Furthermore, the recent data mentioned above suggest that the wet deposition flux was not declining as fast as previously thought. As a result, LOTOX2 was updated to reflect the 2005 flux of 5.0 ng/m^2/d or 34.5 kg/yr projected over the surface of Lake Ontario.

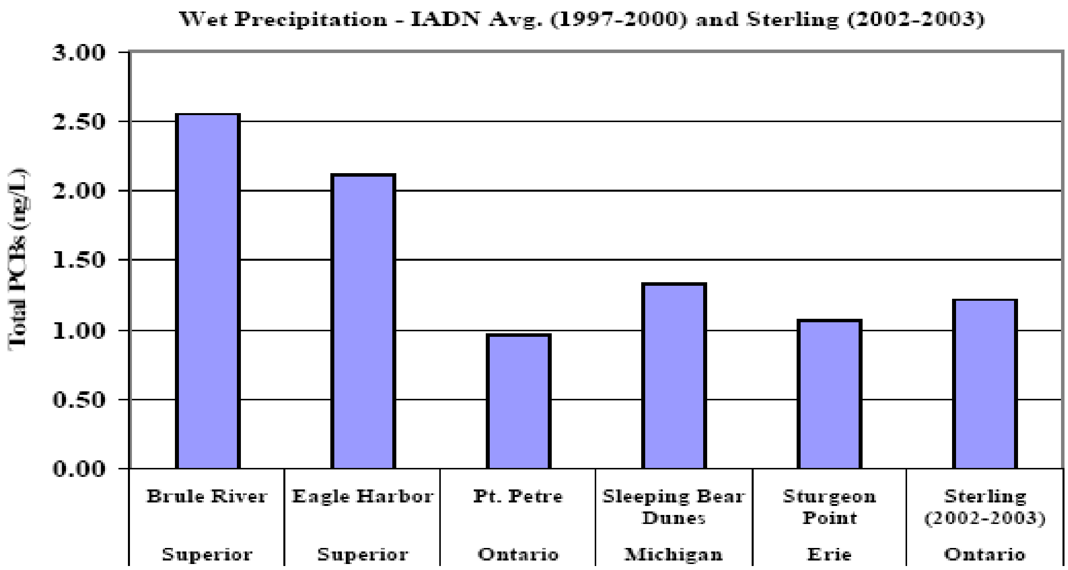


Figure 6-7. Total PCB concentration data from precipitation samples at LOADS (Sterling, NY) and IADN locations

Dry Deposition

Previously, the dry deposition flux was estimated based on work by Hoff, Strachman, Sweet, Chan, Shackleton, Bigleman, Brice, Burniston, Cussion, Gatz, Harlin and Schroeder (1996) and from LOADS data from 2002 to 2003 (Pagano, 2007). These data sources suggested that dry deposition could be a significant source of PCBs and as a result the dry deposition flux was set to three times the wet deposition flux (Atkinson *et al.*, 2008). Measurements of the dry deposition flux were taken at the Sterling, NY site from August 2005 to October 2006 as a continuation of the LOADS study (Holsen, Hopke, Han, Yi, Milligan and Pagano, 2009). The annual average flux was estimated at 34 ng/m^2/d. The recent measurements are an order of magnitude lower than the 2002/2003 estimate of 400 ng/m^2/d. The wide discrepancy between IADN estimates of the dry deposition (near zero) and results from the LOADS study suggest that not enough data exist to sufficiently quantify the dry deposition flux over Lake Ontario. The LOADS results are likely to be biased high because they were collected over land, which can provide a continual particulate matter source. As a result the dry deposition flux in LOTOX2 was updated to a 2005 value of 1.81 ng/m^2/d or 12.5 kg/yr projected over the entire Lake Ontario surface area.

Although the individual magnitude of the wet and dry deposition flux was updated using several assumptions along with recent data, the sum of the two fluxes remains the same between the Atkinson (2008) report and this report. The uncertainty surrounding both fluxes is high and sufficient data do not exist to accurately quantify the flux of PCBs over the lake on an annual basis.

6.5.5 Loading Summary

The above sections describe the PCB forcing functions that drive the LOTOX2 model. The forcing functions are based on the most up to date monitoring data as well as professional judgment to provide a reasonable estimate in instances where data were limited. A summary of the PCB sources to Lake Ontario in 2005 is presented in Table 6-4 and Figure 6-8. The NY direct point sources will be included in the WLA, while all other sources will be included in the LA for the TMDL. An additional flux of PCBs to Lake Ontario is from the sediment; however this flux was ignored because it is assumed to be at equilibrium under future TMDL condition (Section 3 and Section 6.7).

Table 6-4. 2005 PCB loads to Lake Ontario, by Source

Source	2005 Load (kg/yr)	Percent
Nonpoint sources		
Niagara River	147.22	63.1%
New York tributaries[1]	13.00	5.6%
Canadian tributaries [1]	22.00	9.4%
Atmospheric Deposition (wet & dry)	47.00	20.1%
Point sources		
NY Direct Point Sources[2]	4.05	1.7%
Total Load	233.27	100%[3]

[1] 2005 tributary loads are detailed in Table 6-2.

[2] 2005 NY direct point source loads are comprised of facility loads and direct MS4 loads (Section 6.5.2 and Appendix B).

[3] Numbers may not add to 100% due to rounding

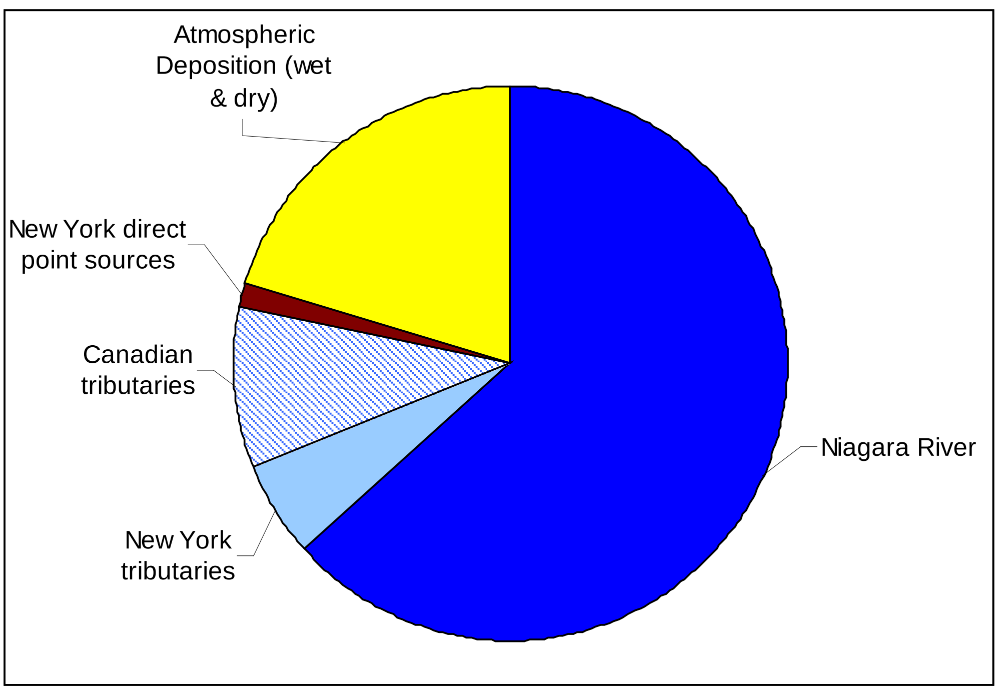


Figure 6-8. 2005 PCB Loads to Lake Ontario by Source

6.6 MODEL CALIBRATION

The LOTOX2 model was originally calibrated for the 1930 to 1995 period, and was confirmed by running the calibrated model through 2001 (LimnoTech, 2004). The calibration and validation was peer-reviewed by an advisory panel and the calibration accepted by USEPA (LimnoTech, 2004). For the confirmation period, only the PCB loading time series and atmospheric boundary gas phase concentrations were extended from 1996 to 2001, using the same trend rate that had been determined for each load component. The boundary conditions and loading time series were reevaluated using monitoring data made available after the completion of the last model update in 2004. It was determined that the improved loading estimates achieved a reasonable fit to available water column and lake trout PCB concentrations, and that the model did not need to be recalibrated. Comparisons to water column data from 1970 to 2005 are shown in Figure 6-9 and comparisons to lake trout concentration data over the same time period are shown in Figure 6-10. Although lake trout PCB concentrations are not a target of this TMDL, the long term availability of these data from several agencies over several decades provide additional confirmation of the model results.

There have been recent changes in the Lake Ontario food web structure and function. During the calibration process some accounting for recent changes in the Lake Ontario ecosystem was included by linearly decreasing the water column concentration of suspended solids (TSS) through the 1980s. This accounted for decreased primary production due to phosphorus load reductions during that period. It is recognized that there are new changes over the past decade as a result of invasive species (specifically Dreissenids and *Bethotrephes*) that could further alter the fate and bioaccumulation of PCBs. However, the LOTOX2 confirmation comparison with PCB fish tissue from 1995 to 2005 suggests that the existing calibration is still quite good. Nevertheless, TSS concentrations are an important input parameter in the model as they influence the fate and transport processes (especially PCB removal processes) in Lake Ontario. As discussed in Section 7.2.3, the spatial and temporal variability in input TSS values was considered when developing the MOS. The MOS determination includes a 10 percent decrease in the input TSS values and overall a 21 percent decrease in the loading capacity.

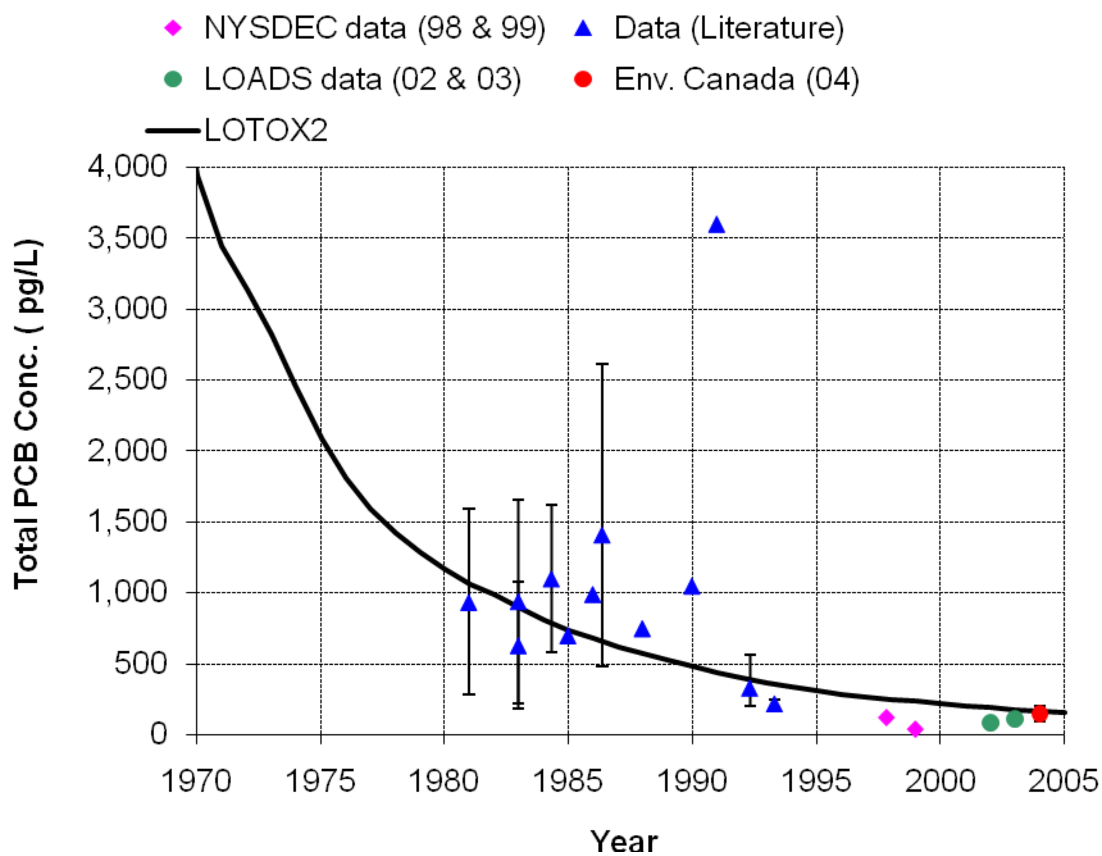


Figure 6-9. Comparison of average annual PCB monitoring data to the lake-wide average annual LOTOX2 simulated results

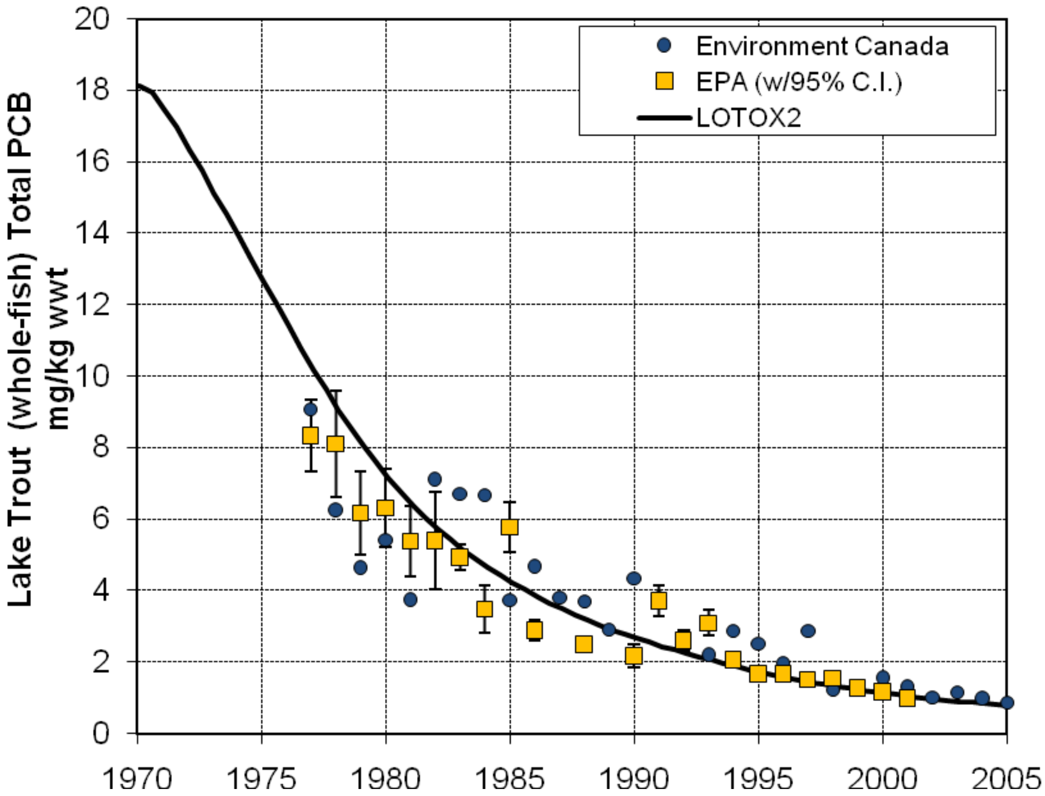


Figure 6-10. Comparison of whole-fish wet weight (wwt) lake trout PCB concentrations and the lake-wide annual average PCB concentration simulated by LOTOX2

6.7 MODEL APPLICATION FOR TMDL DEVELOPMENT

Prior to the application of the model for TMDL development, the updated model was run to verify that it could reproduce results from previous applications of the model. This was done in accordance with Section 1.5 of the Quality Assurance and Project Plan (LimnoTech, 2009b).

The calibrated LOTOX2 model was used to develop a relationship between the annual pollutant load and the TMDL target (lake-wide average annual total PCB water column concentration of 1 pg/l). As outlined in the TMDL approach memo submitted to NYSDEC and USEPA (LimnoTech, 2009a), several assumptions were made to address the complexities of modeling the load response relationship when a system is not currently at steady-state. Those assumptions are reiterated below:

- The 2005 loading rate is held constant throughout the simulation;
- The vapor phase PCB concentration is in equilibrium with the lake-wide averaged dissolved PCB concentration;
- The flux of PCBs to or from the sediment bed is at equilibrium; and

- Steady-state is reached when the change in the lake-wide annual average PCB water column concentration is less than 0.5% between years.

As described in Section 7.2.3, conservative estimates of several model coefficients were used to implicitly incorporate the MOS directly into the loading capacity calculation.

An example illustrating the slow response of Lake Ontario water column PCB concentrations to the assumptions above and a PCB load reduction from the 2005 load to 100 kg/yr is shown in Figure 6-11. The slow response reflects the release of legacy PCBs from the sediment over the length of the simulation. This TMDL is calculated at steady state to avoid the impact of the sediments on the load response curve.

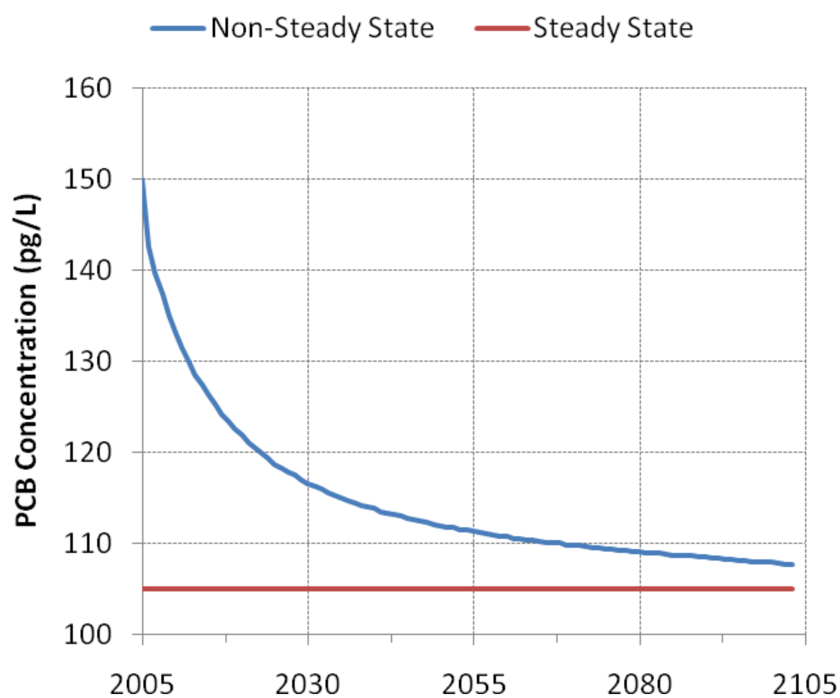


Figure 6-11. LOTOX2 simulation illustrating the slow response of Lake Ontario water column PCBs to a reduced PCB load (example)

To generate additional points for the load response curve LOTOX2 was run to steady state for additional loading scenarios. The results of all of the steady-state runs are summarized in Table 6-5 below and shown graphically in Figure 6-12. At steady-state there is a linear relationship between the PCB load and the water column concentration (equation below).

$$PCBwater\ (pg/l) = 1.34 * PCBload\ (kg/yr)$$

In order to achieve a lake-wide annual average total PCB concentration of 1 pg/l, the annual PCB load to Lake Ontario can not exceed 0.75 kg/yr (2.05 g/d). This represents a reduction of 99.7% from 2005 loads.

Table 6-5. Summary of steady-state LOTOX2 runs used to develop the load response curve

Scenario	Total PCB Load (kg/yr)	Lakewide Annual Average Water Column PCB Concentration (pg/l)
Conservative TMDL	0.75	1.00
Constant (10 kg/yr)	10.00	13.40
Constant (50 kg/yr)	50.00	67.00
Constant (100 kg/yr)	100.00	134.00
2005 Baseline Load	233.27	312.58

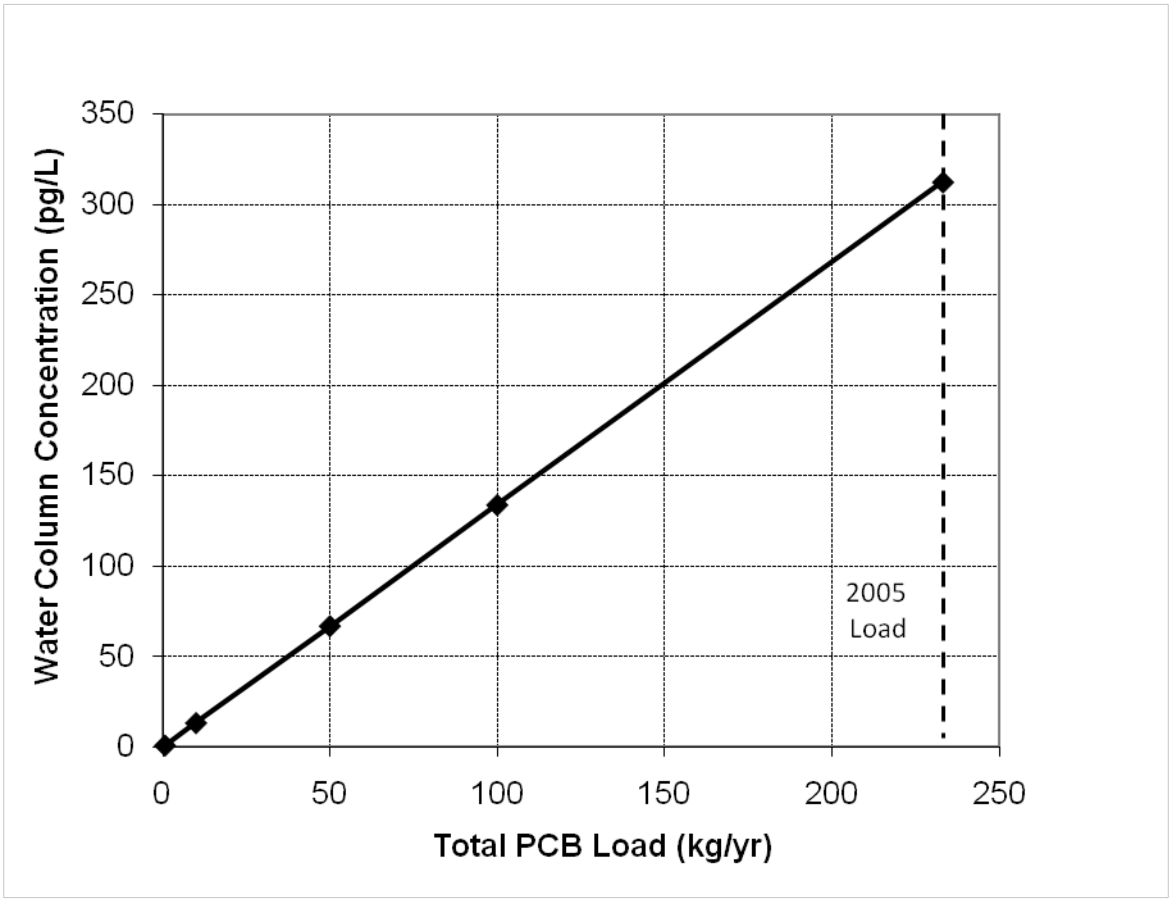


Figure 6-12. Linear relationship between PCB load and water column concentration

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7. TMDL DEVELOPMENT

This section presents the development of the TMDL for PCBs in Lake Ontario. It begins with a description of how the loading capacity was calculated, and then describes how the loading capacity is allocated among point sources, non-point sources, and the margin of safety. A discussion of seasonality considerations and reasonable assurances is also provided.

7.1 CALCULATION OF LOADING CAPACITY

The loading capacity is defined as the maximum pollutant load that a waterbody can receive and still attain compliance with water quality standards. As discussed previously, the loading capacity is calculated using LOTOX2 assuming steady-state conditions (which is predicted to occur in approximately 100 years if the 2005 load is held constant) in Lake Ontario and using a lake-wide, annual average water column total PCB concentration of 1 pg/l as the target.

The load response equation developed in Section 6.7 using conservative coefficients was applied to the target water column concentration to calculate a loading capacity of 0.75 kg/yr. Table 7-1 shows the concentrations and masses of PCBs at a total PCB load of 0.75 kg/yr.

Table 7-1. PCB load required to meet the TMDL target and other concentrations and masses

PCB Load (kg/yr)	Water Column (pg/l)	Lake Trout (ppb)	Sediment Mass (kg)	Water Column Mass (kg)	Vapor-Phase (pg/m^3)
0.75	1.00	3.91	33	1.70	2.91

In order to achieve a lake-wide annual average total PCB concentration of 1 pg/l, the sediment and vapor phase loads must come into equilibrium and the annual PCB load to Lake Ontario can not exceed 0.75 kg/yr (2.054 g/d). This represents a reduction of 99.7% from 2005 PCB loads of 233.27 kg/yr.

7.2 ALLOCATION

A TMDL allocates the loading capacity between WLAs for point sources, LAs for nonpoint sources, and a MOS. This definition is typically illustrated by the following equation:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

The WLA includes direct New York point sources (i.e., the facilities and MS4s described in Section 6.5.2). The LA includes the Niagara River, other New York tributaries, Canadian tributaries, and atmospheric deposition. The WLA is calculated using a 1 pg/l effluent concentration, and the MS4 load receiving a 99.7% reduction from current loads, consistent with the required reduction to meet the load capacity. The remainder of the loading capacity is allocated to the nonpoint sources, based upon their fraction of the baseline (2005) load. The TMDL allocations are shown in Table 7-2. Table 7-3 shows the individual WLAs.

Table 7-2. TMDL load to Lake Ontario, by Source

Source	TMDL Load (kg/yr) [1]
Load Allocations	
Niagara River	0.480
New York tributaries[1]	0.042
Canadian tributaries [1]	0.072
Atmospheric Deposition (wet & dry)	0.153
Wasteload Allocations	
NY Direct Point Sources	0.003
Total Load	0.750 [2]

[1] Annual loads can be expressed as a daily load by using a conversion factor of 2.73 (kg/yr multiplied by 2.73 yields g/day).
[2] Loading capacity

7.2.1 Wasteload Allocations

The WLA represents the point sources of PCBs within the New York State portion of the Lake Ontario watershed that discharge directly to Lake Ontario (see Section 6.5.2). With an effluent concentration of 1 pg/l, direct point sources will be allocated 0.003 kg/yr (0.007 g/d). Individual WLAs are presented in Table 7-3. It is critical to note that this WLA is defined as the Final Numeric Effluent Limit and its effective compliance date will be established in a facilities permit in the future. The analytical method used to determine compliance with the Final Numeric Effluent Limit will be specified at the time the limit becomes enforceable.

EPA Method 1668C determines chlorinated biphenyl congeners in environmental samples by isotope dilution and internal standard high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). The method was developed for use in wastewater, surface water, soil, sediment, biosolids and tissue matrices (USEPA, 2008a). This method can detect some congeners at an estimated method detection limit (EMDL) of 40 pg/l or less and can detect all congeners at an EMDL of 449 pg/l.

Table 7-3. Individual Waste Load Allocations (WLAs)

NPDES #	Facility	WLA (g/yr)
NY0028339	Frank E. Van Lare STP	0.187
NY0028231	Northwest Quad PW Dist 1	0.030
NY0002143	Novelis Corp	0.026
NY0021610	Walter W Bradley WPCF	0.010
NY0029114	Oswego (C) East Side STP	0.007
NY0029106	Oswego (C) West Side STP	0.006
NY0027774	Newfane (T) WWTP	0.002
MS4 direct to Lake Ontario*	Buffalo area and Rochester area	2.3
	Total	2.57

*the load from MS4 areas draining directly to Lake Ontario is attributed to atmospheric deposition therefore, the WLA is expected to be achieved as a result of reduction in atmospheric deposition of PCB to the MS4 areas.

7.2.2 Load Allocation

The LA represents all other sources of PCBs to Lake Ontario that are either within the New York portion of the Lake Ontario watershed or outside of the New York portion of the Lake Ontario watershed. With a load capacity of 0.75 kg/yr, and a WLA of 0.003 kg/yr, the load allocation is calculated as 0.747 kg/yr (2.047 g/d).

7.2.3 Margin of Safety

The method used for developing the MOS is based on what has been termed the Improved Implicit Approach (Dilks and Freedman, 2004). The implicit approach as traditionally applied introduces a MOS through the use of conservative assumptions used in calculating the allowable load. When uncertainty exists for certain TMDL model inputs, the TMDL developer chooses appropriately conservative (i.e., resulting in lower loading capacity) values for these inputs. Thus, the resulting TMDL directly includes the MOS. The method is called implicit because the magnitude of the MOS is not explicitly defined. This method is relatively easy to apply, in that it requires no complex calculations or uncertainty analysis.

One problem with the implicit method is that the magnitude of the resulting MOS is unknown. The improved implicit approach directly addresses this problem through the use of three component steps:

1. Select conservative inputs
2. Calculate the TMDL
3. Estimate MOS

In the first step, conservative values are selected for the TMDL model inputs that are deemed uncertain. Using the above conservative inputs, the TMDL is calculated identical to the way in which the implicit MOS method is currently applied. The water quality model is applied using the conservative input values, and the maximum allowable pollutant loads that maintain compliance with water quality standards are defined. However, the improved process includes an additional step to provide an explicit estimate of the MOS.

In the final step, the conservative input values that were used to determine the TMDL are replaced with best-estimate values for each parameter. The TMDL analysis/modeling is then re-applied using the best-estimate input values, and the best estimate of the loading capacity is defined. The MOS can then be defined as the difference in allowable load between that calculated using the conservative inputs (i.e., the TMDL) and the load capacity using best estimates for the uncertain inputs. The resulting equation is:

MOS = Best estimate of loading capacity – Conservative TMDL

For the LOTOX2 model simulations, three model inputs were chosen to be included in the MOS calculation: total suspended solids concentration (TSS), octanol-water partition coefficient (Koc) for PCBs, and Henry's constant (kH) which regulates the relative concentrations of dissolved PCBs to the vapor phase PCB concentration. All three parameters were previously identified as being critical calibration parameters in the development of LOTOX (LimnoTech, 2004). All three variables were decreased by 10% (Table 7-4) to calculate a new loading capacity for the MOS.

Table 7-4. Description of parameters used to calculate the margin of safety

Parameter Description	Parameter	Best Estimate	Conservative Estimate	Difference
Henry's Constant	KH	4.09E-03	3.68E-03	4.09E-04
Octanol-Water Partition Coeff.	Koc	15.8	1.154	14.69
Winter TSS nearshore	TSS (mg/l)	3.8	3.42	0.38
Summer TSS	TSS (mg/l)	2.2	1.98	0.22
Winter TSS offshore	TSS (mg/l)	0.8	0.72	0.08
Loading Capacity @ 1pg/l	PCB (kg/yr)	0.95	0.75	0.20

In the final step of the MOS calculations, the conservative input values that were used to determine the TMDL are replaced with best-estimate values for each parameter. The TMDL analysis/modeling is then re-applied using the best-estimate input values, and the best estimate of the loading capacity is defined. A 10% reduction in the conservative parameters resulted in a new loading capacity of 0.75 kg-PCBs/yr. The MOS can then be defined as the difference in allowable load between that calculated using the conservative inputs (i.e., the TMDL) and the load capacity using best estimates for the uncertain inputs. This results in an MOS of 0.20 kg/yr. It should be recognized that this additional step associated with the improved implicit approach in no way affects the TMDL. It is strictly designed to provide a quantitative estimate of the magnitude of the MOS. It should also be noted that the final TMDL value does not include an explicit MOS, but rather the loading capacity has been implicitly reduced by the conservative assumptions and that the above process just quantifies the equivalent effect of this MOS.

Total suspended solids were chosen as a key model parameter for several reasons. First, concentrations of TSS vary on spatial (nearshore and offshore) and temporal (seasonal and annual) scales. Second, impacts on the Lake Ontario ecosystem from invasive species (Dreissenids) and other stressors have been shown to impact solids concentrations in Lake Ontario (Bailey, Grapentine, Stewart, Schaner, Chase, Mitchell, and Coulas, 1999). While the LOTOX2 model calibration has been confirmed with numerous fish tissue data and some water column data, any long term changes in key model inputs or assumptions could alter the model predictions. To account for any uncertainties in the model inputs the MOS determination includes a 10% decrease in the input TSS values and overall a 21% decrease in the loading capacity.

7.3 SEASONAL VARIATION AND CRITICAL CONDITIONS

The LOTOX2 model used to develop this TMDL is a time-variable model that provides continuous predictions of water quality over the course of many years, and is capable of considering any seasonal variation that may occur. Due to the extremely slow response time of Lake Ontario PCB concentrations to changes in loads, essentially no seasonal variation occurs in water column PCB concentrations, and the resulting TMDL is based upon annual average conditions.

As discussed previously in the TMDL target section (Section 5.3), changes in lake volume as a result of year-to-year variability in net basin water supply or water level regulation will not cause a change in the annual, lake-wide total PCB concentration of more than 5 percent. Therefore, the environmental conditions assumed for this TMDL appropriately reflect critical conditions.

7.4 REASONABLE ASSURANCE

This TMDL is based upon the assumption that nonpoint source loads of PCBs to Lake Ontario will be reduced in the future. TMDLs that allow for reduction in sources for which an NPDES permit is not required should provide a reasonable assurance that the controls will be implemented and maintained.

A number of programs are already in place designed to reduce PCB loads to Lake Ontario. These consist of:

- Lake Erie (and other Great Lake) LaMPs
- Niagara River Toxics Management Plan
- NYSDEC and USEPA contaminant trackdown efforts
- Great Lakes Areas of Concern RAPs/ Great Lakes Legacy Act
- New York's Water Comprehensive Assessment Strategy
- Canadian contaminant trackdown activities
- Environment Canada's PCB regulations

7.4.1 Lake Erie (and other Great Lakes) LaMPs

Most of the non-atmospheric PCB load to Lake Ontario enters via the Niagara River from Lake Erie. For that reason, PCB controls in the Lake Erie basin are a necessary component to achieving the Lake Ontario PCB TMDL. Similar to Lake Ontario, Lake

Erie also receives a significant portion of its PCB loading from upstream Great Lakes. For this reason, PCB controls throughout the Great Lakes watershed are important to the implementation of the Lake Ontario PCB TMDL.

PCB control efforts throughout the Great Lakes are being developed through LaMPs. The LaMPs are intended to identify critical pollutants that impair beneficial uses and to develop strategies, recommendations and policy options to restore these beneficial uses (USEPA, 2000).

7.4.2 Niagara River Toxics Management Plan

PCB loading to the Niagara River from sources downstream of Lake Erie has also been shown to be important contributors to Lake Ontario. The Niagara River Toxics Management Plan (NRTMP) represents two decades of ongoing work by four environmental agencies in the United States and Canada. As of 2008, the agencies are now evaluating past achievements and future opportunities that exist to coordinate with other related program initiatives occurring within the basin. Further evaluation has been recommended regarding the opportunities that exist to continue to reduce toxic contaminant levels from U.S. sources within the Niagara River basin. USEPA and NYSDEC are now considering additional studies, as well as evaluating the role of the NRTMP in the binational collaboration, towards addressing Beneficial Use Impairments (BUIs) and Area of Concern (AoC) delisting through the RAP process. USEPA has placed high priority on this effort by setting a target date to restore all BUIs in the Niagara River by 2014 as part of its overall strategic plan for the Great Lakes AoCs (USEPA, 2009).

7.4.3 NYSDEC and USEPA Contaminant Trackdown Efforts

The primary implementation measure initially planned for non-regulated New York sources consists of contaminant trackdown efforts to determine the location and magnitude of these PCB sources. Existing contaminant trackdown efforts are described in the 2006 Lake Ontario LaMP Status report (USEPA Region 2 *et al.*, 2006) and are summarized in the paragraphs below.

Information on critical pollutant sources and related problems has been synthesized and used to plan environmental monitoring/sampling which in turn is used to identify and confirm suspected pollutant sources for following up investigation and possible remedial action.

NYSDEC and USEPA conducted a wide variety of environmental investigations across the Lake Ontario basin, evaluating critical pollutant concentrations in water, sediment, fish, and biological samples. Much of this sampling has been guided by reviews of existing information and recommendations provided by core environmental program monitoring and/or other special purpose environmental monitoring activities.

For example, inactive hazardous waste sites in the basin were ranked based on their potential risk to nearby surface waters. Surface waters adjacent to sites with the highest potential were sampled to identify any sites requiring additional attention. Similar approaches have been used to evaluate potential areas of sediment contamination, contaminants in surface water discharges, fish tissue contamination, and the effectiveness of remedial actions

The work to date has developed a good understanding of the location and extent of critical pollutant sources and problems in the U.S. portion of the basin (USEPA Region 2 *et al.*, 2006).

7.4.4 Great Lakes Areas of Concern RAPs/ Great Lakes Legacy Act

Great Lakes AoCs are severely degraded areas within the Great Lakes Basin defined by the U.S.-Canada Great Lakes Water Quality Agreement as "geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area's ability to support aquatic life." In an effort to clean up these AoCs, the United States and Canada committed to cooperate with State and Provincial Governments to ensure that RAPs are developed and implemented for all designated AoCs in the Great Lakes Basin. Forty-three AoCs have been identified, many of them related to PCB contamination. RAPs have been developed, and 24 sediment remediation projects have been implemented in 14 different AoCs.

The Great Lakes Legacy Act (GLLA) was signed into law in 2002, and authorized by Congress in 2008, to provide additional funding to tackle contamination at the 31 AoCs that are wholly or partially located within the United States. Since first authorized, five GLLA remedial projects have been completed, three of which were sites contaminated by PCBs. Three additional remediation projects are underway for sites with PCB contamination. Additional projects are underway to monitor and evaluate six AoC sites, including two tributaries to Lake Ontario (Buffalo River and Eighteenmile Creek). GLLA projects that address PCB-contaminated sediments are expected to reduce PCB loads to Lake Ontario.

7.4.5 New York’s Water Comprehensive Assessment Strategy

NYSDEC’s Comprehensive Assessment Strategy provides another means to identify and remediate potential sources of PCBs to Lake Ontario. The Strategy is described in the Lake Ontario LaMP Status Report as follows:

> “New York State Department of Environmental Conservation’s Comprehensive Assessment Strategy applies a watershed approach as the basic organizing unit in developing water pollution control strategies. Statewide, a Waterbody Inventory is maintained for the numerous individual stream segments and lakes. A Priority Waterbodies List is further developed where designated beneficial uses of these waterbodies are categorized as threatened, stressed, impaired, or precluded. Annual monitoring, assessment, and strategy implementation activities are based on a five-year cycle of the “Rotating Intensive Basin Survey (RIBS)” program which tracks and facilitates watershed actions in each of New York’s 17 major watersheds. Each year 2 to 3 watershed cycles are re-started in the RIBS process while 2 to 3 watershed cycles are completed.
>
> Lake Ontario watersheds include the following: 1) Niagara River-Lake Erie; 2) Genesee River; 3) Oswego-Seneca-Oneida Rivers; 4) Black River; 5) St. Lawrence River, and 6) Lake Ontario Minor Tributaries-Nearshore. In any given

> year, one or more Great Lakes watersheds are addressed in each of the phases of the RIBS process. In conducting a watershed approach, local governments and stakeholders are involved in the monitoring, assessment, and implementation phases of the process. The goal is restoration and protection of a designated waterbody and the watershed. Grant funding, technical assistance, other federal, state or local agencies, and related watershed resources form a partnership to address the priority water and natural resource needs in a targeted watershed.
>
> Under the RIBS program, watershed assessments are used to update the Water Inventory and Priority Waterbodies List which summarize the water quality information and identify priority problems in rivers and lakes across the state. These assessments also provide a starting point for the development and implementation of watershed restoration and protection action strategies. These strategies involve coordinating agencies and stakeholders to focus grant monies, technical assistance, regulatory efforts and other resources to address water quality priorities and natural resource needs of a watershed. Information developed involving the LaMP, such as lake and tributary monitoring, directly supports the development of comprehensive assessment and action strategies for Lake Ontario watersheds" (USEPA, 2008b).

7.4.6 Canadian Contaminant Trackdown Activities

The Province of Ontario also conducts contaminant trackdown efforts to determine the location and magnitude of PCB sources. Existing contaminant trackdown efforts were described in the Lake Ontario LaMP Status Report and are summarized below.

> "Concentrations of total PCB in some Lake Ontario tributaries were found to exceed the Provincial Water Quality Objective of 1.0 ng/l in an OME 1997-98 study, which confirmed results from other investigations. In response, a commitment was made by OME to confirm these findings using an integrated high-frequency sampling approach to characterize typical concentrations of PCBs along with other priority pollutants including polynuclear aromatic hydrocarbons (PAHs), and organochlorine compounds (including DDT and mirex). This approach involved the collection of four-week composite samples made up of subsamples collected every six hours throughout the entire year, rather than relying on 10 to 15 grab samples to characterize annual conditions. In this way, a more complete range of seasonal hydrological conditions within the watershed would be taken into account. This approach was first applied to several Lake Ontario tributaries from July 2000 through June 2001.
>
> As PCBs represent the primary contaminant responsible for many fish consumption advisories, they were chosen as the main target critical pollutant for a pilot study: "Project Trackdown." For selected tributaries, this study was to address: (a) quantifying upstream-downstream differences in total concentrations (and congener patterns where possible) of PCB in water, sediment, and juvenile fish tissue; (b) quantifying differences in biomonitored (caged mussel) tissue PCB concentrations and congener patterns at selected points throughout the watershed; and (c) quantifying differences in PCB concentrations and congeners in semi-permeable membrane devices (SPMDs), which are passive samplers used to

determine the relative “bioavailability” of PCBs at various sites. These devices act as an artificial substitute for fish tissue.

The objective of this pilot project was to develop and evaluate approaches for identifying ongoing PCB sources and to provide guidance for conducting future source trackdown projects. Three pilot watersheds (Twelve Mile Creek, Etobicoke Creek and Cataraqui River) were selected from Lake Ontario tributaries where elevated PCB levels were known to exist and good screening level data for biota, water, and sediment were available from both provincial and federal studies” (USEPA, 2008b).

7.4.7 Environment Canada’s PCB Regulations

In September 2008, Environment Canada published PCB Regulations in the Canada Gazette which were annexed to the Canadian Environmental Protection Act (Environment Canada, 2008). The new regulation imposes deadlines of December 31, 2009 for the allowable use of equipment containing PCBs above 500 mg/kg, and December 31, 2025 for equipment containing PCBs above 50 mg/kg. The regulations also impose deadlines for the elimination of PCBs and PCB-containing material that is in storage, and requires a phase out of all other PCB-related equipment.

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Appendix A. Waterbody Descriptions

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Segment descriptions obtained from NYSDEC (2007)

Fish consumption advisories/impairments for all waters listed below extend into and include tributary (and downstream) waters to the first impassable barrier (NYSDEC, 2008). These tributaries have no known sources of PCBs but have fish consumption restrictions as a result of exposure to PCBs from Lake Ontario. While the TMDL was not directly calculated for these tributaries, meeting the TMDL target for Lake Ontario will result in restoring the fish consumption use in the tributaries.

Lake Ontario Shoreline, Eastern (0303-0023): This segment includes the portion of the Lake Ontario shoreline from Tibbetts point at the mouth of the Saint Lawrence River to Point Peninsula at the southernmost tip of the peninsula. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Eastern (0303-0011): This segment includes the portion of the Lake Ontario shoreline from Point Peninsula at the southernmost tip of the peninsula to Bull Rock Point, encompassing the shorelines of Chaumont and Guffin Bays. Tributaries to this reach/segment, as well as Chaumont Bay and Guffin Bay proper, are listed separately.

Chaumont Bay (0303-0024): This segment includes the waters of the bay north of a line from Clines Point east to Point Salubrious.

Guffin Bay (0303-0025): This segment includes the waters of the bay north of a line from Point Peninsula east to Pillar Point, and south of a line from Clines Point east to Point Salubrious.

Lake Ontario Shoreline, Eastern (0303-0026): This segment includes the portion of the Lake Ontario shoreline from Bull Rock Point to the point of mainland just east of Horse Island near Sackets Harbor, encompassing the shoreline of Black River Bay. Tributaries to this reach/segment, including Black River Bay proper and Black River, are listed separately.

Black River Bay (0303-0102): This segment includes the waters of the bay north of a line from Bull Rock Point passing through Horse Island to the point of mainland just east of Horse Island near Sackets Harbor.

Lake Ontario Shoreline, Eastern (0303-0027): This segment includes the portion of the Lake Ontario shoreline from the point of mainland just east of Horse Island near Sackets Harbor to the eastern point of Association Island, encompassing the shoreline of Henderson Bay. Tributaries to this reach/segment, as well as Henderson Bay proper, are listed separately.

Henderson Bay (0303-0022): This segment includes the waters of the bay south of a line from the eastern point of Association Island to the western point of the mainland just east of Horse Island.

Lake Ontario Shoreline, Eastern (0303-0028): This segment includes the portion of the Lake Ontario shoreline from the eastern point of Association Island to the western point of Sawyer Point at the mouth of Stoney Creek. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Eastern (0303-0029): This segment includes the portion of the Lake Ontario shoreline from the western point of Sawyer Point at the mouth of Stony Creek to a point marked by the extension of Clark Road at Montario Point. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Eastern (0303-0030): This segment includes the portion of the Lake Ontario shoreline from a point marked by the extension of Clark Road at Montario Point to the mouth of the Salmon River in Selkirk. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Eastern (0303-0031): This segment includes the portion of the Lake Ontario shoreline from the mouth of the Salmon River in Selkirk to the mouth of the Little Salmon River in Texas. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Eastern (0303-0017[2]): This segment includes the portion of the Lake Ontario shoreline from the mouth of the Salmon River in Selkirk to a point marked by the extension of the east Oswego Harbor breakwater. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Oswego (0302-0040): This segment includes the portion of the Lake Ontario shoreline from a point marked by the extension of the east Oswego harbor breakwater to the west Oswego harbor breakwater. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Central (0302-0041): This segment includes the portion of the Lake Ontario shoreline from the west Oswego harbor breakwater to West Ninemile Point just west of Nine Mile Creek. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Central (0302-0042): This segment includes the portion of the Lake Ontario shoreline from West Nine Mile Point, just west of Nine Mile Creek to the inlet of Port Bay near Desbrough Park. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Central (0302-0043): This segment includes the portion of the Lake Ontario shoreline from the inlet of Port Bay near Desbrough Park to the inlet of Sodus Bay at Lake Bluff. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Central (0302-0044): This segment includes the portion of the Lake Ontario shoreline from the inlet of Sodus Bay at Sodus point Park Beach to the mouth of Salmon Creek in Pultneyville. Tributaries to the reach/segment are listed separately.

Lake Ontario Shoreline, Central (0302-0045): This segment includes the portion of the Lake Ontario shoreline from the mouth of Salmon Creek in Pultneyville to Nine Mile Point near the mouth of Four Mile Creek. Tributaries to this reach/segment are listed separately.

[2] Identified as 0303-0032 in Table 2-1

Rochester Embayment – East (0302-0002): This segment includes the portion of the Lake Ontario shoreline from Nine Mile Point near the mouth of Four Mile Creek to the Genesee River in Rochester. Tributaries to this reach/segment are listed separately.

Rochester Embayment – West (0301-0068): This segment includes the portion of the Lake Ontario shoreline from the Genesee River in Rochester to Manitou Beach at the mouth of West Creek and Braddock Bay. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Western (0301-0069): This segment includes the portion of the Lake Ontario shoreline from Manitou Beach at the mouth of West Creek and Braddock Bay to Sandy Harbor Beach at the mouth of Sandy Creek in North Hamlin. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Western (0301-0070): This segment includes the portion of the Lake Ontario shoreline from Sandy Harbor Beach at the mouth of Sandy Creek in North Hamlin to Point Breeze at the mouth of Oak Orchard Creek. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Western (0301-0071): This segment includes the portion of the Lake Ontario shoreline from Point Breeze at the mouth of Oak Orchard Creek to the mouth of Eighteenmile Creek in Olcott. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Western (0301-0072): This segment includes the portion of the Lake Ontario shoreline from the mouth of Eighteenmile Creek in Olcott to Roosevelt Beach at the mouth of Twelve Mile Creek near Wilson. Tributaries to this reach/segment are listed separately.

Lake Ontario Shoreline, Western (0301-0053): This segment includes the portion of the Lake Ontario shoreline from Roosevelt Beach at the mouth of Twelve Mile Creek near Wilson to the mouth of the Niagara River. Tributaries to this reach/segment are listed separately.

Tribs from Lake Ontario Islands (0303-0033): There are a number of tributaries to Lake Ontario on Grenadier Island, Galloo Island and Stony Island.

Mud/Kents Creek (0303-0034): WIN Ont 1, enters Mud Bay of Lake Ontario at a point 0.1 mile west of Pleasant Valley Road and 1.4 miles northeast of Baird Point.

Minor Tribs to Lake Ontario (0303-0035): WIN Ont 1 thru 7. This section includes a number or unnamed tribs as well as Fox Creek, Chaumont Bay, Three Mile Bay, Shaver Creek.

Three Mile Creek (0303-0036): WIN Ont 6, enters Three Mile Bay of Lake Ontario at N.Y. Route 12E road crossing 0.2 mile east of center of Three Mile Bay (H).

Chaumont River, Lower (0303-0010): WIN Ont 8, enters Chaumont Bay of Lake Ontario in Village of Chaumont 0.1 mile northeast of N.Y. Route 12E and 0.1 mile northwest of N.Y. Route 179. Mouth to a point 7 miles upstream from mouth and 0.7 mile east of N.Y. Route 12 at Depauville (H).

Chaumont River, Upper (0303-0037): WIN Ont 8, from 7.0 miles upstream from mouth to source.

Horse Creek (0303-0038): WIN Ont 9, enters Sawdust Bay in Village of Chaumont at its most northerly point 0.1 mile southwest of N.Y. Route 12E.

Minor Tribs to Lake Ontario (0303-0039): WIN Ont 9a thru 18a, enter in section from a point of Sawdust Bay 0.6 mile south of junction of N.Y. Route 12E and N.Y. Route 179 in Village of Chaumont to a point on Black River Bay 2.4 miles west of N.Y. Route 179 and 2.9 miles north of Old Military Road at Jewettville

Perch River (0303-0040): WIN Ont 18, enters Lake Ontario at a point on Black River Bay 1.1 miles west of west line of Village of Dexter and 2.6 miles south of N.Y. Route 12E. Mouth to trib. 1, 2.1 miles south of Clayton-Brownville town line and 3.5 miles northeast of northeast corner of Village of Dexter.

Black River (0801-0250): WIN Ont 19 (portion1) Mouth to Watertown water plant intake including section of Black River south of Delano Island.

Minor Tribs to Lake Ontario (0303-0101): WIN Ont 19a thru 24, includes tribs that enter on east shore of Black River Bay in section from a point 1.7 miles north of Old Military Road and 0.8 mile west of N.Y. Route 179 to a point 0.6 mile north of Old Military Road and 0.7 mile west of N.Y. Route 179. Muskalonge Creek which enters Lake Ontario on east shore of Muskalonge Bay 0.5 mile north of Old Military Road and 0.6 mile west of N.Y. Route 179. And tribs that enter on south shore of Muskalonge Bay and Black River Bay in section from a point 0.2 mile north of Old Military Road and 1.0 mile west of N.Y. Route 179 to a point 0.7 mile north of Old Military Road and 2.5 miles west of N.Y. Route 179.

Mill Creek (0303-0044): WIN Ont 25 enters Lake Ontario on south shore of Black River Bay at Madison Barracks 0.3 mile north of Old Military Road and 0.9 mile west of Jewettville. From mouth to trib. 5, 2.7 miles south of N.Y. Route 3 and 0.1 mile east of Stowell Corners.

Minor Tribs to Lake Ontario (0303-0045): WIN Ont 25a thru 39 enter in section from a point 1.1 miles south of Brownville-Hounsfield town line and 0.4 mile southeast of Sackets Harbor lighthouse on Horse Island to a point on shore of Sawyer Bay 1.5 miles southeast of Stony Point lighthouse.

Stony Creek, Lower (0303-0009): WIN Ont 40 enters Lake Ontario 0.4 mile north of Henderson-Ellisburg town line and 1.7 miles west of N.Y. Route 3. From mouth to dam in Henderson. Not including P 1024, 0.9 mile south of Hounsfield-Adams town line and 1.8 miles east of South Harbor Road.

Little Stony Creek (0303-0019): WIN Ont 41 enters Lake Ontario 0.7 mile south of Henderson-Ellisburg town line and 1.6 miles west of N.Y. Route 3. Mouth to trib. 2 0.8 mile south of Henderson-Ellisburg town line and 0.2 mile west of N.Y. Route 3.

Minor Tribs to Lake Ontario (0303-0048): WIN Ont 42 thru 51 including tribs that enters through swamp 2.3 miles south of Henderson-Ellisburg town line and 1.0 mile west of N.Y. Route 3. Blind Creek which enters Lake Ontario through North Pond with mouth 1.6 miles south of Jefferson-Oswego county line and 0.2 mile west of N.Y. Route

3. Mouth to trib. 1, 0.2 mile south of Hadley Road and 0.2 mile east of N.Y. Route 3. And, tribs which enters Lake Ontario through North Pond with mouth 3.3 miles south of Jefferson-Oswego county line and 1.6 miles west of N.Y. Route 3. And tribs that enter Lake Ontario through North Pond with mouth 3.3 miles south of Jefferson-Oswego county line and 1.6 miles west of N.Y. Route 3.

Sandy Creek, Lower (0303-0055): WIN Ont 44 enters Lake Ontario 2.7 miles north of Jefferson-Oswego county line and 1.5 miles west of N.Y. Route 3. Mouth to trib. 10, 0.1 mile south of N.Y. Route 178 and 0.1 mile south west of west line of Village of Adams. And from trib. 10 to trib. 14, on Adams-Rodman town line, 1.2 miles south of N.Y. Route 177.

Sandy Creek, Upper (0303-0020): WIN Ont 44 from 1.0 mile upstream from trib. 29 to 3.0 miles upstream from trib. 29, 0.7 mile north of N.Y. Route 12 and 1.0 mile east of Rutland-Champion town line.

South Sandy Creek (0303-0021): WIN Ont 45 enters Lake Ontario 2.7 miles north of Jefferson-Oswego county line and 1.5 miles west of N.Y. Route 3. From mouth to Monitor Dam in Ellisburg.

North Pond (0303-002): WIN Ont 46b-P1041 Large pond extending 3.5 miles southward from a point 0.2 mile north of Jefferson-Oswego county line and 1.7 miles eastward from its outlet channel to Lake Ontario which is 1.9 miles south of Jefferson-Oswego county line.

Skinner Creek, Lower (0303-0060): WIN Ont 47 enters Lake Ontario through north pond with mouth 0.6 mile south of Jefferson-Oswego county line and 0.3 mile west of N.Y. Route 3. Portion from mouth to trib. 5.

Skinner Creek, Middle (0303-0061): WIN Ont 47 from trib. 5 to Ellisburg-Lorraine town line.

Skinner Creek, Upper (0303-0062): WIN Ont 47 from Ellisburg-Lorraine town line to source.

Lindsey Creek (0303-0063): WIN Ont 48 enters Lake Ontario through North Pond with mouth 0.6 mile south of Jefferson-Oswego county line and 0.3 mile west of N.Y. Route 3. Mouth to source.

Little Sandy Creek, Lower (0303-0013): WIN Ont 50 Enters Lake Ontario through North Pond with mouth, 2.7 miles south of Jefferson-Oswego county line and 0.9 mile west of N.Y. Route 3. From mouth to 0.9 mile upstream from mouth.

Little Sandy Creek, Upper (0303-0064): WIN Ont 50 from 0.9 mile upstream from mouth to P 1050a

South Pond (0303-0065): WIN Ont 51-P 1 Lies on Ont. 51 with its outlet 0.2 mile upstream from mouth of Ont. 51.

Deer Creek/Little Deer Creek (0303-0066): WIN Ont 52 enters Lake Ontario 1.5 miles northwest of junction of N.Y. Routes 3 and 13 at Port Ontario and 1.4 miles west of N.Y. Route 3.

Grindstone Creek (0303-0081): WIN Ont 54 Enters Lake Ontario 1.7 miles southwest of intersection of N.Y. Routes 3 and 13 at Port Ontario and 1.3 miles west of N.Y. Route 3. From mouth to trib. 4.

North Branch Grindstone Creek (0303-0082): WIN Ont 54 from trib 4 to source

Snake Creek (0303-0086): WIN Ont 55 enters Lake Ontario 0.8 mile north of Richland-Mexico town line and 1.3 miles west of N.Y. Route 3.

Sage Creek (0303-0087): WIN Ont 57 enters Lake Ontario 1.6 miles northwest of North Church Corner and 0.3 mile southwest along shore of lake from Richland-Mexico town line.

Little Salmon River (0303-0015): WIN Ont 58 enters Lake Ontario at Mexico Point 0.9 mile northwest of Texas. From mouth to lower dam in Village of Mexico.

Butterfly Creek (0303-0098): WIN Ont 59 enters Lake Ontario 0.7 mile north of North Road and 1.3 miles west of New Haven-Mexico town line.

Catfish Creek (0303-0099): WIN Ont 60 enters Lake Ontario 0.8 mile north of North Road and 0.5 mile southeast of Pleasant Point. From mouth to first dam located at County Route 1.

Minor Tribs to Lake Ontario (0303-0001): WIN Ont 61 thru 65 including Otter Branch which enters Lake Ontario 0.9 mile north of North Road and 0.4 mile south of west from Pleasant Point. Tribs that enter on Sunset Bay 0.1mile west of mouth of Ont. 61a to a point 1.0 mile north of U.S. Route 104 and 0.7 mile northwest of junction of North Road and Middle Road

Oswego River (0701-0022): WIN Ont 66 enters Lake Ontario from southeast at southerly shore in eastern portion of lake and at City of Oswego. Mouth to dam and power station at Lock 6 located 1.8 miles upstream from mouth and in City of Oswego.

Minor Tribs to Lake Ontario (0302-0046): WIN Ont 66b thru 71 including a trib that enters 0.1 mile north of Washington Boulevard and 1.1 miles northeast of Burt Point. Tribs that enter 1.1 miles west of Fruit Valley and 0.8 mile north of Health Camp Road to a point 0.1 mile north of Health Camp Road and 0.2 mile east of Oswego-Cayuga county line. Trib. 68 is named Snake Creek.

Rice Creek (0302-0047): WIN Ont 67 Enters Lake Ontario 0.4 mile southwest of Burt Point and 0.1 mile northeast of junction of Snake Swamp Road and Cemetary Road.

Eightmile Creek (0302-0049): WIN Ont 70 enters Lake Ontario 0.3 mile west of Oswego-Cayuga county line and 0.4 mile north of California Road.

Ninemile Creek Lower (0302-0005): WIN Ont 71 enters Lake Ontario 1.0 mile west of Oswego-Cayuga county line and 0.5 mile southwest of West Ninemile Point. From mouth to trib. 7 in Village of Hannibal 0.05 mile west of east and 0.6 mile north of south village lines.

Ninemile Creek, Upper (0302-0050): WIN Ont 71 From trib. 7 to trib. 18, 0.9 mile south of Oswego-Cayuga county line and 0.6 mile east of N.Y. Route 176.

<u>Minor Tribs to Lake Ontario, Central (0302-0052):</u> WIN Ont 71a thru 79 including Black Creek which enters Lake Ontario 1.9 miles west of Cayuga-Wayne county line, 1.8 miles north of Young Love Road.

<u>Sterling Creek, Lower (0302-0018):</u> WIN Ont 73 Enters Lake Ontario 1.2 miles east of Cayuga-Wayne county line and 1.8 miles north of N.Y. Route 104A.

<u>Little Sodus Bay (0302-0017):</u> WIN Ont 74/P76 Little Sodus Bay is within corporate limits of Village of Fair Haven extending from Lake Ontario southward 2.4 miles and from west village line eastward 0.6 to 0.8 mile.

<u>Blind Sodus Bay (0302-0021):</u> WIN Ont 75/P77 extends 0.8 mile south from Lake Ontario and 0.6 mile west from Cayuga-Wayne county line.

<u>Blind Sodus Creek (0302-0059):</u> WIN Ont 74 enters Lake Ontario 0.2 mile west of Cayuga-Wayne county line

<u>Red Creek (0302-0014):</u> WIN Ont 78 enters Lake Ontario 1.7 miles east of Huron-Wolcott town line.

<u>Minor Tribs to Lake Ontario, Central (0302-0060):</u> WIN Ont 80 thru 83 including tribs that enters 0.7 mile southwest along shore of Lake Ontario from north end of Dutch Street Road 2.3 miles northeast of North Huron and a trib that enters through a swamp (Root Swamp) which is located on shore of lake beginning at a point 1.5 miles northeast of Charles Point and 0.6 mile west of Garner Road, and extending 0.5 mile northeast along lake shore.

<u>Port Bay and Outlet (0302-0012):</u> WIN Ont 80/P89 Ont. 80 enters Lake Ontario 0.4 mile west of Wolcott-Huron town line

<u>East Bay (0302-0011):</u> WIN Ont 82/P93 enters Lake Ontario just east of East Bay Park, and 1.4 miles westward along lake shore from trib. Ont. 81. Mouth to trib. 1, 1.0 mile south of shore of Lake Ontario and 1.4 miles northwest of North Huron. P 93, East Bay, includes all of this section of Ont. 82, Beaver Creek.

<u>Beaver Creek (0302-0062):</u> WIN Ont 82 From trib. 1 to source

<u>Sodus Bay (0302-0020):</u> WIN Ont 84/P96 Body of water in both towns of Huron and Sodus extending southward from Lake Ontario about 4.0 miles to a point 1.0 mile east of Shaker Road and 0.7 mile south of U.S. Route 104.

<u>Sodus Creek (0302-0007):</u> WIN Ont 84/P96-4 enters south end of Sodus Bay 1.0 mile west of N.Y. Route 89 and 0.7 mile south of U.S. Route 104.

<u>Salmon Creek (0302-0064):</u> WIN Ont 85 Enters Lake Ontario at a point 0.5 mile northwest of Junction Lake Road and North Geneva Road

<u>Minor Tribs to Lake Ontario, Central (0302-0016):</u> WIN Ont 86 thru 92 enter at Spring Bluff 0.6 mile north of Lake Road to point 0.1 mile north of Lake Road and 2.0 miles west of Sodus-Williamson town line.

<u>Salmon Creek Lower (0302-0068):</u> WIN Ont 93 Enters Lake Ontario 0.3 mile north of junction of N.Y Route 21 and Lake Road in Pultneyville (H). Mouth to N.Y. Route 21 road bridge 0.8 mile upstream.

Salmon Creek, Upper (0302-0069): WIN Ont 93 from N.Y. Route 21 road bridge to source. P 103a is located 0.1 mile south of U.S. Route 104, 0.2 mile west of Tuckahoe Road.

Minor Tribs to Lake Ontario, Central (0302-0070): WIN Ont 93 thru 99 including tribs that enter 1.0 mile west of mouth of trib. 93 and 0.2 mile north of Lake Road to a point 0.6 mile west of Williamson-Ontario town line and 0.1 mile north of Lake Road and a trib that enters 0.4 mile north of Lake Road and 0.9 mile southeast of Smoky Point.

Bear Creek (0302-0071): WIN Ont 96 enters Lake Ontario 1.2 miles west of Williamson-Ontario town line and 0.1 mile north of Lake Road.

Mill Creek (0302-0072): WIN Ont 98 enters Lake Ontario 0.4 mile north of Lake Road and 0.5 mile southeast of Rocky Point.

Fourmile Creek (0302-0006): WIN Ont 99

Mill Creek (0302-0025): WIN 100

Minor Tribs to Lake Ontario, Central (0302-0028): WIN Ont 101 thru 106 enter 0.1 mile north of N.Y. Route 18 and 1.4 miles southwest of Ninemile Point to a point near Forest Lawn 3.4 miles southwest of Ninemile Point and 0.2 mile north of N.Y. Route 18.

Shipbuilders Creek (0302-0026): WIN Ont 107

Minor Tribs to Lake Ontario (0302-0036): WIN Ont 109 thru 116. Ont. 109 enters Lake Ontario 0.3 mile northeast of sharp (about 90°) turn of N.Y. Route 18 at north end of Sea Breeze. Tribs that enter 1.8 miles east of Paul Boulevard to a point 1.0 mile east of Paul Boulevard.

Genesee River (0401-0001): WIN Ont 117 (portion 1) from natural mouth at its junction with Lake Ontario to Barge Canal Dam at Cort Street, Rochester.

Slater Creek (0301-0020): WIN Ont 120 enters Lake Ontario 0.1 mile southeast of junction of Edgemere Drive and Beach Avenue.

Round Pond Creek (0301-0022): WIN Ont 121 Enters Lake Ontario 0.4 mile southeast of junction of Edgemere Drive and Island Cottage Road.

Larken Creek (0301-0023): WIN Ont 122 enters Lake Ontario 0.2 mile northwest of junction Island Cottage Road and Edgemere Drive.

Long Pond (0301-0015): WIN Ont 123-P154 enters Lake Ontario 0.1 mile east of junction of Long Pond Road and Edgemere Drive.

Buttonwood Creek (0301-0024): WIN Ont 124 enters Braddock Bay 0.3 mile north of East Manitou Road 1.7 miles east of Manitou Road. Mouth to Frisbee Hill Road crossing 0.6 mile west of North Greece Road intersection.

Braddock Bay (0301-0010): WIN Ont124/125-P155a this is an open bay of Lake Ontario lying south of a line drawn from most northerly point of Braddock Heights northwest to terminus of extension of Manitou Beach Road at Manitou Beach.

Salmon Creek (0301-0025): WIN Ont 125 Enters Braddock Bay 0.4 mile south of Manitou Beach Road and 1.5 miles east of Payne Beach Road.

<u>Minor Tribs to Lake Ontario (0301-0030):</u> WIN Ont 126 thru 129 including tribs that enter lake from southwest, east of Payne Beach area and 0.9 mile northwest of Manitou Beach at Braddock Point. Also including tribs that enter 0.2 mile north of Lake Ontario State Parkway and 0.4 mile southeast of Bogus Point to a point 0.1 mile north of Lake Ontario State Parkway and 0.2 mile west of Martin Road.

<u>Sandy Creek (0301-0006):</u> WIN Ont 130 enters Lake Ontario at Sandy Harbor Beach 0.3 mile east of junction of Lake Ontario State Parkway and extension of N.Y. Route 19. Mouth to trib. 1, 0.1 mile south of U.S. Route 104 and 0.1 mile west of Groth Road at Murray. P 159 lies just east of Sandy Creek 0.2 mile east of N.Y. Route 19 starting just south of Lake Ontario State Parkway and extending south 0.3 mile.

<u>Yanty Creek (0301-0032):</u> WIN Ont 131 enters lake from south at Hamlin Beach State Park 0.5 mile west of Brockport water works plant

<u>Minor Tribs to Lake Ontario (0301-0033):</u> WIN Ont 132 thru 137 including tribs that enter the lake from southwest at Hamlin Beach State Park 0.8 and 0.5 mile, respectively, southwest of Bluff Beach and tribs that enter 0.1 mile east of Orleans-Monroe county line and immediately west of Troutburg to a point 0.2 mile north of Lake Shore Road and 0.2 mile east of Brighton Cliff. Trib. 134 is named Bald Eagle Creek.

<u>Bald Eagle Creek (0301-0034)</u>: WIN Ont 134 enter 0.1 mile east of Orleans-Monroe county line and immediately west of Troutburg to a point 0.2 mile north of Lake Shore Road and 0.2 mile east of Brighton Cliff.

<u>Oak Orchard Creek, Lower (0301-0004):</u> WIN Ont 138 (portion 1) Enters Lake Ontario at Point Breeze. Mouth to Barge Canal in Village of Medina 0.1 mile north of N.Y. Route 31 and 0.6 mile west of east village line.

<u>Oak Orchard Creek, Middle (0301-0005):</u> WIN Ont 138 (portion 3) From Barge Canal 0.1 mile north of N.Y. Route 31 and 0.6 mile west of east line of Village of Medina to dam at P 168 (Shelby Mills Pond) located just south of Martin Road and 0.3 mile east of N.Y. Route 63 at Shelby.

<u>Johnson Creek, Lower (0301-0007):</u> WIN Ont 139 (portion 1) Enters Lake Ontario at Lakeside 0.4 mile north of Lake Shore Road and 2.1 miles east of Carlton-Yates town line.

<u>Minor Tribs to Lake Ontario (0301-0048):</u> WIN Ont 140 thru 146 that enter 0.4 mile north of Lake Shore Road and 0.2 mile east of Carlton-Yates town line to a point 0.1 mile north of N.Y. Route 18 and 0.1 mile east of Transit Road extended. Ont 146 is Keg Creek

<u>Marsh Creek (0301-0049):</u> WIN Ont 141 that enters at 0.4 mile north of Lake Shore Road and 0.2 mile east of Carlton-Yates town line to a point 0.1 mile north of N.Y. Route 18 and 0.1 mile east of Transit Road extended.

<u>Golden Hill Creek (0301-0050):</u> WIN Ont 144 enters near 0.4 mile north of Lake Shore Road and 0.2 mile east of Carlton-Yates town line to a point 0.1 mile north of N.Y. Route 18 and 0.1 mile east of Transit Road extended.

<u>Minor Tribs to Lake Ontario (0301-0059):</u> WIN Ont 148a thru 151 that enter in section from point 0.1 mile west of Newfane-Wilson town line and 0.4 mile north of N.Y. Route

18 to point 0.1 mile northeast of east boundary line of Village of Wilson and immediately north of N.Y. Route 18.

Hopkins Creek (0301-0060): WIN Ont 149 enters Lake Ontario 1.5 miles west of Olcott and 0.5 mile north of Lake Road (N.Y. Route 18).

East Branch 12-Mile Creek Lower (0301-0061): WIN Ont 152 Enters Lake Ontario at northwest corner of Village of Wilson. From mouth to N.Y. Route 18 immediately west of Village of Wilson.

Minor Tribs to Lake Ontario (0301-0064): WIN Ont 152b thru 157 including tribs that enter in section from point at Coolidge Beach 2.3 miles west of Wilson and 0.2 mile north of N.Y. Route 18 to point 0.4 mile west of Dickersonville Road and 0.1 mile north of N.Y. Route 18 and tribs that enter in section beginning at point 0.5 mile east of Harrison Grove and 0.1 mile north of Lake Road (N.Y. Route 18) to point 0.8 mile west of Harrison Grove and 0.5 mile north of intersection of Dietz Road and Lake Road (N.Y. Route 18). Ont. 157 enters 1.5 miles east of Fort Niagara Beach and 0.5 mile northwest of intersection of Lake Road and Creek Road.

Sixmile Creek (0301-0065): WIN Ont 154 enters Lake Ontario 0.3 mile northwest of intersection of Porter Center Road and Lake Road (N.Y. Route 18). Low dam near east-west service road off Lutts Road and 0.3 mile west of Porter Center Road terminates Sixmile Creek

Four Mile Creek, Lower (0301-0066): WIN Ont 156 enters Lake Ontario 1.6 miles west of Harrison Grove, 0.6 mile north of Lake Road (N.Y. Route 18). Mouth to trib. 1 which enters from southwest 0.9 mile upstream and is located 0.3 mile southeast of intersection of Lake Road (N.Y. Route 18) and Creek Road.

Appendix B. New York Direct Point Source Facilities

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New York Direct Point Source Facilities

The table below presents the point source dischargers in New York that discharge directly to Lake Ontario. These facilities are referred to in the TMDL as direct New York point sources. A footnote is used to indicate the direct point sources which were determined to be for cooling water operations, and which were excluded from the TMDL.

Table B-1. List of major point source facilities that discharge directly to Lake Ontario

NPDES	Facility Name	County	Flow (MGD)	Flow %	Current Load (kg/yr)
NY0028339	Frank E Van Lare STP	Monroe	135	69.6%	2.332
NY0028231	Northwest Quad PW Dist 1	Monroe	22	11.3%	0.380
NY0002143	Novelis Corp	Oswego	18.61	9.6%	0.321
NY0021610	Walter W Bradley WPCF	Monroe	7.5	3.9%	0.130
NY0029114	Oswego (C) East Side STP	Oswego	5.35	2.8%	0.092
NY0029106	Oswego (C) West Side STP	Oswego	4	2.1%	0.069
NY0027774	Newfane (T) WWTP	Niagara	1.6	0.8%	0.028
		Total	194.06	100.0%	3.352

Table B-2. List of minor[1] and non-contact cooling water[2] facilities that discharge directly to Lake Ontario

NPDES	Facility Name	County	Flow (MGD)	Category
NY0108723	Williamson (T) STP	Wayne	0.625	Minor
NY0027014	Sackets harbor (V) STP	Jefferson	0.600	Minor
NY0028088	Sodus Point (V) WWTP	Wayne	0.570	Minor
NY0020419	Wilson (V) WWTP	Niagara	0.312	Minor
NY0030651	Somerset-Barker SD WWTP	Niagara	0.278	Minor
NY0233196	Independence Station	Oswego	0.246	Minor
NY0161683	Lyndonville WTP	Orleans	0.150	Minor
NY0216321	MHC Brennan Beach RV Resort, LLC	Oswego	0.032	Minor
NY0002186	Oswego Harbor Power	Oswego	999.9	Non-Contact
NY0020109	Fitzpatrick Nuclear Power Plant	Oswego	570.3	Non-Contact
NY0000493	R E Ginna Nuclear Pwr Plt, LLC	Wayne	542.2	Non-Contact
NY0001015	Nine Mile Point Nuclear Sta.	Oswego	396.6	Non-Contact
NY0104213	AES Somerset, LLC	Niagara	274.2	Non-Contact

[1]Point sources with a flow of less than 1 million gal/day are considered minor.

[2]Direct point source determined for water cooling operations which were excluded from the point source load calculation and wasteload allocation.

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Appendix C. Point Source Memo

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MEMORANDUM

DATE: 11/02/09

FROM: Ed Verhamme, Joe DePinto

PROJECT: LOTMDL2

TO: Rosella O'Connor, EPA-Region 2
Lorraine Gregory, NYSDEC

CC: Dave Dilks, Penelope Moskus

SUBJECT: New York Point Sources of PCBs to Lake Ontario Watershed - Updated

SUMMARY

This memo documents the information available on point sources of PCBs to the Lake Ontario watershed from regulated dischargers within the State of New York. It also uses those available data to estimate the current point source load of PCBs to the New York portion of Lake Ontario from direct dischargers is 3.35 kg/yr, which represents approximately 2% of the 2005 total PCB load to Lake Ontario from New York and Canadian tributaries.

DISCHARGE MONITORING REPORTS

A review of the Discharge Monitoring Reports (DMR) from 2006 to 2008 by staff at NYSDEC (e-mail from Steve Volger NYSDEC) for all PCB data within the Great Lakes watershed revealed that only three dischargers report PCB data directly to NYSDEC as part of their DMR. The three dischargers are listed below in Table 1. All three of the dischargers are located within the Niagara River watershed and were excluded from the TMDL because they are outside of the Lake Ontario watershed.

Table 1. PCB load from 3 facilities as reported from DMR data. nd = non-detect.

	PCB - 1248 Load (kg/yr)		
Facility	Maximum	Minimum	Average
Tonawanda Engine Plant	19.6	0.0	3.1
CWM Chemical Services	nd	nd	Nd
Niagara Falls WWTF	13.2	0.0	0.5

SPECIAL EFFLUENT STUDIES

Several reports are available from NYSDEC that investigated PCB sources at select wastewater treatment plants, combined sewer overflows, and at other locations within the Lake Ontario watershed. The most useful PCB data were collected by the Trace Organics Platform Sampler (TOPS) at five WWTPs in 1996 (Litten 1997). Recently, the concentrations reported in the 1997 document were updated to reflect known limitations of the TOPS data (Litten 2009). The updated data along with the permitted flow for each WWTP were used to calculate a flow-weighted average concentration of 12.5 ng/L. The

TOPS sample from the Carthage WWTP on 9/30/96 was excluded from the analysis due to its unusually high concentration.

Table 2. Results of the updated 1996 TOPS results from the effluents of five WWTPs in New York (Litten 1997 updated with Litten 2009)

		PCB (ng/L)			PCB (g/d)			
POTW	Flow (MGD)	Sample 1	Sample 2	Sample 3	Load 1	Load 2	Load 3	Avg Load
Lockport	22	1.72	3.64	7.71	0.1	0.3	0.6	0.4
Tonawanda	30	1.75	3.96	8.75	0.2	0.4	1.0	0.5
Rochester	135	10.79	11.84	24.42	5.5	6.1	12.5	8.0
Alden	0.65	3.38	3.86	8.74	0.0	0.0	0.0	0.0
Carthage	4	6.67	10.23	158.16	0.1	0.2	-	0.1
Total	191.65			Total avg. daily PCB load (g/d)				9.1

The Litten study represents the last time PCB concentrations were reported using high precision methods with very low detection limits (<0.01 ng/L). Monitoring of point sources for compliance with NPDES permits only requires a detection limit of 65 ng/L. Clearly, using the detection limit or half the detection limit is not a reasonable assumption to make in estimating the point source load. We could however apply the flow-weighted PCB concentration (12.5 ng/L) measured by TOPS to an estimate of the total flow being discharged by point sources within the watershed. This assumes that all unmonitored point sources are discharging at an average concentration of 12.5 ng/L, which is most likely a very conservative assumption considering that the TOPS samples were collected near populated industrial areas.

PERMITTED FLOWS

A recent extraction from the Integrated Compliance Information System (ICIS) was completed by NYSDEC for all New York permit holders within the Great Lakes watershed (email from Lorraine Gregory on 5/19/09 and 10/30/09). Of the 548 facilities in the report, 428 (78%) have a flow listed. Facilities without a listed flow were assumed to be zero and excluded from the calculation. Twelve of the facilities were assumed to be associated with water cooling operations and were also excluded from the calculation. A summary of the total flow by major category for the remaining point sources is listed below in Table 3.

Point sources within the Lake Ontario watershed proper (excluding Niagara River and Lake Erie) are broken down by direct and indirect dischargers. Direct dischargers list either Lake Ontario or an embayment of Lake Ontario as the receiving water body name in the ICIS database report. For Niagara River and Lake Erie facilities direct and indirect point sources are grouped together.

Table 3. Summary of total flow for New York point sources within the Great Lakes watershed.

Major Basin	Total Flow (MGD)
Lake Ontario Direct	194.06
Lake Ontario Indirect	683.4
Niagara River	497.3
Lake Erie	74.8

Of the fifteen facilities that discharge directly to Lake Ontario, seven of them have a permitted flow larger than 1 MGD (Table 4 and 5). The flow from the seven major facilities accounts for 99% of the total permitted flow and as such, 1 MGD was used as cutoff to define major and minor point sources. If we assume that all of the major point sources have an average concentration of 12.5 ng/L, then we can estimate the total PCB load from all facilities as 3.4 kg/yr.

Table 4. List of major direct point sources of PCBs to Lake Ontario

NPDES	Facility Name	County	Flow (MGD)	Flow %	Current Load (kg/yr)
NY0028339	Frank E Van Lare STP	Monroe	135	69.6%	2.332
NY0028231	Northwest Quad PW Dist 1	Monroe	22	11.3%	0.380
NY0002143	Novelis Corp	Oswego	18.61	9.6%	0.321
NY0021610	Walter W Bradley WPCF	Monroe	7.5	3.9%	0.130
NY0029114	Oswego (C) East Side STP	Oswego	5.35	2.8%	0.092
NY0029106	Oswego (C) West Side STP	Oswego	4	2.1%	0.069
NY0027774	Newfane (T) WWTP	Niagara	1.6	0.8%	0.028
		Total	194.06	100.0%	3.352

Table 5. List of minor and non-contact cooling water facilities that discharge directly to Lake Ontario

NPDES	Facility Name	County	Flow (MGD)	Category
NY0108723	Williamson (T) STP	Wayne	0.625	Minor
NY0027014	Sackets harbor (V) STP	Jefferson	0.600	Minor
NY0028088	Sodus Point (V) WWTP	Wayne	0.570	Minor
NY0020419	Wilson (V) WWTP	Niagara	0.312	Minor
NY0030651	Somerset-Barker SD WWTP	Niagara	0.278	Minor
NY0233196	Independence Station	Oswego	0.246	Minor
NY0161683	Lyndonville WTP	Orleans	0.150	Minor
NY0216321	MHC Brennan Beach RV Resort, LLC	Oswego	0.032	Minor
NY0002186	Oswego Harbor Power	Oswego	999.9	Non-Contact
NY0020109	Fitzpatrick Nuclear Power Plant	Oswego	570.3	Non-Contact
NY0000493	R E Ginna Nuclear Pwr Plt,, LLC	Wayne	542.2	Non-Contact
NY0001015	Nine Mile Point Nuclear Sta.	Oswego	396.6	Non-Contact
NY0104213	AES Somerset, LLC	Niagara	274.2	Non-Contact

THOMAS YOUNG ESTIMATE

Another estimate of the point source PCB load to Lake Ontario was done by Thomas Young in 2000 for the Lake Ontario Lakewide Management Plan (LaMP). Dr. Young used data from the Permit Compliance System (PCS) as well as other sources to come up with 10 different approaches to estimate the total PCB load. A summary of the PCB point source load estimates from New York dischargers to the Niagara River/Lake Ontario is shown in Table 4.

Table 4. Summary of the minimum, maximum, and average point source PCB load estimate from New York dischargers to the Niagara River and Lake Ontario (Young 2000).

	Load (kg/yr)		
Discharge Location	Minimum	Maximum	Average
Niagara River	0.8	52.6	26.7
Other	0.8	17.7	9.3
Total	1.6	70.3	35.9

Dr. Young mentions in his report that it was very difficult to develop an accurate load estimate given the state of the available data and limitations of using high detection limits for permit compliance. The maximum PCB load estimate is the result of using the permit limit PCB concentration and the maximum reported or maximum permitted flow for a facility. Subsequently the actual point source PCB load is likely to lie near the lower end of the range shown above.

The estimated total PCB load to Lake Ontario from all Canadian and New York tributary and point sources in 1995 was 357 kg/yr (Table 5; LimnoTech estimate from LOTOX2). In 1995 (when the TOPS samples were taken), direct New York point sources may have represented ~1% of the total runoff associated PCB load to the lake. Monitoring data suggests that tributary PCB loads to Lake Ontario have been decreasing exponentially since the mid 1970s and the estimated tributary PCB load in 2005 were 183 kg/yr (Atkinson *et al.*, 2008). This estimate excludes atmospheric deposition, sediment feedback, and absorption from the atmosphere. If we assume point sources have not decreased substantially since 1995, then direct point sources might make up ~2% of the total tributary and point source load to the lake in 2005.

Table 5. Summary of PCB loads to Lake Ontario in 1995 and 2005.

Load (kg/yr)	1995	2005
Total Canadian and NY Tributaries	357	183
Direct P.S. to Lake Ontario	3.4	3.4
P.S. % of Total	0.9 %	1.8 %

CONCLUSION

The above analysis of available data and special studies suggests that the best estimate of point source loading of PCBs directly to Lake Ontario is approximately 3.35 kg/yr. Point sources may also be contributing to tributary PCB loads to the lake, but no attempt is made here to estimate the PCB load to Lake Ontario from indirect dischargers.

REFERENCES

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Litten, S. 2009. Personal communication: Update of TOPS data from 1996. Received on 5/19/09 via Lorraine Gregory (NYSDEC).

Young. T. 2000. Toxic Chemical Loads to Lake Ontario: US Point Source Loading Update for 2000. Prepared for the Great Lakes Program at the State University of New York at Buffalo.

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Appendix D. Implementation Plan for WLAs in Permits

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New York State Department of Environmental Conservation Implementation Plan for WLAs in Permits

To Implement the Waste Load Allocations (WLAs) established in the Lake Ontario PCB Total Maximum Daily Load, (TMDL), the New York State Department of Environmental Conservation (DEC) will:

- Require affected dischargers to implement a PCB monitoring plan using Method 1668C
- Review the monitoring data to determine where it would be appropriate to require a PCB Minimization Plan
- Establish an interim limit based on the data collected using Method 1668C, referred to as the Existing Effluent Quality (EEQ) Limit
- Incorporate the WLA into an affected dischargers permit
- Issue a multi-discharger variance (MDV) to affected dischargers

Monitoring and Discharger Evaluation

There is very little data regarding the actual PCB load currently being discharged into Lake Ontario from the point sources identified in this TMDL. As such, as an interim measure, the facilities with an established WLA (excluding the MS4's since their load is attributed to atmospheric deposition and implementation of the general requirements of the MS4 permit will result in reductions of illicit discharges from MS4s) and/or other discharges as deemed appropriate by the DEC will be required to implement a monitoring program using Method 1668C to establish a representative accounting of their actual current PCB load to the Lake. This data will be used to determine which dischargers are discharging PCBs at levels that will require the implementation of a PCB Minimization Plan as described below and other requirements as appropriate shall be established in accordance with SPDES permitting guidance and regulations.

PCB Minimization Plan

40 CFP Part 132 (Great Lakes Initiative, GLI) is applicable since PCBs are one of the Bioaccumulative Chemicals of Concern in the Great Lakes. Therefore the WLA was determined by setting the concentration in the discharge equal to the water quality criteria for total PCBs of 1.0 pg/l. The United States Government Accountability Office (GAO) Testimony Before the Subcommittee on Water Resources, and Environment, Committee on Transportation and Infrastructure, House of Representatives: Great Lakes Initiative, January 23, 2008 acknowledges that permit flexibilities are required to allow discharges in excess of GLI water quality standards in the event of such realties as current analytical method detection limits are above the water quality standard. EPA Method 1668C determines chlorinated biphenyl congeners in environmental samples by isotope dilution and internal standard high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). The method was developed for use in wastewater, surface water, soil, sediment, biosolids and tissue matrices (USEPA, 2008). This method can detect some congeners at an estimated method detection limit (EMDL) of 40 pg/l or less and can detect all congeners at an EMDL of 449 pg/l. These detection levels are above the current WQS of 1 pg/l. As such, one of the permit flexibilities identified in the GAO report to allow for discharges greater than the GLI water quality standard is if the permit requires a Pollutant Minimization Program (PMP) which sets forth a series of actions by the

discharger to improve water quality when the pollutant concentration cannot be measured down to the water quality criterion.

The NYSDEC has developed a PCB Minimization Program which will be incorporated into the SPDES permits for those dischargers where monitoring indicates a PCB minimization program is appropriate. The NYSDEC's PCB Minimization Program is as follows:

1. **General** - The permittee shall develop, implement, and maintain a Polychlorinated Biphenyl Minimization Program (PCBMP) for those outfalls which have shown through monitoring using 1668C that concentrations of PCBs in their discharge have a reasonable potential for being reduced.

2. **PCBMP Elements** - The PCBMP shall be documented in narrative form and shall include any necessary drawings or maps. Other related documents already prepared for the facility may be used as part of the PCBMP and may be incorporated by reference. As a minimum, the PCBMP shall include an on-going program consisting of: periodic monitoring; an acceptable control strategy which will become enforceable under a permit; and, submission of annual status reports.

   A. Monitoring - The permittee shall conduct periodic monitoring designed to quantify and, over time, track the reduction of PCBs. Wastewater treatment plant influents and effluents, and other outfalls shall be monitored using EPA Method 1668C at a frequency which shall be designed to be representative of the discharge

   B. Control Strategy - An acceptable control strategy is required for reducing PCB discharges via cost-effective measures, which may include, but is not limited to, source identification, more stringent control of tributary waste streams, remediation, and/or installation of new or improved treatment facilities. Required monitoring shall also be used, and supplemented if appropriate to determine the most effective way to operate the wastewater treatment system(s) to ensure effective removal of PCBs while maintaining compliance with other permit requirements.

   C. Annual Status Report - An annual status report shall be submitted to the Regional Water Engineer and to the Bureau of Water Permits summarizing: (a) all PCBMP monitoring results for the previous year; (b) a list of known and potential PCB sources; (c) all action undertaken pursuant to the strategy during the previous year, (d) actions planned for the upcoming year, and (e) progress toward the goal. The first annual status report is due one year after the permit is modified to include the PCBMP requirement and follow-up status reports are due annually thereafter.

3. **PCBMP Modification** - The PCBMP shall be modified whenever: (a)changes at the facility or within the collection system(s) increase the potential for PCB discharges; (b) actual discharges indicate an increase in PCBs detected in the effluent as measured with EPA Method 1668C; (c) a letter from the Department identifies inadequacies in the PCBMP; or (d) pursuant to a permit modification.

Establishment of Interim and Final Effluent Limits

The DEC shall establish an interim Existing Effluent Quality (EEQ) limit for affected dischargers based on the monitoring data collected by the dischargers using Method 1668C.

Per the requirements of the GLI as well as this TMDL, all direct dischargers to Lake Ontario are ultimately required to meet an effluent limit based on a concentration in their effluent of 1 pg/l total PCBs. At this time, there are no analytical methods available to detect total PCBs at that concentration. Once the DEC incorporates a WLA based on the 1 pg/l concentration in a discharger's effluent, the DEC will have to issue a multi-discharger variance to the permit condition.