



Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring, Fall 2021 - Sediment Quality

REPORT

Prepared for Manitoba Infrastructure
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Lake Manitoba & Lake St. Martin Outlet Channels Project

Aquatic Environment Monitoring Fall 2021

Sediment Quality

An Updated Data Report Prepared for
Manitoba Transportation and Infrastructure

By:

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EXECUTIVE SUMMARY

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). An Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). Regulatory review of the EIS identified a need for sediment quality data information to properly assess potential Project effects. Although not a component of the AEMP, it was noted within the AEMP that sediment quality sampling would be conducted post-operation if total suspended solids monitoring indicated that large amounts of sediment were mobilized during channel operation. This report combines the results of sediment quality sampling conducted in 2020 (NSC 2021a) with results of sediment quality sampling conducted in fall 2021 at an additional site in Lake St. Martin. The site was added to enhance spatial coverage provided by the 2020 sampling program. Overall, sediment sampling conducted in 2020 and 2021 included 10 sites as follows: two sites in Lake Manitoba; five sites in Lake St. Martin; and three sites in Lake Winnipeg in Sturgeon Bay.

At each site, sediment samples were collected for laboratory analysis of particle size, nitrogen, carbon, metals and major ions. Samples of surficial sediment were collected using either an Ekman or Ponar grab sampler; each sample was a composite of the top 5 cm of sediment from a minimum of three grabs. Sediment characteristics, including composition, colour, odour, presence of vegetation or debris, and sample depth were recorded for each sample. Three replicate samples spaced approximately 20 m apart were collected from each site. Samples were submitted to a Canadian Association for Laboratory Accreditations, Inc. accredited laboratory for analysis. In addition, *in situ* profiles of water quality parameters including pH, specific conductance, dissolved oxygen, turbidity, and water temperature were collected at the time of sampling.

Quality Assurance/Quality Control (QA/QC) measures were incorporated over the course of the monitoring program including standard sampling methods and the collection of replicate samples at each sampling site.

Results were compared to the Manitoba Sediment Quality Guidelines (SQGs) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) PAL guidelines. Additionally, the Ontario SQGs and the British Columbia sediment alert concentration (BC SAC) for selenium were applied to supplement the Manitoba and CCME guidelines.

The results of the sediment sampling program indicated that the surficial sediments in Lake Manitoba, Lake St. Martin, and Sturgeon Bay are dominated by sand or silt and that clay makes up a small proportion of the sediments. Parameters with Manitoba and CCME SQGs were below PAL guidelines at all sites sampled, including: arsenic; cadmium; chromium; copper; lead; mercury; and zinc.

Total Kjeldahl nitrogen (TKN), total organic carbon (TOC), and nickel exceeded the Ontario SQGs at two or more sites sampled. TKN exceeded the Ontario Lowest Effect Level (LEL) at all but two sites (Lake Manitoba at the Fairford River and a nearshore site in Sturgeon Bay) and the Ontario Severe Effect Level (SEL) at one site (south basin of Lake St. Martin). TOC exceeded the Ontario LEL at seven of ten sites (exceptions were Lake Manitoba at the Fairford River and two sites in Sturgeon Bay near the proposed Lake St. Martin Outlet Channel) but was consistently below the Ontario SEL. Nickel exceeded the Ontario LEL at three locations (south basin of Lake St. Martin, Lake St. Martin at Dauphin River, and the offshore site in Sturgeon Bay) but was consistently below the SEL. Phosphorus, iron and manganese were below the Ontario SQGs at all sites. Selenium was below the BC SAC at all sites sampled.

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ACRONYMS

AEMP	Aquatic Effects Monitoring Program
BC	British Columbia
BCMECCS	BC Ministry of Environment and Climate Change Strategy
CCME	Canadian Council of Ministers of the Environment
DL	Analytical Detection Limit
DO	Dissolved Oxygen
EIS	Environmental Impact Statement
FRWCS	Fairford Water Control Structure
ISQG	Interim Sediment Quality Guideline
LEL	Lowest Effect Level
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
MTI	Manitoba Transportation and Infrastructure
MWS	Manitoba Water Stewardship
NSC	North/South Consultants Inc.
PAL	Protection of Freshwater Aquatic Life
PEL	Probable Effect Level
QA/QC	Quality Assurance/Quality Control
SAC	Sediment Alert Concentration
SD	Standard Deviation
SEL	Severe Effect Level
SQG	Sediment Quality Guideline
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon

1.0

INTRODUCTION

North/South Consultants Inc. (NSC) was retained by Manitoba Transportation and Infrastructure (MTI) to collect supplemental data with respect to the aquatic environment in support of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project). The proposed Project is designed to manage flood waters on Lake Manitoba and Lake St. Martin by providing a channel by which flood waters can be conveyed, in addition to the natural outflow via the Fairford and Dauphin rivers (Figure 1). The Project consists of two outlet channels that are intended to work together:

- The 24 km Lake Manitoba Outlet Channel (LMOC) will work in tandem with the existing water control structure on the Fairford River (the Fairford Water Control Structure or FRWCS) to help regulate water levels and mitigate flooding on Lake Manitoba; and
- The 24 km Lake St. Martin Outlet Channel (LSMOC) will restore a more natural water regime to Lake St. Martin and will also provide flood protection by mitigating increased inflows from operation of the FRWCS, as well as additional inflows from the planned outlet from Lake Manitoba.

An Aquatic Effects Monitoring Program (AEMP) was developed in 2020 to provide a plan for monitoring the effects of the Project on the aquatic environment, focusing on key issues identified in the Environmental Impact Statement (EIS). The specific objectives of the AEMP were to:

- Verify the predicted effects presented in the surface water quality and fish and fish habitat sections of the EIS;
- Determine the effectiveness of mitigation measures;
- Assess the need for additional mitigation measures if initial measures are not adequate;
- Determine the effectiveness of any additional/adapted measure(s); and
- Confirm compliance with regulatory requirements relevant to surface water quality and fish and fish habitat set out in the Project approvals (e.g., Manitoba Environment Act License; Fisheries Act Authorization).

Regulatory review of the EIS identified a need for sediment quality data information to assess potential project effects (Lake Manitoba and Lake St. Martin Outlet Channels Project - Technical Review Information Requests Round 1 Package 1 – April 23, 2020; Information Request 12). Although not a component of the AEMP, it was noted within the AEMP that sediment quality monitoring would be conducted after operation if total suspended solids (TSS) monitoring indicated that large amounts of sediment were mobilized during channel operation. Collection of pre-Project sediment quality samples will enable comparison to future samples if required after operation.

This report combines the results of sediment quality sampling conducted in 2020 (NSC 2021a) with results of sediment quality sampling conducted in fall 2021 at an additional site in Lake St. Martin. The new site was added to enhance spatial coverage provided by the 2020 sampling program.

2.0

METHODS

2.1 SAMPLING DATES

Sediment sampling was initiated in mid-October 2020 to coincide with the water quality monitoring program (NSC 2021b). However, due to poor weather conditions, including strong winds and the early and rapid formation of ice, the sediment sampling program was postponed until December 2020 when ice cover was sufficient to allow safe sampling through the ice. Following completion of the 2020 sampling program, a gap was identified in the data such that one additional site (i.e., Lake St. Martin at the inlet of the Dauphin River) was sampled in October 2021. Sampling dates were as follows:

- October 13, 2020;
- December 9-11, 2020; and
- October 20, 2021.

2.2 SAMPLING SITES

The study area for the monitoring program is comprised of Lake Manitoba, the Fairford and Dauphin rivers, Lake St. Martin, and Sturgeon Bay in Lake Winnipeg. Sediment sampling was conducted at ten sites in the study area. Information on sampling locations is listed in Table 1 and illustrated in Figure 1. Sampling sites were as follows:

- Two sites in Lake Manitoba,
 - Watchorn Bay at the proposed LMOC (WHB2), and
 - at the inlet of the Fairford River (LMB-FR);
- Five sites in Lake St. Martin,
 - Birch Bay (BB-LSM),
 - at the outlet of the Fairford River (LSM-FR),
 - middle of the south basin (LSM5),
 - at the inlet of the Dauphin River (LSM-DR), and
 - the eastern bay near the proposed LSMOC (LSM3); and
- Three sites in Lake Winnipeg in Sturgeon Bay,
 - at the outlet of the Dauphin River (SB-DR),
 - nearshore at the proposed LSMOC (SB1), and
 - offshore of the proposed LSMOC (SB2).

Sediment sampling was also attempted in the middle of the north basin of Lake St. Martin near water quality monitoring site LSM1 (NSC 2021b); however, the sediments in this area of the lake were too compact to allow for sampling. As an alternative, sampling was conducted at the inlet of the Dauphin River (LSM-DR) in fall 2021.

2.3 PARAMETERS

At each site, sediment samples were collected for laboratory analysis of particle size, nitrogen, carbon, and metals and major ions (e.g., aluminum, iron, calcium). A detailed list of parameters measured at the laboratory is provided in Table 2.

In situ measurements of water quality parameters were collected at each sampling site to supplement the sediment quality information. Water quality parameters measured included dissolved oxygen (DO), water temperature, specific conductance, pH, and turbidity.

2.4 FIELD METHODS

Sampling sites were accessed by boat in October 2020 and October 2021, and by snowmobile in December 2020. Sampling date and time were noted for each site. Sample locations were recorded using a handheld Garmin GPS receiver. Total water depth was recorded using a hand-held depth sounder. In December 2020, holes were drilled through the ice with an electric auger then widened using an ice saw; snow depth and ice-thickness were recorded.

In situ measurements of water quality parameters including pH, specific conductance, DO, turbidity, and water temperature were collected. In October 2020 and October 2021, *in situ* measurements were taken using a YSI EXO™2 sonde; and, in December 2020, measurements were taken using a YSI ProPlus water quality meter and an Analite turbidity meter. At each site, *in situ* profiles were taken such that measurements were recorded near the surface (i.e., at 0.3 m) and at increments of either 0.5 m (where total water depth was less than 5 m) or 1.0 m (where total water depth was at least 5m).

Sediment was collected using either an Ekman or Ponar grab sampler. Material from the top 0-5 cm was taken from the central portion of each grab using a stainless-steel spoon and placed into a Pyrex® bowl for homogenization; care was taken to avoid sediments that may have come in contact with the sampling device. Each sample was comprised of material from at least three grabs and successive grabs were separated spatially to avoid re-sampling the same location while still collecting the grabs as close as feasible to one another. Samples were placed into glass jars and zip top bags supplied by ALS Laboratories. All equipment was site rinsed prior to sample collection. Sediment characteristics, including composition, colour, odour, presence of vegetation or debris, and sample depth were recorded for each sample. Three replicate samples spaced approximately 20 m apart were collected from each site.

After collection, samples were placed in a cooler and kept cool but not frozen (using ice packs or hot water bottles as appropriate) until submission to ALS Laboratories in Winnipeg, MB (a Canadian Association for Laboratory Accreditations, Inc. accredited laboratory) for analysis.

2.5 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) measures were incorporated over the course of the monitoring program. Standard QA/QC measures were followed during sample collection including but not limited to: the use of latex gloves; the use of clean site rinsed equipment; standard labelling practices;

and meter calibration. Additionally, the sampling program incorporated the collection of triplicate samples (i.e., three separate sub-samples) at each sampling site. Replicate samples provide a measure of variability of environmental conditions and the overall precision associated with field methods and laboratory analyses.

All sediment quality data were examined qualitatively for potential outliers and/or transcription or analytical errors. Where one replicate sample differed notably from the others, the measurement was flagged as “suspect” and the laboratory was asked to verify the result.

2.6 DATA ANALYSIS

All data analyses treated censored values (i.e., values reported as below the DL) as equal to one half the analytical detection limit (DL). Mean and standard deviation (SD) were calculated for each sampling site (n=3); however, SD was not calculated in cases where the result for more than one sample was below the DL. Total Kjeldahl Nitrogen (TKN) results were converted from mg/kg as provided by the analytical laboratory to units of percent (%) in order to facilitate comparison to guidelines.

2.7 COMPARISON TO SEDIMENT QUALITY GUIDELINES

Results were compared to the Manitoba Sediment Quality Guidelines (SQGs; MWS 2011) for the protection of aquatic life (PAL) as well as the Canadian Council of Ministers of the Environment (CCME) PAL guidelines (CCME 1999; updated to 2021). Manitoba includes SQGs and Probable Effect Levels (PELs) for some metals (MWS 2011) which are equivalent to the CCME Interim Sediment Quality Guidelines (ISQGs) and PELs, respectively. To supplement the Manitoba/CCME guidelines, the Ontario SQGs (Fletcher et al. 2008) and the British Columbia sediment alert concentration (SAC) for selenium (BCMECCS 2019) were also applied. Manitoba, CCME and Ontario specify two values with similar intentions: SQG/ISQG (Manitoba/CCME) and lowest effect level (LEL; Ontario) are concentrations below which adverse effects are rarely expected; and PEL (Manitoba and CCME) and severe effect level (SEL; Ontario) are concentrations above which there is a higher risk for adverse effects to occur. A summary of relevant sediment quality criteria is presented in Table 3.

3.0 RESULTS

This section describes the results of the sediment quality program conducted in 2020 and 2021. Table 4 and Figures 2-16 summarize the sediment quality data collected. Supplemental field data and raw laboratory results are provided in Appendix 1 and Appendix 2, respectively. *In situ* water quality data collected during the sediment quality program are provided in Appendix 3. The following is a summary of these results.

3.1 *IN SITU* WATER QUALITY

In general, *In situ* water quality variables including, temperature, DO, turbidity, pH, and specific conductance were consistent across depth at most sites. An exception to this occurred at the offshore site in Sturgeon Bay (SB2) and in Lake St. Martin (LSM3) where there was a slight decrease in DO at depth. Despite this, all sites remained oxygenated at the sediment water interface.

3.2 SEDIMENT TEXTURE

Surficial sediment samples at most sites were dominated by sand (Figure 2); however, silt dominated the samples collected from Lake St. Martin in the south basin, at the Dauphin River inlet, and in the eastern bay near the proposed LSMOC (LSM5, LSM-DR, and LSM3, respectively); as well as the offshore site in Sturgeon Bay (SB2). Clay constituted a small proportion of the surficial sediments at all sites sampled.

3.3 NUTRIENTS

TKN (Figure 3) exceeded the Ontario LEL (550 mg/kg) at most sites sampled but was, with two exceptions, below the SEL (4800 mg/kg); the exceptions were at the south basin of Lake St. Martin (LSM5) and at inlet to the Dauphin River (LSM-DR) where TKN exceeded the Ontario SEL. TKN was below the Ontario LEL at Lake Manitoba at the Fairford River (LMB-FR) and at the nearshore site on Sturgeon Bay (SB1).

Total organic carbon (TOC; Figure 4) exceeded the Ontario LEL (1%) at most sites sampled but was below the SEL (10%). TOC was below the DL, including Lake Manitoba at the Fairford River (LMB-FR), and both the nearshore and offshore sites on Sturgeon Bay (SB1 and SB2; Table 4).

Total phosphorus was below the Ontario LEL (600 mg/kg) and SEL (2000 mg/kg) at all sites sampled (Figure 5).

3.4 METALS

Mean concentrations of all metals for which there are Manitoba and CCME sediment quality criteria were consistently below the SQG/ISQG and PEL, including: arsenic (Figure 6); cadmium (Figure 7); chromium (Figure 8); copper (Figure 9); lead (Figure 10); mercury (Figure 11); and zinc (Figure 12). Similarly, with one exception, individual sample concentrations were within PAL guidelines. The exception was one of three

samples collected from the middle of the south basin of Lake St. Martin (LSM5) in which arsenic (5.98 mg/kg) was at the SQG/ISQG (5.9 mg/kg) but well below the PEL (17 mg/kg; Appendix 2).

Mean nickel concentrations in surficial sediments exceeded the Ontario LEL (16 mg/kg) in the south basin of Lake St. Martin (LSM5), Lake St. Martin at Dauphin River (LSM-DR), and at the offshore site in Sturgeon Bay (SB2); concentrations were below this guideline at all other sites sampled (Figure 13). Nickel was below the Ontario SEL (75 mg/kg) at all sites sampled.

Iron and manganese were below the Ontario LEL and therefore the SEL at all sites sampled (Figures 14 and 15, respectively).

Additionally, selenium was below the BC SAC (2 mg/kg) at all sites sampled (Figure 16).

4.0

SUMMARY

Surficial sediments in Lake Manitoba, Lake St. Martin and Sturgeon Bay were dominated by sand or silt; clay made up a small proportion of the surficial sediments. Sediment quality parameters with Manitoba and CCME SQGs were below PAL guidelines at all sites sampled, including: arsenic; cadmium; chromium; copper; lead; mercury; and zinc.

In addition to the Manitoba and CCME guidelines, results were compared to selected Ontario SQGs and the BC SAC for selenium. Phosphorus, iron and manganese were below the Ontario SQGs at all sites; selenium was below the BC SAC. Conversely, TKN, TOC and nickel exceeded Ontario SQGs at two or more sites sampled. TKN exceeded the Ontario LEL at all but two sites (LMB-FR and SB1) and exceeded the Ontario SEL at two sites (LSM5 and LSM-DR). TOC exceeded the Ontario LEL at seven of ten sites (exceptions were LMB-FR, SB1 and SB2) but was consistently below the Ontario SEL. Nickel exceeded the Ontario LEL at three locations (LSM5, LSM-DR, and SB2) but was consistently below the SEL.

5.0**REFERENCES**

- British Columbia Ministry of Environment and Climate Change Strategy (BCMECCS). 2019. British Columbia approved water quality guidelines: aquatic life, wildlife & agriculture, summary report. Water Protection and Sustainability Branch, August 2019.
- Canadian Council of Ministers of the Environment (CCME). 1999 (Updated to 2021). Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg.
- Fletcher, R., P. Welsh, and T. Fletcher. 2008. Guidelines for identifying, assessing and managing contaminated sediments in Ontario: an integrated approach. Ontario Ministry of the Environment, May 2008. 107 pp.
- Manitoba Water Stewardship (MWS). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Water Stewardship Report 2011-01. July 4, 2011. 68 pp.
- North/South Consultants Inc. (NSC). 2021a. Lake Manitoba and Lake St. Martin Outlet Channels Project - Aquatic Environment Monitoring Fall 2020. Sediment Quality. A report prepared for Manitoba Transportation and Infrastructure by North/South Consultants Inc. vi + 41 p.
- NSC. 2021b. Lake Manitoba and Lake St. Martin Outlet Channels Project - Aquatic Environment Monitoring Fall 2020. Water Quality. A data report prepared for Manitoba Transportation and Infrastructure by North/South Consultants Inc. v + 75 pp.

Table 1. Sediment quality sampling sites, 2020 and 2021.

Waterbody	Location Description	Site ID	Sampling Date	Sampling Time	UTM Coordinates		
					Zone	Easting	Northing
Lake Manitoba	Watchorn Bay at proposed LMOC	WHB2	8-Dec-20	9:20	14U	529300	5681102
	at the inlet to the Fairford River	LMB-FR	9-Dec-20	8:50	14U	516805	5713010
Lake St. Martin	Birch Bay	BB-LSM	13-Oct-20	12:20	14U	534252	5704286
	at Fairford River	LSM-FR	13-Oct-20	15:50	14U	528313	5716449
	middle of south basin	LSM5	9-Dec-20	13:25	14U	536040	5724699
	at the inlet to the Dauphin River	LSM-DR	20-Oct-21	11:30	14U	547471	5740361
Lake Winnipeg	eastern bay near proposed LSMOC	LSM3	11-Dec-20	11:50	14U	555895	5737191
	at the Dauphin River	SB-DR	10-Dec-20	15:05	14U	566731	5757355
	nearshore at proposed LSMOC	SB1	10-Dec-20	12:50	14U	573476	5751450
	offshore at proposed LSMOC	SB2	10-Dec-20	9:55	14U	576810	5753557

Table 2. Laboratory measured parameters in sediment samples collected.

Sediment Quality Parameters		
Particle Size	Metals and Major Ions	
Moisture	Aluminum (Al)	Molybdenum (Mo)
% Sand (2.0mm - 0.05mm)	Antimony (Sb)	Nickel (Ni)
% Silt (0.05mm - 2um)	Arsenic (As)	Phosphorus (P)
% Clay (<2um)	Barium (Ba)	Potassium (K)
Texture	Beryllium (Be)	Selenium (Se)
	Bismuth (Bi)	Silver (Ag)
<u>Nitrogen</u>	Boron (B)	Sodium (Na)
Nitrate/Nitrite	Cadmium (Cd)	Strontium (Sr)
Nitrate	Calcium (Ca)	Sulfur (S)
Nitrite	Chromium (Cr)	Thallium (Tl)
Total Kjeldahl Nitrogen	Cobalt (Co)	Tin (Sn)
	Copper (Cu)	Titanium (Ti)
<u>Carbon</u>	Iron (Fe)	Tungsten (W)
Inorganic Carbon	Lead (Pb)	Uranium (U)
Inorganic Carbon (as CaCO ₃ Equivalent)	Lithium (Li)	Vanadium (V)
Total Organic Carbon	Magnesium (Mg)	Zinc (Zn)
Total Carbon	Manganese (Mn)	Zirconium (Zr)
	Mercury (Hg)	

Table 3. Summary of Manitoba (MWS 2011) and CCME (1999 updated to 2021) sediment quality guidelines, as well as supplemental guidelines from Ontario (Fletcher et al. 2008) and British Columbia (BCMECCS 2019).

Parameter	Units	Manitoba/CCME		Ontario		British Columbia
		ISQG	PEL	LEL	SEL	SAC
Total Kjeldahl Nitrogen	mg/kg	-	-	550	4800	-
Total Phosphorus	mg/kg	-	-	600	2000	-
Total Organic Carbon	%	-	-	1	10	-
Arsenic	mg/kg	5.9	17	-	-	-
Cadmium	mg/kg	0.6	3.5	-	-	-
Chromium	mg/kg	37.3	90	-	-	-
Copper	mg/kg	35.7	197	-	-	-
Iron	mg/kg	-	-	20000	40000	-
Lead	mg/kg	35	91.3	-	-	-
Manganese	mg/kg	-	-	460	1100	-
Mercury	mg/kg	0.17	0.486	-	-	-
Nickel	mg/kg	-	-	16	75	-
Selenium	mg/kg	-	-	-	-	2
Zinc	mg/kg	123	315	-	-	-

ISQG = Sediment Quality Guideline; ISQG = Interim Sediment Quality Guideline; PEL = Probable Effect Level; LEL = Lowest Effect Level; SEL = Severe Effect Level; and SAC = Sediment Alert Concentration.

Table 4. Mean and standard deviation (SD) of sediment quality parameters at sampling sites in Lake Manitoba, Lake St. Martin and Lake Winnipeg, 2020-2021.

Parameter	Units	Analytical Detection Limit	Lake Manitoba				Lake St. Martin						Lake Winnipeg									
			WHB2		LMB-FR		BB-LSM		LSM-FR		LSM5		LSM-DR		LSM3		SB-DR		SB1		SB2	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<u>Particle Size</u>																						
Moisture	%	0.1	32	9.08	34.4	2.88	46.4	2.75	71.1	13.1	87.9	0.51	76.7	1.42	62.4	2.26	38.6	4.48	25.2	1.36	51.5	0.92
% Sand (2.0mm - 0.05mm)	%	1	91.1	3.48	95.6	1.81	88.7	3.22	60.7	17.9	3.7	2.75	8.3	1.99	33.7	5.61	79	5.15	96.6	0.12	12.2	5.01
% Silt (0.05mm - 2µm)	%	1	8.1	3.3	4.3	1.79	11.1	3.16	38.2	16.9	79.2	5.31	69.2	2.85	63.3	5.5	17.5	4.8	1.6	0.21	72.1	0.83
% Clay (<2µm)	%	1	<1.0	-	<1.0	-	<1.0	-	1.1	-	17.1	2.81	22.5	4.6	3	0.49	3.6	0.35	1.8	0.29	15.6	5.14
<u>Nitrogen</u>																						
Nitrate/Nitrite	mg N/kg	1	1.9	0.15	2	0	1.4	0.21	1.6	0.32	3.9	0.4	1.5	0.14	3.6	0.21	4.5	1.73	1.5	0.15	3.5	0.46
Nitrate	mg N/kg	1.1	<1.1	-	<1.1	-	<1.1	-	<1.1	-	<1.1	0.35	1.4	0.77	<1.1	-	2.8	1.57	<1.1	-	1.4	0.77
Nitrite	mg N/kg	0.4	1.19	0.182	1.59	0.032	0.91	0.186	1.03	0.272	2.82	0.437	0.94	0.272	2.75	0.28	1.63	0.272	0.97	0.099	2	0.27
Total Kjeldahl Nitrogen	mg/kg	200/400/1000	720	60.8	497	40.4	1490	131	4033	1850	7567	1097	5770	1080	2260	147	620	105	297	5.8	1400	233
<u>Carbon</u>																						
Inorganic Carbon	%	0.05	4.04	1.32	5.83	0.765	1.61	0.139	3.23	0.122	5.66	0.347	5.95	0.137	4.96	0.58	3.61	0.804	1.73	0.463	4.01	0.349
Inorganic Carbon (as CaCO ₃ Equivalent)	%	0.4	33.7	11	48.6	6.37	13.4	1.13	26.9	1.01	47.2	2.9	49.6	1.16	41.3	4.85	30.1	6.7	14.4	3.9	33.4	2.9
Total Organic Carbon	%	various	2.2	1.3	<1.2	-	2.96	0.26	6.5	1.7	9.2	0.26	34	0.23	4.9	0.7	<0.93	-	<0.37	-	3.4	0.23
Total Carbon	%	0.05	6.2	0.28	6.1	0.212	4.57	0.397	9.68	1.86	14.9	0.058	8.17	0.351	9.8	0.173	4.39	0.248	1.81	0.053	7.38	0.106
<u>Metals</u>																						
Aluminum (Al)	mg/kg	50	2273	110	2167	85	2453	75	2570	431	7783	749	7500	741	4067	490	4317	462	2447	185	10063	469
Antimony (Sb)	mg/kg	0.1	<0.10	-	<0.10	-	<0.10	-	<0.10	-	0.42	0.06	0.16	0.02	<0.10	-	<0.10	-	<0.10	-	0.13	0.01
Arsenic (As)	mg/kg	0.1	1.06	0.006	0.74	0.065	0.91	0.04	1.24	0.286	5.45	0.648	3.15	0.282	1.61	0.122	1.51	0.081	0.96	0.081	2.58	0.075
Barium (Ba)	mg/kg	0.5	29.5	1.12	23.7	4.38	23.9	1.18	67.8	7.49	148	8.3	192.7	13.5	63.3	7.62	25.8	3.45	11.5	1.04	66.9	3.94
Beryllium (Be)	mg/kg	0.1	<0.10	-	<0.10	-	<0.10	-	0.13	0.017	0.29	0.017	0.27	0.042	0.13	0.015	0.15	0.015	<0.10	-	0.35	0.021
Bismuth (Bi)	mg/kg	0.2	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-	<0.20	-
Boron (B)	mg/kg	5	13.8	0.95	8.5	0.95	9.2	0.4	14.4	1.63	27.7	2.01	26.7	1.45	17	2.17	10.2	0.6	6	0.26	14.4	0.4
Cadmium (Cd)	mg/kg	0.02	0.052	0.0032	0.029	0.0052	0.067	0.003	0.098	0.0366	0.289	0.0512	0.198	0.02	0.097	0.0096	0.044	0.0012	<0.020	-	0.124	0.0064
Calcium (Ca)	mg/kg	50	64700	1852	73667	8051	68300	2170	122667	8021	204667	4163	268667	10263	155000	13748	69133	5637	31100	872	88433	3092
Chromium (Cr)	mg/kg	0.5	5.2	0.194	5.27	0.286	5.66	0.45	7.1	1.4	19.6	0.666	18.1	2.12	8.69	1.1	10.6	1.04	5.62	0.397	23.9	0.76
Cobalt (Co)	mg/kg	0.1	1.35	0.021	1.22	0.11	1.61	0.066	2.18	0.535	5.32	0.252	4.18	0.364	1.94	0.195	3.31	0.226	1.48	0.104	6.2	0.23
Copper (Cu)	mg/kg	0.5	2.9	0.036	1.93	0.405	3.29	0.271	7.12	2.1	17.7	0.67	12.1	0.924	4.3	0.451	4.63	0.691	1.66	0.212	13.9	0.78
Iron (Fe)	mg/kg	50	3037	49.3	2740	252	3397	143	4410	865	10303	495	9403	671	4940	540	5803	545	3020	178	12767	252
Lead (Pb)	mg/kg	0.5	2.14	0.089	1.36	0.18	2.21	0.11	3.61	1.29	10	2.52	6.53	1.47	3.06	0.265	2.97	0.324	1.53	0.164	6.55	0.263
Lithium (Li)	mg/kg	2	3.7	0.17	3.9	0.36	4.6	0.15	5.8	1.05	11.9	0.64	13	0.47	7.2	0.95	7.7	0.7	3.9	0.25	15.7	0.69
Magnesium (Mg)	mg/kg	20	21967	1150	28433	1358	28367	1447	27833	1595	20633	252	26033	1893	51767	3696	38233	2285	17100	819	52733	1589
Manganese (Mn)	mg/kg	1	97.9	1.22	98.4	10.2	96.7	4.05	159	22	306	13.5	330	24.01	193	18.6	153	7.5	78.2	6.1	308	12.7
Mercury (Hg)	mg/kg	0.0050/0.010	0.0103	0.00015	0.0065	0.00026	0.0131	0.00118	0.0121	0.00488	0.038	0.0072	0.0147	0.00808	0.0159	0.00058	0.0109	0.00131	<0.0050	-	0.0211	0.00106
Molybdenum (Mo)	mg/kg	0.1	0.32	0.021	0.25	0.044	0.17	0.012	0.44	0.081	2.79	0.122	0.98	0.163	0.46	0.046	0.13	0.023	<0.10	-	0.22	0.012

Table 4. Continued.

Parameter	Units	Analytical Detection Limit	Lake Manitoba				Lake St. Martin						Lake Winnipeg									
			WHB2		LMB-FR		BB-LSM		LSM-FR		LSM5		LSM-DR		LSM3		SB-DR		SB1		SB2	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Nickel (Ni)	mg/kg	0.5	4.68	0.07	3.59	0.418	4.56	0.295	7.82	2.06	23.4	1.47	16.1	1.25	6.58	0.741	7.33	0.739	3.44	0.202	17.4	1.01
Phosphorus (P)	mg/kg	50	350	33.2	260	20.1	357	24.4	286	52	390	60.3	353	35.2	303	20.5	420	4	387	43.3	442	11
Potassium (K)	mg/kg	100	497	11.5	453	61.1	537	35.1	883	174	2307	188	2303	172	1037	125	943	125	403	40.4	2200	72.1
Selenium (Se)	mg/kg	0.2	<0.20	-	<0.20	-	<0.20	-	0.29	0.074	1.21	0.031	<0.20	-	0.25	0.015	<0.20	-	<0.20	-	<0.20	-
Silver (Ag)	mg/kg	0.1	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-	<0.10	-
Sodium (Na)	mg/kg	50	394	15.5	337	64.8	334	19.1	773	215	1773	110	1447	32.1	671	96	278	31.5	119	6.7	384	19.5
Strontium (Sr)	mg/kg	0.5	77.8	4.47	69.1	12.1	65.3	1.84	207	28.3	456	8.5	758	30.32	230	24.6	32.8	2.15	18.6	0.93	44.9	0.42
Sulfur (S)	mg/kg	1000	1267	57.7	<1000	-	1400	100	2567	379	7033	57.7	6667	586	2467	306	<1000	-	<1000	-	1200	100
Thallium (Tl)	mg/kg	0.05	0.065	0.0032	0.053	0.0026	0.083	0.0032	0.065	0.0089	0.165	0.0067	0.133	0.0036	0.074	0.0081	0.083	0.0095	<0.050	-	0.151	0.0065
Tin (Sn)	mg/kg	2	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-	<2.0	-
Titanium (Ti)	mg/kg	1	127	4.2	137	13.6	127	4.6	123	93.9	291	32.5	314	36.3	197	24.5	269	23.3	274	20.8	448	21.8
Tungsten (W)	mg/kg	0.5	-	-	-	-	<0.50	-	<0.50	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium (U)	mg/kg	0.05	0.458	0.0275	0.373	0.0288	0.388	0.0258	0.718	0.108	2.82	0.226	1.19	0.1212	0.643	0.0594	0.467	0.0571	0.341	0.0333	0.949	0.0255
Vanadium (V)	mg/kg	0.2	5.92	0.229	5.57	0.361	6.01	0.29	7.4	1.2	24	2.27	18.8	1.94	10.3	1.24	11.8	1.21	6.68	0.496	26.3	0.89
Zinc (Zn)	mg/kg	2	9.3	0.47	6.9	0.8	11.3	1.32	16.9	5.14	44.6	3.07	36.6	2.65	16.2	1.96	14.5	1.42	6.2	0.5	32.1	0.95
Zirconium (Zr)	mg/kg	1	1.1	0.06	1.2	0.17	1.2	0	1.4	0.29	3.7	0	5.1	0.701	2	0.26	3.2	0.3	2.5	0.21	8.8	0.35

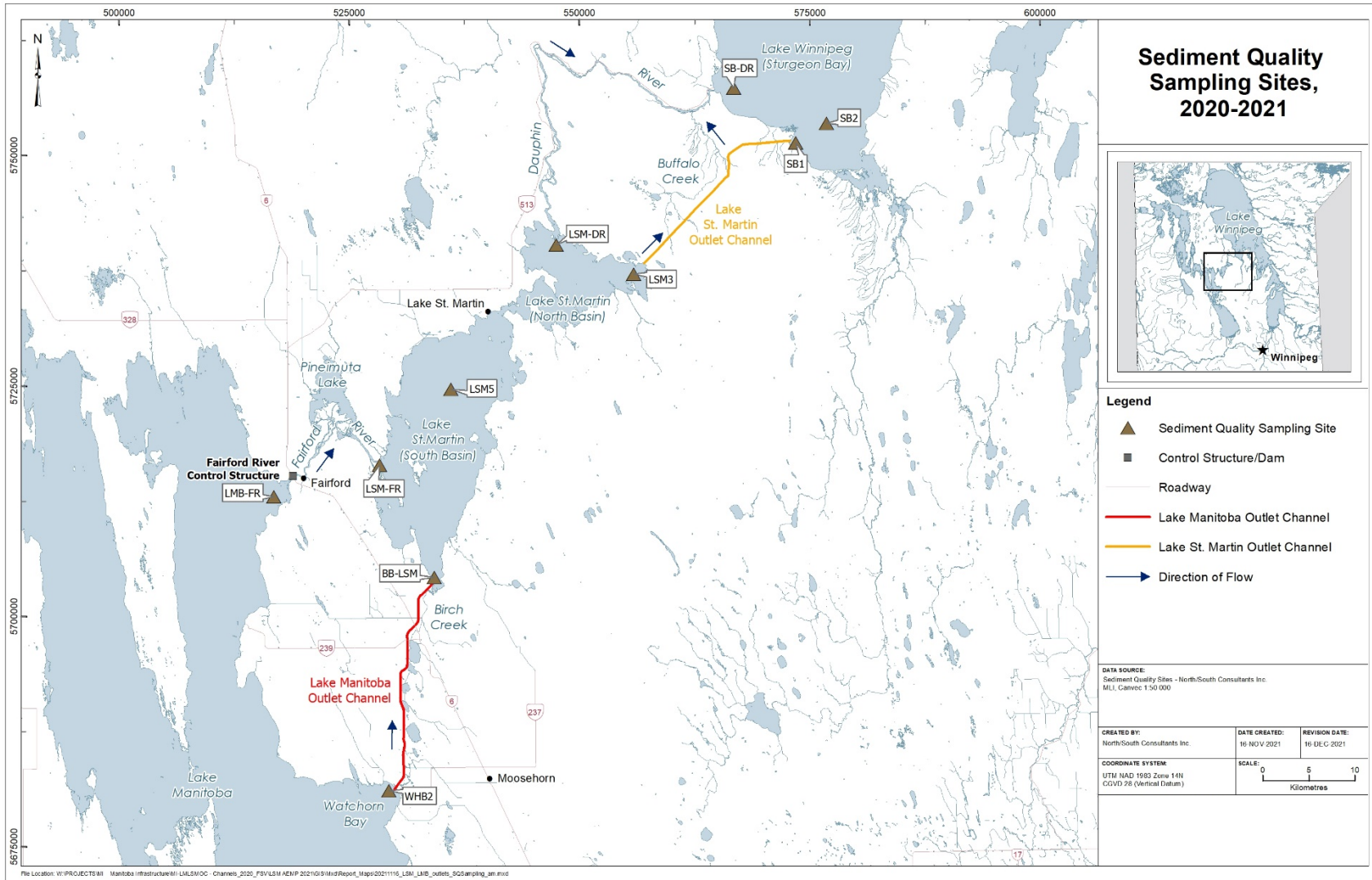


Figure 1. Sediment quality sampling locations, 2020-2021.

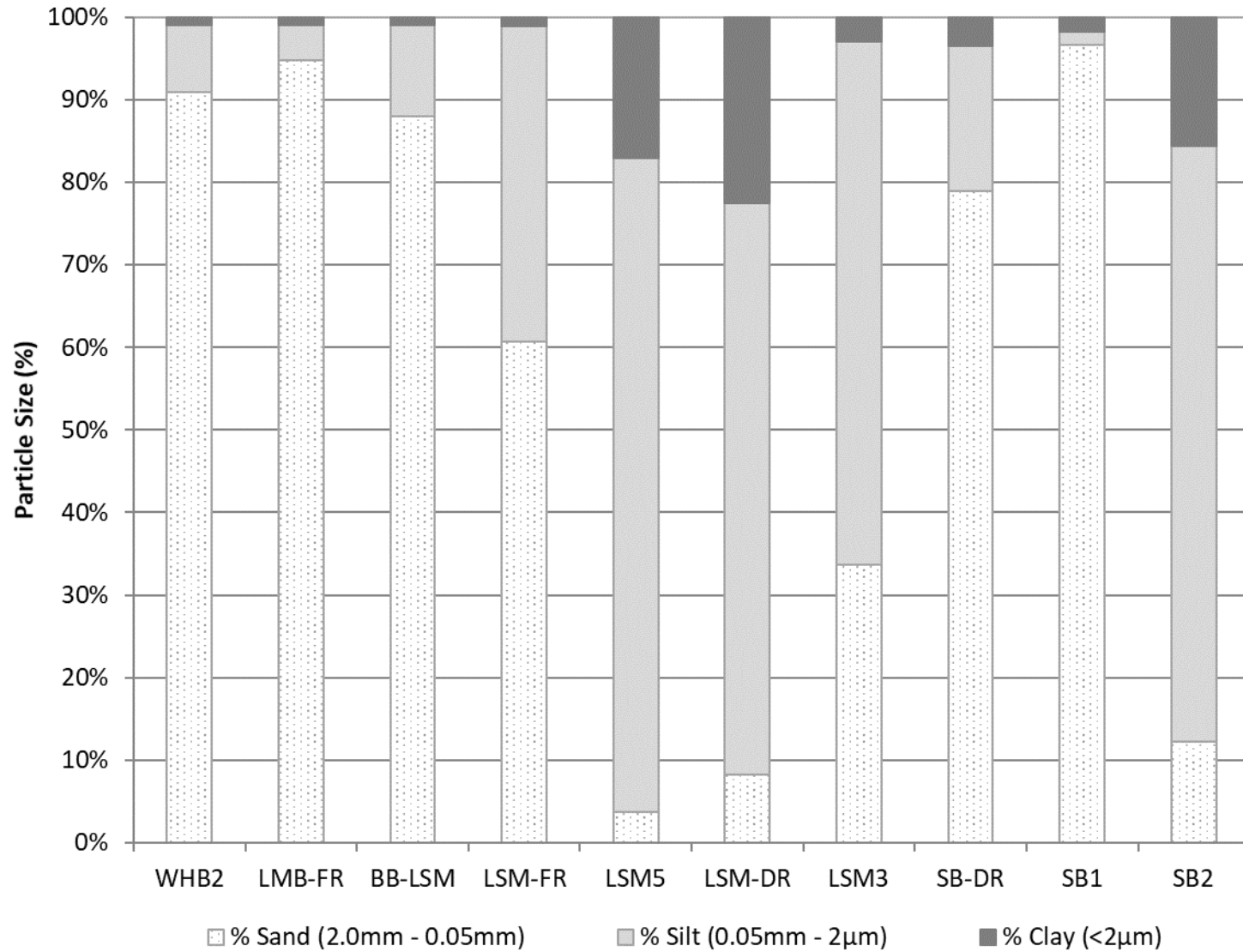


Figure 2. Particle size of surficial sediments samples (n=3) collected at sites in Lake Manitoba, Lake St. Martin and Sturgeon Bay.

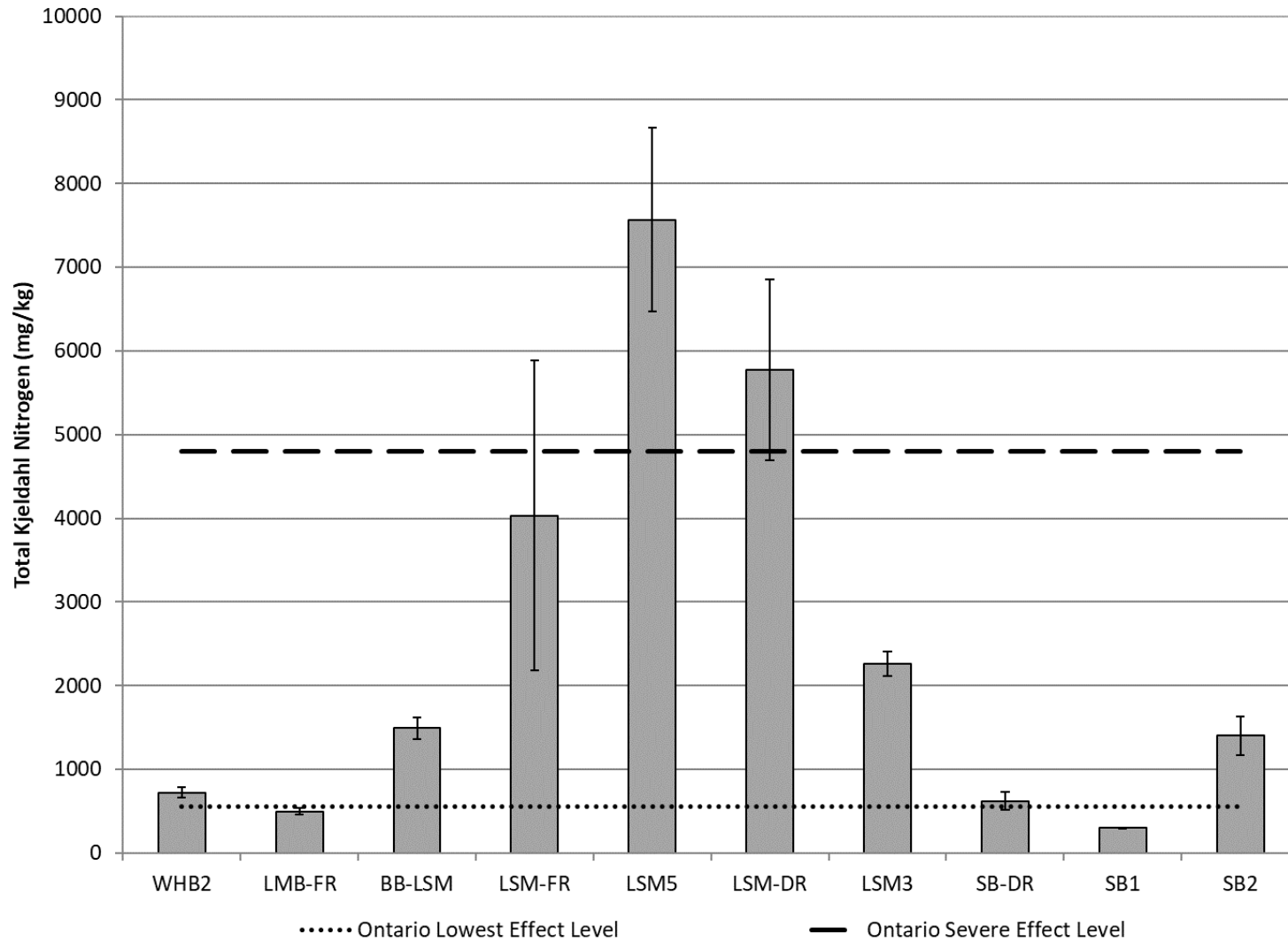


Figure 3. Mean (\pm SD) concentration of total Kjeldahl nitrogen in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

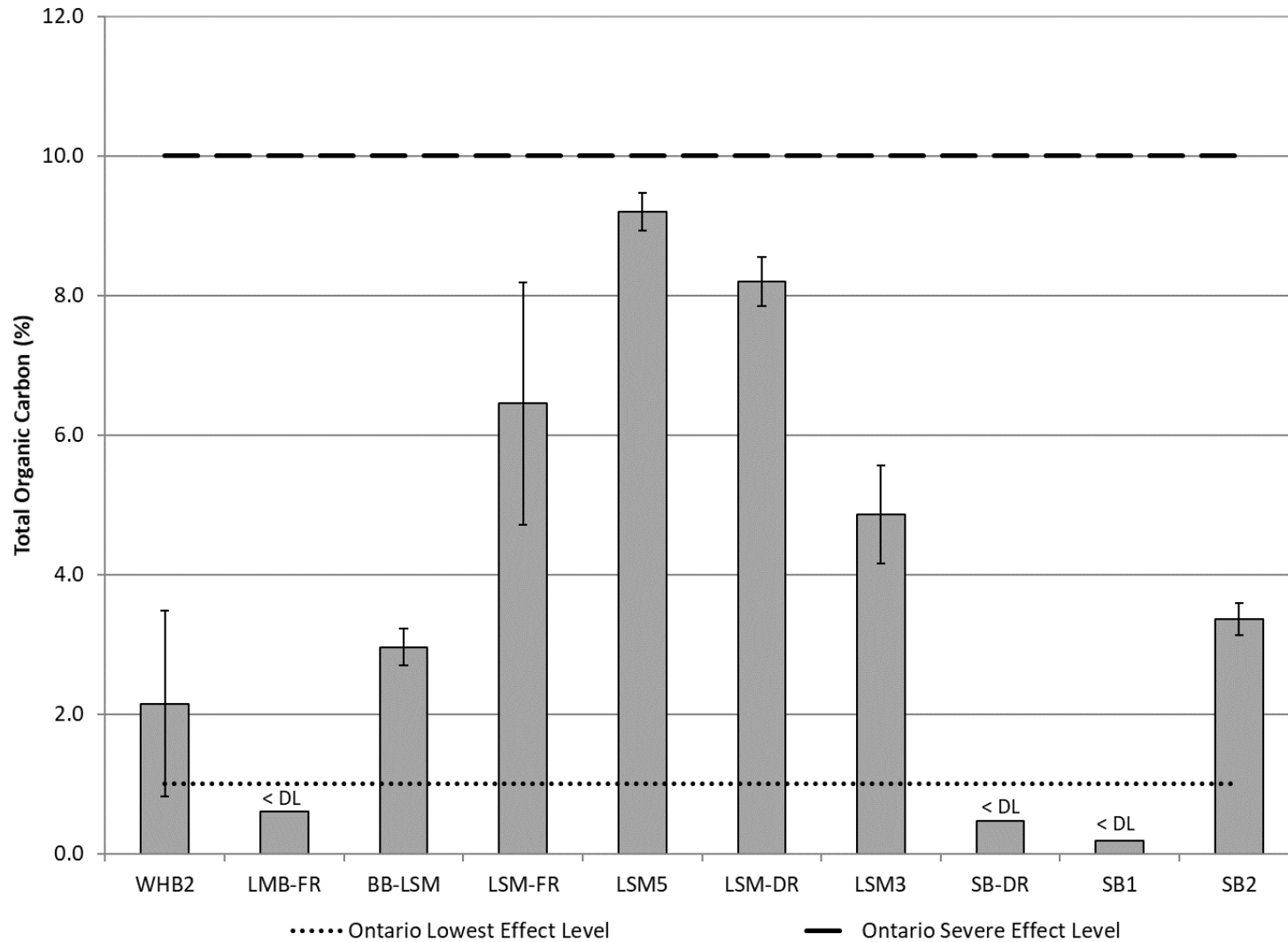


Figure 4. Mean (\pm SD) percent total organic carbon in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

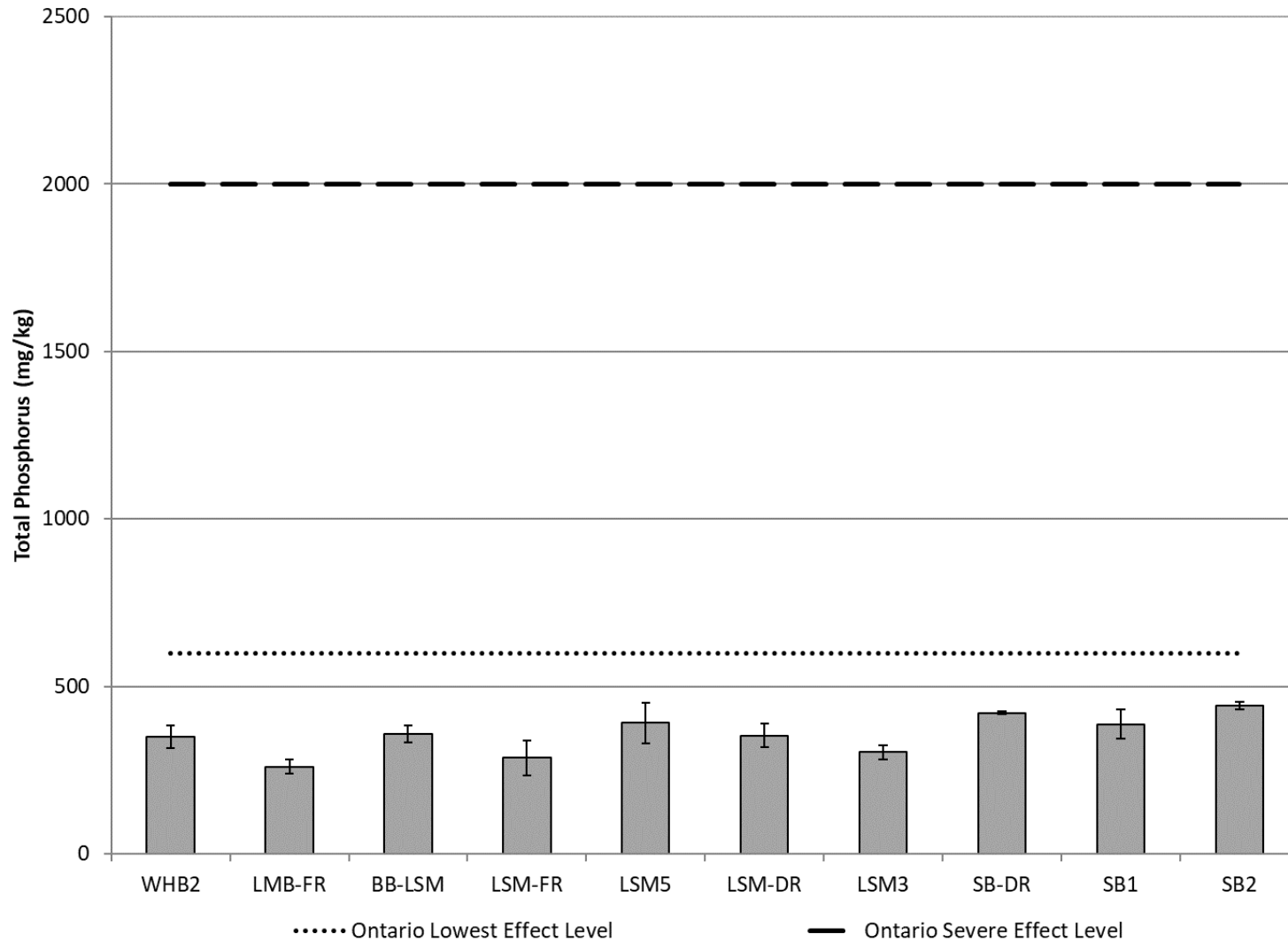


Figure 5. Mean (\pm SD) concentration of total phosphorus in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

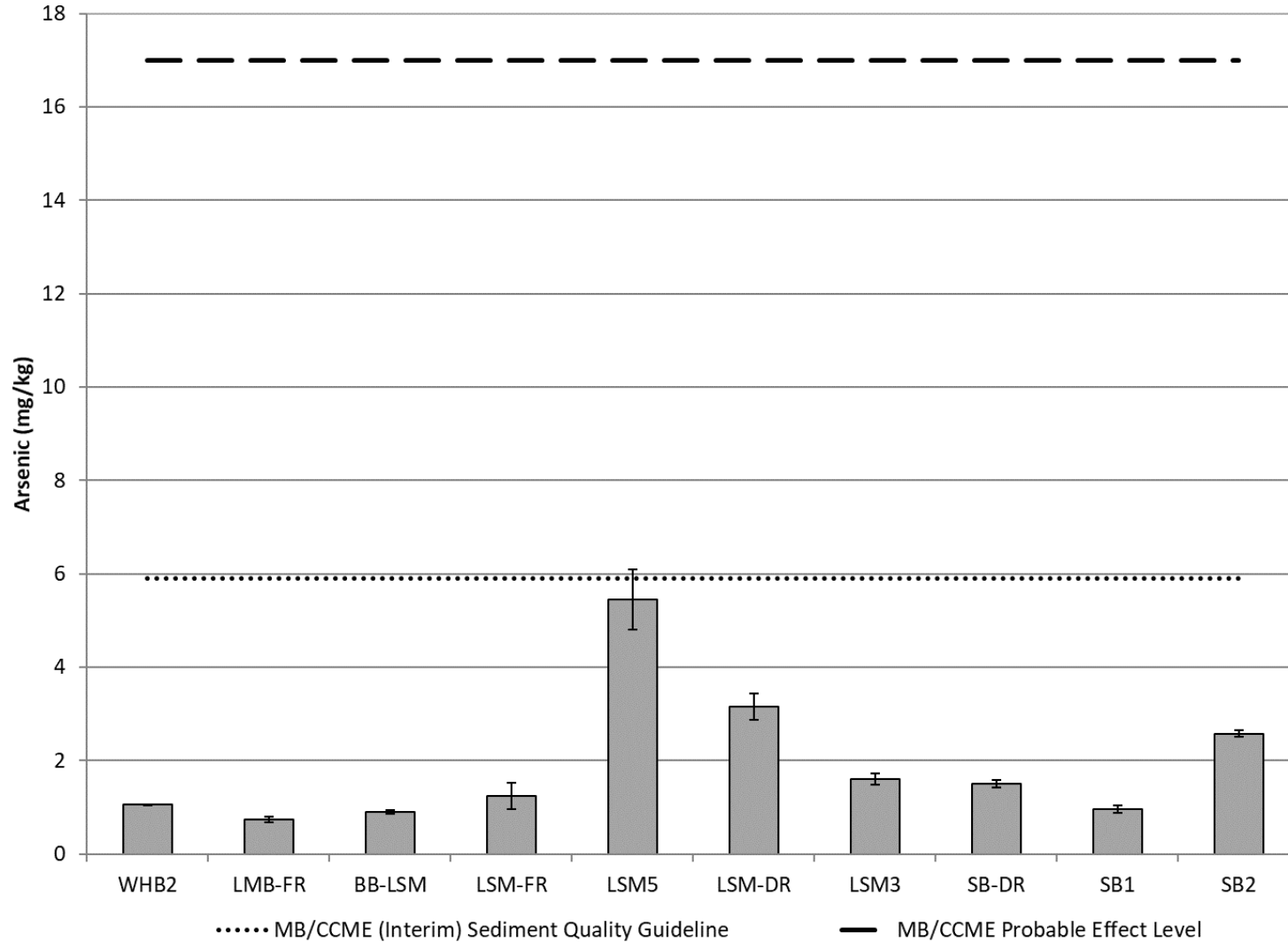


Figure 6. Mean (\pm SD) concentration of arsenic in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

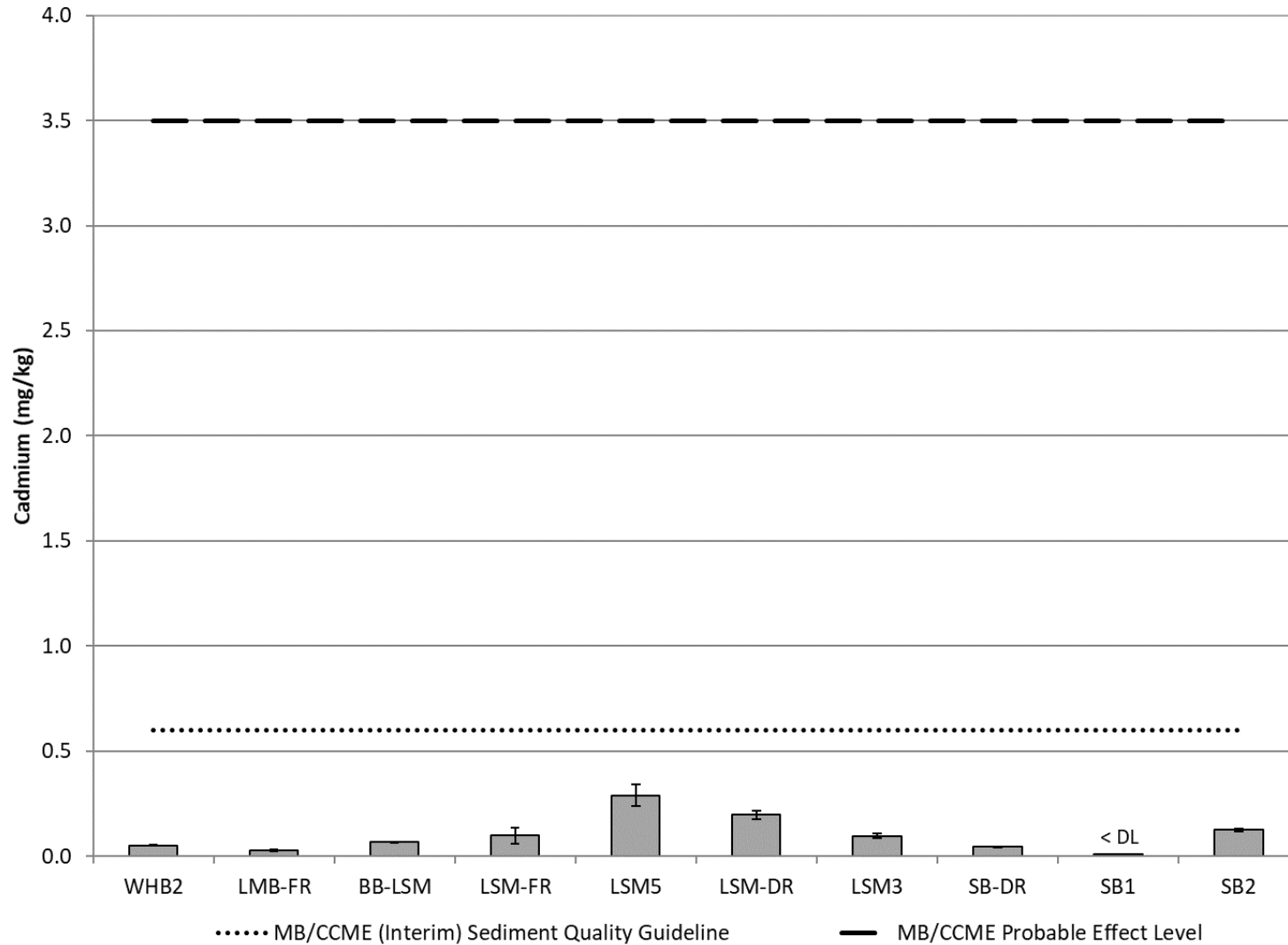


Figure 7. Mean (\pm SD) concentration of cadmium in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

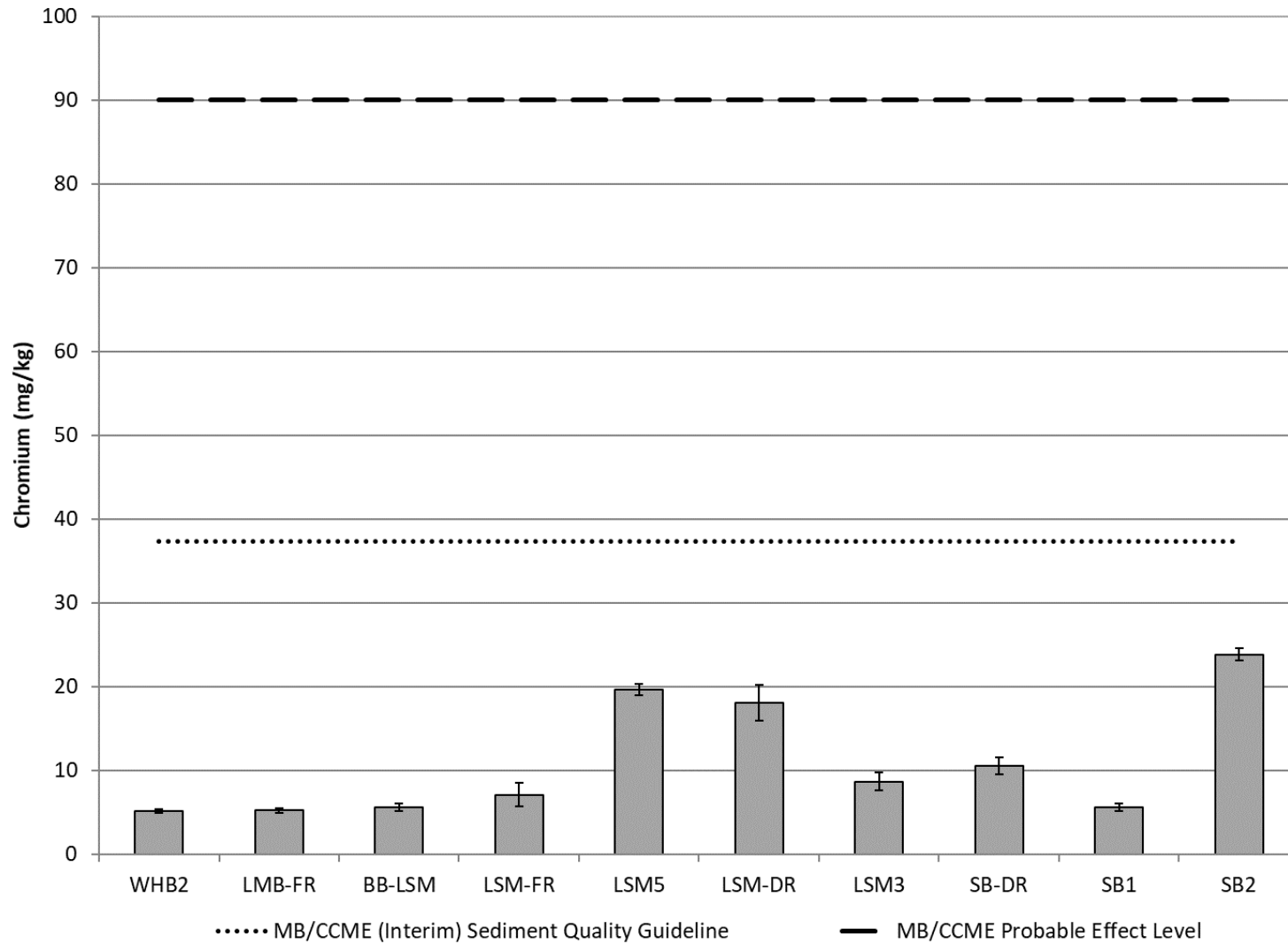


Figure 8. Mean (\pm SD) concentration of chromium in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

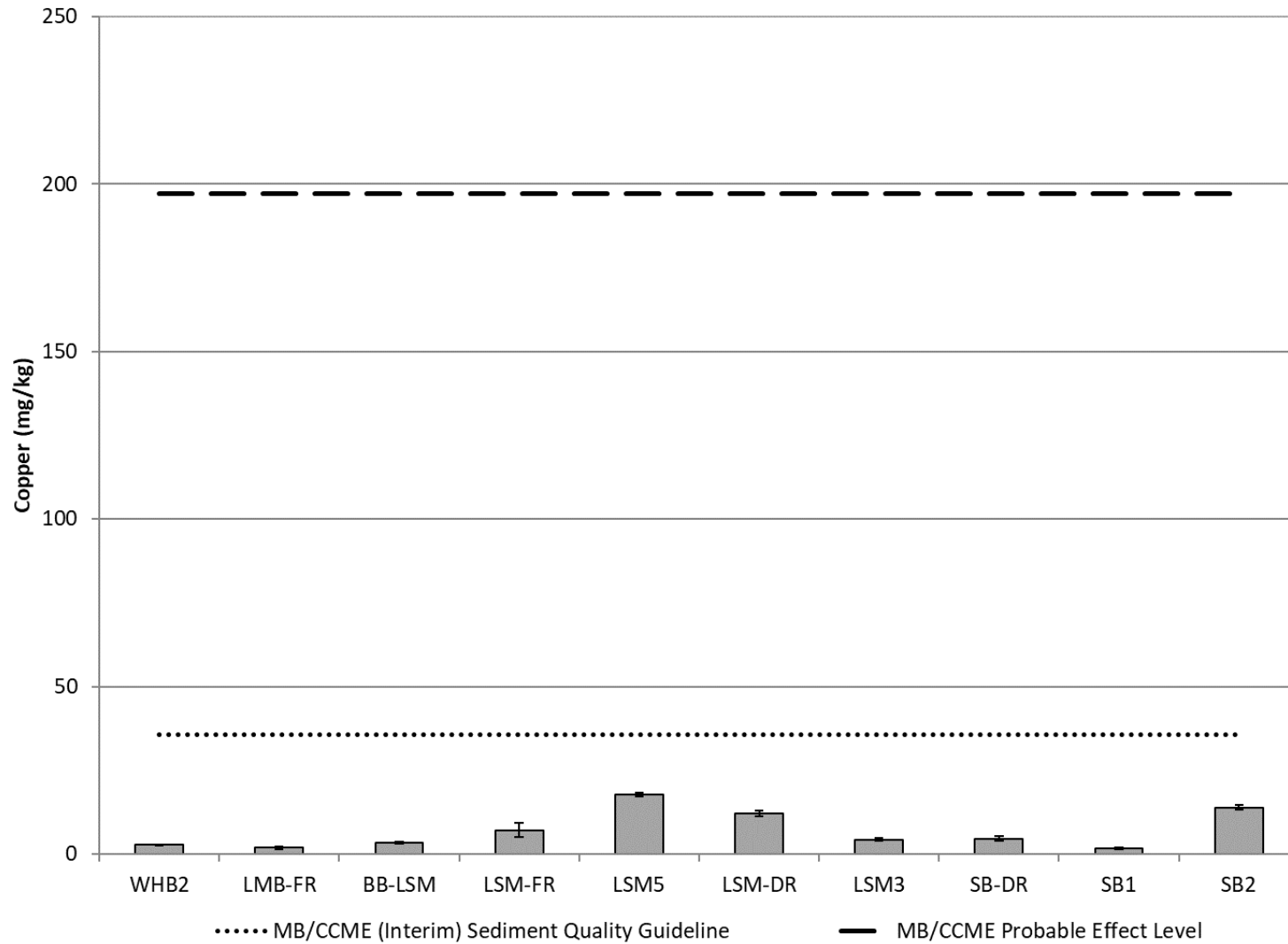


Figure 9. Mean (\pm SD) concentration of copper in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

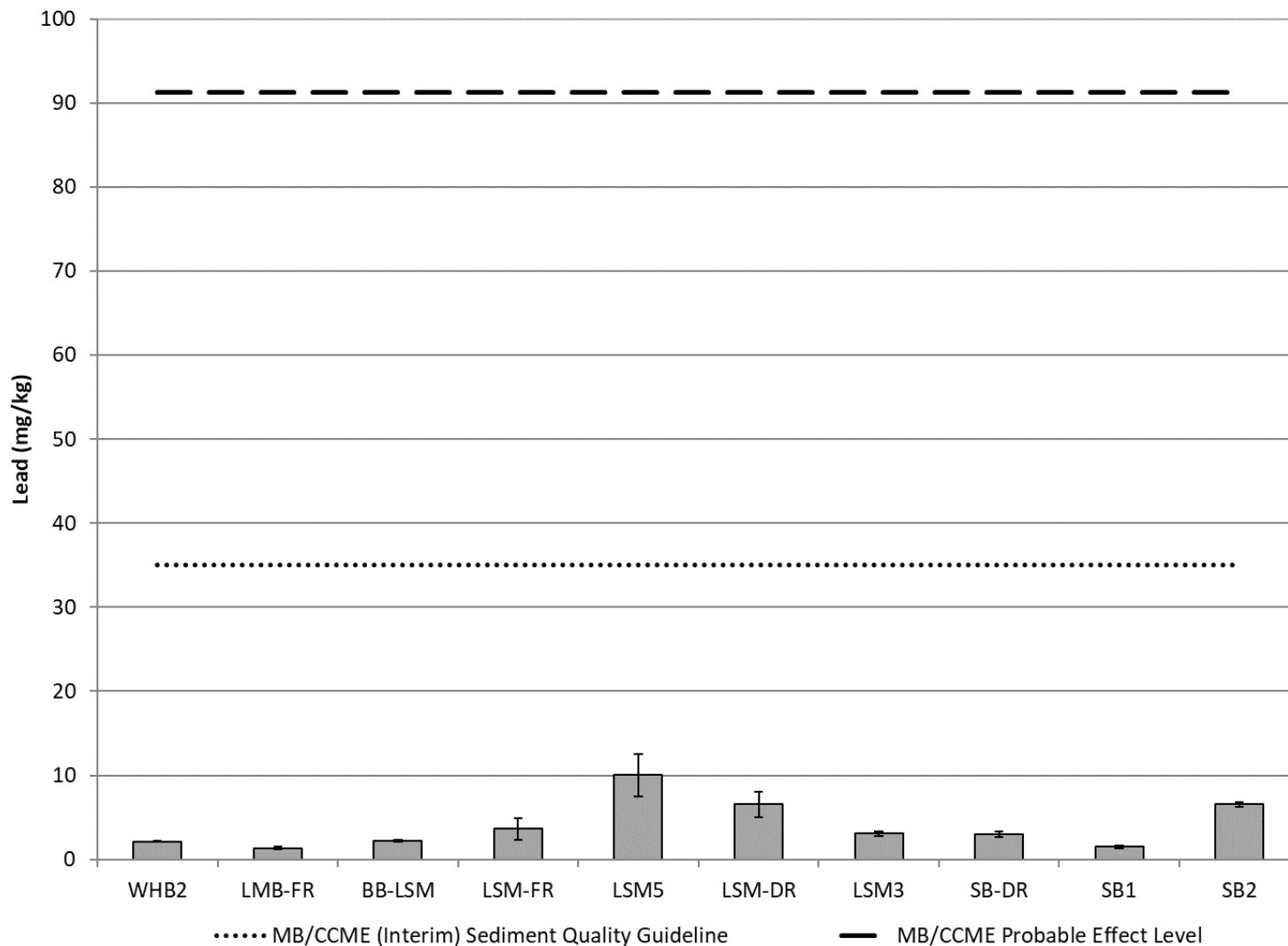


Figure 10. Mean (\pm SD) concentration of lead in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

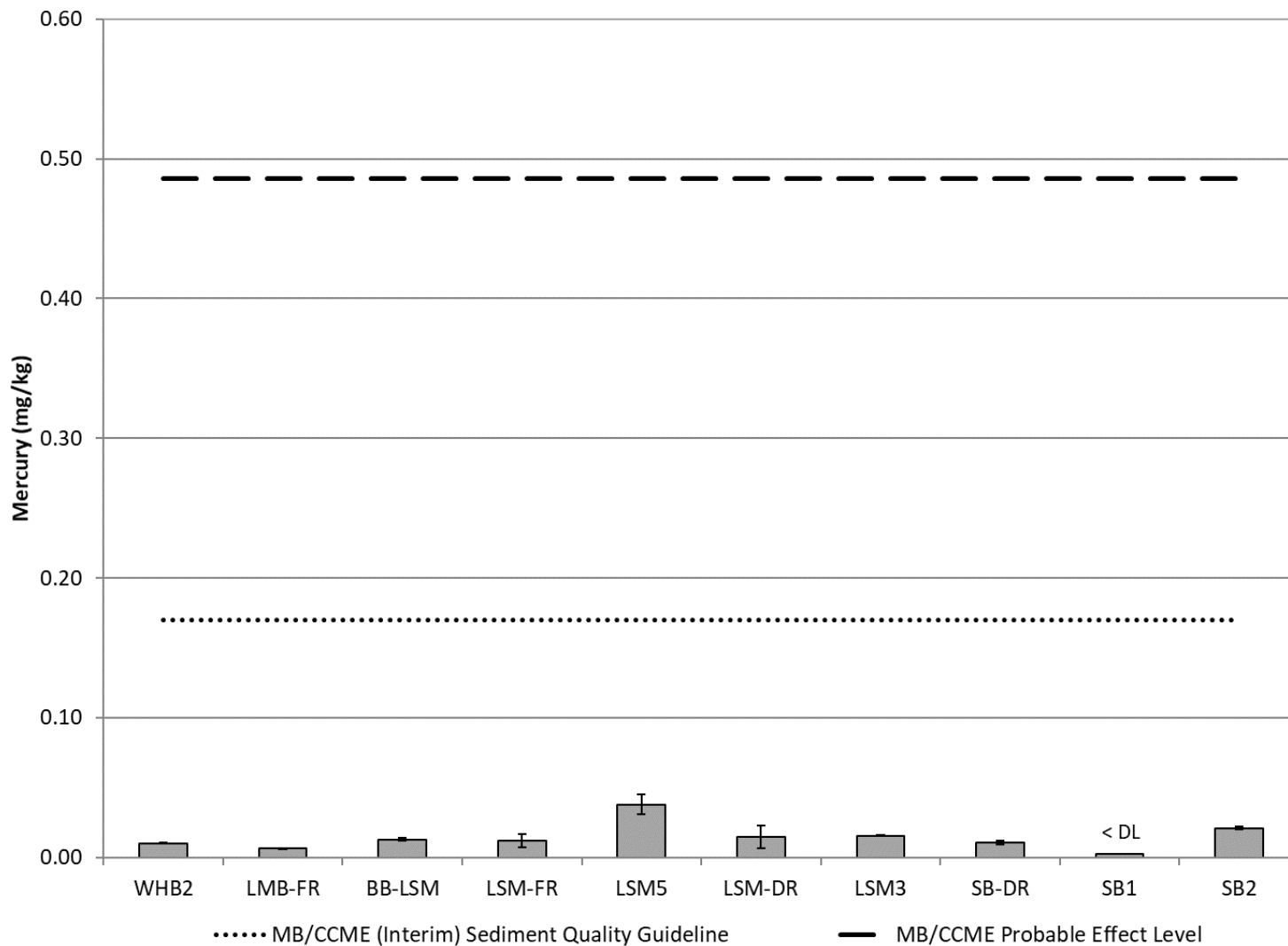


Figure 11. Mean (\pm SD) concentration of mercury in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

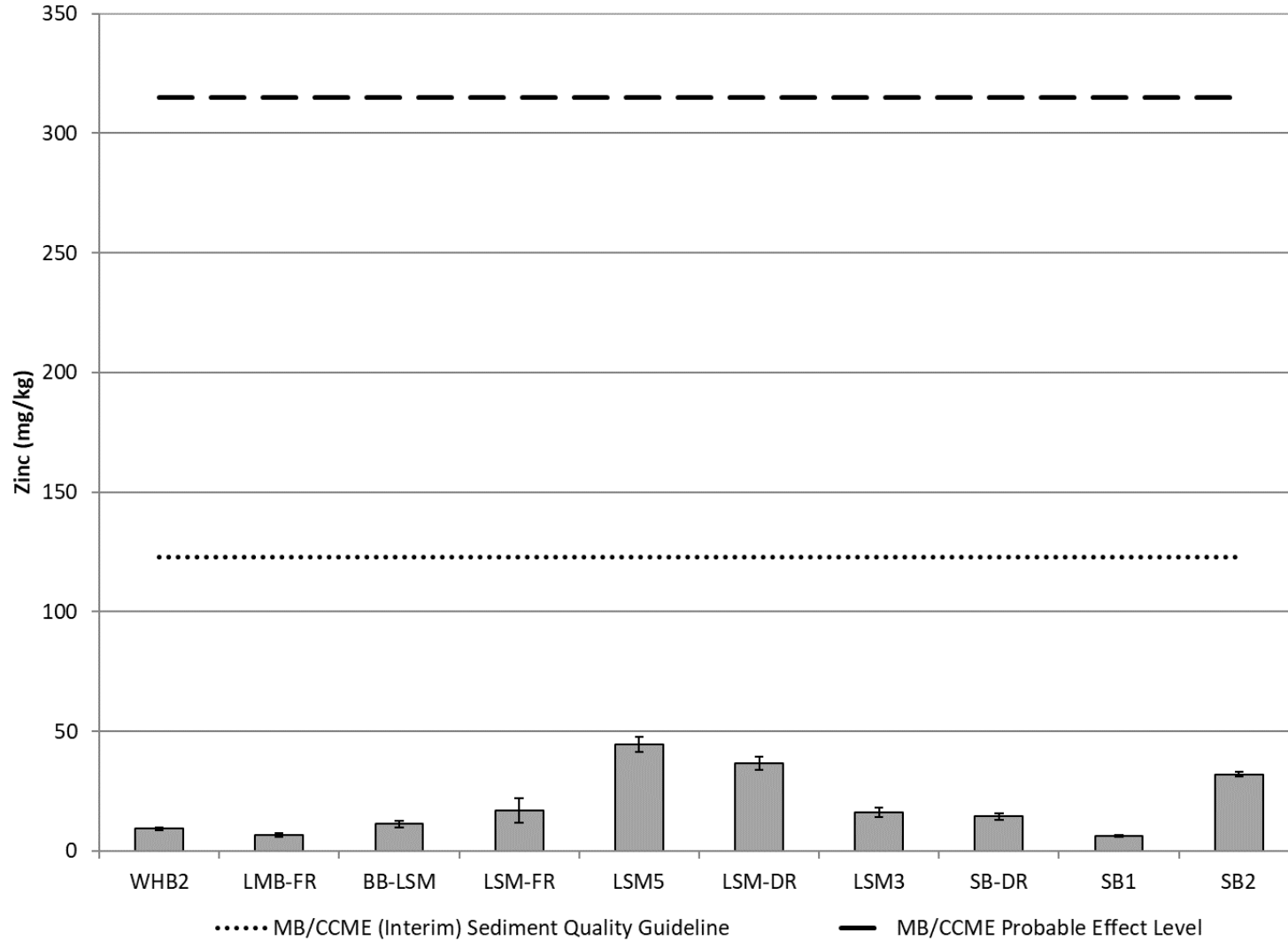


Figure 12. Mean (\pm SD) concentration of zinc in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to Manitoba/CCME sediment quality guidelines.

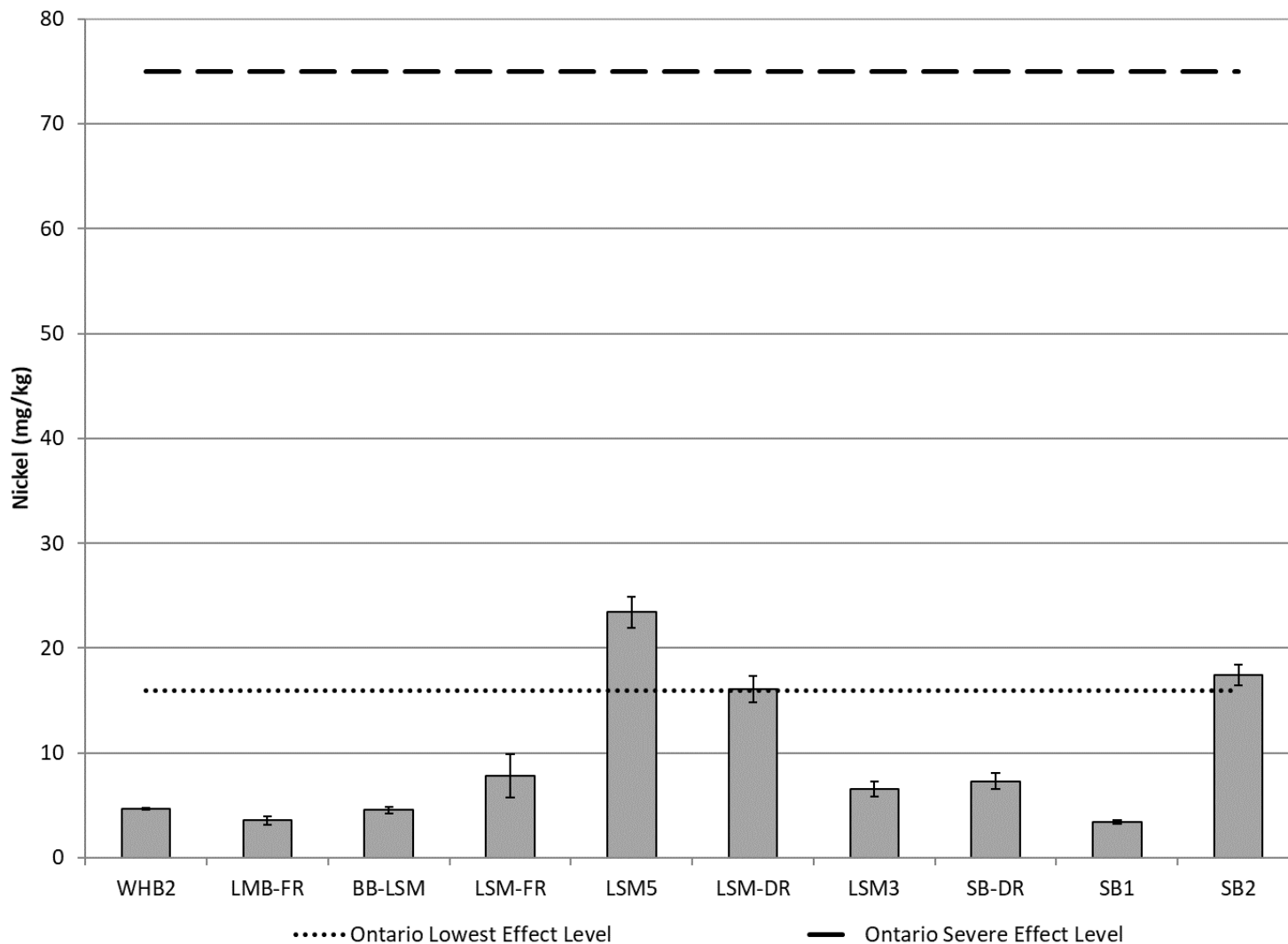


Figure 13. Mean (\pm SD) concentration of nickel in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

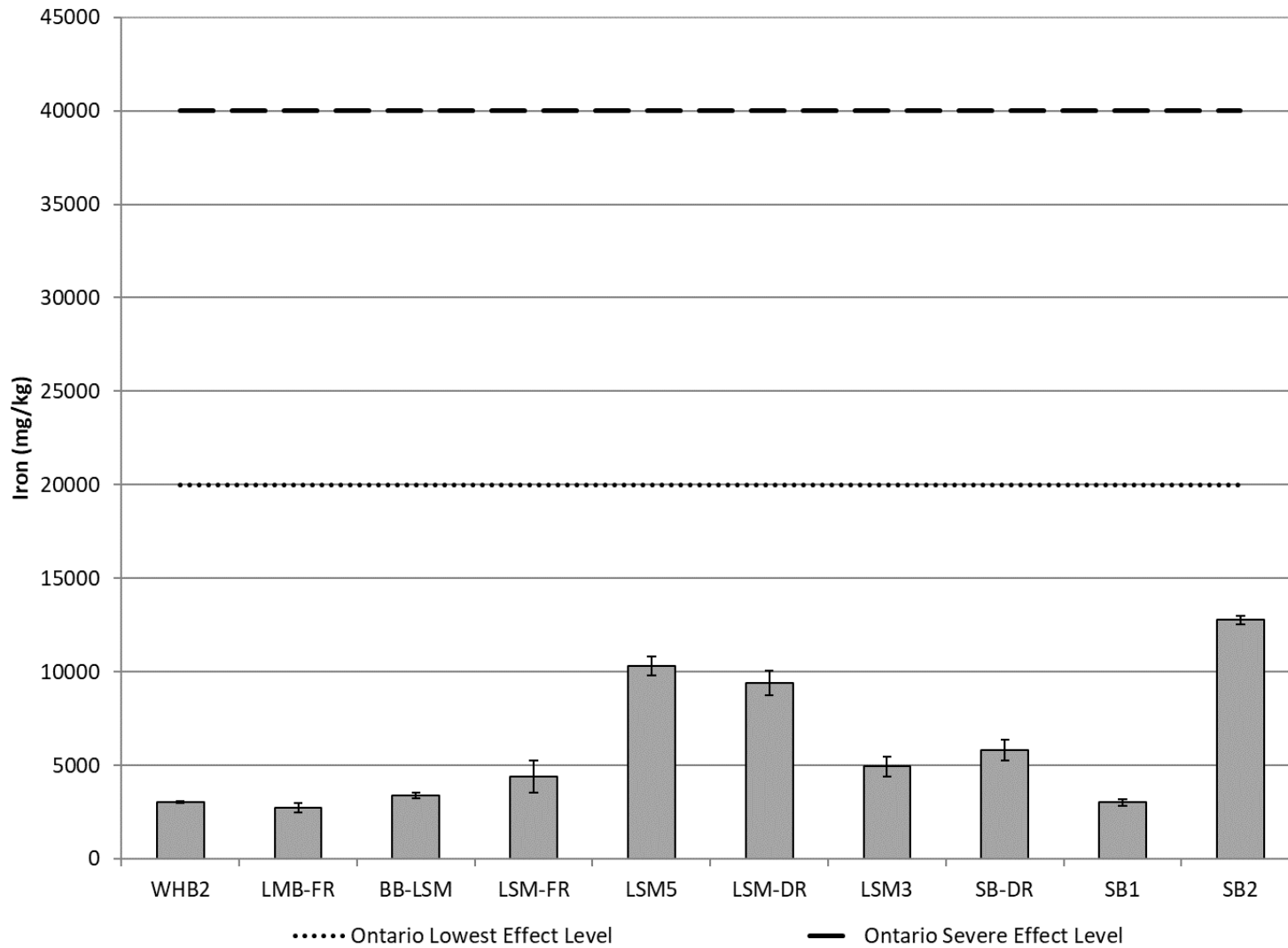


Figure 14. Mean (\pm SD) concentration of iron in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

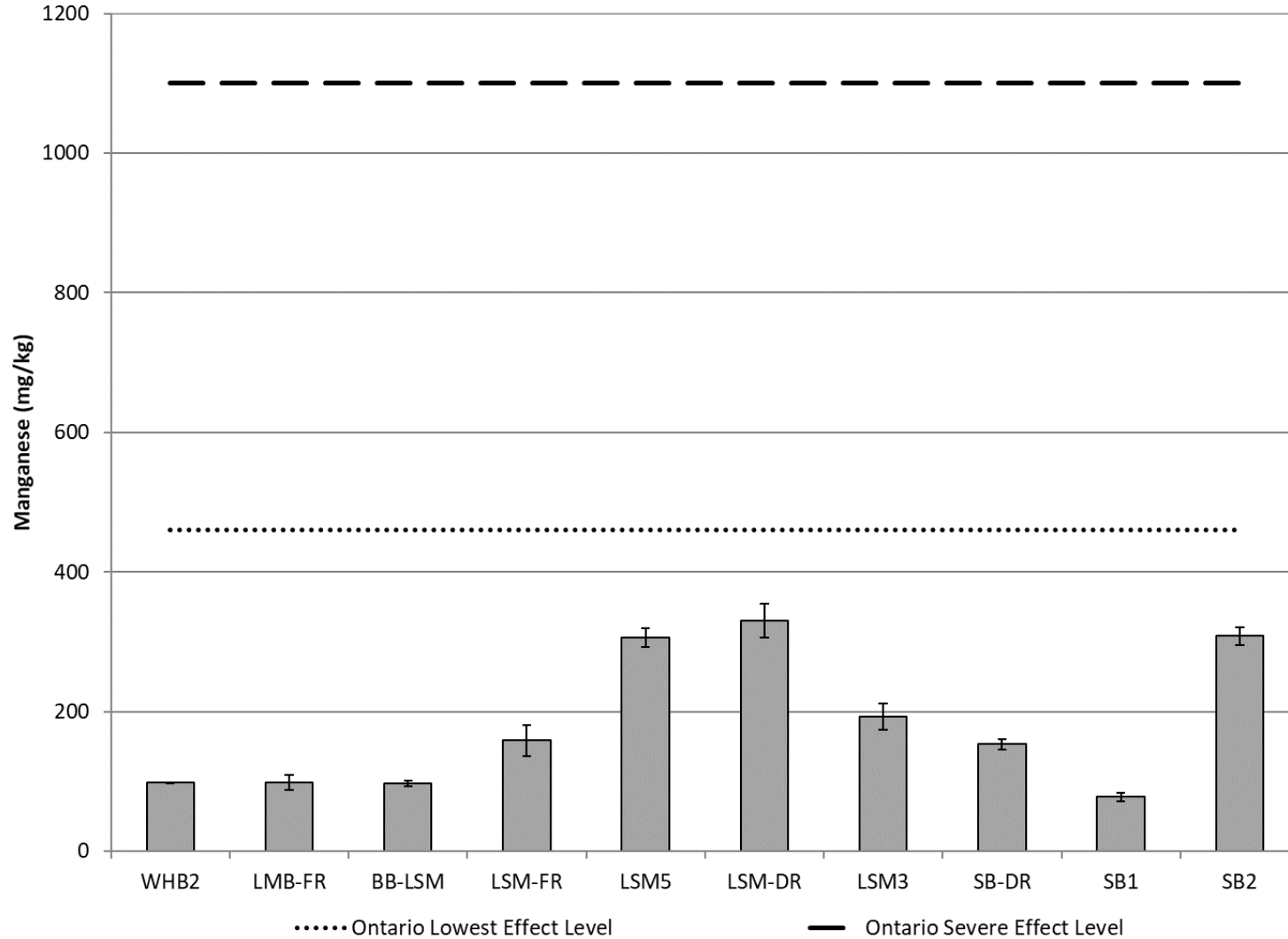


Figure 15. Mean (\pm SD) concentration of manganese in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the Ontario sediment quality guidelines.

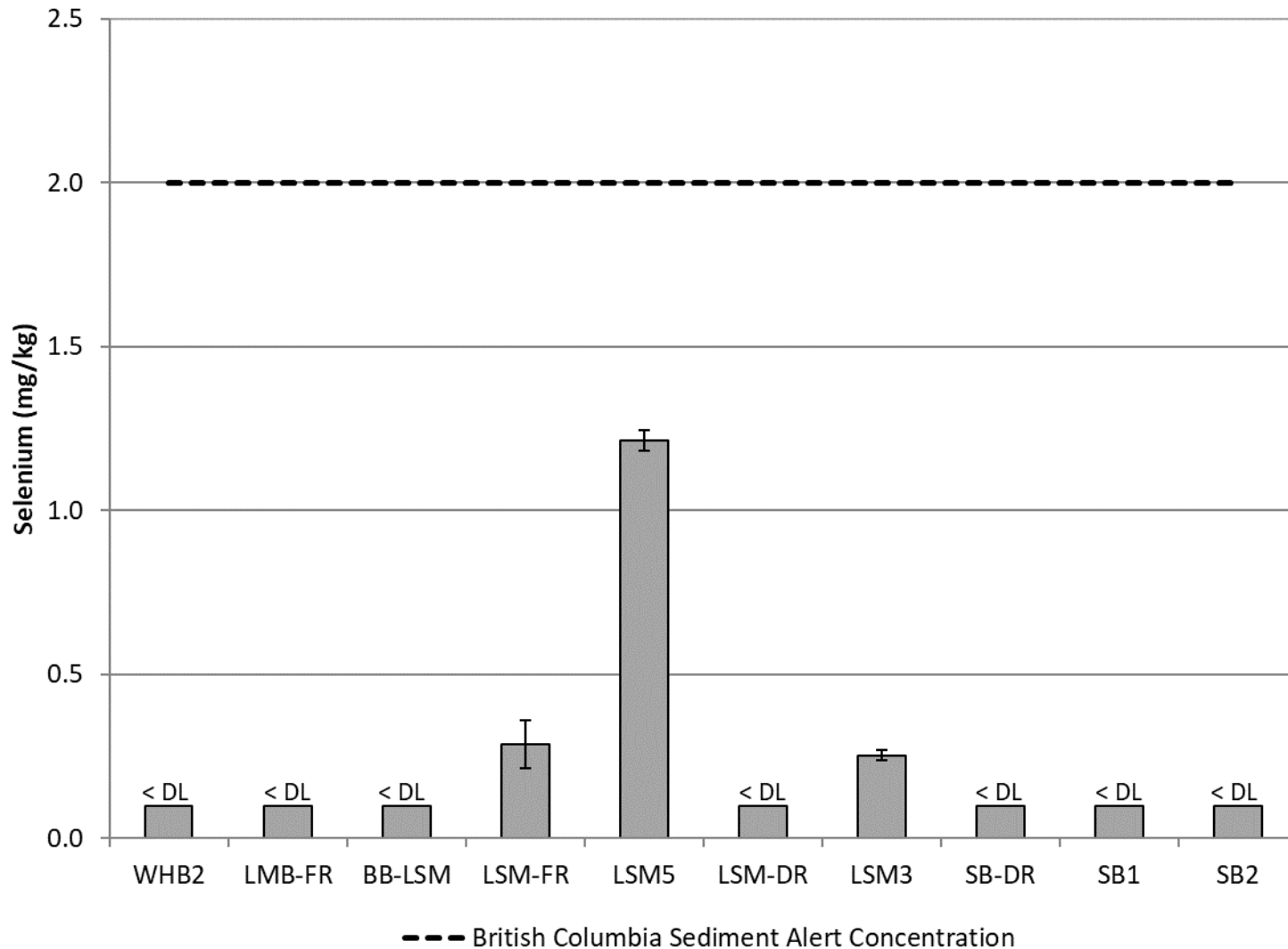


Figure 16. Mean (\pm SD) concentration of selenium in surficial sediments at sites sampled in Lake Manitoba, Lake St. Martin and Sturgeon Bay compared to the British Columbia sediment alert concentration.

APPENDIX 1. SEDIMENT SAMPLE FIELD DATA

Appendix 1. Supplemental field data for sediment samples collected.

Waterbody	Site ID	Sampling Date	Sampling Time	Sample ID	Sample UTM			Gear Type	Number of Grabs	Penetration Depth (cm)
					Zone	Easting	Northing			
Lake Manitoba	WHB2	8-Dec-20	9:20	WHB2-A	14U	529301	5681101	Ponar	3	4
				WHB2-B	14U	529307	5681098	Ponar	3	2-5
				WHB2-C	14U	529302	5681095	Ponar	3	2-4
	LMB-FR	9-Dec-20	8:50	LMB-FR-A	14U	516808	5713014	Ponar	6	2-4
				LMB-FR-B	14U	516808	5713007	Ponar	4	2-3
				LMB-FR-C	14U	516813	5713010	Ponar	4	2-5
Lake St. Martin	BB-LSM	13-Oct-20	12:20	BB-LSM-A	14U	534252	5704278	Ekman	3	~8
				BB-LSM-B	14U	534309	5704302	Ekman	3	10
				BB-LSM-C	14U	534344	5704292	Ekman	3	~8
	LSM-FR	13-Oct-20	15:50	LSM-FR-A	14U	528393	5716449	Ekman	3	15
				LSM-FR-B	14U	528384	5716416	Ekman	3	15
				LSM-FR-C	14U	528370	5716395	Ekman	3	6
	LSM5	9-Dec-20	13:25	LSM5-A	14U	536042	5724701	Ponar	3	5-8
				LSM5-B	14U	536037	5724707	Ponar	3	6-8
				LSM5-C	14U	536038	5724702	Ponar	3	6-8
	LSM-DR	20-Oct-21	11:30	LSM-DR-A	14U	547471	5740360	Ponar	3	8
				LSM-DR-B	14U	547472	5740365	Ponar	3	8
				LSM-DR-C	14U	547475	5740364	Ponar	3	8
	LSM3	11-Dec-20	11:50	LSM3-A	14U	555898	5737193	Ponar	3	4-6
				LSM3-B	14U	555895	5737189	Ponar	3	5
				LSM3-C	14U	555894	5737191	Ponar	3	5-6
Lake Winnipeg	SB-DR	10-Dec-20	15:05	SB-DR-A	14U	566734	5757357	Ponar	3	5-6
				SB-DR-B	14U	566736	5757358	Ponar	3	5-7
				SB-DR-C	14U	566732	5757356	Ponar	3	5-7
	SB1	10-Dec-20	12:50	SB1-A	14U	573475	5751448	Ponar	3	5
				SB1-B	14U	573473	5751446	Ponar	3	4-5
				SB1-C	14U	573477	5751448	Ponar	3	4-5
	SB2	10-Dec-20	9:55	SB2-A	14U	576810	5753558	Ponar	3	5-7
				SB2-B	14U	576815	5753555	Ponar	3	5-6
				SB2-C	14U	576812	5753558	Ponar	3	5-7

Appendix 1. Continued.

Waterbody	Site ID	Sample ID	Field Observations				
			Texture	Consistency	Colour	Odour	Comments
Lake Manitoba	WHB2	WHB2-A	chunky	soft	grey with brown silt	slight sulfur	60% SA/10% CL/5% SI/25% GR
		WHB2-B	chunky	soft/moderate	grey	strong sulfur	20% SA/20% CL/10% SI/50% GR
		WHB2-C	chunky	soft	grey	strong sulfur	40% SA/15% CL/5% SI/40% GR
	LMB-FR	LMB-FR-A	rocky	soft	grey	slight sulfur	20% SA/45% GR/30% CL/5% SI
		LMB-FR-B	rocky	hard	grey	slight sulfur	25% SA/50% GR/5% CO/5% SI
		LMB-FR-C	rocky	moderate	grey	none	55% GR/25% SA/30% CL/5% CO/5% SI
Lake St. Martin	BB-LSM	BB-LSM-A	clay/sand	uniform	grey/brown at surface	slight	small bivalve shells in sample
		BB-LSM-B	clay/sand	uniform	grey/brown at surface	smelly	small bivalve shells in sample
		BB-LSM-C	clay/sand	uniform	grey/brown at surface	smelly	small bivalve shells in sample
	LSM-FR	LSM-FR-A	clay	soft/runny	grey/black	stinky	plants
		LSM-FR-B	clay/sand	soft/runny	grey/black	stinky	some plants; more sand than clay
		LSM-FR-C	sand/silt	soft/runny	grey	n.r.	some snail shells; <i>Myriophyllum</i> ; ground is harder here.
	LSM5	LSM5-A	smooth	soft	grey	slight sulfur	30% CL/70% SI; dead pea clams and snail shells
		LSM5-B	smooth	soft	grey/brown	strong sulfur	30% CL/70% SI; chironomids
		LSM5-C	smooth	soft	grey	strong sulfur	30% CL/70% SI
	LSM-DR	LSM-DR-A	grainy	mucky, soft, runny	grey	slight sulfur	crushed shells, no vegetation
		LSM-DR-B	grainy	mucky, soft, runny	grey	slight sulfur	crushed shells incorporated into sediments, some vegetation and roots
		LSM-DR-C	grainy	mucky, soft, runny	grey	slight sulfur	some vegetation
	LSM3	LSM3-A	smooth	soft	grey	strong sulfur	40% SI/60% CL
		LSM3-B	smooth	soft	grey	strong sulfur	40% SI/60% CL
		LSM3-C	smooth	soft	grey	strong sulfur	50% CL/45% SI/5% SA
Lake Winnipeg	SB-DR	SB-DR-A	grainy	moderate	grey, brown silt on top	n.r.	30% SA/20% SI/50% CL
		SB-DR-B	grainy	moderate	grey, brown silt on top	n.r.	20% SA/40% SI/40% CL
		SB-DR-C	grainy	soft	grey/brown	n.r.	40% SI/50% CL/10% SA
	SB1	SB1-A	moderate	uniform	grey	none	live/dead zebra mussels; 90% SA/10% SI
		SB1-B	moderate	n.r.	grey	n.r.	few live zebra mussels; 90% SA/10% SI
		SB1-C	moderate	sandy	grey/brown	n.r.	few small zebra mussels; 90% SA/10% SI
	SB2	SB2-A	smooth	moderate	grey/brown	n.r.	40% SI/60% CL; ~10 zebra mussels
		SB2-B	smooth	soft/moderate	grey/brown	n.r.	30% SI/70% CL
		SB2-C	smooth	soft/moderate	grey/brown	n.r.	30% SI/70% CL

n.r. = not recorded; CL = clay; SI = silt; SA = sand; GR = gravel; and CO = cobble

APPENDIX 2. RAW LABORATORY RESULTS

Appendix 2. Raw laboratory results for sediment samples collected.

Waterbody	Site ID	Sampling Date	Sampling Time	ALS Report ID	Sample ID	Moisture (%)	Particle Size			Texture
							% Sand (2.0mm - 0.05mm) (%)	% Silt (0.05mm – 2µm) (%)	% Clay (<2µm) (%)	
<i>Analytical Detection Limit</i>						0.10	1.0	1.0	1.0	n/a
Lake Manitoba	WHB2	8-Dec-20	9:20	L2541414-1	WHB2-A	38.1	87.1	11.9	<1.0	Sand
				L2541414-2	WHB2-B	21.6	93.4	6.0	<1.0	Sand
				L2541414-3	WHB2-C	36.4	92.8	6.4	<1.0	Sand
	LMB-FR	9-Dec-20	8:50	L2541414-19	LMB-FR-A	31.3	95.3	4.7	<1.0	Sand
				L2541414-20	LMB-FR-B	37.0	97.5	2.3	<1.0	Sand
				L2541414-21	LMB-FR-C	34.9	93.9	5.8	<1.0	Sand
Lake St. Martin	BB-LSM	13-Oct-20	12:20	L2520956-1	BB-LSM-A	43.4	91.5	8.4	<1.0	Sand
				L2520956-2	BB-LSM-B	48.8	85.2	14.6	<1.0	Sand/Loamy sand
				L2520956-3	BB-LSM-C	47.0	89.5	10.4	<1.0	Sand
	LSM-FR	13-Oct-20	15:50	L2520956-4	LSM-FR-A	80.7	41.8	55.8	2.4	Silt loam
				L2520956-5	LSM-FR-B	76.4	62.7	36.7	<1.0	Sandy loam
				L2520956-6	LSM-FR-C	56.2	77.5	22.1	<1.0	Loamy sand
	LSM5	9-Dec-20	13:25	L2541414-4	LSM5-A	87.5	5.0	75.2	19.8	Silt loam
				L2541414-5	LSM5-B	88.5	5.5	77.1	17.4	Silt loam
				L2541414-6	LSM5-C	87.8	<1.0	85.2	14.2	Silt loam
LSM-DR	20-Oct-21	11:30	L2653781-1	LSM-DR-A	75.1	10.6	71.7	17.8	Silt loam	
			L2653781-2	LSM-DR-B	77.6	6.9	66.1	27.0	Silt loam	
			L2653781-3	LSM-DR-C	77.5	7.5	69.8	22.6	Silt loam	
LSM3	11-Dec-20	11:50	L2541414-7	LSM3-A	59.8	27.2	69.6	3.2	Silt loam	
			L2541414-8	LSM3-B	63.9	37.3	59.3	3.3	Silt loam	
			L2541414-9	LSM3-C	63.5	36.5	61.1	2.4	Silt loam	
Lake Winnipeg	SB-DR	10-Dec-20	15:05	L2541414-10	SB-DR-A	35.0	84.6	12.2	3.2	Loamy sand
				L2541414-11	SB-DR-B	37.1	77.8	18.6	3.6	Loamy sand
				L2541414-12	SB-DR-C	43.6	74.5	21.6	3.9	Loamy sand
	SB1	10-Dec-20	12:50	L2541414-13	SB1-A	24.7	96.5	1.4	2.1	Sand
				L2541414-14	SB1-B	26.7	96.7	1.7	1.6	Sand
				L2541414-15	SB1-C	24.1	96.7	1.8	1.6	Sand
	SB2	10-Dec-20	9:55	L2541414-16	SB2-A	51.7	10.2	71.2	18.6	Silt loam
				L2541414-17	SB2-B	52.3	17.9	72.4	9.7	Silt loam
				L2541414-18	SB2-C	50.5	8.5	72.8	18.6	Silt loam

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Nitrogen				Carbon			
			Nitrate/ Nitrite (mg N/kg)	Nitrate (mg N/kg)	Nitrite (mg N/kg)	Total Kjeldahl Nitrogen (%)	Inorganic Carbon (%)	Inorganic Carbon (as CaCO ₃ Equivalent) (%)	Total Organic Carbon (%)	Total Carbon (%)
<i>Analytical Detection Limit</i>			1.0	1.1	0.40	0.020/0.040/0.10	0.050	0.40	various	0.05
Lake Manitoba	WHB2	WHB2-A	2.1	<1.1	1.39	0.075	3.28	27.3	2.6	5.89
		WHB2-B	1.8	<1.1	1.04	0.065	5.57	46.4	<1.3	6.29
		WHB2-C	1.9	<1.1	1.13	0.076	3.28	27.3	3.2	6.43
	LMB-FR	LMB-FR-A	2.0	<1.1	1.57	0.045	6.70	55.8	<1.2	6.20
		LMB-FR-B	2.0	<1.1	1.63	0.052	5.53	46.1	<1.2	5.86
		LMB-FR-C	2.0	<1.1	1.58	0.052	5.26	43.8	<1.3	6.25
Lake St. Martin	BB-LSM	BB-LSM-A	1.6	<1.1	1.10	0.135	1.45	12.1	2.67	4.12
		BB-LSM-B	1.3	<1.1	0.89	0.161	1.69	14.1	3.18	4.87
		BB-LSM-C	1.2	<1.1	0.73	0.151	1.69	14.0	3.03	4.72
	LSM-FR	LSM-FR-A	1.8	<1.1	1.00	0.59	3.34	27.8	8.3	11.6
		LSM-FR-B	1.2	<1.1	0.78	0.40	3.26	27.1	6.3	9.54
		LSM-FR-C	1.7	<1.1	1.32	0.22	3.10	25.8	4.8	7.89
	LSM5	LSM5-A	3.7	1.2	2.48	0.72	6.05	50.4	8.9	14.9
		LSM5-B	3.7	<1.1	2.66	0.67	5.38	44.8	9.4	14.8
		LSM5-C	4.4	1.1	3.31	0.88	5.56	46.3	9.3	14.9
	LSM-DR	LSM-DR-A	1.4	<1.1	0.97	0.50	6.11	50.9	7.8	13.9
		LSM-DR-B	<1.0	<1.0	0.65	0.70	5.89	49.0	8.5	14.4
		LSM-DR-C	1.6	<1.1	1.19	0.53	5.86	48.8	8.2	14.1
	LSM3	LSM3-A	3.4	<1.1	2.44	0.217	5.55	46.2	4.2	9.7
		LSM3-B	3.7	<1.1	2.81	0.243	4.94	41.1	4.8	9.7
		LSM3-C	3.8	<1.1	2.99	0.218	4.39	36.5	5.6	10.0
Lake Winnipeg	SB-DR	SB-DR-A	3.0	1.6	1.32	0.051	3.52	29.3	<0.83	4.17
		SB-DR-B	4.1	2.3	1.77	0.063	4.45	37.1	<0.87	4.35
		SB-DR-C	6.4	4.6	1.81	0.072	2.85	23.8	1.81	4.66
	SB1	SB1-A	1.7	<1.1	1.08	0.030	2.23	18.6	<0.36	1.79
		SB1-B	1.5	<1.1	0.92	0.030	1.32	11.0	0.45	1.77
		SB1-C	1.4	<1.1	0.90	0.029	1.63	13.6	<0.37	1.87
	SB2	SB2-A	4.0	2.0	1.99	0.159	4.41	36.7	3.1	7.50
		SB2-B	3.4	1.7	1.73	0.147	3.81	31.8	3.5	7.34
		SB2-C	3.1	<1.1	2.27	0.114	3.80	31.7	3.5	7.30

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals									
			Aluminum (Al) (mg/kg)	Antimony (Sb) (mg/kg)	Arsenic (As) (mg/kg)	Barium (Ba) (mg/kg)	Beryllium (Be) (mg/kg)	Bismuth (Bi) (mg/kg)	Boron (B) (mg/kg)	Cadmium (Cd) (mg/kg)	Calcium (Ca) (mg/kg)	Chromium (Cr) (mg/kg)
<i>Analytical Detection Limit</i>			50	0.10	0.10	0.50	0.10	0.20	5.0	0.020	50	0.50
Lake Manitoba	WHB2	WHB2-A	2220	<0.10	1.06	29.8	<0.10	<0.20	13.5	0.054	62800	5.07
		WHB2-B	2200	<0.10	1.05	28.3	<0.10	<0.20	13.1	0.053	64800	5.10
		WHB2-C	2400	<0.10	1.06	30.5	<0.10	<0.20	14.9	0.048	66500	5.42
	LMB-FR	LMB-FR-A	2170	<0.10	0.74	23.1	<0.10	<0.20	8.0	0.032	70600	5.47
		LMB-FR-B	2080	<0.10	0.67	19.7	<0.10	<0.20	7.9	0.023	67600	4.94
		LMB-FR-C	2250	<0.10	0.80	28.4	<0.10	<0.20	9.6	0.032	82800	5.39
Lake St. Martin	BB-LSM	BB-LSM-A	2380	<0.10	0.86	22.6	<0.10	<0.20	8.8	0.064	65800	5.20
		BB-LSM-B	2530	<0.10	0.93	24.9	<0.10	<0.20	9.6	0.070	69700	6.10
		BB-LSM-C	2450	<0.10	0.93	24.2	<0.10	<0.20	9.3	0.067	69400	5.68
	LSM-FR	LSM-FR-A	2890	<0.10	1.56	76.2	0.15	<0.20	16.2	0.130	122000	8.02
		LSM-FR-B	2080	<0.10	1.15	61.9	0.12	<0.20	13.8	0.105	115000	5.49
		LSM-FR-C	2740	<0.10	1.01	65.2	0.12	<0.20	13.1	0.058	131000	7.79
	LSM5	LSM5-A	7150	0.36	4.73	141	0.27	<0.20	26.0	0.230	208000	19.2
		LSM5-B	7590	0.42	5.65	145	0.30	<0.20	27.1	0.312	200000	19.3
		LSM5-C	8610	0.47	5.98	157	0.30	<0.20	29.9	0.324	206000	20.4
	LSM-DR	LSM-DR-A	8120	0.18	3.26	206	0.32	<0.20	28.1	0.217	266000	19.8
		LSM-DR-B	7700	0.17	3.36	193	0.24	<0.20	26.8	0.199	260000	18.7
		LSM-DR-C	6680	0.14	2.83	179	0.26	<0.20	25.2	0.177	280000	15.7
	LSM3	LSM3-A	3580	<0.10	1.50	56.0	0.12	<0.20	14.7	0.088	140000	7.61
		LSM3-B	4060	<0.10	1.58	62.7	0.13	<0.20	17.3	0.095	158000	8.67
		LSM3-C	4560	<0.10	1.74	71.2	0.15	<0.20	19.0	0.107	167000	9.80
Lake Winnipeg	SB-DR	SB-DR-A	3880	<0.10	1.60	22.3	0.13	<0.20	10.1	0.045	73600	9.52
		SB-DR-B	4270	<0.10	1.44	26.0	0.15	<0.20	9.6	0.045	62800	10.6
		SB-DR-C	4800	<0.10	1.50	29.2	0.16	<0.20	10.8	0.043	71000	11.6
	SB1	SB1-A	2450	<0.10	0.95	12.0	<0.10	<0.20	5.8	<0.020	30700	5.79
		SB1-B	2260	<0.10	0.89	10.3	<0.10	<0.20	5.9	<0.020	30500	5.17
		SB1-C	2630	<0.10	1.05	12.2	<0.10	<0.20	6.3	<0.020	32100	5.91
	SB2	SB2-A	9860	0.13	2.59	67.9	0.37	<0.20	14.0	0.127	85000	23.7
		SB2-B	10600	0.13	2.65	70.3	0.36	<0.20	14.8	0.129	89300	24.7
		SB2-C	9730	0.14	2.50	62.6	0.33	<0.20	14.4	0.117	91000	23.2

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals									
			Cobalt (Co) (mg/kg)	Copper (Cu) (mg/kg)	Iron (Fe) (mg/kg)	Lead (Pb) (mg/kg)	Lithium (Li) (mg/kg)	Magnesium (Mg) (mg/kg)	Manganese (Mn) (mg/kg)	Mercury (Hg) (mg/kg)	Molybdenum (Mo) (mg/kg)	Nickel (Ni) (mg/kg)
<i>Analytical Detection Limit</i>			<i>0.10</i>	<i>0.50</i>	<i>50</i>	<i>0.50</i>	<i>2.0</i>	<i>20</i>	<i>1.0</i>	<i>0.0050/0.010</i>	<i>0.10</i>	<i>0.50</i>
Lake Manitoba	WHB2	WHB2-A	1.33	2.93	2980	2.24	3.5	20800	97.3	0.0103	0.33	4.61
		WHB2-B	1.37	2.91	3070	2.11	3.8	23100	97.1	0.0105	0.30	4.69
		WHB2-C	1.34	2.86	3060	2.07	3.8	22000	99.3	0.0102	0.34	4.75
	LMB-FR	LMB-FR-A	1.18	2.13	2670	1.31	3.6	27700	94.8	0.0066	0.23	3.68
		LMB-FR-B	1.13	1.46	2530	1.21	3.8	27600	90.5	0.0062	0.22	3.13
		LMB-FR-C	1.34	2.19	3020	1.56	4.3	30000	110	0.0067	0.30	3.95
Lake St. Martin	BB-LSM	BB-LSM-A	1.55	3.01	3240	2.08	4.4	26700	92.2	0.0118	0.16	4.26
		BB-LSM-B	1.68	3.55	3520	2.28	4.7	29100	100	0.0141	0.18	4.85
		BB-LSM-C	1.60	3.31	3430	2.26	4.6	29300	98.0	0.0134	0.18	4.56
	LSM-FR	LSM-FR-A	2.80	9.36	5380	4.86	6.9	28600	184	0.0176	0.53	10.2
		LSM-FR-B	1.85	6.81	3720	3.70	4.8	26000	147	0.0102	0.39	6.79
		LSM-FR-C	1.90	5.19	4130	2.28	5.7	28900	145	0.0084	0.39	6.48
	LSM5	LSM5-A	5.05	17.0	9810	7.23	11.6	20600	293	0.030	2.71	25.1
		LSM5-B	5.35	17.9	10300	10.8	11.4	20400	306	0.040	2.73	22.3
		LSM5-C	5.55	18.3	10800	12.1	12.6	20900	320	0.044	2.93	22.9
	LSM-DR	LSM-DR-A	4.38	12.6	9900	6.52	13.2	25200	340	<0.020	1.16	17.0
		LSM-DR-B	4.40	12.6	9670	8.00	13.4	28200	348	0.024	0.95	16.7
		LSM-DR-C	3.76	11.0	8640	5.07	12.5	24700	303	<0.020	0.84	14.7
	LSM3	LSM3-A	1.74	3.87	4410	2.79	6.2	47500	172	0.0162	0.43	5.86
		LSM3-B	1.94	4.26	4920	3.06	7.3	53800	198	0.0152	0.43	6.55
		LSM3-C	2.13	4.77	5490	3.32	8.1	54000	208	0.0162	0.51	7.34
Lake Winnipeg	SB-DR	SB-DR-A	3.07	3.84	5260	2.62	7.2	39700	146	0.0094	0.10	6.55
		SB-DR-B	3.33	4.93	5800	3.03	7.4	35600	153	0.0113	0.14	7.42
		SB-DR-C	3.52	5.12	6350	3.26	8.5	39400	161	0.0119	0.14	8.02
	SB1	SB1-A	1.53	1.81	3080	1.59	3.9	16900	78.3	<0.0050	<0.10	3.55
		SB1-B	1.36	1.42	2820	1.34	3.6	16400	72.1	<0.0050	<0.10	3.21
		SB1-C	1.55	1.76	3160	1.65	4.1	18000	84.3	<0.0050	<0.10	3.57
	SB2	SB2-A	6.19	14.3	12800	6.74	16.1	50900	302	0.0221	0.23	17.3
		SB2-B	6.43	14.4	13000	6.66	16.1	53600	323	0.0213	0.23	18.5
		SB2-C	5.97	13.0	12500	6.25	14.9	53700	300	0.0200	0.21	16.5

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals									
			Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Sulfur (S)	Thallium (Tl)	Tin (Sn)	Titanium (Ti)
			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
<i>Analytical Detection Limit</i>			50	100	0.20	0.10	50	0.50	1000	0.050	2.0	1.0
Lake Manitoba	WHB2	WHB2-A	340	490	0.20	<0.10	405	78.2	1200	0.064	<2.0	124
		WHB2-B	387	490	<0.20	<0.10	376	73.1	1300	0.069	<2.0	126
		WHB2-C	323	510	<0.20	<0.10	400	82.0	1300	0.063	<2.0	132
	LMB-FR	LMB-FR-A	239	440	<0.20	<0.10	312	68.1	<1000	0.056	<2.0	135
		LMB-FR-B	279	400	<0.20	<0.10	289	57.6	<1000	0.051	<2.0	151
		LMB-FR-C	263	520	<0.20	<0.10	411	81.7	<1000	0.052	<2.0	124
Lake St. Martin	BB-LSM	BB-LSM-A	336	500	<0.20	<0.10	323	63.7	1300	0.084	<2.0	123
		BB-LSM-B	384	570	0.23	<0.10	356	64.8	1400	0.085	<2.0	132
		BB-LSM-C	352	540	0.21	<0.10	323	67.3	1500	0.079	<2.0	126
	LSM-FR	LSM-FR-A	339	1080	0.37	<0.10	980	199	3000	0.062	<2.0	71.8
		LSM-FR-B	284	750	0.26	<0.10	789	183	2300	0.058	<2.0	65.1
		LSM-FR-C	235	820	0.23	<0.10	551	238	2400	0.075	<2.0	231
	LSM5	LSM5-A	322	2140	1.18	<0.10	1720	462	7000	0.162	<2.0	269
		LSM5-B	436	2270	1.22	<0.10	1700	446	7000	0.161	<2.0	275
		LSM5-C	413	2510	1.24	<0.10	1900	459	7100	0.173	<2.0	328
	LSM-DR	LSM-DR-A	333	2460	0.79	<0.10	1410	793	7100	0.136	<2.0	347
		LSM-DR-B	394	2330	0.77	<0.10	1470	740	6900	0.129	<2.0	319
		LSM-DR-C	333	2120	0.61	<0.10	1460	741	6000	0.134	<2.0	275
	LSM3	LSM3-A	283	910	0.24	<0.10	570	207	2200	0.065	<2.0	173
		LSM3-B	303	1040	0.25	<0.10	683	228	2400	0.075	<2.0	196
		LSM3-C	324	1160	0.27	<0.10	761	256	2800	0.081	<2.0	222
Lake Winnipeg	SB-DR	SB-DR-A	421	820	<0.20	<0.10	247	32.0	<1000	0.074	<2.0	248
		SB-DR-B	424	940	<0.20	<0.10	276	31.1	<1000	0.083	<2.0	265
		SB-DR-C	416	1070	<0.20	<0.10	310	35.2	<1000	0.093	<2.0	294
	SB1	SB1-A	419	410	<0.20	<0.10	115	18.3	<1000	<0.050	<2.0	263
		SB1-B	338	360	<0.20	<0.10	116	17.8	<1000	<0.050	<2.0	261
		SB1-C	405	440	<0.20	<0.10	127	19.6	<1000	<0.050	<2.0	298
	SB2	SB2-A	430	2180	0.22	<0.10	369	44.6	1300	0.151	<2.0	424
		SB2-B	451	2280	0.22	<0.10	406	44.8	1200	0.157	<2.0	467
		SB2-C	446	2140	<0.20	<0.10	377	45.4	1100	0.144	<2.0	452

Appendix 2. Continued.

Waterbody	Site ID	Sample ID	Metals				
			Tungsten (W) (mg/kg)	Uranium (U) (mg/kg)	Vanadium (V) (mg/kg)	Zinc (Zn) (mg/kg)	Zirconium (Zr) (mg/kg)
<i>Analytical Detection Limit</i>			<i>0.50</i>	<i>0.050</i>	<i>0.20</i>	<i>2.0</i>	<i>1.0</i>
Lake Manitoba	WHB2	WHB2-A	-	0.457	5.81	9.1	1.1
		WHB2-B	-	0.486	5.76	9.8	1.0
		WHB2-C	-	0.431	6.18	8.9	1.1
	LMB-FR	LMB-FR-A	-	0.399	5.60	6.8	1.1
		LMB-FR-B	-	0.378	5.20	6.1	1.1
		LMB-FR-C	-	0.342	5.92	7.7	1.4
Lake St. Martin	BB-LSM	BB-LSM-A	<0.50	0.358	5.69	12.7	1.2
		BB-LSM-B	<0.50	0.400	6.25	11.0	1.2
		BB-LSM-C	<0.50	0.405	6.10	10.1	1.2
	LSM-FR	LSM-FR-A	<0.50	0.786	8.43	22.7	1.6
		LSM-FR-B	<0.50	0.593	6.09	14.9	1.1
		LSM-FR-C	<0.50	0.774	7.69	13.0	1.6
	LSM5	LSM5-A	-	2.58	21.9	41.4	3.7
		LSM5-B	-	2.84	23.6	45.0	3.7
		LSM5-C	-	3.03	26.4	47.5	3.7
	LSM-DR	LSM-DR-A	<0.50	1.32	20.5	36.8	5.9
		LSM-DR-B	<0.50	1.17	19.3	39.2	5.0
		LSM-DR-C	<0.50	1.08	16.7	33.9	4.5
	LSM3	LSM3-A	-	0.601	9.13	14.3	1.8
		LSM3-B	-	0.617	10.1	16.0	1.9
		LSM3-C	-	0.711	11.6	18.2	2.3
Lake Winnipeg	SB-DR	SB-DR-A	-	0.425	10.7	12.9	2.9
		SB-DR-B	-	0.444	11.7	15.2	3.2
		SB-DR-C	-	0.532	13.1	15.5	3.5
	SB1	SB1-A	-	0.353	6.71	6.7	2.6
		SB1-B	-	0.303	6.17	5.7	2.3
		SB1-C	-	0.366	7.16	6.3	2.7
	SB2	SB2-A	-	0.966	26.0	31.8	9.2
		SB2-B	-	0.962	27.3	33.2	8.8
		SB2-C	-	0.920	25.6	31.4	8.5

APPENDIX 3. *IN SITU* WATER QUALITY DATA

Appendix 3. *In situ* water quality data collected during the sediment quality sampling program, fall 2020.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth ¹ (m)	Sample Depth ¹ (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH
Lake Manitoba	WHB2	8-Dec-20	9:20	0.00	0.4	1.8	0.3	1.5	13.69	98.1	1253	2.01	7.60
							1.0	2.7	13.41	99.4	1256	2.90	7.62
							1.5	3.3	13.77	104.0	1284	3.20	7.69
Lake Manitoba	LMB-FR	9-Dec-20	8:50	0.00	0.4	2.2	0.3	1.1	13.00	92.2	1214	2.41	8.11
							0.5	1.2	13.80	98.7	1203	2.64	8.10
							1.0	1.6	13.38	96.2	1202	3.04	8.08
							1.5	1.9	13.09	95.1	1196	3.09	8.08
							2.0	2.6	13.03	96.7	1230	3.33	8.06
Lake St. Martin	BB-LSM	13-Oct-20	12:20	-	-	2.6	0.3	7.76	11.13	93.7	1073	6.58	8.38
							1.0	7.76	11.12	93.7	1073	6.48	8.38
Lake St. Martin	LSM-FR	13-Oct-20	15:50	-	-	1.9	0.3	6.98	11.67	96.4	1107	18.50	8.15
							1.0	6.97	11.65	96.3	1107	18.75	8.15
Lake St. Martin	LSM5	9-Dec-20	13:25	0.00	0.35	3.6	0.3	1.1	13.90	98.6	1208	2.30	8.28
							1.0	1.5	13.79	99.0	1201	2.05	8.30
							1.5	1.6	14.14	101.5	1201	2.31	8.31
							2.0	1.8	13.65	98.8	1197	2.13	8.31
							2.5	2.4	12.49	91.0	1189	2.40	8.30
						3.0	3.1	12.38	92.7	1176	2.60	8.29	
Lake St. Martin	LSM-DR	20-Oct-21	11:30	-	-	0.8	0.4	6.45	11.40	93.0	1174	9.74	8.59
Lake St. Martin	LSM3	11-Dec-20	11:50	0.03	0.32	0.8	0.3	3.70	11.45	87.4	1418	1.28	8.38
							0.8	4.70	8.04	62.9	1501	2.54	8.19
Lake Winnipeg	SB-DR	10-Dec-20	15:05	0.01	0.4	5.0	0.3	0.30	13.10	90.6	439	24.7	8.14
							1.0	0.50	13.09	91.5	449	22.7	8.11
							2.0	0.60	12.31	86.3	472	15.5	8.08
							3.0	0.60	12.76	89.1	535	16.6	8.06
							4.0	0.10	11.57	80.0	1138	10.3	7.89

Appendix 3. Continued.

Waterbody	Site ID	Sampling Date	Sampling Time	Snow Depth (m)	Ice Thickness (m)	Total Water Depth ¹ (m)	Sample Depth ¹ (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Turbidity (NTU)	pH
Lake Winnipeg	SB1	10-Dec-20	12:50	0.01	0.35	1.3	0.3	0.30	13.64	94.6	492	17.51	8.10
							1.0	1.20	12.69	90.0	500	15.64	8.07
Lake Winnipeg	SB2	10-Dec-20	9:55	0.03	0.33	6.2	0.3	0.30	12.82	89.2	471	20.5	7.96
							1.0	0.50	12.54	87.2	464	17.64	7.95
							2.0	0.50	13.12	91.7	463	19.74	7.94
							3.0	0.50	12.83	89.7	463	18.18	7.94
							4.0	0.60	13.06	91.5	472	18.68	7.92
							5.0	0.80	13.00	91.7	499	19.1	7.91
						6.0	1.80	9.92	73.0	576	14.04	7.85	

¹ Represents effective depth during the ice-cover period.