

**APPENDIX H**

**CHEMICAL CONTAMINANT QUALITY ASSURANCE  
PROCEDURES AND DATA, AND ENVIRONMENTAL  
CONCERN RATINGS**

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## APPENDIX H

### CHEMICAL CONTAMINANT QUALITY ASSURANCE PROCEDURES AND DATA, AND ENVIRONMENTAL CONCERN RATINGS

#### 1.0 INTRODUCTION

Each year, sediment samples are collected from selected stormwater flows to evaluate the associated level of environmental concern. Samples are collected from the following locations (in decreasing order of preference) to identify contaminants originating from the catchment area:

- a) from accumulated material within the discharge
- b) from accumulated material from the nearest upstream station containing sediment
- c) from an obvious "delta" outside the mouth of the discharge
- d) from material located between larger rocks within one meter of the mouth of the discharge

Each sample is analyzed for low and high molecular weight polycyclic aromatic hydrocarbons (LPAH and HPAH respectively) and eight metals: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), silver (Ag) and zinc (Zn). Detailed information on the methods used for laboratory analysis in 2005/2006 is presented in Gormican (2005 and 2006).

Quality assurance and quality control (QA/QC) programs are a set of protocols that are adopted to ensure that the results of any study are valid, internally consistent and comparable with other similar projects. These protocols are set out in writing and are based on the most current and relevant research on the related topics. This appendix discusses:

- field sampling and handling procedures
- quality assurance in the field
- quality assurance in the laboratory

#### 2.0 FIELD SAMPLING AND HANDLING PROCEDURES

Sediment sampling is undertaken each year during the summer months when stormwater flows are generally at their lowest. This helps prevent resuspension of the sediments as samples are collected.

The top two to five centimetres of accumulated sediments are sampled using polyethylene and stainless steel scoops (for metals and PAH respectively). Sampling equipment is cleaned with metal and phosphate-free detergent and tap water, rinsed with distilled water and rinsed in the stormwater flow prior to sample collection. Sediments are placed in labeled, acid-washed glass jars with Teflon lined lids supplied by the analytical laboratory, frozen and delivered by courier over night to Cantest Ltd. in Vancouver.

##### 2.1 Quality Assurance in the Field

Field duplicates are prepared by placing approximately 500 mL of sediment into a bowl made of appropriate material (stainless steel for PAHs, polyethylene for metals) and homogenizing with scoops of appropriate material. Sediments are then split by alternating placement into labelled acid-washed jars with Teflon lined lids.

Ten per cent of all samples collected each year are submitted blind to the laboratory as field replicates. There are no specific precision requirements for these replicates. Rather, the results represent the variation in real sampling conditions and are used to indicate whether modifications to sample collection procedures are required.

A full description of field sampling procedures for the 2005/2006 sediment sampling program is presented in Gormican (2005) and Gormican (2006).

### **2.1.2 Quality Assurance in the Laboratory**

The QA program for sediment sampling includes laboratory triplicates, and Standard Reference Materials (SRM). Precision and accuracy of the laboratory analysis is estimated from the results of the triplicates and SRM recovery. A full description of the laboratory QA measures undertaken during the 2005/2006 sediment sampling program is presented in Gormican (2005 and 2006).

**Table 1. Chemical Contaminant Concentrations for 1999 – 2006**  
 Shading indicates exceedence of 75% of the marine sediment quality guideline.

CRD Flow #	Date	Arsenic µg/g	Cadmium µg/g	Chromium µg/g	Copper µg/g	Lead µg/g	Mercury µg/g	Silver µg/g	Zinc µg/g	LPAH µg/g	HPAH µg/g
	MSQG	57	5.1	260	390	450	0.41	6.1	410	5.2	12
7002	09-Sep-04	3	0.2	25	14	7	0.04	0.1	61	0.1	0
7002	18-Aug-05	3	0.2	20	16	6	0.04	0.1	68	0.0	0
7003	09-Sep-04	7	0.2	32	26	10	0.06	0.1	79	0.1	0
7003	18-Aug-05	5	0.2	20	39	5	0.04	0.1	107	0.0	0
7003	23-Oct-06	5	0.2	23	10	4	0.05	0.1	36	0.1	0
7004	09-Sep-04	2	0.2	22	52	2	0.01	0.1	109	0.1	0
7004	18-Aug-05	2	0.2	18	38	2	0.01	0.1	147	0.0	0
7015	06-Jul-99	5	0.2	42	24	8	0.03	0.1	94	0.1	0
7015	01-Aug-01	6	0.2	21	14	20	0.05	0.6	65	1.1	12
7015	31-Jul-02	11	0.1	74	29	15	0.05	0.1	142	0.5	2
7015	18-Jul-03	10	0.0	63	25	21	0.04	<0.1	102	0.3	1
7015	20-Jul-06	6	0.2	19	16	13	0.08	0.1	45	0.6	2
7021	06-Jul-99	5	0.1	36	24	5	0.03	0.1	65	0.1	0
7021	07-Jul-06	5	0.2	28	21	5	0.04	0.1	91	0.1	0
7022	01-Aug-01	6	0.2	39	49	29	0.04	0.2	110	0.2	0
7022	07-Jul-06	3	0.2	24	23	16	0.06	0.1	106	0.1	0
7051	01-Aug-01	4	0.1	36	32	16	0.03	0.1	282	0.2	1
7051	31-Jul-02	3	0.1	25	22	9	0.02	0.1	184	0.2	1
7051	18-Jul-03	4	0.1	33	30	12	0.03	<0.1	126	0.1	0
7051-1	18-Jul-03	4	0.2	43	42	88	0.06	<0.1	129	0.2	0
7402	09-Sep-04	5	0.3	21	22	11	0.05	0.1	479	0.1	0
7402	28-Jul-05	12	0.4	34	44	16	0.11	0.1	191	0.1	0
7402	07-Jul-06	12	0.4	28	35	17	0.07	0.1	275	0.1	0
7407	31-Jul-02	4	0.1	37	24	7	0.05	0.1	58	0.1	0
7407	01-Aug-06	5	0.2	30	23	45	0.03	0.1	149	0.1	0
7410	11-Jul-03	3	0.0	20	12	4	0.02	<0.1	43	0.1	0
7411	28-Jul-05	5	0.4	28	38	59	0.13	0.1	280	0.0	0
7411	14-Aug-06	3	0.2	19	13	5	0.02	0.1	237	0.1	0
7600	25-Jun-02	6	0.1	25	17	5	0.04	0.1	48	0.1	0
7600	18-Jul-03	6	0.2	18	9	3	0.01	0.1	43	0.1	0

continued...

Table 1 continued

CRD Flow #	Date	Arsenic mg/g	Cadmium µg/g	Chromium µg/g	Copper µg/g	Lead µg/g	Mercury µg/g	Silver µg/g	Zinc µg/g	LPAH µg/g	HPAH µg/g
	MSQG	57	5.1	260	390	450	0.41	6.1	410	5.2	12
7613	23-Jul-03	5	0.0	45	46	9	0.06	<0.1	85	0.1	0
7613	09-Sep-04	4	0.2	21	37	88	0.02	0.1	87	0.1	0
7625	18-Aug-05	3	0.2	12	11	6	0.02	0.1	45	0.0	0
7625	18-Jul-06	4	0.2	24	15	12	0.04	0.1	100	0.1	0
7626	01-Sep-05	10	0.2	37	35	18	0.02	0.1	185	0.0	0
7626	18-Jul-06	5	0.2	32	39	14	0.04	0.1	89	0.1	0
7628	01-Sep-05	3	0.2	17	11	7	0.01	0.1	85	0.0	0
7800	01-Aug-01	4	0.5	33	47	40	0.06	0.2	346	0.1	1
7800	30-Jul-02	3	0.1	17	19	21	0.02	0.1	72	0.1	0
7800	14-Jul-03	3	0.3	21	30	21	0.07	<0.1	155	0.1	0
7800	09-Sep-04	2	0.2	11	20	28	0.03	0.1	74	0.1	0
7800-1	30-Jul-02	8	0.3	38	43	18	0.08	0.1	77	0.1	0
7810	01-Aug-01	2	0.1	21	10	5	0.02	0.1	53	0.1	0
7810	29-Sep-06	3	0.4	20	21	7	0.18	<0.1	126	0.1	0
7820	01-Aug-01	7	0.1	28	18	9	0.02	0.1	46	0.1	0
7820	31-Aug-05	5	0.2	.2	40	7	0.02	0.1	76	0.0	0

**Table 2. Calculation of Toxic Equivalent Units (TEU) for Metals and PAH Compounds – Southern Gulf Islands Report, 1999-2006**  
 Shading indicates an exceedence or near exceedence of marine sediment quality guidelines (MSQG) (see Section 2.2).

CRD Flow #	Date	Arsenic	Cad-mium	Chromium	Copper	Lead	Mercury	Silver	Zinc	LPAH	HPAH	TEU	Contamin-ant Rating
7002	09-Sep-04	0.05	0.04	0.10	0.04	0.02	0.10	0.02	0.15	0.01	0.01	0.54	Low
7002	18-Aug-05	0.06	0.04	0.08	0.04	0.01	0.11	0.02	0.26	0.00	0.00	0.62	Low
7003	09-Sep-04	0.12	0.04	0.12	0.07	0.02	0.15	0.02	0.19	0.01	0.01	0.75	Low
7003	18-Aug-05	0.08	0.04	0.08	0.10	0.01	0.11	0.02	0.26	0.00	0.00	0.70	Low
7003	23-Oct-06	0.08	0.04	0.09	0.02	0.01	0.12	0.02	0.09	0.01	0.01	0.49	Low
7004	09-Sep-04	0.03	0.04	0.08	0.13	0.01	0.02	0.02	0.27	0.01	0.01	0.62	Low
7004	18-Aug-05	0.04	0.04	0.07	0.10	0.00	0.02	0.02	0.36	0.00	0.00	0.65	Low
7015	06-Jul-99	0.09	0.04	0.16	0.06	0.02	0.08	0.02	0.23	0.01	0.01	0.71	Low
7015	01-Aug-01	0.10	0.04	0.08	0.04	0.04	0.11	0.10	0.16	0.22	1.00	1.89	High
7015	31-Jul-02	0.19	0.01	0.28	0.07	0.03	0.11	0.02	0.35	0.09	0.16	1.22	Moderate
7015	18-Jul-03	0.18	0.01	0.24	0.06	0.05	0.08	0.02	0.25	0.05	0.07	1.01	Moderate
7015	07-Jul-06	0.10	0.04	0.07	0.04	0.03	0.20	0.02	0.11	0.11	0.13	0.75	Low
7021	06-Jul-99	0.09	0.02	0.14	0.06	0.01	0.07	0.02	0.16	0.01	0.01	0.59	Low
7021	07-Jul-06	0.09	0.04	0.11	0.05	0.01	0.10	0.02	0.22	0.01	0.01	0.66	Low
7022	01-Aug-01	0.11	0.03	0.15	0.13	0.06	0.10	0.03	0.27	0.04	0.02	0.95	Low
7022	07-Jul-06	0.06	0.04	0.09	0.06	0.03	0.15	0.02	0.26	0.02	0.01	0.74	Low
7051	01-Aug-01	0.07	0.02	0.14	0.08	0.04	0.07	0.02	0.69	0.04	0.06	1.22	Moderate
7051	31-Jul-02	0.06	0.02	0.10	0.06	0.02	0.06	0.02	0.45	0.03	0.09	0.91	Low
7051	18-Jul-03	0.07	0.02	0.13	0.08	0.03	0.08	0.02	0.31	0.02	0.03	0.77	Low
7051-1	18-Jul-03	0.08	0.04	0.16	0.11	0.20	0.14	0.02	0.31	0.03	0.03	1.12	Moderate
7402	09-Sep-04	0.09	0.06	0.08	0.06	0.02	0.12	0.02	1.17	0.01	0.01	1.64	High
7402	28-Jul-05	0.22	0.07	0.13	0.11	0.03	0.28	0.02	0.47	0.01	0.00	1.34	Moderate
7402	01-Aug-06	0.21	0.08	0.11	0.09	0.04	0.17	0.02	0.67	0.01	0.01	1.41	Moderate
7407	31-Jul-02	0.08	0.02	0.14	0.06	0.02	0.11	0.02	0.14	0.01	0.01	0.61	Low
7407	14-Aug-06	0.10	0.04	0.12	0.06	0.10	0.07	0.02	0.36	0.01	0.02	0.80	Low
7410	11-Jul-03	0.05	0.01	0.08	0.03	0.01	0.05	0.02	0.31	0.01	0.01	0.36	Low
7411	28-Jul-05	0.08	0.08	0.11	0.10	0.13	0.32	0.02	0.68	0.00	0.00	1.52	Moderate
7411	01-Aug-06	0.06	0.04	0.07	0.03	0.01	0.05	0.02	0.58	0.01	0.01	0.88	Low
7600	25-Jun-02	0.11	0.01	0.10	0.04	0.01	0.09	0.02	0.12	0.02	0.02	0.54	Low
7600	18-Jul-06	0.10	0.04	0.07	0.02	0.01	0.02	0.02	0.10	0.01	0.01	0.40	Low
7613	23-Jul-03	0.09	0.01	0.17	0.12	0.02	0.14	0.02	0.21	0.01	0.01	0.79	Low

continued...

Table 2 Continued

CRD Flow #	Date	Arsenic	Cad-mium	Chromium	Copper	Lead	Mercury	Silver	Zinc	LPAH	HPAH	TEU	Contamin-ant Rating
7613	09-Sep-04	0.06	0.04	0.08	0.09	0.19	0.05	0.02	0.21	0.02	0.04	0.80	Low
7625	18-Jul-05	0.05	0.04	0.05	0.03	0.01	0.05	0.02	0.11	0.00	0.00	0.36	Low
7625	18-Jul-06	0.06	0.04	0.09	0.04	0.03	0.10	0.02	0.24	0.01	0.01	0.64	Low
7626	01-Sep-05	0.18	0.04	0.14	0.06	0.04	0.05	0.02	0.45	0.00	0.00	0.98	Low
7626	18-Jul-06	0.08	0.04	0.12	0.10	0.03	0.10	0.02	0.22	0.02	0.04	0.77	Low
7628	01-Sep-05	0.05	0.04	0.07	0.03	0.01	0.02	0.02	0.21	0.00	0.00	0.45	Low
7800	01-Aug-01	0.08	0.09	0.13	0.12	0.09	0.14	0.04	0.84	0.02	0.05	1.59	High
7800	30-Jul-02	0.05	0.03	0.07	0.05	0.05	0.05	0.02	0.17	0.01	0.01	0.51	Low
7800	14-Jul-03	0.06	0.05	0.08	0.08	0.05	0.16	0.02	0.38	0.02	0.02	0.91	Low
7800	09-Sep-04	0.03	0.04	0.04	0.05	0.06	0.07	0.02	0.18	0.01	0.01	0.51	Low
7800-1	30-Jul-02	0.14	0.05	0.15	0.11	0.04	0.19	0.02	0.19	0.01	0.01	0.91	Low
7810	01-Aug-01	0.04	0.01	0.08	0.03	0.01	0.04	0.02	0.13	0.01	0.01	0.38	Low
7810	29-Sep-06	0.05	0.08	0.08	0.05	0.02	0.44	0.02	0.31	0.02	0.00	1.06	Moderate
7820	01-Aug-01	0.12	0.01	0.11	0.05	0.02	0.04	0.02	0.11	0.01	0.01	0.50	Low
7820	31-Aug-05	0.09	0.04	0.12	0.10	0.02	0.05	0.02	0.19	0.00	0.00	0.63	Low

**Table 3. Summary of Ratings for Environmental Concern – 1999 - 2006**

CRD Flow #	Contaminant Ratings							Toxic Equivalent Unit (TEU)			Comments and Recommendations
	2000	2001	2002	2003	2004	2005	2006	2004	2005	2006	
7002	-	-	-	-	Low	Low	-	0.54	0.62	-	Rated low in 2004 and 2005. Re-sample in <b>2010</b> to monitor for change now that contaminant levels have been confirmed.
7003	-	-	-	-	Low	Low	Low	0.75	0.70	0.49	Rated low in 2004 and 2005. Re-sample in <b>2011</b> to monitor for change now that contaminant levels have been confirmed.
7004	-	-	-	-	Low	Low	-	0.62	0.65	-	Rated low in 2004 and 2005. Re-sample in <b>2010</b> to monitor for change now that contaminant levels have been confirmed.
7015	Low	High	Moderate	Moderate	-	-	Low	-	-	0.75	Rated low in 2006. Rated moderate in 2002 and 2003 due to slightly elevated chromium and zinc concentrations. Rated high in 2001 due to HPAH. Re-sample in <b>2007</b> to confirm rating.
7021	Low	-	-	-	-	-	Low	-	-	0.66	Rated low in 1999 and 2006. Re-sample in <b>2011</b> to monitor for change now that contaminant levels have been confirmed.
7022	-	Low	-	-	-	-	Low	-	-	0.74	Rated low in 2001 and 2006. Re-sample in <b>2011</b> to monitor for change now that contaminant levels have been confirmed.
7051	-	Moderate	Low	Low	-	-	-	-	-	-	Rated low in 2002 and 2003. Rated moderate in 2001 due to slightly elevated zinc concentration. Re-sample in <b>2008</b> to monitor for change now that contaminant levels have been confirmed.
7402	-	-	-	-	High	Moderate	Moderate	1.64	1.34	1.41	Rated moderate in 2005 and 2006 based on slightly elevated zinc concentrations. Rated high in 2004 based on an elevated zinc concentration. Resample in <b>2009</b> to monitor for change now that contaminant levels have been confirmed.

Continued...

Table 3 continued

CRD Flow #	Contaminant Ratings							Toxic Equivalent Unit (TEU)			Comments and Recommendations
	2000	2001	2002	2003	2004	2005	2006	2004	2005	2006	
7407	-	-	Low	-	-	-	Low	-	-	0.80	Rated low in 2002 and 2006. Re-sample in <b>2011</b> to monitor for change now that contaminant levels have been confirmed.
7410	-	-	-	Low	-	-	-	-	-	-	Rated low in 2003. Re-sample to confirm rating as schedules and budgets allow.
7411	-	-	-	-	-	Moderate	Low	-	1.52	0.88	Rated low in 2006. Rated moderate in 2005 due to a slightly elevated zinc concentration. Re-sample in <b>2007</b> to confirm contaminant levels.
7600	-	-	Low	-	-	-	Low	-	-	0.40	Rated low in 2002 and 2006. Re-sample in <b>2011</b> to monitor for change now that contaminant levels have been confirmed.
7613	-	-	-	Low	Low	-	-	0.80	-	-	Rated low in 2003 and 2004. Re-sample in <b>2009</b> to monitor for change now that contaminant levels have been confirmed.
7625	-	-	-	-	-	Low	Low	-	0.36	0.64	Rated low in 2005 and 2006. Re-sample in <b>2010</b> to monitor for change now that contaminant levels have been confirmed.
7626	-	-	-	-	-	Low	Low	-	0.98	0.77	Rated low in 2005 and 2006. Re-sample in <b>2010</b> to monitor for change now that contaminant levels have been confirmed.
7628	-	-	-	-	-	Low	-	-	0.45	-	Rated low in 2005. Re-sample to confirm rating as schedules and budgets allow.
7800	-	High	Low	Low	Low	-	-	0.51	-	-	Rated low in 2002, 2003 and 2004. Rated high in 2001 due to elevated zinc concentration. Re-sample in <b>2009</b> to monitor for change now that contaminant levels have been confirmed.
7810	-	Low	-	-	-	-	Moderate	-	-	1.06	Rated moderate in 2006. Rated low in 2001. Re-sample in <b>2008</b> to confirm rating.
7820	-	Low	-	-	-	Low	-	-	0.63	-	Rated low in 2001. Resample to confirm rating as schedules and budgets allow.

Habitat Rating: 2.0 – 3.0 = lower mitigative priority, 3.5 – 4.5 = moderate mitigative priority, 5.0 – 6.0 = higher mitigative priority.

Contaminant Rating is based on the TEU and is discussed in Section 2.2.

**Table 4. Habitat Ratings for Discharges Sampled from 1998 to 2006**

<b>CRD Discharge #</b>	<b>Habitat Sensitivity Rating (a)</b>	<b>Flow Rating (b)</b>	<b>Flushing Rating (c)</b>	<b>Habitat Rating<sup>1</sup> (a+b+c)</b>
7002				
7003				
7004				
7015	1	0.5	1	2.5
7021	1	0.5	0.5	2.0
7022	1	0.5	1.5	3.0
7051	1	0.5	1.5	3.0
7402				
7407	3	0.5	1.5	5.0
7410	2	0.5	1.5	4.0
7411				
7600	3	0.5	1.0	4.5
7613	3	0.5	1	4.5
7625				
7626				
7628				
7800	3	0.5	0.5	4.0
7810				
7820	1	0.5	0.5	2.0

<sup>1</sup>Habitat Rating: 2.0 – 3.0 = lower mitigative priority  
 3.5 – 4.5 = moderate mitigative priority  
 5.0 to 6.0 = higher mitigative priority