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From: Taylor, Sheree L.
Sent: April 12, 2012 3:31 PM
To: Carson, Katie
Subject: FW: Ministry of Environment Updated PFOS Report
Attachments: BinbrookReservoir_SamplingProgram_08Mar2012.pdf

From: O'Connor, Chris (ENE) [mailto:Chris.O'Connor2@ontario.ca]
Sent: April 12, 2012 3:12 PM
To: clerk@hamilton.ca
Cc: Paparella, Guy
Subject: Ministry of Environment Updated PFOS Report

Hello Rose,

Please see the attached updated report prepared by the Ministry of the Environment on PFOS in the Welland River and Lake Niapenco. Please forward to Council for their information.

Thank you.

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PFOS in the Welland River and Lake Niapenco

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Dated: March 8, 2012

Lake Niapenco (Welland River) Water and Sediment Sampling Program for PFOS

Project Background and Objectives

The purpose of this project is to further advance the knowledge of potential sources and distribution of perfluorooctanyl sulfonate (PFOS) within the Welland River and Lake Niapenco. PFOS was found to be at elevated concentrations in select aquatic organisms in a study completed by Environment Canada. Concentrations were also found in sport fish, which lead to issuing a fish consumption advisory.

This project will involve two phases of field work. Phase 1 was conducted on May 2nd 2011 with the potential for additional sampling to occur within Lake Niapenco (Binbrook Reservoir) later in the summer of 2011 (Phase 2). Additional water samples will be collected to assess linkages with total suspended solids and contaminant movement within the river under different flows. The sampling efforts will investigate the quality of water and sediment within the Welland River upstream of Lake Niapenco to aid in identifying the source of PFOS.

The objectives of this project are:

- To conduct a track down assessment for potential sources of PFOS;
- To assess sediment quality for PFOS upstream of the outlet of Lake Niapenco;
- To assess water quality for PFOS upstream of the inlet of Lake Niapenco;
- To assess water quality for PFOS downstream of the outlet of Lake Niapenco; and
- To assess the extent of PFOS contamination, both vertically and horizontally, in Lake Niapenco.

Sediment Sampling Locations and Analysis

Phase 1

A total of 15 sampling locations were selected to ascertain concentrations of PFOS in the Welland River, within tributaries of the Welland River, and at the outlet of Lake Niapenco (Table 1). One additional sampling site was located within the Twenty Mile Creek Watershed. Map 1 identifies all sampling locations. All locations will be sampled for water however only 9 locations were sampled for sediment as the remaining locations were previously sampled by MOE's Environmental Monitoring and Reporting Branch (EMRB). The data obtained from the sediment and water samples will build on existing results from Environment Canada and EMRB. As previously mentioned, water samples will also be collected during different stream flow conditions. The land use around the sampling locations is largely agricultural with the exception of the John C. Munro Hamilton International Airport (HIA) and the closed Glanford Landfill Site.

Sediment samples were collected from the top 10 cm and placed in an appropriate sampling jar. White Church, Hwy 6 E and Tyneside were collected using a sediment

dredge Ponar while all remaining locations were collected using a stainless steel mixing spoon and homogenized in a stainless steel pan. Grab water samples were collected in PET 500 mL bottles from the centre of the stream, where possible, and using a water sampling pole where depths were too deep. Analyses of the samples included perfluorooctanyl sulfonate (MOE Lab Code PFAS 3457), total suspended solids (for water; MOE Lab Code TSD 3188), total organic content (MOE Lab Code ORGC 3012) and particle size (for sediment; MOE Lab Code PART 3328).

Phase 2

The second phase of sampling targeted Lake Niapenco specifically to provide a benchmark of PFOS concentrations within the reservoir for sediments. Phase 2 sediment sampling within Lake Niapenco will be collected using a corer up to a total depth of 1 m which will provide a vertical assessment of concentrations. Sediment samples were analyzed at 1 cm increments up to a total depth of 10 cm. Sampling locations are shown on Map 2.

Table 1. Water and sediment sampling locations.

Site Name	Location	Northing	Easting
Butter	Welland River@ Butter Rd	4779998	584461
Upper James	20 Mile Creek @ Upper James St	4779890	588596
Glancaster	Tributary to Welland @ Glancaster Rd	4780059	585691
Ditch 2	Ditch 2 @ Airport Rd	4779275	586429
Ditch 3	Ditch 3 @ Airport Rd	4779174	586883
Ditch 4	Ditch 4 @ Airport Rd	4779080	587211
Pond	Pond on HIA	4779789	586197
Ditch 1a	Ditch 1 @ Airport Rd	4779430	586014
Ditch 1b	Ditch 1 @ Hwy 6	4778958	585633
Ditch 1c	Ditch 1 @ Whitechurch Rd	4778202	585483
White Church	Welland River @ White Church Rd	4778082	585822
Hwy 6 W	Welland River @ Hwy 6 Upstream	4776233	587398
Hwy 6 E	Welland River @ Hwy 6 Downstream	4776163	587565
Ferris	Welland River @ Ferris Rd	4774800	588801
Tyneside	Welland River @ Tyneside Rd	4773787	590999
Lake Niapenco Outlet	Welland River @ Harrison Rd	4772527	595543

Results

Water Quality Results

Water and sediment samples were collected May 2, 2011. Precipitation occurred regularly from April 25 to May 2 inclusive with rainfall totaling approximately 55 mm (Environment Canada metrological station Hamilton A – Climate ID 6153194). There were eleven perfluorinated compounds (PFCs) that were analyzed and include

perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorodecane sulfonate (PFDS), perfluorooctane sulfonamide (PFOSA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUNA), perfluorododecanoic acid (PFDoA), and perfluorotetradecanoic acid (PFTDA - solids only). The focus of the analysis was to evaluate concentrations of perfluorooctane sulfonate (PFOS) as data has generally been limited to this parameter.

Water quality results indicate that perfluorodecane sulfonate, perfluorooctane sulfonamide, perfluoroundecanoic acid, and perfluorododecanoic acid were generally below the method detection limits.

PFOS concentrations were highest in the HIA Pond and downgradient of the pond along Ditch 1 with concentrations ranging from 49,000 (HIA Pond), 8,600 (Ditch 1a) and 5,600 (Ditch 1b) ng/L respectively. These concentrations exceed the Lowest Observed Effect Concentration (LOEC) of 5,000 ng/L, which is based on several species of plants, invertebrate, and fish. Concentrations at the other sampling locations proceeding from upstream to downstream of the airport within the Welland River steadily decreased from 260 to 53 ng/L from sampling location Ditch 1c to the outlet of Lake Niapenco. Background PFOS concentrations at sampling location Butter Road were the lowest of all field samples and had a concentration of 7.3 ng/L.

The tributaries along the southern boundary of the HIA also decreased in concentrations with distance from the fire training pad and were near background levels at Ditch 4 (7.9 ng/L). The Glancaster Road sampling location which captures runoff from the western boundary of the airport had a PFOS concentration of 200 ng/L and is comparable to concentrations in the Welland River between sampling locations Ditch 1c and Hwy6 E. Concentrations are higher than background and indicate that surface water drainage from the western property boundary may be contributing PFOS from the old training area, but at lower concentrations than the southern property boundary along Ditch 1. The Upper James sampling location is within the Twenty Mile Creek watershed and had a concentration of 15 ng/L, which is comparable to background levels.

Figure 1 illustrates PFOS concentrations from the upstream to downstream sampling locations. PFOS concentrations were converted to the logarithmic values to account for the wide range in scale. As indicated, PFOS concentrations generally decrease as distance from the airport increases. Sampling locations Ditch 2, 3, and 4, which drain the southern boundary of the airport displayed a decreasing trend in concentrations from west to east. However sampling location Ditch 2 had a higher concentration compared to the other two sampling locations indicating that the area drained at this location may contribute more PFOS. The duplicate sample was collected at the White Church location and both results were similar. The blank sample had a PFOS concentration of 5 ng/L.

In 2010, Environment Canada collected water samples at various locations both upstream and downstream of Lake Niapenco. Based on UTM coordinates, the MOE monitoring program sampled in the general proximity of four of the Environment Canada sampling

locations. These included the White Church, Hwy 6 W, Ferris, and Tyneside locations. With the exception of the Ferris Road sampling location concentrations were typically higher in 2010; particularly at the White Church sampling location which had a concentration of 596 ng/L compared to 240 ng/ on May 2, 2011. The results from 2010 followed the same general trend of decreasing concentrations moving downstream in the reach.

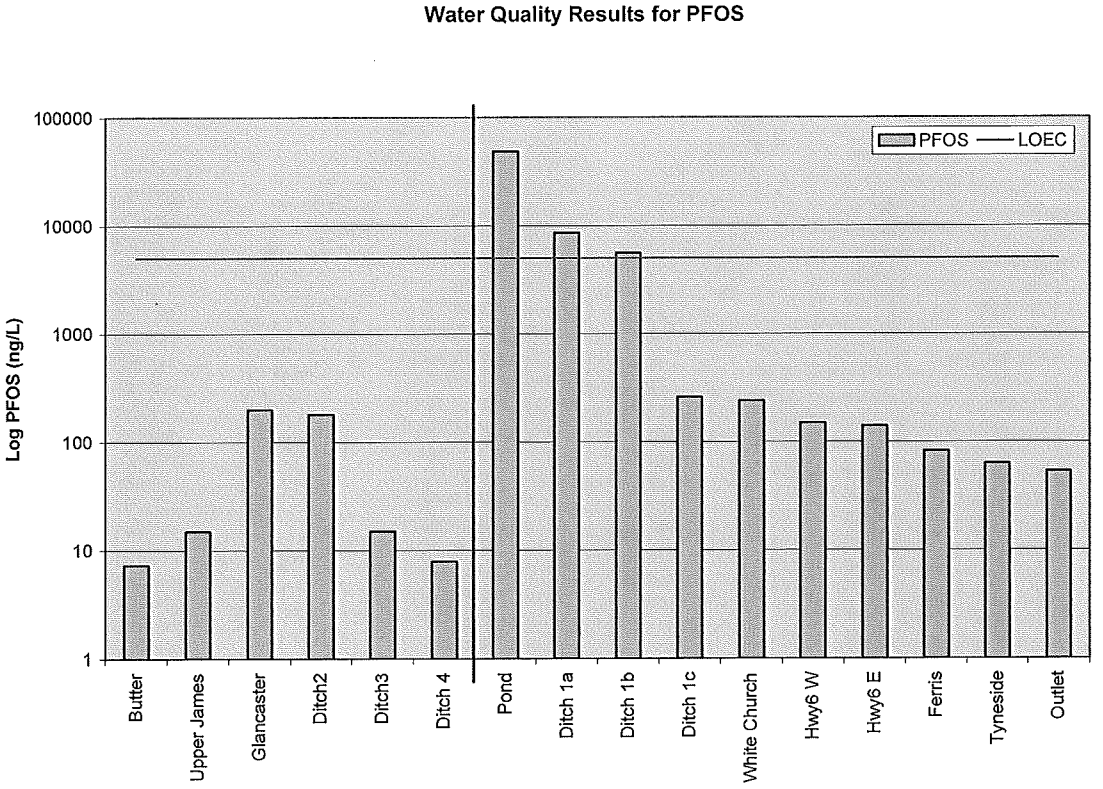


Figure 1. Water quality results for PFOS concentrations upstream of the Lake Niapenco outlet.

Sediment Quality Results

EMRB collected sediment samples in 2010 at the Butter Road, HIA Pond, Ditch 1a, Ditch 2, Ditch 3, White Church Road, and Hwy 6 W locations. The sediment results at the HIA Pond and Ditch 1a sampling locations were the highest with concentrations of 1011 ng/g and 230 ng/g respectively. The reference station at Butter Road had a concentration of 0.7 ng/g.

The remaining sediment samples were collected by MOE Technical Support. With the exception of sampling locations Ditch 1b (54 ng/g), Ditch 1c (15 ng/g), and White Church (17 ng/g) PFOS concentrations ranged from 0.23-8.5 ng/g (Figure 2). As with the water quality results, sediment concentrations followed the same decreasing trend as the distance from the HIA increased. The sampling location in Twenty Mile Creek at Upper

James had a PFOS concentration of 5.1 ng/g. The results of the sediment sampling are depicted in Figure 2. The duplicate sample was collected at the Hwy 6 E location and both results were similar.

Toxicity data for sediment dwelling organisms is not available and there is no sediment benchmark for toxicity associated with PFOS. However, given the persistence of perfluorinated surfactants and their ability to bioaccumulate in the environment makes assessing sediment concentrations important.

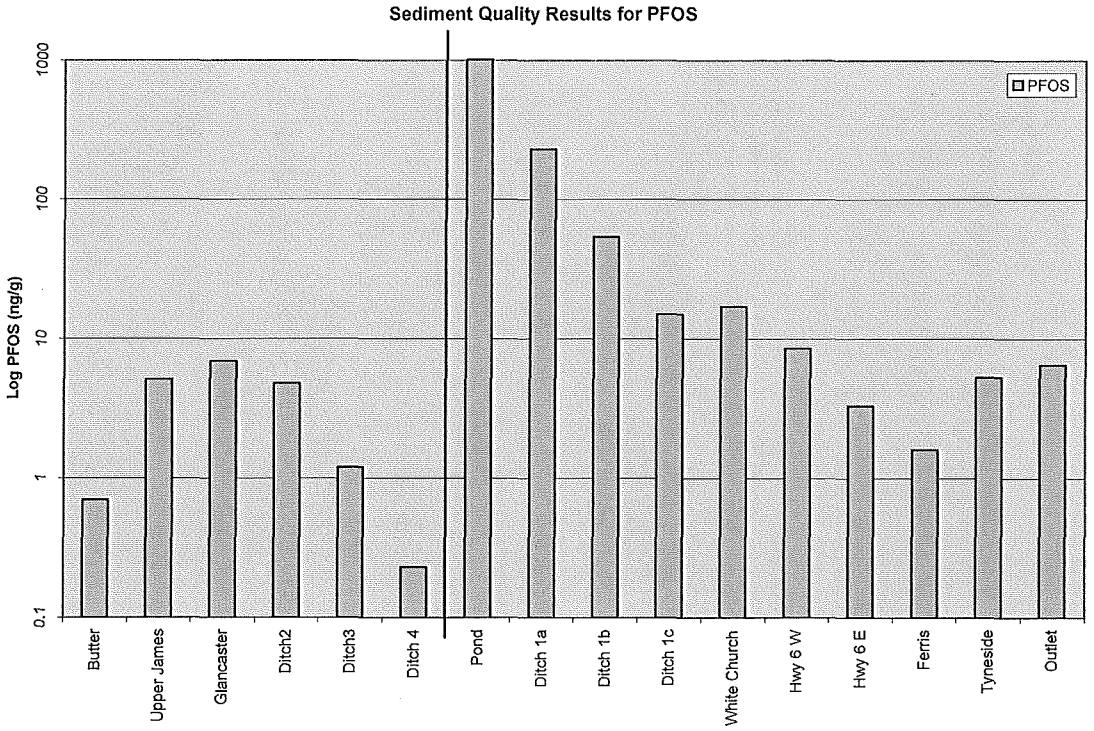


Figure 2. Sediment quality results for PFOS concentrations upstream of the Lake Niapenco outlet.

Lake Niapenco Sediment Core Quality Results

Similarly to sediments in the watercourses, the same 11 perfluorinated compounds were analyzed for at a total of nine sampling locations within Lake Niapenco. The samples were collected between July 4 and July 6, 2011. PFCs were measured in the top 10 cm of sediment except for sampling location LN4, which only had 7 cm of sediment collected. For all of the samples, the perfluorinated compounds identified were predominately PFOS, which represented ~90% or greater of the total perfluorinated compounds within the sample, while PFOA represented ~5 to 8%. There were also minor detections of PFNA (LN7, 8, 9, 5 and 3), PFOSA (LN2, 3) and PFUNA (LN5, 3). Table 2 summarizes the range of PFOS and PFOA at each sampling site.

Average core PFOS concentrations were marginally higher in sediments from samples collected in front of the weir (closer to the inlet of the reservoir) at LN7, LN8, and LN9 compared to LN1, LN2, LN3, LN4, LN5, and LN6, which are below the weir (Figure 3). Concentrations at sampling locations below the weir are generally comparable except at location LN4, which was lower than the other 5 sampling locations.

PFOS concentrations at different depths were generally similar but show a slight increasing temporal trend from the older sediments to those more recently deposited (Table 3). The average PFOS concentration was highest for the 4-5 cm section, but was largely influenced by the result of 8.9 ng/g at sampling location LN7. Average PFOS concentrations ranged from 2.1 ng/g (6-7 cm) to 3.2 ng/g (4-5 cm).

Table 2. PFOS and PFOA concentrations in sediments of Lake Niapenco.

Sample Location	PFOS (ng/g)	PFOA (ng/g)	Average PFOS (ng/g)
LN7	1.0-8.9	0.06-0.28	2.7
LN8	3.2-4.9	0.13-0.19	3.8
LN9	3.1-4.3	0.13-0.20	3.6
LN1	2.1-2.6	0.08-0.18	2.3
LN2	1.9-2.8	0.08-0.10	2.3
LN6	1.4-1.9	0.08-0.45	1.7
LN4	0.52-1.2	0.06-0.08	0.84
LN5	1.7-3.2	0.10-0.17	2.4
LN3	1.9-3.5	0.09-0.13	2.7

Table 3. PFOS concentrations at depth in sediments of Lake Niapenco.

Sample Location	Depth (cm)									
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
LN7	2.6	2.6	2.6	2.2	8.9	1.8	1.7	1.6	1.8	1.0
LN8	4.3	3.4	3.4	3.4	3.7	3.2	3.5	3.7	4.4	4.9
LN9	4.3	3.9	3.8	3.8	3.3	3.8	3.3	3.2	3.1	3.5
LN1	2.4	2.6	2.4	2.5	2.1	2.2	2.1	2.2	2.2	2.2
LN2	2.2	2.7	2.8	2.5	2.1	1.9	1.9	1.9	2.2	2.4
LN6	1.8	1.8	1.7	1.8	1.8	1.6	1.9	1.8	1.7	1.4
LN4	1.1	0.68	1.2	0.69	1.1	0.62	0.52	-	-	-
LN5	2.3	2.9	2.8	2.2	3.2	2.0	1.8	1.7	2.1	2.5
LN3	2.8	3.5	3.0	3.4	2.7	2.7	2.3	2.4	2.3	1.9
Average	2.6	2.7	2.6	2.5	3.2	2.2	2.1	2.3	2.5	2.5

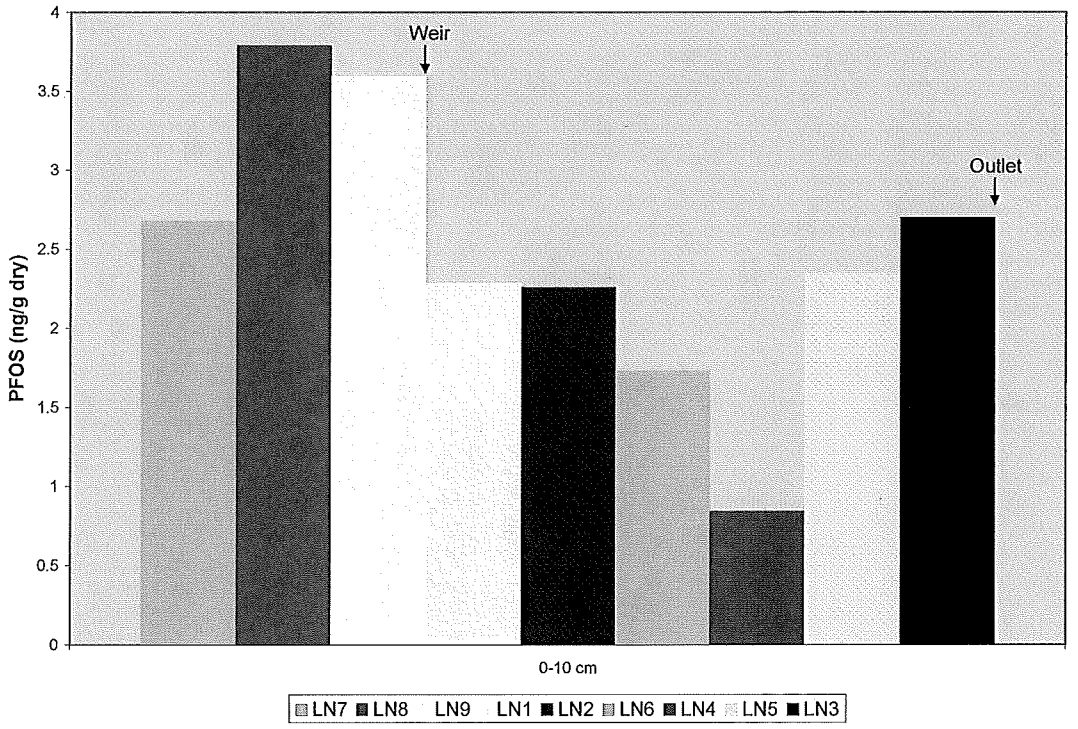


Figure 3. Average PFOS concentrations in sediments of Lake Niapenco.

As expected, sediments enriched with PFOS from upstream contributions resulted in elevated concentrations in the sediments of Lake Niapenco compared to concentrations (0.7 ng/g) at Butter Road. However Lake Niapenco sediments were much lower than sampling locations on or proximate to the HIA (1011 and 230 ng/g) and were marginally lower than samples collected in the Welland River near the inlet of reservoir, which were generally less than 10 ng/g.

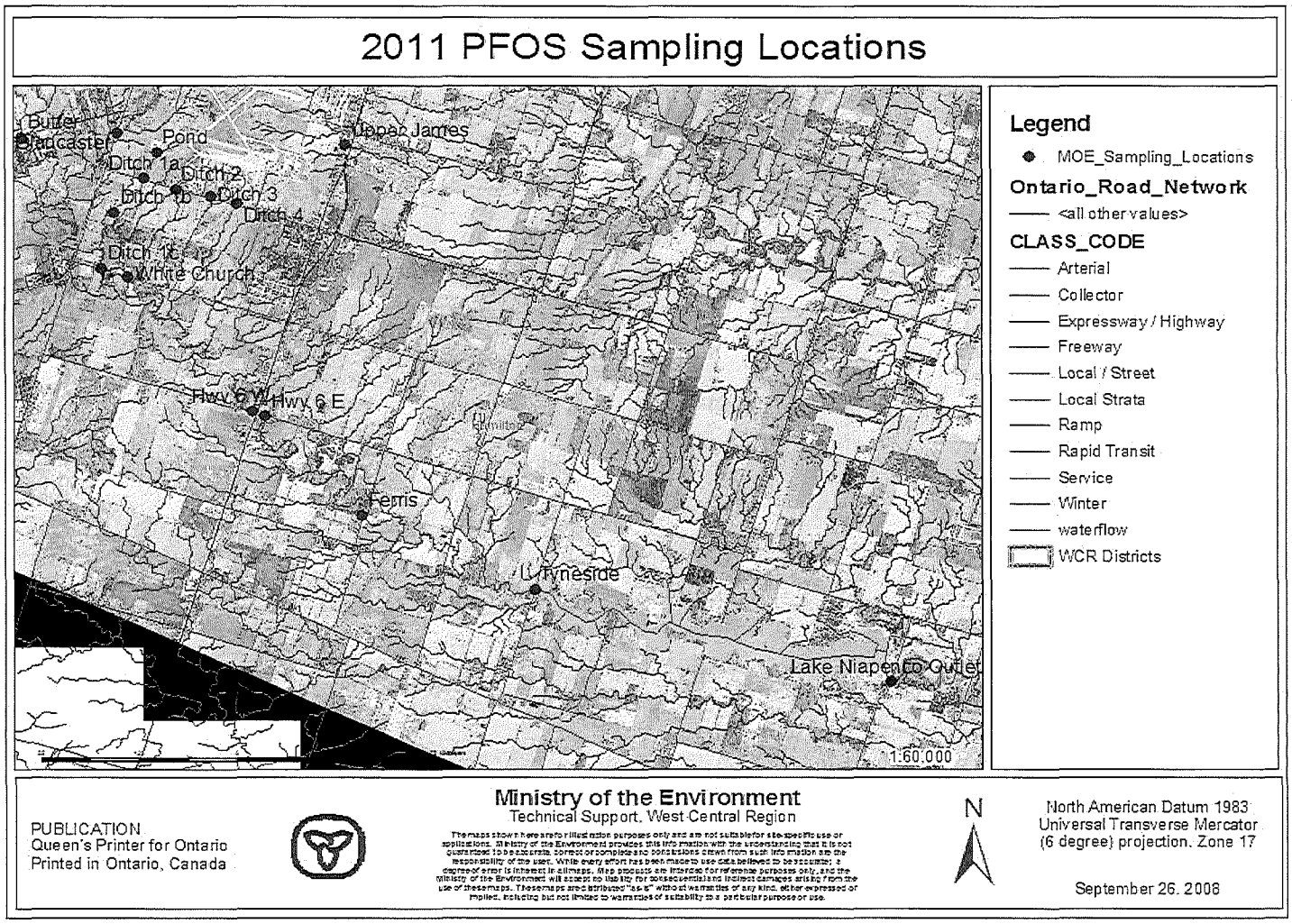
Conclusions

The water quality results indicate that the HIA is the primary source of PFOS relative to background concentrations particularly from the southern property boundary, but also from the western property boundary to a lesser extent. Also, PFOS concentrations exceed the LOEC on-site and off-site adjacent of the airport. Based on the concentrations at sampling locations HIA Pond and Ditch, 1 impact to aquatic organisms would be expected. The antecedent precipitation and resulting flows would have offered substantial dilution and mitigated downstream impacts on the day the water samples were collected.

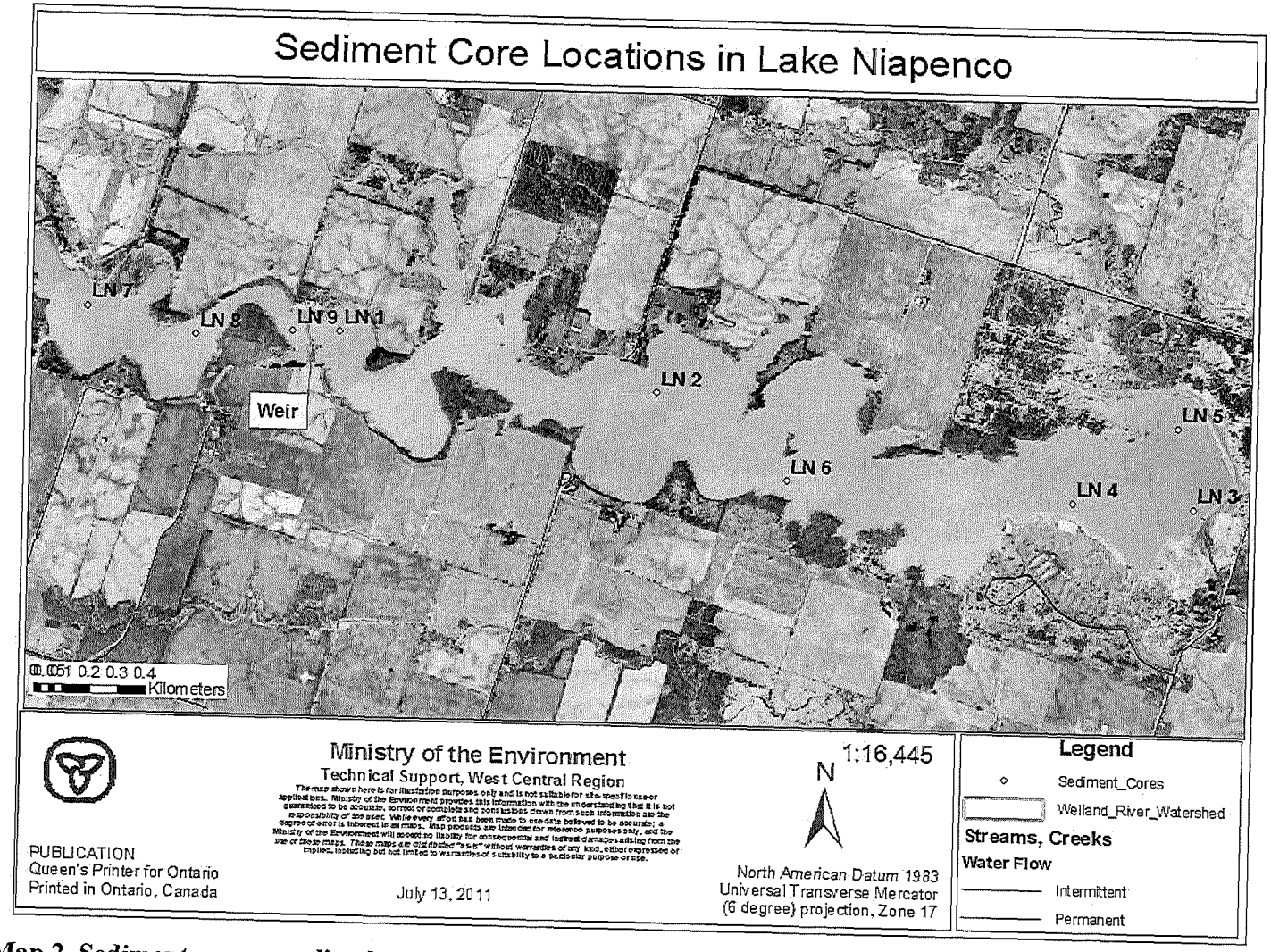
Sediment quality results from the Welland River upstream of Lake Niapenco exhibited a similar trend as the water chemistry results. PFOS concentrations were highest at the HIA property and decreased further downstream. PFOS concentrations in the sediments of

Lake Niapenco were marginally higher above the weir compared to below, but were similar to concentrations in the sediments located in the reach immediately upstream of the inlet. No definitive trends were observed with specific depths but concentrations did increase slightly from the older to newer deposited sediments. As mentioned previously, there are no toxicity benchmarks for PFOS in sediments.

As indicated by the water and sediment chemistry data, it appears that the predominant source of PFOS is occurring from the HIA. No measurable water or sediment contributions from the closed Glanford Landfill site were observed. Existing PFOS contaminated sediment within the Welland River should be considered a potential source of PFOS because when sediments are disturbed they can be re-introduced into the water column and result in uptake by aquatic organisms.



Map 1. PFOS sampling locations.



Map 2. Sediment core sampling locations in Lake Niapenco.