



Assessment of Fraser River Water and Sediment Quality 2000

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Executive Summary

This document summarizes the results of water and sediment quality analyses conducted on samples collected throughout the lower Fraser River in January and December, 2000. Results are compared with applicable water quality objectives (as proposed in Swain *et al.* 1998) and/or water quality guidelines (Nagpal *et al.* 1998).

Water samples collected at all sites had concentrations of PCBs below detection limits (<0.1 µg/L). However, this value is 1000 times the maximum guideline value of 0.1 ng/L, making a useful interpretation of these data impossible. Chlorophenol concentrations were below the water quality objectives proposed for this substance in all instances.

Concentrations of cobalt, copper, iron, lead, manganese and zinc exceeded applicable guidelines for at least one of the sites monitored in the lower Fraser River. In addition, detection limits used to analyze antimony, arsenic and silver were too high to determine if these metals were a concern. Finally, the forms of both aluminum and chromium measured for this study were different than the forms for which an objective had been proposed, so again no useful interpretation of these data can be made.

Nutrient concentrations were below the applicable objective values at all sites where they were measured.

MTBE concentrations were below detection limits (<0.001 mg/L) as well as below water quality guideline values in all instances where it was measured.

Chlorophenol and PCB concentrations in all of the sediment samples collected were below the applicable water quality objectives and/or guidelines.

The majority of the PAH species analyzed in sediment samples were present in concentrations below the applicable sediment quality objective and/or guideline. Exceptions to this include dibenz(a,h)anthracene, which exceeded the objective value at one site, and naphthalene, phenanthrene and pyrene, which all exceeded the applicable objectives at a number of sites. Concentrations of these PAHs were highest at the marina sites.

Concentrations of chromium, copper, iron, lead, manganese, nickel and zinc exceeded sediment quality objectives and/or guidelines at at least one of the sites where samples were collected. Mercury concentrations were consistently below objective values. Arsenic, cadmium, selenium and silver were measured using analytical methods with detection limits higher than the applicable objective and/or guideline, so although concentrations were almost invariably below detection limits, no useful interpretation could be made of data associated with these metals.

Dioxin and furan TEQs measured at three sites in the lower Fraser River were below the interim sediment quality guideline for freshwater.

To give some indication of overall variability in sediment contaminant concentrations within each site, triplicate Ponar grab samples and Phleger core samples were collected on one occasion. In general, variability within sites was relatively small for all parameters measured.

1.0 Introduction

Water quality objectives were first established for the lower Fraser River in 1985 (Swain and Holms 1985). At that time, water quality and sediment data collected by the Ministry of Environment from the mid-1970's to about 1982 between Kanaka Creek (located between the Stave and Pitt rivers on the north side of the Fraser River) and the mouth of the Fraser River were compared with existing water quality guidelines. In instances where the guidelines for appropriate water uses were threatened or exceeded, water quality objectives were proposed to protect those water uses. These proposed water quality objectives were updated in 1995 to incorporate water and sediment quality data collected between 1985 and 1994 (Swain *et al.* 1998). In this report, water quality and sediment data collected in 2000 at a number of locations throughout the lower Fraser River are analyzed and compared with water quality objectives (where they exist), or with the appropriate water quality guideline for those parameters where objectives have not been proposed.

2.0 Site Locations and Monitoring Schedule

A total of five sites throughout the lower Fraser River were sampled for a variety of water quality parameters in January and/or December 2000, and two sites were sampled for methyl tertiary-butyl ether (MTBE) only in December 2000. During this same period, sediment samples were collected at 13 different sites. Table 1 includes details of sampling location names and the dates and times of sampling, and Figure 1 shows sampling locations. Sampling locations were strategically selected between Barnston Island and the mouth of the river to reflect the considerable diversity of the lower Fraser River. Sites were chosen in each of the North, Middle and Main Arms, as well as in the estuarine and non-estuarine portions of the river. The majority of sampling locations were selected in sloughs and marinas due to the increased likelihood of contamination in these areas (slower moving waters are flushed less quickly) as well as the slower sedimentation rates that occur there. The slower rates of sedimentation allow for a longer period to be reflected in a sediment core of a given depth. Sampling was conducted during the winter months as this is the period during which flow levels in the Fraser River are at their lowest, and therefore dilution of contaminants present in the river would be minimized. As well,

contaminant levels will be at a maximum prior to spring freshet, when sediments would likely be scoured by higher water levels.

Locations of the various sampling sites within the Fraser River are as follows: Sapperton Channel and Barnston Island are located upstream from New Westminster (where the initial trifurcation of the Fraser River occurs). The Tree Island Slough site, the Bridgeport Marina sites, the Belkin Slough site and the McDonald Slough site are located in the North Arm of the Fraser River; the Gallion Marina sites are located in the Middle Arm of the Fraser River; the Annacis Channel site is located in the Annacis Channel; and the Shelter Point Marina sites, the Deas Slough sites and the Ewen Slough site are located in the Main Arm of the Fraser River.

Table 1. Sampling schedule for water quality and sediment sampling in the lower Fraser River, 2000

Site Name	EMS ID	Sampling Date		
		Water - General Chemistry	Water - MTBE	Sediment
Fraser River at Barnston Island	E206965	Jan. 21, Dec. 8		Jan. 21, Dec. 8
Fraser River at Sapperton Channel	E206966	Dec. 8		Dec. 8
Fraser River at Belkin Slough	E206967	Dec. 8		Dec. 8
Fraser River at McDonald Slough	E206968	Jan. 20, Dec. 9		Jan. 20, Dec. 9
Fraser River at Annacis Island	E206969	Dec. 8		Dec. 8
Fraser River at Ewen Slough	E206970	Jan. 20, Dec. 7		Jan. 20, Dec. 7
N Arm Site 1 Bridgepoint Marina			Dec. 9	Dec. 9
N Arm Site 2 Bridgepoint Marina				Dec. 9
Middle Arm Site 1 Gallion Marina			Dec. 9	Dec. 9
Middle Arm Site 2 Gallion Marina				Dec. 9
Deas Slough Main Arm #1			Dec. 7	Dec. 7
Annieville Channel - Shelter Point Marina Site 1			Dec. 8	Dec. 8
Annieville Channel - Shelter Point Marina Site 2				Dec. 8

Figure 1. Location of sampling sites in the lower Fraser River, 2000.





3.0 Description of Sampling Methodology

Integrated Resource Consultants Inc. collected all water and sediment samples in both January and December 2000. In each case, Resource Inventory Committee (RIC) standards were followed for both water (Cavanagh *et al.* 1994) and sediment (RIC 1997) sampling.

Sediment samples were collected at three Fraser River sites in January 2000: Barnston Island, McDonald Slough and Ewen Slough. In each instance, triplicate Ponar grab samples were collected, as well as triplicate Phleger cores. The grab samples were composited, while the core samples were divided into upper and lower samples, represented by the core segment above and below 15 cm depth.

Water samples collected in January 2000 were sampled at the same locations as the sediment samples (Barnston Island, McDonald Slough and Ewen Slough). A 3-L Van Dorn bottle was used to collect water samples 0.5 metres below the surface of the river at each site.

Phleger core samples were collected at the Oak St., Gallion Marina, Deas Slough and Annieville Channel sites in December 2000. Cores were then split into two sub-samples, the first consisting of the first 15 cm of the core, and the second sub-sample consisting of the sediment core between 15 and 30 cm in depth. Sediment samples collected at the remaining sites (McDonald Slough, Sapperton Channel, Barnston Island, Belkin Slough, Annacis Island and Ewen Slough) consisted of a composite of three separate Ponar grab samples.

Water samples were collected in December at six sites (McDonald Slough, Sapperton Channel, Barnston Island, Belkin Slough, Annacis Island and Ewen Slough), and again a 3-L Van Dorn bottle was used to collect samples 0.5 metres below the surface of the river at each site.

All samples (water and sediment) were placed on ice in coolers after collection and transported to the Pacific Environmental Science Centre (PESC) for analysis. All water samples were analyzed for chlorophenols, polychlorinated biphenyls (PCB's), metals, nutrients and general physical parameters. Sediment samples collected in January 2000 were analyzed for extractable petroleum hydrocarbons (EPH), polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzofurans and dibenzodioxins (dioxins and furans) (one sample at each site only), chlorophenols, PCB's, and metals. Sediment samples collected in December 2000 were analyzed for the same parameters, with the exception of the dioxins and furans.

4.0 Results and Discussion

In this section, both water column and sediment parameters are compared with existing water quality objectives established for the Fraser River (see Appendix I) (Swain *et al.* 1998), or the applicable water/sediment quality guidelines in those instances where objectives have not been established. For the purpose of determining compliance with guidelines and objectives, the water uses that are being protected in the lower Fraser River include: sensitive aquatic life and wildlife, primary (*e.g.* swimming, water skiing) and secondary (*e.g.* canoeing, boating) contact recreation, irrigation, and livestock watering.

4.1 Water Column

Water column samples were collected at three sites in January: Barnston Island, McDonald Slough and Ewen Slough. Samples were again collected at these sites in December, in addition to two other sites, Sapperton Channel and Annacis Island. As mentioned in Section 2, Barnston Island and the Sapperton Channel site are located upstream from the Fraser River trifurcation, the Annacis Island sample was collected in the Annacis Channel, and the McDonald Slough and Ewen Slough are both located near the mouth of the river, in the North and Main arms, respectively. Due to the estuarine nature of the lower sites, some parameters (primarily salts such as chloride, sodium, potassium, and calcium) are considerably higher at these two lower sites than at the upstream sites not influenced by ocean waters. Water chemistry results from these sites are included in Appendix II.

4.1.1 PCBs and Chlorophenols

All of the PCBs sampled at these five sites were present in concentrations below detection limits (<0.1 µg/L), as were both tetra- and pentachlorophenol (detection limits of <0.005 µg/L 2,3,4,5 - tetrachlorophenol, <0.002 µg/L 2,3,4,6 - tetrachlorophenol, and <0.005 µg/L pentachlorophenol). However, as the guidelines for the protection of freshwater and marine aquatic life from PCBs range between 0.00025 ng/L for 3,3',4,4',5-pentachlorobiphenyl and 0.04 ng/L for 3,3',4,4'-tetrachlorobiphenyl, and the total concentration of all PCB's should not exceed 0.1 ng/L, the detection limits for this parameter are too high by a factor of at least 100. Therefore, it is not possible to determine if PCB's are a concern at these sites.

The detection limits for both tetra- and pentachlorophenol are well below the current water quality objectives for the North and Middle arms of the Fraser River (0.1 µg/L for both substances) (Swain *et al.* 1998), and these parameters are not a concern at present. There currently are no water quality objectives for either PCB's or total chlorophenols in the lower Fraser River.

4.1.2 Metals

Included in Appendix II is a list of the lowest guidelines applicable for each parameter in order to protect the most sensitive aquatic use (see also Appendix I). The majority of parameters are present in concentrations considerably below the most stringent guideline. However, exceptions to this include aluminum, chromium, cobalt, copper, iron, lead, manganese and zinc.

For two of these parameters (aluminum and chromium), the form measured for this study was not the same form for which the water quality guideline was developed. In this study, the total aluminum concentration was measured while the applicable guideline refers to dissolved aluminum, and in the case of chromium the objective refers to the various oxidation states (hexavalent and trivalent forms) while again only the total concentration was measured. Aluminum concentrations have historically exceeded the guideline on a regular basis, but chromium values have typically been well below the guideline (Swain *et al.* 1998). In both instances, exceedences have typically been associated with high levels of suspended solids, suggesting that a significant portion of the metals were bound to suspended particles and therefore not bio-available.

Other instances where clear definitive statements regarding compliance cannot be made include antimony, arsenic and silver. Although these were measured at concentrations consistently below detection limits, their detection limits were in fact higher than the applicable guideline. Because of this, compliance of these parameters with the appropriate guideline or water quality objective cannot be determined.

In the case of cobalt, copper, iron, lead, manganese and zinc, concentrations measured at at least one of the sites had a value higher than the applicable guideline or objective. Copper and lead were analyzed at low level detection limits (0.0006 mg/L for both parameters) for the January samples, to ensure that the detection limit did not exceed the water quality guideline. In all of the December samples these parameters were below detection limits, but both the low level copper analysis and the high level lead analysis for the sample collected at Barnston Island on January 21 exceeded the guideline for the protection of aquatic life, with values of 0.0027 mg/L and 0.07 mg/L, respectively. The January Barnston Island sample also exceeded the aquatic life guideline for cobalt (with a value of 0.014 mg/L versus the guideline of 0.0009 mg/L). The zinc concentration at the McDonald Slough site for the January sample (0.062 mg/L) exceeded the freshwater guideline of 0.03 mg/L; however, due to the relatively high estuarine influence, the marine 4-day average guideline of 0.086 mg/L may be more appropriate, in which case no exceedence occurred. All of the samples collected at all of the sites had iron concentrations higher than the guideline of 0.03 mg/L, with a maximum value of 0.47 mg/L at the McDonald Slough site in January. Finally, the manganese concentration in samples collected from McDonald Slough and Ewen Slough on January 20 (0.046 mg/L and 0.032 mg/L, respectively) exceeded the water quality objective of 0.030 mg/L.

4.1.3 Nutrients

There were measurable levels of ammonia present at all of the sampling locations for each of the sampling periods. Concentrations ranged from a minimum of 0.028 mg/L ammonia at the Barnston Island site in January and the Sapperton Channel site in December, to a maximum of 0.115 mg/L in the McDonald Slough in January. A large number of combined sewer overflows empty into the North Arm of the Fraser River and are likely responsible for the presence of this ammonia, since it is generally transformed quickly to other forms of nitrogen. However, values are well below the maximum guideline of 8 mg/L at a pH of 7.8 and a water temperature of 5°C, as well as the 30-day guideline of 1.7 mg/L at the same pH and temperature. Similarly, the maximum nitrate and nitrite values are well below the relevant guidelines for these parameters. Therefore, while large volumes of nutrients continue to be added to the lower Fraser River, dilution, chemical reactions and biological uptake tend to keep concentrations below the level where impacts would be a concern.

4.1.4 MTBE

Water samples collected in early December 2000 at the Gallion Marina, Bridgepoint Marina, Annieville Channel and Deas Slough sites were analyzed for MTBE. Concentrations of MTBE were below detection limits (<0.001 mg/L) for all samples analyzed. The most stringent guideline for this parameter is 0.02 mg/L for the protection of both drinking water and primary contact recreation, and so these uses are not in jeopardy from MTBE.

4.2 Sediment Sampling

In January 2000, triplicate Ponar grab samples and triplicate Phleger core samples were collected at Barnston Island, McDonald Slough and Ewen Slough. In December, Ponar grab samples were again collected at these sites, as well as additional grab samples from Sapperton Channel, Belkin Slough and Annacis Island. Also in December, Phleger core samples were collected at Bridgepoint Marina, Gallion Marina, Deas Slough and Annieville Channel. Sediment cores were split into upper and lower portions (0-15 cm depth and 15-30 cm depth), to give an indication if long-term changes are occurring in the concentrations of contaminants. While sedimentation rates vary considerably throughout the lower mainland, rates as high as 13 cm/yr have been recorded near the mouth of the main fluvial distributary (Hart *et al.* 1998). It is likely that in the majority of the locations where samples were collected rates were considerably lower than this due to the lower flow rates associated with sloughs and marinas. It would therefore be expected that the 15 cm core sub-sections would represent a number of years worth of deposition. Sediment quality results from these sites are included in Appendix III.

4.2.1 Sediment Composition

Sediment composition was measured on all samples collected in December. All of the samples were classified as Silt Loams, with the exception of the composite grab sample collected at Annacis Island which was classified a Loam. The coarsest samples were collected at Annacis Island and McDonald Slough. In all cases, samples contained almost no gravel, and consisted of sand, silt and clay in varying ratios. The majority of particle sizes at all sites were between 0.002 mm and 0.053 mm in diameter. From field notes taken at the time of the January samples, no odour was observed for any of the Barnston Island, McDonald Slough or Ewen Slough samples. Moisture content for the December grab samples ranged between 33% for the Annacis Island sample to 45.4% for the Barnston Island sample.

4.2.2 PCBs and Chlorophenols

PCB and chlorophenol concentrations were measured in the grab samples collected in December. All samples had concentrations of these parameters below detection limits (<0.005 µg/g for each PCB, <0.0005 µg/g for the tetrachlorophenols, and <0.0002 µg/g for the pentachlorophenol), with the exception of the pentachlorophenol concentration measured at Sapperton Channel. In this instance, the concentration was 0.0005 µg/g. The current water quality objective for chlorophenols in sediment for the Fraser River between Hope and Sturgeon and Roberts Banks is a maximum of 0.01 µg total chlorophenols per gram of sediment (dry weight), and so all values are well below the objective. The water quality objective for total PCB concentrations in sediment is a maximum of 0.02 µg/g dry sediment. As there are eight different PCBs measured in each sample, with a detection limit of <0.005 µg/g each, all we can state for certain is that the concentration of total PCBs is <0.04 µg/g, which is higher than the objective value. Therefore, no conclusions can be made about PCB concentrations at these sites.

Historically, PCB concentrations have been below detection limits in the North, Middle and Main arms of the Fraser River, with the exception of one value for Aroclor 1254 in the North Arm in 1987 (0.10 µg/g) (Swain *et al.* 1998). Similarly, chlorophenol concentrations have generally been below detection limits, except directly below the Annacis and Lulu Island STPs. It appears, based on both historical and recent sampling, that neither of these groups of chemicals is presently a concern in the lower Fraser River.

4.2.3 Extractable Petroleum Hydrocarbons (EPH) and Polycyclic Aromatic Hydrocarbons (PAHs)

Light (LEPH) and heavy extractable petroleum hydrocarbon (HEPH) concentrations were measured at the Barnston Island, McDonald Slough and Ewen Slough sites in January 2000. Concentrations of the total EPH, HEPH and LEPH were all below detection limits (<200 µg/g). There are currently no water quality objectives in the lower Fraser River or water quality guidelines in general for EPH concentrations in sediment.

Sediment PAH concentrations at the upper sampling location (Barnston Island) were almost invariably below detection limits for all hydrocarbon species (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene) measured in both January (detection limit <0.01 µg/g) and December (detection limit <0.02 µg/g). The exception to this was one Ponar grab sample which contained a concentration of fluoranthene equal to the detection limit (0.01 µg/g). As expected, sediment PAH concentrations were highest in the marinas, likely due to spills and discharges from inboard and outboard boat motors. There were also measurable concentrations of a number of PAHs in Annieville Channel, Sapperton Channel, McDonald Slough and Ewen Slough.

The water quality objective for acenaphthene in sediment in the North, Middle and Main arms is a maximum of 0.15 µg/g dry weight normalized to 1% organic carbon (Appendix I). Acenaphthene was present in measurable concentrations at the Bridgepoint and Gallion Marinas, in Deas Slough, and in the Annieville Channel, with concentrations ranging from 0.02 µg/g (at Bridgepoint Marina) to 0.07 µg/g (at Gallion Marina). These values are considerably below the water quality objective for this parameter. Concentrations in the deeper portions of the core did not appear to differ significantly from concentrations in the shallower portions of the core at any of the sites. Historically, concentrations have also not exceeded the objective (Swain *et al.* 1998).

Acenaphthylene concentrations were below detection limits (<0.01 and <0.02 µg/g) for all samples except those collected in McDonald Slough in January 2000. At that site, one of the lower replicate core samples and all of the upper core samples had measurable concentrations between 0.01 and 0.02 µg/g. However, these values are considerably lower than the water quality objective of a maximum of 0.66 µg/g dry weight between September and April. Acenaphthylene concentrations have also been historically low (Swain *et al.* 1998).

Anthracene concentrations were below detection limits (<0.01 µg/g) at Barnston Island and Ewen Slough for the January samples, and were also below detection limits (<0.02 µg/g) for all grab samples collected in December (Barnston Island, Sapperton Channel, Belkin Slough, McDonald Slough, Annacis Island and Ewen Slough). In the remaining locations, concentrations ranged from <0.02 µg/g to a maximum of 0.1 µg/g at the Annieville Channel Site 2 shallow core. These values are well below the water quality objective of 0.6 µg/g dry weight normalized to 1% organic carbon. There does not appear to be any significant difference in concentrations of anthracene in the deep and shallow core samples.

Benzo(a)anthracene was present in measurable concentrations in the majority of the sites monitored (with the exception of Barnston Island in January). Concentrations ranged from below detection limits (<0.01 or <0.02 µg/g) to a maximum of 0.11 µg/g in the Annieville Channel Site 2 deep core. All values are below the water quality objective of 0.2 µg/g dry weight.

Benzo(a)pyrene was also present at levels above the minimum detection limit at most of the sites (again, the exception was Barnston Island in January, as well as Deas Slough, the Annieville Channel Site 1, and the December samples collected at Belkin Slough, Annacis Island, McDonald Slough and Ewen Slough). The maximum measured concentration was 0.04 µg/g at the Bridgepoint Marina Site 2 and the Annieville Channel Site 2. These maximum values were slightly lower than the water quality objective for benzo(a)pyrene of 0.06 µg/g dry weight normalized to 1% organic carbon.

Benzo(b)fluoranthene ranged in concentration at the various sites from below detection limits (<0.01 µg/g) to a maximum of 0.11 µg/g at the Bridgepoint Marina Site 2, while benzo(k)fluoranthene concentrations ranged from <0.01 µg/g to a maximum of 0.09 µg/g in the McDonald Slough site. No water quality objective exists for benzofluoranthenes in the lower Fraser River, but the existing guideline allows a maximum total benzofluoranthene concentration of 0.3 µg/g dry weight for the protection of aquatic life (Nagpal *et al.* 1998). Therefore, this parameter is not a concern.

The maximum benzo(g,h,i)perylene concentration measured at any site was 0.05 µg/g at the Bridgepoint Marina Site 2 in the deeper core section. While there are no objectives currently proposed for this parameter in the lower Fraser River, this value is one-half of the no-effect threshold value of 0.1 µg/g (Nagpal *et al.* 1998).

Chrysene concentrations ranged from below detection limits (<0.01 or <0.02 µg/g) to a maximum of 0.09 µg/g at the Gallion Marina Site 1 deep core. This maximum value is considerably lower than the water quality objective proposed for the lower Fraser River of 0.2 µg/g dry weight normalized to 1% organic carbon.

Concentrations of dibenzo(a,h)anthracene were below detection limits (<0.01 or <0.02 µg/g) at all sites, with the exception of the deeper core collected at the Bridgepoint Marina Site 1 on December 9. This value was equal to the detection limit of 0.02 µg/g, and exceeded the water quality guideline of 0.005 µg/g proposed for this reach (Swain *et al.* 1998). While the objective was exceeded at this site, the fact

that it occurred at the detection limit (where accuracy tends to decrease), coupled with the fact that the detection limit is considerably higher than the objective, suggests that this parameter should undergo further scrutiny.

Concentrations of fluoranthene were higher at all sites than any other PAH, with values ranging from <0.01 µg/g at Barnston Island and Ewen Slough to 0.47 µg/g in the Annieville Channel Site 2 deep core. Values are still well below the water quality guideline of 2 µg/g for this substance.

Fluorene concentrations in lower Fraser sediments ranged from below detection limits (<0.01 µg/g or <0.02 µg/g) to a maximum of 0.09 µg/g in the Bridgepoint Marina Site 2 deep core. All values remained below the water quality objective of 0.2 µg/g for this reach of the river.

Concentrations of indeno(1,2,3-cd)pyrene ranged from below detection limits to a maximum of 0.06 µg/g at the Bridgepoint Marina Site 2 in the deeper core sample. This value is slightly lower than the 0.07 µg/g no-effect threshold guideline (Nagpal *et al.* 1998).

Naphthalene concentrations were often below detection limits, except at the Gallion and Bridgepoint marina sites, as well as the McDonald Slough in both the January and December sampling and Ewen Slough in the January sampling only. The maximum naphthalene concentration measured was 0.13 µg/g at the Gallion Marina Site 1 in the deeper core. This value was considerably higher than the objective of 0.01 µg/g for this hydrocarbon, and a total of 17 samples had concentrations above this level. There does not appear to be a significant difference between the shallow and deep core samples for this parameter, so it would appear that naphthalene contamination is a problem that has been present for some time and is ongoing. This is consistent with the findings of earlier studies, which show frequent exceedences of water quality guidelines by this parameter (Swain *et al.* 1998).

Concentrations of phenanthrene were relatively high, especially at the Gallion Marina and Annieville Channel sites. The maximum concentration of 0.37 µg/g occurred in the Annieville Channel Site 2 deeper core. This value is considerably higher than the objective of 0.0867 µg/g dry weight for the period of September to April. In fact, a total of 11 samples (from the marina sites, Deas Slough and the Annieville Channel sites) exceeded the objective. Therefore, this parameter is also a cause for concern, and may be impacting sensitive aquatic life in the area.

The final PAH measured at these sites was pyrene, which was found in concentrations ranging from below detection (<0.01 µg/g or <0.02 µg/g) to a maximum of 0.30 µg/g. While there are no objectives for this parameter, the interim sediment quality guideline is a maximum of 0.053 µg/g (Nagpal *et al.* 1998). A total of 16 samples exceeded this guideline. Earlier studies used a less restrictive guideline of 0.49 µg/g, and all concentrations reported for those studies fell below this value (Swain *et al.* 1998). The maximum value recorded in 1992 (0.13 µg/g) did however exceed the current, more stringent, guideline. Based on trends in previous reports, coupled with the results of sampling in 2000, it would appear that concentrations of pyrene may be increasing in sediments in the lower Fraser basin.

While a careful comparison of PAH concentrations in upper and lower core samples collected at the various sites shows no obvious trend, the fact that the highest concentration of each PAH reported in this section occurred in a deeper core sample may give some evidence that PAH concentrations are, in general, decreasing in the lower Fraser River. In fact, although the overall trend for pyrene concentrations appears to be increasing over time (based on a comparison of samples collected between 1989 and the present), this trend may be reversing in recent times, as concentrations of pyrene

in the shallower core samples appears to be lower than that found in the deeper core samples. However, concentrations of this PAH in both portions exceed the safe level for freshwater aquatic life.

4.2.4 Metals

There are a minimal number of metals for which sediment quality guidelines have been developed, and no objectives have been proposed for metals concentrations in sediments in the lower Fraser River. Metals for which sediment guidelines exist include: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver and zinc.

Arsenic concentrations were below detection limits ($<8 \mu\text{g/g}$ or $<10 \mu\text{g/g}$) for all samples except one grab sample replicate from Barnston Island (concentration equal to the detection limit of $8 \mu\text{g/g}$) and one shallow core replicate from McDonald Slough (concentration $8.4 \mu\text{g/g}$). However, as the guideline for arsenic concentrations in sediment is only $5.9 \mu\text{g/g}$, the fact that values are below detection does not ensure the protection of aquatic life. Because the only measurable values were very near the detection limit (where accuracy decreases significantly), it is recommended that future samples be analyzed using a more sensitive test, to determine if arsenic is in fact a problem in lower Fraser River sediments.

Cadmium concentrations were measured at four different detection limits: $<0.8 \mu\text{g/g}$, $<4 \mu\text{g/g}$, $<5 \mu\text{g/g}$ and $<8 \mu\text{g/g}$. All values measured at all sites were below the relevant detection limits, but unfortunately the guideline for the protection of aquatic life from cadmium in sediments is only $0.6 \mu\text{g/g}$. Therefore, again a lower detection limit (preferably $0.06 \mu\text{g/g}$) is necessary to determine if the guideline is being exceeded.

Concentrations of chromium ranged from $34.4 \mu\text{g/g}$ in one of the Barnston Island shallow core replicates to a maximum of $59.6 \mu\text{g/g}$ in both the Belkin Slough sample and the deeper core from Deas Slough. All of the samples collected (with the exception of the one minimum value measured at Barnston Island) exceeded the sediment quality guideline of $37 \mu\text{g/g}$. Swain *et al.* (1998) found that, in general, chromium concentrations had increased between 1987 and 1995, and it appears that this trend is perhaps continuing. Therefore, chromium concentrations are a concern in lower Fraser River sediments.

Copper concentrations ranged from $27.3 \mu\text{g/g}$ in one shallow core replicate from Barnston Island to $59.6 \mu\text{g/g}$ in the deeper core sample from Deas Slough. A total of 38 of 47 samples collected had copper concentrations exceeding the guideline of $36 \mu\text{g/g}$. The lowest concentrations were consistently measured at Barnston Island, while the highest concentrations were measured at the Deas Slough and McDonald Slough sites.

Iron concentrations also exceeded the guideline of $21,200 \mu\text{g/g}$ in all of the samples collected, with values ranging from $21,400 \mu\text{g/g}$ to $43,500 \mu\text{g/g}$.

The majority of sediment samples had lead concentrations below the maximum guideline value of $35 \mu\text{g/g}$. A few exceptions to this occurred, with three samples at McDonald Slough ranging from $39 \mu\text{g/g}$ to $42 \mu\text{g/g}$, and one sample from Barnston Island with a concentration of $53 \mu\text{g/g}$ lead.

Manganese concentrations ranged from $384 \mu\text{g/g}$ at McDonald Slough in the deeper core segment to $762 \mu\text{g/g}$ at Barnston Island. The majority of values exceeded the guideline of $460 \mu\text{g/g}$ for the protection of aquatic life. For the samples collected in January, manganese concentrations were considerably

higher in the Ponar grab samples than in the Phleger core samples, suggesting that manganese concentrations may be increasing (since Ponar grabs collect primarily surface sediments).

Mercury concentrations were measured in all of the samples collected in January, as well as the Ponar grab samples collected in December. Concentrations ranged from 0.038 µg/g at Barnston Island to a maximum of 0.097 µg/g at Ewen Slough. All values were safely below the sediment quality guideline of 0.174 µg/g for the protection of sensitive freshwater aquatic life.

Nickel concentrations showed very little variability among sites, ranging between 46 µg/g at both Barnston Island and McDonald Slough in the deeper cores and a maximum of 61 µg/g at the Annieville Channel Site 1 in the shallower portion of the core. However, the guideline for nickel concentrations in sediment is only 16 µg/g, and was exceeded by all of the samples collected.

Selenium concentrations were below detection limit (<8 µg/g or <10 µg/g) for all samples analyzed as part of this study. However, as the guideline for selenium in sediments is only 5 µg/g, no definitive statement can be made about the compliance of these samples with the guideline. Similarly, while silver concentrations were below detection limits (<2 µg/g) in all of the sediment samples, the guideline for silver concentrations in sediment is only 0.5 µg/g. It is recommended that in the future, when sediment samples are analyzed for selenium and/or silver, more sensitive analytical methods (preferably with detection limits of 0.5 µg/g and 0.05 µg/g, respectively) be used to ensure that the results can be usefully interpreted.

Concentrations of zinc at the majority of sites were below the acceptable guideline of 123 µg/g, with values ranging from 64.6 µg/g in the shallow core sample from Barnston Island to a maximum of 113 µg/g in the Bridgepoint Marina Site 2 deeper sediment core. The exception to this was a single value of 152.1 µg/g measured at the Gallion Marina Site 1, in the shallow sediment core.

4.2.5 Dioxins and Furans

Dioxin and furan concentrations were measured in one sample each collected from Barnston Island, McDonald Slough and Ewen Slough in January 2000 (see Table 6 in Appendix III). To determine the cumulative toxicity of the various species of dioxins and furans, toxic equivalency factors (TEFs) ranging from 1 (for 2,3,7,8-TCDD and 1,2,3,7,8-PCDD, the most toxic isomers), to 0.0001 (for OCDD and OCDF, the least toxic isomers) are applied to the various concentrations. Toxicity is then determined by summing the toxic equivalents (TEQs) of the different isomers, and comparing this value to the interim sediment quality guideline for freshwater sediments of 0.85 pg/g dry weight. The TEQ measured at Barnston Island was the lowest of the three sites, with a value of 0.048 pg/g, and McDonald Slough had the highest concentration, at 0.486 pg/g. Although the McDonald Slough concentration was ten times that measured at Barnston Island, it is still only about half of the guideline value, suggesting that dioxins and furans are not an immediate concern at these sites.

4.3 Variability of contaminants in sediments

For samples collected in January at the Barnston Island, McDonald Slough and Ewen Slough sites, triplicates of the Ponar grab samples and the deep and shallow Phleger core samples were collected to give an indication of the variability of contaminants within a site. Appendix IV shows these data, as well as the relative percent mean difference within each triplicate sample. For the sake of this analysis, values reported below the detection limit were reported at the detection limit (i.e. <4 µg/g was reported

as 4 µg/g). This method occasionally resulted in misleading values, because when detection limits changed a relative percent mean difference was reported even when values were below detection limit (e.g., values of <10 µg/g and <8 µg/g would show an 11% relative mean difference, even though both were below detection limits).

The overall variability between samples was relatively low. The highest values were reported for PAHs at or near the detection limit - this is to be expected, as the difference between two very similar samples might be greater than 100% (for example, 0.01 µg/g and 0.02 µg/g differ by a relative percent mean difference of 100%). In general, there was relatively low variability in metals concentrations between samples, with the highest variability in metals such as aluminum, cobalt, lead, mercury and potassium.

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Appendix I. Summary of Proposed Water Quality Objectives for the Lower Fraser River.

Characteristics	Kanaka Creek to the trifurcation	North and Middle Arms	Main Arm	Sturgeon and Roberts Banks
Designated Water uses	aquatic life, wildlife, livestock watering, irrigation, secondary contact recreation			

Designated Water Uses	not applicable	primary contact recreation		
fecal coliforms	less than or equal to 200 CFU/100 mL geometric mean, April to October			
enterococci	less than or equal to 20 CFU/100 mL geometric mean, April to October			
<i>Escherichia coli</i>	less than or equal to 77 CFU/100 mL geometric mean, April to October			
<i>Pseudomonas aeruginosa</i>	less than or equal to 10 CFU/100 mL geometric mean, April to October			
suspended solids	less than or equal to 10 mg/L increase when the u/s background is less than 100 mg/L or		not applicable	
			
	less than or equal to 110% of the u/s background when the background is greater than 100 mg/L			
total ammonia nitrogen	<u>AMMONIA TABLES</u>		not applicable	
total nitrite nitrogen	<u>NITRITE TABLE</u>		not applicable	
pH	6.5 to 8.5		not applicable	
dissolved oxygen	greater than or equal to 5 mg/L instantaneous minimum		greater than or equal to 5 mg/L instantaneous minimum	
	30-day mean greater than or equal to 8.0 mg/L or 80% saturation whichever is higher from May to October			
 greater than or equal to 9 mg/L instantaneous minimum 30-day mean greater than or equal to 11.0 mg/L from November to April		30-day mean greater than or equal to 8.0 mg/L or 80% saturation whichever is higher	
total chromium	not applicable	less than or equal to 26 µg/g dry weight of sediment, long-term	not applicable	
Characteristics	Kanaka Creek to the trifurcation	North and Middle Arms	Main Arm	Sturgeon and Roberts Banks
total copper	less than or equal to 2 µg/L mean when hardness is less than 50 mg/L			not applicable
			
	less than or equal to [0.04 (mean hardness)] µg/L when hardness is greater than 50 mg/L			
			

	less than $[0.094(\text{hardness}) + 2]$ µg/L maximum			
total lead	less than or equal to 3.31 + $\exp(1.273(\ln(\text{mean hardness}) - 4.705))$ µg/L mean and	For Freshwater: less than or equal to 3.31 + $\exp(1.273(\ln(\text{mean hardness}) - 4.705))$ µg/L mean and less than $\exp(1.273(\ln(\text{hardness}) - 1.460))$ µg/L maximum		not applicable
 less than $\exp(1.273(\ln(\text{hardness}) - 1.460))$ µg/L maximum For Estuarine and Marine Water: less than or equal to 2 µg/L mean with 80% of values less than or equal to 3 µg/L less than 140 µg/L maximum		
total manganese	less than 100 µg/L maximum			not applicable
total zinc	less than or equal to 14 µg/L mean			not applicable
			
	less than 30 µg/L maximum			
total PCBs	In sediments:			not applicable
	less than or equal to 0.02 micrograms/g dry weight of sediments normalized to 1% organic carbon			
			
	In Whole Fish			
	less than or equal to 0.1 µg/g wet weight			
Characteristics	Kanaka Creek to the trifurcation	North and Middle Arms	Main Arm	Sturgeon and Roberts Banks
total chlorophenols	In sediments: less than or equal to 0.01 micrograms/g dry weight of sediment In Fish Muscle less than or equal to 0.2 micrograms/g wet weight			not applicable
2,3,4,6-TTCP	not applicable	less than or equal to 0.04 µg/L when pH is less than 7.1	not applicable	
			
		less than or equal to 0.3 µg/L when pH is greater than 7.1		
2,3,5,6-TTCP	not applicable	less than or	not applicable	

		equal to 0.02 µg/L when pH is less than 7.1		
			
		less than or equal to 0.1 µg/L when pH is between 7.1 and 8.1		
			
		less than or equal to 0.25 µg/L when pH is greater than 8.1		
PCP	not applicable	less than or equal to 0.02 µg/L when pH is less than 6.9	not applicable	
			
		less than or equal to 0.1 µg/L when pH is greater than 6.9 and less than 7.9		
Characteristics	Kanaka Creek to the trifurcation	North and Middle Arms	Main Arm	Sturgeon and Roberts Banks
Dioxins and Furans 2,3,7,8-T4CDD TEQ's	In sediments: less than or equal to 0.25 pg TEQ/g sediment normalized to 1% organic carbon In Fish Muscle: less than or equal to 50 pg/g wet weight in fish muscle or egg tissue			In Sediment: less than or equal to 0.25 pg TEQ/g sediment normalized to 1% organic carbon
PAHs	In Sediment:			not applicable
acridine	less than or equal to 1 microgram/g dry weight normalized to 1% organic carbon			
PAHs	In Sediment:			
acenaphthene	less than or equal to 0.15 microgram/g dry weight normalized to 1% organic carbon			
PAHs	In Sediment:	In Sediment:		not applicable
acenaphthylene	less than or equal to 0.66 microgram/g dry	less than or equal to 0.01 microgram/g dry weight		

	weight normalized to 1% organic carbon	normalized to 1% organic carbon in May to August	
		
		In Sediment:	
		less than or equal to 0.66 microgram/g dry weight normalized to 1% organic carbon in September to April	
PAHs	In Sediment:		not applicable
anthracene	less than or equal to 0.6 microgram/g dry weight normalized to 1% organic carbon		
PAHs	In Sediment:		not applicable
benzo(a)anthracene	less than or equal to 0.2 microgram/g dry weight normalized to 1% organic carbon		
Characteristics	Kanaka Creek to the trifurcation	North and Middle Arms	Main Arm
			Sturgeon and Roberts Banks
PAHs	In Sediment:		In Sediment:
benzo(a)pyrene	less than or equal to 0.06 µg/g dry weight normalized to 1% organic carbon		less than or equal to 0.06 µg/g dry weight normalized to 1% organic carbon
		
	In Fish Muscle:		
	less than or equal to 4 µg/kg wet weight when consumers eat less than or equal to 50 g/week		
		
	less than or equal to 2 µg/kg wet weight when consumers eat more than 50 and less than or equal to 100 g/week		
		
	less than or equal to 1 µg/kg wet weight when consumers eat more than 100 and less than or equal to 200 g/week		
PAHs	In Sediment:		
chrysene	less than or equal to 0.2 µg/g dry weight normalized to 1% organic carbon		
PAHs	In Sediment:		not applicable
di-benzo(a,h)anthracene	less than or equal to 0.005 µg/g dry weight normalized to 1% organic carbon		
PAHs	In Sediment:		not applicable

fluoranthene	less than or equal to 2 µg/g dry weight normalized to 1% organic carbon		
PAHs	In Sediment:		
fluorene	less than or equal to 0.2 µg/g dry weight normalized to 1% organic carbon		
PAHs	In Sediment:		
naphthalene	less than or equal to 0.01 µg/g dry weight normalized to 1% organic carbon		
PAHs	In Sediment:	In Sediment:	not applicable
phenanthrene	less than or equal to 0.0867 µg/g dry weight normalized to 1% organic carbon	less than or equal to 0.04 µg/g dry weight normalized to 1% organic carbon in May to August	
		
		In Sediment:	
		less than or equal to 0.0867 µg/g dry weight normalized to 1% organic carbon in September to April	

Appendix II. Results of Water Column Sampling in Lower Fraser River 2000

Table 1. Water quality results for samples collected in January, 2000 (all units mg/L unless otherwise stated)

	E206965	E206968	E206970	British Columbia Water Quality Guidelines
	Fraser River at Barnston Island	Fraser River at McDonald Slough	Fraser River at Ewen Slough	
	21-Jan-00	20-Jan-00	20-Jan-00	
	10:00	13:30	10:15	
Chloride	2.6	4200	2200	
pH	7.44	7.82	7.78	6.5 - 8.5 (AL)*
Turbidity (NTU)	5.1	5.9	4.5	
Nitrogen - Ammonia	0.028	0.115	0.05	15 mg/L at pH 7.5 (AL)*
Nitrogen - Nitrite	<0.002	0.003	0.003	0.06 mg/L max (AL)*
Nitrogen - Nitrate + Nitrite	0.167	0.24	0.211	
2,3,4,5-Tetrachlorophenol	<0.005	<0.005	<0.005	

(µg/L)				
2,3,4,6-Tetrachlorophenol (µg/L)	<0.002	<0.002	<0.002	
2,4,6-Tribromophenol, surrogate (%)	94	96	107	
Pentachlorophenol	<0.005	<0.005	<0.005	
Aroclor 1016 (µg/L)	<0.1	<0.1	<0.1	
Aroclor 1221 (µg/L)	<0.1	<0.1	<0.1	
Aroclor 1232 (µg/L)	<0.1	<0.1	<0.1	
Aroclor 1242 (µg/L)	<0.1	<0.1	<0.1	
Aroclor 1248 (µg/L)	<0.1	<0.1	<0.1	
Aroclor 1254 (µg/L)	<0.1	<0.1	<0.1	
Aroclor 1260 (µg/L)	<0.1	<0.1	<0.1	
Aroclor 1262 (µg/L)	<0.1	<0.1	<0.1	
Monobromobiphenyl (%)	88	87	100	
Copper (low level)	0.0027	0.0038	0.0029	0.002 mg/L at hardness <50 mg/L; <0.04*hardness when hardness >50 mg/L (AL)*
Lead (low level)	0.0016	0.0009	<0.0006	0.004 mg/L (AL)*
Aluminum	0.39	0.29	0.21	0.1 mg/L diss. (AL)*
Antimony	<0.06	<0.06	<0.06	0.02 mg/L (AL)*
Arsenic	<0.06	<0.06	<0.06	0.005 µg/L (AL)*
Barium	0.018	0.023	0.018	1 mg/L av. (AL)*
Beryllium	0.002	<0.001	<0.001	0.0053 mg/L chronic (AL)*
Boron	0.01	0.61	0.5	0.5-6 mg/L, depending (IR)*
	E206965	E206968	E206970	
	Fraser River at Barnston Island	Fraser River at McDonald Slough	Fraser River at Ewen Slough	British Columbia Water Quality Guidelines
	21-Jan-00	20-Jan-00	20-Jan-00	
Cadmium	<0.006	<0.006	<0.006	0.00001 mg/L at hardness <30 mg/L (AL)*
Calcium	3.67	63.6	54.6	

Chromium	0.013	<0.006	<0.006	0.001 mg/L max Cr (VI); 0.009 mg/L max Cr (III) (AL)*
Cobalt	0.014	<0.006	<0.006	0.0009 mg/L (AL)*
Copper	0.008	<0.006	<0.006	0.002 mg/L at hardness <50 mg/L; <0.04*hardness when hardness >50 mg/L (AL)*
Iron	0.402	0.47	0.404	0.3 mg/L (AL)*
Lead	0.07	<0.06	<0.06	0.004 mg/L (AL)*
Magnesium	3.4	167	137	
Manganese	0.022	0.046	0.032	0.1 mg/L (AL)*
Molybdenum	<0.01	<0.01	<0.01	1 mg/L (AL)*
Nickel	<0.02	<0.02	<0.02	0.025 mg/L at hardness <60 mg/L (AL)*
Phosphorus	<0.1	<0.1	<0.1	
Potassium	0.9	52.7	43.8	
Selenium	<0.06	<0.06	<0.06	0.002 mg/L (AL)*
Silicon	3.67	3.24	3.3	
Silver	<0.01	<0.01	<0.01	0.001 mg/L max at hardness <100 (AL)*
Sodium	4	1060	1010	
Strontium	0.082	1.09	0.901	
Sulphur	3.15	120	98.2	
Tin	<0.06	<0.06	<0.06	Organic Sn
Titanium	0.022	0.012	0.01	0.1 mg/L (AL)*
Vanadium	<0.01	<0.01	<0.01	0.1 mg/L (LS, IR)*
Zinc	0.013	0.062	0.013	0.03 mg/L max (AL)*
Hardness	23	843	698	

*AL = aquatic life; LS = livestock watering; IR = irrigation

Table 2. Water quality results for samples collected in January, 2000 (all units mg/L unless otherwise stated)

	E206965	E206966	E206967	E206968	E206969	E206970
	Fraser River at Barnston Island	Fraser River at Sapperton Channel	Fraser River at Belkin Slough	Fraser River at McDonald Slough	Fraser River at Annacis Island	Fraser River at Ewen Slough
	08-Dec-00	08-Dec-00	8-Dec-00	09-Dec-00	08-Dec-00	07-Dec-00
	12:20	13:25	14:05	0:00	11:00	0:00

Chloride	1.6	1.8	11.1	4840	16	2810
Fluoride	0.06	0.06	0.05	<1	0.05	<1
Sulphate	10.2	9.4	10.9	644	11.9	373
Bromide	<0.05	<0.05	<0.05	15	<0.05	8
pH	7.57	7.75	7.83	7.74	7.82	7.69
Turbidity	4.5	5.2	5.5	5.5	5.2	4.2
Nitrogen - Nitrate	0.128	0.144	0.141	0.6	0.135	0.8
Nitrogen - Nitrite	<0.005	<0.005	<0.005	<0.5	<0.005	<0.5
Nitrogen - Ammonia	0.052	0.028	0.065	0.062	0.108	0.112
Ortho-phosphate (diss)	<0.05	<0.05	<0.05	<5	<0.05	<5
2,3,4,5-Tetrachlorophenol (µg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,4,6-Tetrachlorophenol (µg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2,4,6-Tribromophenol, surrogate (µg/L)	101	119		114	111	94
Pentachlorophenol	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1016 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1254 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1262 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Monobromobiphenyl	86	91		91	92	88
Aluminum	0.27	0.23	0.26	0.17	0.26	0.14
Antimony	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Arsenic	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Barium	0.016	0.015	0.017	0.018	0.017	0.018
Beryllium	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Boron	<0.01	<0.01	0.01	0.77	0.01	0.59
Cadmium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Calcium	15.8	14.6	15.1	74.9	15.6	61.5

	n Island	n Island	n Island	d Slough	d Slough	d Slough	Ewen Slough	Ewen Slough	Ewen Slough
	21-Jan-00	21-Jan-00	21-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00
	10:15	10:45	10:45	13:40	14:10	14:10	10:30	10:50	10:50
	Grab Rep 1	Lower Rep 1	Upper Rep 1	Grab Rep 1	Lower Rep 1	Upper Rep 1	Grab Rep 1	Lower Rep 1	Upper Rep 1
EPH (C10-18)	<200	<200	<200	<200	<200	<200	<200	<200	<200
EPH (C19-31)	<200	<200	<200	<200	<200	<200	<200	<200	<200
HEPH	<200	<200	<200	<200	<200	<200	<200	<200	<200
LEPH	<200	<200	<200	<200	<200	<200	<200	<200	<200
Acenaphthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01	0.01	0.02	0.03	<0.01	0.01	<0.01
Benzo(a)anthracene	<0.01	<0.01	<0.01	0.02	0.03	0.03	0.01	0.02	<0.01
Benzo(a)pyrene	<0.01	<0.01	<0.01	0.02	0.03	0.03	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	<0.01	0.04	0.05	0.07	0.02	0.02	0.01
Benzo(g,h,i)perylene	<0.01	<0.01	<0.01	0.02	0.02	0.03	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	0.01	0.02	0.03	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	<0.01	0.03	0.04	0.04	0.02	0.03	0.01
Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	0.01	<0.01	<0.01	0.05	0.16	0.12	<0.01	0.06	0.04
Fluorene	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.04	0.01	<0.01
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	0.01	0.02	0.02	<0.01	<0.01	<0.01
Naphthalene	0.01	<0.01	<0.01	0.02	0.05	0.05	0.01	0.02	0.01
Phenanthrene	0.02	<0.01	<0.01	0.04	0.05	0.06	0.03	0.04	0.03
Pyrene	0.02	<0.01	<0.01	0.05	0.14	0.12	0.03	0.06	0.03
Carbon, total organic	1.09	0.49	0.39	1.7	1	1.1	1.37	1.24	1.1
Moisture content	43.8	32.2	29.7	47.1	32.4	38	47.1	39.1	39.5
2,3,4,5-TTCP	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
2,3,4,6-TTCP	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	0.0016	<0.0005	<0.0005	<0.0005

2,4,6 - TBP, surrogate	117	74	104	121	73	62	111	114	118
Pentachlorophenol	<0.000 2	<0.000 2	<0.000 2	0.0005	0.0005	0.0005	<0.000 2	<0.000 2	<0.000 2
Aroclor 1016	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1221	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1232	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1242	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1248	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1254	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1260	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1262	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Monobromobiphenyl	99	93	97	85	93	51	92	86	95

	Fraser River at Barnston Island	Fraser River at Barnston Island	Fraser River at Barnston Island	Fraser River at McDonald Slough	Fraser River at McDonald Slough	Fraser River at McDonald Slough	Fraser River at Ewen Slough	Fraser River at Ewen Slough	Fraser River at Ewen Slough
	21-Jan-00	21-Jan-00	21-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00	20-Jan-00
	10:15	10:45	10:45	13:40	14:10	14:10	10:30	10:50	10:50
	Grab Rep 1	Lower Rep 1	Upper Rep 1	Grab Rep 1	Lower Rep 1	Upper Rep 1	Grab Rep 1	Lower Rep 1	Upper Rep 1
Aluminum	22800	10500	17400	27400	25000	30000	28000	26900	28000
Antimony	<8	<8	<8	<8	<8	<8	<8	<10	<8
Arsenic	<8	<8	<8	<8	<8	<8	<8	<10	<8
Barium	183	103	143	142	132	172	184	165	179
Beryllium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Boron	77	53	66	96	82	91	87	85	86
Cadmium	<4	<8	<4	<4	<4	<4	<4	<4	<4
Calcium	11100	9500	12100	8130	8000	8000	10000	9290	9350
Chromium	50.5	34.4	48	51.1	53.3	55.4	54	51	54.8
Cobalt	11.1	10.3	10.9	12.2	13.1	11.7	12.9	12	12.5
Copper	38.8	30.4	27.3	41.2	36.1	41.9	41.9	42	41.1
Iron	37200	27900	31800	44020	38200	41100	41700	40200	40400
Lead	21	14	53	39	33	42	24	30	18
Magnesium	12100	9500	10600	12900	10000	10000	10000	13200	13100
Manganese	610	500	501	550	396	438	683	522	535

Molybdenum	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	54	46	50	51	49	50	55	53	55
Phosphorus	830	740	691	1230	900	1000	900	882	910
Potassium	3110	940	2390	4630	4000	6000	5000	4210	4650
Selenium	<8	<8	<8	<8	<8	<8	<8	<10	<8
Silicon	418	870	544	745	700	880	640	757	626
Silver	<2	<2	<2	<2	<2	<2	<2	<2	<2
Sodium	623	200	479	4780	2000	3000	3000	1810	1940
Strontium	71.7	45.8	70.4	72.1	62.5	72.8	77.6	69.4	73.4
Sulphur	619	537	535	1080	4400	3200	730	1460	1100
Tin	<8	<8	<8	<8	<8	<8	<8	<10	<8
Titanium	1880	811	1800	1920	1870	2010	2070	1980	2000
Vanadium	88	55	85	96	93	100	95	92	95
Zinc	84.4	62.4	64.6	105	91.8	109	93.2	94	92.8
Mercury	0.054	0.056	0.038	0.079	0.073	0.076	0.097	0.069	0.063

Table 2. Ponar grab samples collected in the lower Fraser River, December 2000

	E206965	E206966	E206967	E206968	E206969	E206970
	Fraser River at Barnston Island	Fraser River at Sapperton Channel	Fraser River at Belkin Slough	Fraser River at McDonald Slough	Fraser River at Annacis Island	Fraser River at Ewen Slough
	08-Dec-00	08-Dec-00	08-Dec-00	09-Dec-00	08-Dec-00	07-Dec-00
	12:45	13:25	14:05	0:00	11:00	12:10
	Composite of 3 grabs	Composite of 3 grabs	Composite of 3 grabs	Composite of 3 grabs	Composite of 3 grabs	Composite of 3 grabs
Carbon, Total Organic	11600	12400	10200	10200	9430	11300
D: Dry Sieve, 2.00mm, %< by wt.	99.91	99.26	100	99.84	99.94	99.84
G: Wet Sieve, 0.250mm, % entire sample by wt.	99.84	97.66	99.92	92.62	86.95	99.72
H: Wet Sieve 0.125mm, % entire sample by wt.	98.85	93.6	99.4	88.59	79.2	99.24
K: Pipette, 0.053 mm, %< by wt.	80.31	77.15	93.24	67.4	51.31	87.97
M: Pipette, 0.002mm, %< by wt.	12.77	12.26	16.06	11.89	8.44	14.66

N: Gravel, >2.00mm, dry sieve, %< by wt.	0.09	0.74	<0.01	0.16	0.06	0.16
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	19.6	22.11	6.76	32.44	48.63	11.86
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	67.54	64.89	77.18	55.52	42.86	73.32
Q: Clay, <0.002mm, pipette, % entire sample by wt.	12.77	12.26	16.06	11.89	8.44	14.66
Textural Category	Silt Loam	Silt Loam	Silt Loam	Silt Loam	Loam	Silt Loam
Moisture content (%)	45.4	41.5	43	37.5	33	44
2,3,4,5 - Tetrachlorophenol	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
2,3,4,6 - Tetrachlorophenol	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
2,4,6 - Tribromophenol, surrogate (%)	60	66	66	91	65	98
Pentachlorophenol	<0.0002	0.0005	<0.0002	<0.0002	<0.0002	<0.0002
Aroclor 1016	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1221	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1232	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1242	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1248	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1254	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1260	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1262	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Monobromobiphenyl (%)	87	97	107	111	88	92
Acenaphthene-d10, surrogate	73	72	86	86	81	84
Acenaphthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anthracene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(a)anthracene	<0.02	0.04	<0.02	0.03	0.02	0.02
Benzo(a)pyrene	<0.02	0.02	<0.02	<0.02	<0.02	<0.02
Benzo(b)fluoranthene	<0.02	0.05	<0.02	0.04	0.03	0.02
Benzo(g,h,i)perylene	<0.02	0.03	<0.02	0.02	<0.02	<0.02
Benzo(k)fluoranthene	<0.02	0.03	<0.02	<0.02	<0.02	<0.02
	E206965	E206966	E206967	E206968	E206969	E206970
	Fraser River at Barnston	Fraser River at Sapperton	Fraser River at Belkin	Fraser River at McDonald	Fraser River at Annacis	Fraser River at Ewen

	Island	Channel	Slough	Slough	Island	Slough
Chrysene	<0.02	0.04	<0.02	0.03	0.02	<0.02
Chrysene-d12, surrogate	75	70	78	43	85	85
Dibenz(a,h)anthracene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	<0.02	0.1	0.03	0.06	0.05	0.03
Fluorene	<0.02	<0.02	<0.02	0.02	<0.02	<0.02
Indeno(1,2,3-cd)pyrene	<0.02	0.05	<0.02	0.03	0.02	<0.02
Naphthalene	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
Naphthalene-d8, surrogate	43	54	85	70	75	79
Perylene-d12, surrogate	85	71	75	82	86	51
Phenanthrene	<0.02	0.08	0.02	0.06	0.04	0.03
Phenanthrene-d10, surrogate	89	82	83	95	90	86
Pyrene	<0.02	0.09	0.02	0.05	0.04	0.02
Aluminum	27884	30599	33327	19914	20491	23979
Antimony	<8	<8	<8	<8	<8	<8
Arsenic	<8	<8	<8	<8	<8	<8
Barium	226	250	274	97	153	131
Beryllium	0.7	0.7	0.8	0.5	0.5	0.5
Boron	84	88	94	83	72	84
Cadmium	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Calcium	12056	11960	11813	9063	10934	8767
Chromium	52.8	56.9	59.6	45.3	44.1	50.6
Cobalt	12.3	12.5	13	10.4	10.7	13.5
Copper	42.5	37.6	41.5	35.5	33.3	37.1
Iron	37000	38300	40900	34400	33100	37500
Lead	18	28	24	23	18	22
Magnesium	12824	12480	13577	12222	11443	12793
Manganese	762	663	742	430	593	539
Molybdenum	<2	<2	<2	<2	<2	<2
Nickel	57	54	60	52	51	55
Phosphorus	826	897	945	922	845	969
Potassium	4551	5151	5902	2707	2563	3336
Selenium	<8	<8	<8	<8	<8	<8
Silicon	890	569	592	801	827	789
Silver	<2	<2	<2	<2	<2	<2
Sodium	796	902	1011	3571	526	2537

Strontium	79.5	86.4	86.5	56.9	64.7	64.7
Sulphur	668	727	628	1140	624	668
Tin	<8	<8	<8	<8	<8	<8
Titanium	1860	1980	2030	1680	1700	1844
Vanadium	94	102	105	81	82	89
Zinc	85.6	101	102	88.1	77.1	87.7
Mercury	0.052	0.079	0.052	0.048	0.046	0.054

Table 3. Results of sediment samples collected at Bridgepoint Marina, December 2000

	9250 Oak St in N Arm Site 1 Bridgepoint Marina	9250 Oak St in N Arm Site 1 Bridgepoint Marina	9250 Oak St in N Arm Site 2 Bridgepoint Marina	9250 Oak St in N Arm Site 2 Bridgepoint Marina
	09-Dec-00	09-Dec-00	09-Dec-00	09-Dec-00
	0:00	0:00	0:00	0:00
	0-15 cm of sediment core	15-30 cm of sediment core	0-15 cm of sediment core	15-30 cm of sediment core
Carbon, Total Organic	14400	13700	13700	15000
D: Dry Sieve, 2.00mm, %< by wt.	100	100	99.92	99.99
G: Wet Sieve, 0.250mm, % entire sample by wt.	99.91	99.97	99.86	99.96
H: Wet Sieve 0.125mm, % entire sample by wt.	99.73	99.72	99.74	99.58
K: Pipette, 0.053 mm, %< by wt.	91.47	91.32	95.4	95.88
M: Pipette, 0.002mm, %< by wt.	13.45	14.75	16.79	18.38
N: Gravel, >2.00mm, dry sieve, %< by wt.	<0.01	<0.01	0.08	0.01
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	8.53	8.68	4.51	4.1
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	78.02	76.57	78.61	77.5
Q: Clay, <0.002mm, pipette, % entire sample by wt.	13.45	14.75	16.79	18.38
Textural Category	Silt Loam	Silt Loam	Silt Loam	Silt Loam
Acenaphthene-d10, surrogate	87	78	83	84
Acenaphthene	0.02	0.02	<0.02	0.02

Acenaphthylene	<0.02	<0.02	<0.02	<0.02
Anthracene	0.03	0.03	0.02	0.02
Benzo(a)anthracene	0.04	0.06	0.04	0.07
Benzo(a)pyrene	0.02	0.03	0.02	0.04
Benzo(b)fluoranthene	0.05	0.07	0.05	0.11
Benzo(g,h,i)perylene	0.02	0.03	0.02	0.05
Benzo(k)fluoranthene	0.03	0.04	0.02	0.04
Chrysene	0.06	0.07	0.05	0.07
Chrysene-d12, surrogate	82	81	62	72
Dibenz(a,h)anthracene	<0.02	0.02	<0.02	<0.02
Fluoranthene	0.16	0.21	0.13	0.21
Fluorene	0.03	0.03	0.02	0.03
Indeno(1,2,3-cd)pyrene	0.03	0.05	0.03	0.06
Naphthalene	0.05	0.05	0.04	0.04
Naphthalene-d8, surrogate	80	67	74	76
Perylene-d12, surrogate	79	79	58	70
Phenanthrene	0.11	0.13	0.09	0.12
Phenanthrene-d10, surrogate	95	96	85	92
Pyrene	0.13	0.17	0.1	0.17
	9250 Oak St in N Arm Site 1 Bridgepoint Marina	9250 Oak St in N Arm Site 1 Bridgepoint Marina	9250 Oak St in N Arm Site 2 Bridgepoint Marina	9250 Oak St in N Arm Site 2 Bridgepoint Marina
	0-15 cm of sediment core	15-30 cm of sediment core	0-15 cm of sediment core	15-30 cm of sediment core
Aluminum	26478	26400	28462	26681
Antimony	<8	<8	<8	<8
Arsenic	<8	<8	<8	<8
Barium	181	177	188	166
Beryllium	0.5	0.5	0.6	0.5
Boron	83	87	95	92
Cadmium	<0.8	<0.8	0.9	<0.8
Calcium	10745	10209	10821	9565
Chromium	53.9	53	56.9	52.2
Cobalt	12.2	14.2	13.2	14.4

Copper	37.3	41.6	49.2	47.4
Iron	36900	39000	41900	41200
Lead	31	29	34	27
Magnesium	12463	12940	13847	13321
Manganese	543	574	617	591
Molybdenum	<2	<2	<2	<2
Nickel	53	55	59	57
Phosphorus	954	1001	1069	1041
Potassium	3732	3495	4023	3463
Selenium	<8	<8	<8	<8
Silicon	949	841	701	892
Silver	<2	<2	<2	<2
Sodium	1354	1179	1521	1343
Strontium	80.3	73.6	81	70.7
Sulphur	962	1066	1193	1273
Tin	<8	<8	<8	<8
Titanium	2040	2030	2100	1950
Vanadium	93	96	101	95
Zinc	96.6	104	109	113

Table 4. Results of sediment samples collected at Gallion Marina, December 2000

	Middle Arm Site 1 Gallion Marina	Middle Arm Site 1 Gallion Marina	Middle Arm Site 2 Gallion Marina	Middle Arm Site 2 Gallion Marina
	09-Dec-00	09-Dec-00	09-Dec-00	09-Dec-00
	0:00	0:00	0:00	0:00
	0-15 cm of sediment core	15-30 cm of sediment core	0-15 cm of sediment core	15-30 cm of sediment core
Carbon, Total Organic	9560	7980	7470	9250
D: Dry Sieve, 2.00mm, %< by wt.	100	100	100	100
G: Wet Sieve, 0.250mm, % entire sample by wt.	99.84	98.92	99.92	99.93
H: Wet Sieve 0.125mm, % entire sample by wt.	99.5	92.38	99.11	99.15
K: Pipette, 0.053 mm, %< by wt.	87.11	66.38	70.13	76.27

M: Pipette, 0.002mm, %< by wt.	12.47	9.44	8.87	10.43
N: Gravel, >2.00mm, dry sieve, %< by wt.	<0.01	<0.01	<0.01	<0.01
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	12.89	33.62	29.87	23.73
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	74.64	56.94	61.27	65.84
Q: Clay, <0.002mm, pipette, % entire sample by wt.	12.47	9.44	8.87	10.43
Textural Category	Silt Loam	Silt Loam	Silt Loam	Silt Loam
Acenaphthene-d10, surrogate	76	83	84	79
Acenaphthene	0.04	0.07	0.07	0.06
Acenaphthylene	<0.02	<0.02	<0.02	<0.02
Anthracene	0.03	0.05	0.02	0.02
Benzo(a)anthracene	0.08	0.08	0.06	0.04
Benzo(a)pyrene	0.03	0.03	0.03	<0.02
Benzo(b)fluoranthene	0.05	0.07	0.06	0.04
Benzo(g,h,i)perylene	0.03	0.03	0.02	<0.02
Benzo(k)fluoranthene	0.04	0.04	0.03	0.02
Chrysene	0.06	0.09	0.05	0.04
Chrysene-d12, surrogate	70	77	83	80
Dibenz(a,h)anthracene	<0.02	<0.02	<0.02	<0.02
Fluoranthene	0.23	0.38	0.27	0.21
Fluorene	0.05	0.08	0.07	0.06
Indeno(1,2,3-cd)pyrene	0.04	0.04	0.04	0.04
Naphthalene	0.09	0.13	0.11	0.07
Naphthalene-d8, surrogate	74	72	73	63
Perylene-d12, surrogate	68	74	82	79
Phenanthrene	0.13	0.25	0.26	0.2
Phenanthrene-d10, surrogate	84	93	96	91
Pyrene	0.17	0.26	0.17	0.14
	Middle Arm Site 1 Gallion Marina	Middle Arm Site 1 Gallion Marina	Middle Arm Site 2 Gallion Marina	Middle Arm Site 2 Gallion Marina
	0-15 cm of sediment core	15-30 cm of sediment core	0-15 cm of sediment core	15-30 cm of sediment core

Aluminum	23545	18568	22517	21316
Antimony	<8	<8	<8	<8
Arsenic	<8	<8	<8	<8
Barium	151	120	166	159
Beryllium	0.5	0.4	0.5	0.5
Boron	78	69	72	74
Cadmium	<0.8	<0.8	<0.8	<0.8
Calcium	10158	9359	11082	11007
Chromium	46.5	43.8	45.2	46.3
Cobalt	10.6	9.4	10.9	10.7
Copper	36.8	32.6	35.8	35.7
Iron	34600	31300	32300	34100
Lead	27	21	24	18
Magnesium	12033	10978	11329	11781
Manganese	489	450	519	562
Molybdenum	<2	<2	<2	<2
Nickel	48	48	49	52
Phosphorus	919	842	850	880
Potassium	3228	2199	3166	2526
Selenium	<8	<8	<8	<8
Silicon	803	823	834	843
Silver	<2	<2	<2	<2
Sodium	1402	1030	1177	1114
Strontium	67.7	56	75.8	69.4
Sulphur	1502	1084	728	849
Tin	<8	<8	<8	<8
Titanium	1880	1590	1930	1810
Vanadium	86	77	85	85
Zinc	152.1	86.2	77.9	84.9

Table 5. Results of sediment samples collected at Annieville Channel, December 2000

	SW End of Annieville Channel Main Arm Site 1	SW End of Annieville Channel Main Arm Site 1	SW End of Annieville Channel Main Arm Site 2	SW End of Annieville Channel Main Arm Site 2
	08-Dec-00	08-Dec-00	08-Dec-00	08-Dec-00

	9:20	9:20	10:00	10:00
	0-15cm of sediment core	15-30cm of sediment core	0-15cm of sediment core	15-30cm of sediment core
Carbon, Total Organic	8570	9650	6170	7520
D: Dry Sieve, 2.00mm, %< by wt.	100	100	99.99	100
G: Wet Sieve, 0.250mm, % entire sample by wt.	99.96	99.97	99.81	99.94
H: Wet Sieve 0.125mm, % entire sample by wt.	99.54	99.55	97.43	98.63
K: Pipette, 0.053 mm, %< by wt.	83.3	81.57	65.3	70.42
M: Pipette, 0.002mm, %< by wt.	12.36	12.84	8.67	9.28
N: Gravel, >2.00mm, dry sieve, %< by wt.	<0.01	<0.01	0.01	<0.01
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	16.7	18.43	34.69	29.58
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	70.93	68.72	56.63	61.14
Q: Clay, <0.002mm, pipette, % entire sample by wt.	12.36	12.84	8.67	9.28
Textural Category	Silt Loam	Silt Loam	Silt Loam	Silt Loam
Acenaphthene-d10, surrogate	64	72	76	55
Acenaphthene	<0.02	<0.02	0.04	0.05
Acenaphthylene	<0.02	<0.02	<0.02	<0.02
Anthracene	<0.02	<0.02	0.1	0.05
Benzo(a)anthracene	0.02	0.03	0.07	0.11
Benzo(a)pyrene	<0.02	<0.02	0.02	0.04
Benzo(b)fluoranthene	0.03	0.04	0.05	0.08
Benzo(g,h,i)perylene	<0.02	<0.02	<0.02	0.02
Benzo(k)fluoranthene	<0.02	<0.02	0.03	0.05
Chrysene	<0.02	<0.02	0.05	0.08
Chrysene-d12, surrogate	71	75	77	65
Dibenz(a,h)anthracene	<0.02	<0.02	<0.02	<0.02
Fluoranthene	0.05	0.1	0.22	0.47
Fluorene	<0.02	<0.02	0.05	0.09
Indeno(1,2,3-cd)pyrene	<0.02	<0.02	0.04	0.04
Naphthalene	<0.02	<0.02	0.02	<0.02
Naphthalene-d8, surrogate	44	68	55	19
Perylene-d12, surrogate	70	73	78	65

Phenanthrene	0.03	0.07	0.18	0.37
Phenanthrene-d10, surrogate	82	93	90	75
Pyrene	0.04	0.07	0.14	0.3
	SW End of Annieville Channel Main Arm Site 1	SW End of Annieville Channel Main Arm Site 1	SW End of Annieville Channel Main Arm Site 2	SW End of Annieville Channel Main Arm Site 2
	0-15cm of sediment core	15-30cm of sediment core	0-15cm of sediment core	15-30cm of sediment core
Aluminum	26552	26802	21318	24368
Antimony	<8	<8	<8	<8
Arsenic	<8	<8	<8	<8
Barium	206	214	169	202
Beryllium	0.5	0.6	0.4	0.5
Boron	86	83	71	76
Cadmium	<0.8	<0.8	<0.8	<0.8
Calcium	12881	12397	10720	11929
Chromium	57.6	54.1	45.9	52.3
Cobalt	13.6	11.3	8.9	11.2
Copper	38.8	39.5	31.1	34.9
Iron	38900	37000	21400	34400
Lead	28	23	23	23
Magnesium	13342	12401	10570	11523
Manganese	643	646	515	590
Molybdenum	<2	<2	<2	<2
Nickel	61	58	52	51
Phosphorus	870	861	774	868
Potassium	3647	3920	3039	3488
Selenium	<8	<8	<8	<8
Silicon	558	476	571	626
Silver	<2	<2	<2	<2
Sodium	891	796	675	756
Strontium	85.7	83	70.9	79.3
Sulphur	820	744	605	667
Tin	<8	<8	<8	<8
Titanium	2120	2070	1930	2100
Vanadium	98	96	86	94

Zinc	88.9	88.4	71.1	80
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Table 6. Results of sediment samples collected at Deas Slough, December 2000

	Deas Slough Main Arm #1	Deas Slough Main Arm #1
	07-Dec-00	07-Dec-00
	10:15	10:15
	0-15cm of sediment core	15-30cm of sediment core
Carbon, Total Organic	11700	11700
D: Dry Sieve, 2.00mm, %< by wt.	99.97	100
G: Wet Sieve, 0.250mm, % entire sample by wt.	99.93	99.97
H: Wet Sieve 0.125mm, % entire sample by wt.	99.56	99.81
K: Pipette, 0.053 mm, %< by wt.	88.74	92.75
M: Pipette, 0.002mm, %< by wt.	14.65	15.53
N: Gravel, >2.00mm, dry sieve, %< by wt.	0.03	<0.01
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	11.23	7.25
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	74.09	77.22
Q: Clay, <0.002mm, pipette, % entire sample by wt.	14.65	15.53
Textural Category	Silt Loam	Silt Loam
Acenaphthene-d10, surrogate	80	70
Acenaphthene	<0.02	0.04
Acenaphthylene	<0.02	<0.02
Anthracene	<0.02	0.04
Benzo(a)anthracene	<0.02	0.03
Benzo(a)pyrene	<0.02	<0.02
Benzo(b)fluoranthene	0.03	0.03
Benzo(g,h,i)perylene	<0.02	<0.02
Benzo(k)fluoranthene	<0.02	<0.02
Chrysene	<0.02	<0.02
Chrysene-d12, surrogate	79	59

Dibenz(a,h)anthracene	<0.02	<0.02
Fluoranthene	0.04	0.14
Fluorene	<0.02	<0.02
Indeno(1,2,3-cd)pyrene	<0.02	<0.02
Naphthalene	<0.02	<0.02
Naphthalene-d8, surrogate	66	57
Perylene-d12, surrogate	66	55
Phenanthrene	0.04	0.27
Phenanthrene-d10, surrogate	102	78
Pyrene	<0.02	0.08
	Deas Slough Main Arm #1	Deas Slough Main Arm #1
	0-15cm of sediment core	15-30cm of sediment core
Aluminum	30909	31641
Antimony	<8	<8
Arsenic	<8	<8
Barium	239	245
Beryllium	0.7	0.7
Boron	92	94
Cadmium	<0.8	<0.8
Calcium	11937	11602
Chromium	57.6	59.6
Cobalt	14.2	12.3
Copper	42.3	42.6
Iron	40300	40800
Lead	24	26
Magnesium	13964	13835
Manganese	650	643
Molybdenum	<2	<2
Nickel	60	59
Phosphorus	920	911
Potassium	5072	5241
Selenium	<8	<8
Silicon	641	640
Silver	<2	<2

Sodium	1748	1801
Strontium	85.8	84.8
Sulphur	881	1210
Tin	<8	<8
Titanium	2110	2160
Vanadium	102	106
Zinc	95.1	97.8

Table 7. Results of dioxins and furans analysis of sediment samples collected in January 2000

	E206965	E206968	E206970				
	Fraser River at Barnston Island	Fraser River at McDonald Slough	Fraser River at Ewen Slough	TEQ Conversion Factor	Fraser River at Barnston Island	Fraser River at McDonald Slough	Fraser River at Ewen Slough
	21-Jan-00	20-Jan-00	20-Jan-00		TEQ	TEQ	TEQ
	10:15	13:40	10:30				
	Grab Rep 1	Grab Rep 1	Grab Rep 1				
1,2,3,4,6,7,8 - H7CDD	15	39	16	0.001	0.015	0.039	0.016
1,2,3,4,6,7,8 - H7CDF	2	21	3.2	0.01	0.02	0.21	0.032
1,2,3,4,7,8 H6CDD	<1.1	<1.1	<1.1	0.5			
1,2,3,4,7,8 H6CDF	<1.1	<1.1	<1.1	0.1			
1,2,3,4,7,8,9 H7CDF	<1.4	<1.4	<1.4	0.01			
1,2,3,6,7,8 H6CDD	<1.1	6.2	1.4	0.01		0.062	0.014
1,2,3,6,7,8 H6CDF	<1.1	<1.1	<1.1	0.1			
1,2,3,7,8 P5CDD	<1.1	<1.1	<1.1	1			
1,2,3,7,8 P5CDF	<1.1	<1.1	<1.1	0.05			
1,2,3,7,8,9 H6CDD	<1.1	2.4	<1.1	0.01		0.024	
1,2,3,7,8,9 H6CDF	<1.1	<1.1	<1.1	0.1			

13C-H6CDD surrogate	92	90	98				
13C-H6CDF surrogate	92	89	96				
13C-H7CDD surrogate	86	88	87				
13C-H7CDF surrogate	84	84	85				
13C-O8CDD surrogate	96	99	99				
13C-P5CDD surrogate	110	89	97				
13C-P5CDF surrogate	90	83	91				
13C-T4CDD surrogate	83	82	83				
13C-T4CDF surrogate	82	82	85				
2,3,4,6,7,8 H6CDF	<1.1	<1.1	<1.1	0.1			
2,3,4,7,8 P5CDF	<1.1	<1.1	<1.1	0.05			
2,3,7,8 T4CDD	<0.3	<0.3	<0.3	1			
2,3,7,8 T4CDF	<0.3	2.5	1.1	0.05		0.125	0.055
H6CDD - Total	7.1	40	12				
H6CDF - Total	<1.1	33	4.4				
H7CDD - Total	48	85	43				
H7CDF - Total	7.3	73	12				
O8CDD	130	230	130	0.0001	0.013	0.023	0.013
O8CDF	4.2	25	5.7	0.0001	0.00042	0.0025	0.00057
P5CDD - Total	<1.1	1.9	<1.1				
P5CDF - Total	<1.1	11	1.2				
T4CDD - Total	1.2	4.2	1.7				
T4CDF - Total	1	7.9	2				
				Total TEQ	0.048	0.486	0.131

Appendix IV. Sediment QA/QC data.

Table 1. Comparison of relative percent mean difference for triplicate samples collected at Barnston Island.

	E206 965	E206 965	E206 965		E206 965	E206 965	E206 965		E206 965	E206 965	E206 965	
	Fraser River at Barnston Island	Fraser River at Barnston Island	Fraser River at Barnston Island		Fraser River at Barnston Island	Fraser River at Barnston Island	Fraser River at Barnston Island		Fraser River at Barnston Island	Fraser River at Barnston Island	Fraser River at Barnston Island	
	21- Jan- 00	21- Jan- 00	21- Jan- 00		21- Jan- 00	21- Jan- 00	21- Jan- 00		21- Jan- 00	21- Jan- 00	21- Jan- 00	
	10:15	10:20	10:25	Relati ve % Mean Diff.	10:45	11:00	11:15	Relati ve % Mean Diff.	10:45	11:00	11:15	Relati ve % Mean Diff.
	Grab Rep 1	Grab Rep 2	Grab Rep 3		Lower Rep 1	Lower Rep 2	Lower Rep 3		Upper Rep 1	Upper Rep 2	Upper Rep 3	
EPH (C10-18)	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
EPH (C19-31)	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
HEPH	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
LEPH	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
Acenaphthene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Acenaphthylene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Anthracene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(a)anthra cene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(a)pyrene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(b)fluoran thene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(g,h,i)per ylene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(k)fluoran thene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Chrysene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%

Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Fluoranthene	0.01	0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Fluorene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Naphthalene	0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Phenanthrene	0.02	0.01	<0.01	75%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Pyrene	0.02	<0.01	<0.01	75%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Carbon, total organic	1.09	1.12	1.09	5%	0.49	0.57	0.48	33%	0.39	0.24	0.23	56%
	Grab Rep 1	Grab Rep 2	Grab Rep 3	Relative % mean diff.	Lower Rep 1	Lower Rep 2	Lower Rep 3	Relative % mean diff.	Upper Rep 1	Upper Rep 2	Upper Rep 3	Relative % mean diff.
Moisture content	43.8	43.6	42.8	2%	32.2	32.3	33	2%	29.7	29.8	30.2	2%
2,3,4,5 - TTCP	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
2,3,4,6 - TTCP	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
2,4,6 - TBP, surrogate	117	73	87	63%	74	76	83	12%	104	69	63	52%
Pentachlorophenol	<0.0002	<0.0002	<0.0002	0%	<0.0002	<0.0002	<0.0002	0%	<0.0002	<0.0002	<0.0002	0%
Aroclor 1016	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1221	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1232	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1242	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1248	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1254	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1260	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1262	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%

Monobromobiphenyl	99	100	93	8%	93	102	97	14%	97	94	92	5%
Aluminum	22800	27300	25400	25%	10500	20500	18900	70%	17400	18200	18700	7%
Antimony	<8	<8	<8	0%	<8	<8	<8	0%	<8	<8	<8	0%
Arsenic	<8	<8	8	0%	<8	<8	<8	0%	<8	<8	<8	0%
Barium	183	232	214	32%	103	178	161	62%	143	148	155	8%
Beryllium	<0.2	<0.2	<0.2	0%	<0.2	<0.2	<0.2	0%	<0.2	<0.2	<0.2	0%
Boron	77	83	79	13%	53	70	68	30%	66	67	71	7%
Cadmium	<4	<4	<4	0%	<8	<8	<4	60%	<4	<0.8	<8	244%
Calcium	11100	11800	11400	10%	9500	12600	11900	34%	12100	12500	12600	4%
Chromium	50.5	53.7	52.1	9%	34.4	49.3	47.2	39%	48	49.3	49.2	3%
Cobalt	11.1	13	12.7	18%	10.3	11.9	10	33%	10.9	10.1	10	9%
Copper	38.8	37.2	38.6	8%	30.4	31	30.2	5%	27.3	28.9	30.3	10%
Iron	37200	38400	37600	5%	27900	33500	32400	21%	31800	31900	33500	5%
Lead	21	21.3	24	14%	14	13	18	40%	53	22	27	106%

	Grab Rep 1	Grab Rep 2	Grab Rep 3	Relative % mean diff.	Lower Rep 1	Lower Rep 2	Lower Rep 3	Relative % mean diff.	Upper Rep 1	Upper Rep 2	Upper Rep 3	Relative % mean diff.
Magnesium	12100	12600	12200	7%	9500	10800	10500	16%	10600	10900	10800	4%
Manganese	610	625	619	3%	500	582	564	18%	501	511	522	4%
Molybdenum	<2	<2	<2	0%	<2	<2	<2	0%	<2	<2	<2	0%
Nickel	54	53	55	6%	46	50	49	10%	50	49	52	8%
Phosphorus	830	856	833	6%	740	758	730	6%	691	721	758	9%
Potassium	3110	4600	4010	53%	940	2930	2570	109%	2390	2500	2650	10%
Selenium	<8	8	<8	0%	<8	<8	<8	0%	<8	<8	<8	0%
Silicon	418	515	686	50%	870	555	524	53%	544	688	549	48%
Silver	<2	<2	<2	0%	<2	<2	<2	0%	<2	<2	<2	0%
Sodium	623	791	719	34%	200	543	469	103%	479	510	535	11%
Strontium	71.7	82.2	77.5	20%	45.8	74.9	68.1	57%	70.4	72.4	73.6	4%
Sulphur	619	641	615	8%	537	553	531	7%	535	533	553	4%
Tin	<8	<8	<8	0%	<8	<8	<8	0%	<8	<8	<8	0%
Titanium	1880	1820	1960	11%	811	1850	1710	81%	1800	1760	1890	9%
Vanadium	88	98	93	16%	55	86	80	50%	85	83	88	8%
Zinc	84.4	86.9	85.5	5%	62.4	71.1	70	14%	64.6	67.2	65.5	7%

Mercury	0.054	0.057	0.059	9%	0.056	0.064	0.044	51%	0.038	0.045	0.04	29%
	Avg. relative % mean difference:			9%	Avg. relative % mean difference:			16%	Avg. relative % mean difference:			10%

Table 2. Comparison of relative percent mean difference for triplicate samples collected at McDonald Slough.

	E2069 68	E2069 68	E2069 68		E2069 68	E2069 68	E2069 68		E2069 68	E2069 68	E2069 68	
	Fraser River at McDo nald Sloug h	Fraser River at McDo nald Sloug h	Fraser River at McDo nald Sloug h		Fraser River at McDo nald Sloug h	Fraser River at McDo nald Sloug h	Fraser River at McDo nald Sloug h		Fraser River at McDo nald Sloug h	Fraser River at McDo nald Sloug h	Fraser River at McDo nald Sloug h	
	20- Jan- 00	20- Jan- 00	20- Jan- 00		20- Jan- 00	20- Jan- 00	20- Jan- 00		20- Jan- 00	20- Jan- 00	20- Jan- 00	
	13:40	13:50	14:00	Relat ive % Mea n Diff.	14:10	14:20	14:30	Relat ive % Mea n Diff.	14:10	14:20	14:30	Relat ive % Mea n Diff.
	Grab Rep 1	Grab Rep 2	Grab Rep 3		Lower Rep 1	Lower Rep 2	Lower Rep 3		Upper Rep 1	Upper Rep 2	Lower Rep 3	
EPH (C10-18)	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
EPH (C19-31)	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
HEPH	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
LEPH	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
Acenaphthene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	0.01	0%
Acenaphthylene	<0.01	<0.01	<0.01	0%	0.01	<0.01	0.01	0%	0.01	0.01	0.02	75%
Anthracene	0.01	0.01	0.01	0%	0.02	<0.01	0.02	120 %	0.03	0.02	0.03	75%
Benzo(a)anthracene	0.02	0.02	0.02	0%	0.03	<0.01	0.03	171 %	0.03	0.04	0.05	50%
Benzo(a)pyrene	0.02	0.02	0.02	0%	0.03	<0.01	0.02	150 %	0.03	0.05	0.04	75%
Benzo(b)fluoranthene	0.04	0.04	0.03	27%	0.05	<0.01	0.05	218 %	0.07	0.08	0.09	25%

Benzo(g,h,i)perylene	0.02	0.02	0.02	0%	0.02	<0.01	0.02	120%	0.03	0.04	0.03	60%
Benzo(k)fluoranthene	0.01	0.01	0.01	0%	0.02	<0.01	0.02	120%	0.03	0.03	0.03	0%
Chrysene	0.03	0.03	0.03	0%	0.04	<0.01	0.04	200%	0.04	0.05	0.06	40%
Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Fluoranthene	0.05	0.06	0.05	38%	0.16	0.02	0.15	245%	0.12	0.12	0.14	16%
Fluorene	<0.01	<0.01	<0.01	0%	0.01	<0.01	0.01	0%	0.02	0.02	0.02	0%
Indeno(1,2,3-cd)pyrene	0.01	0.01	0.01	0%	0.02	<0.01	0.01	75%	0.02	0.03	0.03	38%
Naphthalene	0.02	0.02	0.03	43%	0.05	0.01	0.06	225%	0.05	0.05	0.07	35%
Phenanthrene	0.04	0.04	0.04	0%	0.05	<0.01	0.05	218%	0.06	0.06	0.07	16%
Pyrene	0.05	0.06	0.05	38%	0.14	0.02	0.13	238%	0.12	0.13	0.15	23%
Carbon, total organic	1.7	1.43	1.36	23%	1	0.84	0.95	29%	1.1	1.31	1.07	39%
Moisture content	47.1	45.9	45.5	3%	32.4	33.9	34	5%	38	38.1	39.2	3%
	Grab Rep 1	Grab Rep 2	Grab Rep 3	Relative % mean diff.	Lower Rep 1	Lower Rep 2	Lower Rep 3	Relative % mean diff.	Upper Rep 1	Upper Rep 2	Lower Rep 3	Relative % mean diff.
2,3,4,5 - TTCP	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
2,3,4,6 - TTCP	<0.0005	<0.0005	<0.0005	0%	0.0007	0.0005	0.0006	50%	0.0016	0.0012	0.0013	37%
2,4,6 - TBP, surrogate	121	107	74	47%	73	73	60	19%	62	40	88	111%
Pentachlorophenol	0.0005	0.0004	0.0004	23%	0.0005	0.0004	0.0005	43%	0.0005	0.0004	0.0005	43%
Aroclor 1016	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1221	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1232	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%

Aroclor 1242	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1248	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1254	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1260	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1262	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Monobromobiphenyl	85	92	93	9%	93	92	80	15%	51	40	42	29%
Aluminum	27400	27500	26400	4%	25000	23000	24000	13%	30000	25000	25000	19%
Antimony	<8	<8	<8	0%	<8	<8	<8	0%	<8	<8	<8	0%
Arsenic	<8	<8	<8	0%	<8	<8	<8	0%	<8	8.4	<8	10%
Barium	142	147	133	14%	132	114	122	21%	172	122	125	38%
Beryllium	<0.2	<0.2	<0.2	0%	<0.2	<0.2	<0.2	0%	<0.2	<0.2	<0.2	0%
Boron	96	94	96	4%	82	77	81	11%	91	86	84	8%
Cadmium	<4	<0.8	<0.8	171%	<4	<4	<4	0%	<4	<4	<4	0%
Calcium	8130	8090	8030	1%	8000	7000	8000	26%	8000	8000	8000	0%
Chromium	51.1	52.6	51.4	5%	53.3	47.7	51	18%	55.4	52.9	50	10%
Cobalt	12.2	12.3	12.9	6%	13.1	11.5	12.9	24%	11.7	13.4	12.1	24%
Copper	41.2	41.1	41.8	2%	36.1	35.4	36.4	5%	41.9	41.9	41.9	0%
Iron	44020	43500	44100	129%	38200	37200	37900	5%	41100	40300	39400	4%
Lead	39	33	32	20%	33	33	32	3%	42	34	40	36%
Magnesium	12900	12800	12800	1%	10000	10000	10000	0%	10000	10000	10000	0%
Manganese	550	545	552	2%	396	384	386	4%	438	422	414	6%
Molybdenum	<2	<2	<2	0%	<2	<2	<2	0%	<2	<2	<2	0%
	Grab Rep 1	Grab Rep 2	Grab Rep 3	Relative % mean diff.	Lower Rep 1	Lower Rep 2	Lower Rep 3	Relative % mean diff.	Upper Rep 1	Upper Rep 2	Lower Rep 3	Relative % mean diff.
Nickel	51	49	53	12%	49	46	49	13%	50	50	48	4%
Phosphorus	1230	1210	1220	2%	900	900	900	0%	1000	1000	900	10%
Potassium	4630	4760	4300	13%	4000	4000	4000	0%	6000	4000	4000	43%
Selenium	<8	<8	<8	0%	<8	<8	<8	0%	<8	<8	<8	0%
Silicon	745	707	755	12%	700	710	790	12%	880	750	670	27%
Silver	<2	<2	<2	0%	<2	<2	<2	0%	<2	<2	<2	0%

Sodium	4780	4680	4670	2%	2000	2000	2000	0%	3000	3000	3000	0%
Strontium	72.1	71.9	70.4	2%	62.5	57.6	58.3	9%	72.8	63.4	62.9	15%
Sulphur	1080	1100	1100	2%	4400	4200	4500	11%	3200	3200	3100	3%
Tin	<8	<8	<8	0%	<8	<8	<8	0%	<8	<8	<8	0%
Titanium	1920	1880	1890	3%	1870	1820	1700	9%	2010	1850	1820	10%
Vanadium	96	95	93	3%	93	87	89	9%	100	92	90	11%
Zinc	105	103	104	3%	91.8	88.5	90	5%	109	107	105	4%
Mercury	0.079	0.073	0.073	8%	0.073	0.066	0.074	21%	0.076	0.072	0.076	11%
	Avg. relative % mean difference:			10%	Avg. relative % mean difference:			38%	Avg. relative % mean difference:			17%

Table 2. Comparison of relative percent mean difference for triplicate samples collected at Ewen Slough.

	E2069 70	E2069 70	E2069 70		E2069 70	E2069 70	E2069 70		E2069 70	E2069 70	E2069 70	
	Fraser River at Ewen Sloug h	Fraser River at Ewen Sloug h	Fraser River at Ewen Sloug h		Fraser River at Ewen Sloug h	Fraser River at Ewen Sloug h	Fraser River at Ewen Sloug h		Fraser River at Ewen Sloug h	Fraser River at Ewen Sloug h	Fraser River at Ewen Sloug h	
	20- Jan-00	20- Jan-00	20- Jan-00		20- Jan- 00	20- Jan- 00	20- Jan- 00		20- Jan- 00	20- Jan- 00	20- Jan- 00	
	10:30	10:35	10:40	Rel. % Mea n Diff.	10:50	11:00	11:10	Rel. % Mea n Diff.	10:50	11:00	11:10	Rel. % Mea n Diff.
	Grab Rep 1	Grab Rep 2	Grab Rep 3		Lower Rep 1	Lower Rep 2	Lower Rep 3		Upper Rep 1	Upper Rep 2	Upper Rep 3	
EPH (C10-18)	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
EPH (C19-31)	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
HEPH	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
LEPH	<200	<200	<200	0%	<200	<200	<200	0%	<200	<200	<200	0%
Acenaphthene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Acenaphthylene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Anthracene	<0.01	<0.01	<0.01	0%	0.01	0.01	0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(a)anthracene	0.01	<0.01	0.01	0%	0.02	0.02	0.02	0%	<0.01	0.01	0.01	0%

Benzo(a)pyrene	<0.01	<0.01	<0.01	0%	<0.01	0.01	0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(b)fluorant hene	0.02	0.01	0.02	120%	0.02	0.03	0.03	38%	0.01	0.02	0.02	60%
Benzo(g,h,i)perylene	<0.01	<0.01	<0.01	0%	<0.01	0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Benzo(k)fluorant hene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Chrysene	0.02	0.02	0.02	0%	0.03	0.02	0.02	43%	0.01	0.02	0.02	60%
Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Fluoranthene	<0.01	0.04	0.04	100%	0.06	0.06	0.06	0%	0.04	0.04	0.04	0%
Fluorene	0.04	<0.01	<0.01	150%	0.01	0.01	0.01	0%	<0.01	<0.01	<0.01	0%
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%	<0.01	<0.01	<0.01	0%
Naphthalene	0.01	0.02	0.01	150%	0.02	0.02	0.02	0%	0.01	0.01	0.01	0%
Phenanthrene	0.03	0.03	0.03	0%	0.04	0.04	0.05	23%	0.03	0.03	0.03	0%
Pyrene	0.03	0.03	0.03	0%	0.06	0.06	0.06	0%	0.03	0.03	0.03	0%
Carbon, total organic	1.37	1.4	1.27	12%	1.24	1.31	1.25	10%	1.1	1.06	1	9%
Moisture content	47.1	46.8	46.4	1%	39.1	39.3	40	2%	39.5	39.8	37.1	8%
	Grab Rep 1	Grab Rep 2	Grab Rep 3	Relative % mean diff.	Lower Rep 1	Lower Rep 2	Lower Rep 3	Relative % mean diff.	Upper Rep 1	Upper Rep 2	Lower Rep 3	Relative % mean diff.
2,3,4,5 - TTCP	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
2,3,4,6 - TTCP	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
2,4,6 - TBP, surrogate	111	117	120	8%	114	120	122	7%	118	129	106	29%
Pentachlorophenol	<0.0002	<0.0002	0.0003	43%	<0.0002	<0.0002	<0.0002	0%	<0.0002	<0.0002	<0.0002	0%
Aroclor 1016	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%
Aroclor 1221	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%	<0.0005	<0.0005	<0.0005	0%

Aroclor 1232	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1242	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1248	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1254	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1260	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Aroclor 1262	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%	<0.00 5	<0.00 5	<0.00 5	0%
Monobromobiphenyl	92	95	96	4%	86	81	84	10%	95	93	93	2%
Aluminum	28000	29000	31000	10%	26900	31000	29300	20%	28000	26800	29500	14%
Antimony	<8	<8	<8	0%	<10	<10	<10	0%	<8	<8	<8	0%
Arsenic	<8	<8	<8	0%	<10	<10	<10	0%	<8	<8	<8	0%
Barium	184	190	213	15%	165	215	190	39%	179	166	193	22%
Beryllium	<0.2	<0.2	<0.2	0%	<0.2	<0.2	<0.2	0%	<0.2	<0.2	<0.2	0%
Boron	87	91	91	4%	85	90	89	7%	86	85	88	5%
Cadmium	<4	<4	<4	0%	<4	<4	<5	23%	<4	<4	<4	0%
Calcium	10000	10000	10000	0%	9290	9880	9820	7%	9350	9240	9680	6%
Chromium	54	52.8	56.7	9%	51	57	55	15%	54.8	54.7	56.4	3%
Cobalt	12.9	13.8	15.2	16%	12	13.9	13	22%	12.5	13	10.7	23%
Copper	41.9	41.4	41.5	1%	42	42.5	43	2%	41.1	42.3	41.4	5%
Iron	41700	42200	42100	1%	40200	41400	42000	4%	40400	40700	41200	2%
Lead	24	24	24	0%	30	33	33	9%	18	19	25	34%
Magnesium	10000	10000	10000	0%	13200	13600	13700	4%	13100	13200	13300	2%
Manganese	683	692	661	6%	522	536	543	4%	535	540	546	2%
Molybdenum	<2	<2	<2	0%	<2	<2	<2	0%	<2	<2	<2	0%
	Grab Rep 1	Grab Rep 2	Grab Rep 3	Relative % mean diff.	Lower Rep 1	Lower Rep 2	Lower Rep 3	Relative % mean diff.	Upper Rep 1	Upper Rep 2	Lower Rep 3	Relative % mean diff.
Nickel	55	58	54	13%	53	52	56	9%	55	55	55	0%
Phosphorus	900	900	900	0%	882	900	919	4%	910	911	910	0%
Potassium	5000	5000	6000	19%	4210	5720	4910	47%	4650	4200	5050	28%
Selenium	<8	<8	<8	0%	<10	<10	<10	0%	<8	<8	<8	0%

Silicon	640	630	590	8%	757	710	635	17%	626	650	700	11%
Silver	<2	<2	<2	0%	<2	<2	<2	0%	<2	<2	<2	0%
Sodium	3000	3000	3000	0%	1810	2100	1990	20%	1940	1940	1960	1%
Strontium	77.6	79.1	81.9	5%	69.4	78.3	75	16%	73.4	71.3	77	11%
Sulphur	730	760	830	13%	1460	1480	1510	3%	1100	1100	1100	0%
Tin	<8	<8	<8	0%	<10	<10	<10	0%	<8	<8	<8	0%
Titanium	2070	2120	2040	6%	1980	2090	2090	5%	2000	1960	2110	9%
Vanadium	95	97	100	5%	92	100	98	10%	95	92	98	9%
Zinc	93.2	94.8	95.8	3%	94	96.1	96.7	3%	92.8	93.5	94.7	2%
Mercury	0.097	0.073	0.064	42%	0.069	0.067	0.096	40%	0.063	0.069	0.064	17%
	Avg. relative % mean difference:			12%	Avg. relative % mean difference:			7%	Avg. relative % mean difference:			6%