



September 22, 2017

Disposal at Sea Program
 Environmental Stewardship Branch, Pacific and Yukon Region
 Environment and Climate Change Canada
 201 – 401 Burrard Street
 Vancouver, BC V6C 3S5

**Re: Load Site Sediment Assessment Report
 Campbell River Harbour Reconfiguration Project
 705 Island Highway, Campbell River, BC**

1. INTRODUCTION

Keystone Environmental Ltd. (Keystone Environmental) has prepared this initial sediment characterization report for Public Services and Procurement Canada (PSPC) and the Small Craft Harbours (SCH) division of Fisheries and Oceans Canada, as part of the Campbell River Harbour Reconfiguration Project (the Project). The Project involves the removal of the existing pile-supported wharf structure and associated components, dredging within the footprint of the existing wharf (up to 13,100 m³ over an area of approximately 7,100 m²), and installing two pile-supported concrete abutments for the new trestle and ramp to provide vehicle access. SCH is proposing to remove the upper 0.5m of dredge material for upland disposal. The remaining sediment underneath is proposed for ocean disposal (up to 10,000 m³).

The report reviews the available surface and subsurface sediment chemistry data and surface sediment toxicity bioassay results within the area of proposed reconfiguration works. Due to the extensive costs associated with upland disposal, Keystone Environmental would like to discuss disposal at sea options for the Project with Environment and Climate Change Canada (ECCC).

2. BACKGROUND

The proposed Project is part of the Campbell River Harbour Revitalization Project undertaken by SCH to expand and improve the wharf and harbour capacity. SCH is mandated to keep harbours that are critical to the fishing industry open and in good repair. The purpose of the Project is to replace the existing wharf constructed on wooden piles, with new concrete floats with a vehicle ramp built in the same location to improve access, capacity, reduce long-term maintenance costs associated with pile inspection and repair and reduce potential sources of contamination by removing treated piles and the boat grid.

Based on review of sediment chemistry data (discussed below), SCH plans to remove the first 0.5 m for upland disposal. This will allow the remainder of the clean native sediment to be disposed of at sea.

The proposed dredge area is 7,100 m² (approximately 100 m by 70 m), with a volume of approximately 13,100 m³ as shown in Figure 1. The current seabed ranges from -3 m to 1.0 m chart datum (CD) within the dredge cut. The dredge area will be cut to -3.0 m CD where boats have access, and to -2.0 m under the proposed new floats, with the exception of the northwest corner where it will be cut to -3.5 m CD to accommodate the float structure for a new Search and Rescue shed. The volume of material below 0.5m that would be disposed of at sea is less than 10,000 m³.

3. PREVIOUS SAMPLING

3.1 2001 Sediment Testing

Pottinger Gaherty Environmental Consultants Ltd. (PGL) completed sediment sampling in 2001. Divers were used to collect 49 samples across the harbour basin, 42 of which were analysed and seven of which were located within the proposed dredge footprint. Samples were analysed for total metals, polycyclic aromatic hydrocarbons (PAHs), light and heavy extractable petroleum hydrocarbons (LEPH/HEPH), simultaneously extractable metals (SEM) and acid-volatile sulphides (AVS), total organic carbon (TOC).

Data from the seven samples within the dredge footprint (CANTEST, 2001) were found to be elevated in spots above ECCC Disposal at Sea guidelines for metals and PAHs. Arsenic ranged from 3.00 to 24.0 mg/kg, with an average of 10.4 mg/kg. Cadmium ranged from less than detect (0.3 mg/kg) up to 2.6 mg/kg. Copper ranged from 16.0 to 1,250 mg/kg, with an average of 561.6 mg/kg. Lead ranged from less than detect (30 mg/kg) to 567 mg/kg, averaging 134.9 mg/kg. Mercury ranged from 0.07 to 14.7 mg/kg, with an average of 4.35 mg/kg. Zinc ranged from 32 to 629 mg/kg, averaging 267.4 mg/kg. Total PAHs ranged from 2.48 to 354 mg/kg, with an average of 75.8 mg/kg. The SEM:AVS ratio for two samples located within the dredge footprint were 0.08 and 0.25, suggesting that there was more than sufficient AVS to bind all SEM and reduce bioavailability to benthic organisms.

3.2 2016 Sediment Testing

In March 2016, Keystone Environmental collected sediment samples at a total of 13 stations within the dredge footprint (Figure 1). Samples were collected via Standard and Petit PONAR samplers and divers using a shovel. Samples were collected to depth of between 10 and 20 cm with each sampling method, and were analyzed for the following parameters: total metals, PAHs, polychlorinated biphenyls (PCBs), TOC, grain size distribution, and moisture. One sample was also analyzed for toxicity characteristic leaching procedure (TCLP) metals and soluble sodium and chloride to assist in evaluating potential disposal alternatives.

To summarize the data from Maxxam (2016), the substrate material within the dredge footprint was found to be comprised mainly of sand with some silt and trace amounts of clay, mostly loamy sand, with some sandy loam. TOC ranged from 0.09 to 2.7 %, with an average of 0.98 %. Moisture content ranged from 20 to 54 %, with an average of 36 %. Samples were found to be

elevated for PAHs on 11 of 13 samples, ranging from 1.8 to 33 mg/kg. Copper exceeded the ECCC Disposal at Sea criterion in each sample analyzed, and there were some exceedances for arsenic, cadmium, lead and zinc. One elevated result for PCBs was observed. Results are discussed in Section 4.1.

3.3 2016 Sediment Toxicity Testing

Three composite sediment samples were collected as composites from the following locations: SED16-36 + SED16-38 = SEDCOMP-1; SED16-27 + SED16-34 = SEDCOMP-2; and SED16-28 + SED16-29 = SEDCOMP-3.

These samples were submitted for the following marine sediment toxicity tests:

- 10-day amphipod: Environment Canada (1998), EPS 1/RM/35
- Echinoderm larval development: Environment Canada (2014), EPS 1/RM/58
- Solid-phase Microtox: Environment Canada (2002), EPS 1/RM/42

Each of the samples submitted passed for the three toxicity tests performed (Nautilus Environmental, 2016). Details on the test results for each sample are provided in Section 4.3.

3.4 2016 Additional Sediment Testing

In late September and October 2016, SNC-Lavalin Inc. (SNC-Lavalin) collected 23 samples throughout the harbour basin, including 19 samples from 10 locations (multiple depths at 9 locations) in the northwest portion of the dredge footprint (SNC, 2016). The 19 samples were analyzed for total metals and one for PAHs. A total of 19 samples from 10 locations located were collected and analyzed for total metals; PAHs; benzene, toluene, ethylbenzene, xylene and volatile petroleum hydrocarbons (BTEX/VPH); volatile organic compounds (VOCs); salinity; and TCLP metals.

Data from these samples (CARO 2016a, 2016b) showed high concentrations of metals and PAHs in several samples, with a distinct reduction in metal concentrations observed below 0.5 m (i.e., 0.6 to 0.7 m).

4. SUMMARY OF RECENT DATA WITHIN THE DREDGE CUT

The following summary of sediment chemistry and toxicology results includes data from within the dredge footprint and collected within five years. The results are presented for near surface (0 to 0.5 m) and subsurface (0.6 to 0.7 m).

4.1 Near Surface (0 to 0.5 m) Sediment Chemistry Results

The analytical results for surface sediment samples within the dredge footprint are provided in Tables 1 to 7 (attached). Concentrations of metals, hydrocarbons, and PCBs are summarized in Table 4-1.

Table 4-1 Summary of Sediment Chemistry Results up to 0.5 m within the Proposed Dredge Cut, Campbell River Harbour

Parameter	Range (mg/kg)		Average	UCLM ₉₅	# Samples Above Criteria
	Low	High			
Arsenic	1.5	17.3	6.42	7.87	11/30
Cadmium	0.11	5.28	0.814	1.059	17/30
Copper	36.1	4,700	394.1	664.9	30/30
Lead	4.59	99.7	36.92	46.78	14/30
Mercury	<0.04	2.93	0.549	0.789	7/30
Zinc	53.2	2,620	249.7	621.3	18/30
Total PAHs	1.8	264	27.82	57.94	12/14
Total PCBs	<0.02	0.66	N/A	N/A	1/13

Form metals, the 95% upper confidence level mean (UCLM₉₅) concentration of arsenic for the first 0.5 m was 7.87 mg/kg, with 11 out of 30 samples slightly elevated above the ECCC Disposal at Sea screening criterion of 7.24 mg/kg, but well below the Canadian Council for the Ministers of the Environment (CCME) Probable Effects Level (PEL) of 41.6 mg/kg. The UCLM₉₅ concentration for cadmium in the first 0.5 m was 1.059 mg/kg, and 17 of 30 samples were found to be elevated above the screening criterion of 0.60 mg/kg. One sample was elevated above the CCME PEL of 4.2 mg/kg (PS06021-SE019: 5.28 mg/kg). The UCLM₉₅ for copper was 664.9 mg/kg, and 17 of 30 samples were elevated above the CCME PEL. Lead concentrations had a UCLM₉₅ of 46.78, slightly elevated above the screening criterion of 30.2 mg/kg but well below the CCME PEL of 112 mg/kg. The UCLM₉₅ for mercury was 0.789, slightly elevated above the screening value of 0.75 mg/kg. The UCLM₉₅ for zinc concentrations was 621.3 mg/kg, with three samples elevated above the CCME PEL of 271 mg/kg. Chromium concentrations were found to be below the ECCC Disposal at Sea criterion.

Total PAHs were found to be in exceedance of the ECCC Disposal at Sea criterion of 2.50 mg/kg in 12 of the 14 samples in the first 0.5 m, with a UCLM₉₅ of 57.94. Total PCBs were found to be in exceedance of EC Disposal at Sea criteria of 0.1 mg/kg in one of the 13 samples within the dredge footprint (SED16-36: 0.66 mg/kg).

4.2 Subsurface (0.6 to 0.7 m) Sediment Chemistry Results

At 0.60 to 0.70 m below the harbour basin surface, sample data for metals were found to be within ECCC Disposal at Sea criteria, with the typical exception of copper (Table 4-2).

Table 4-2 Subsurface (0.6 to 0.7m) Sediment Chemistry Results

Parameter	Range (mg/kg)		Average	UCLM ₉₅	# Samples Above Criteria
	Low	High			
Arsenic	1.30	2.00	1.65	N/A	0/2
Cadmium	0.05	0.05	0.05	N/A	0/2
Copper	29.6	31.1	30.4	N/A	2/2
Lead	0.7	0.9	0.8	N/A	0/2
Mercury	<0.04	<0.04	<0.04	N/A	0/2
Zinc	31	28	29.5	N/A	0/2
Total PCBs	ND	ND	ND	N/D	N/D
Total PAHs	ND	ND	ND	N/D	N/D

These results show the sediment between 0.6 and 0.7 m is considerably lower in the concentrations of metals, PAHs and PCBs compared to the first 0.5 m. These results are also displayed in Figures 4-1 through 4-6, below for arsenic, cadmium, copper, lead, mercury and zinc levels within the dredge cut.

Figure 4-1 Arsenic Concentrations with Depth – Campbell River Harbour

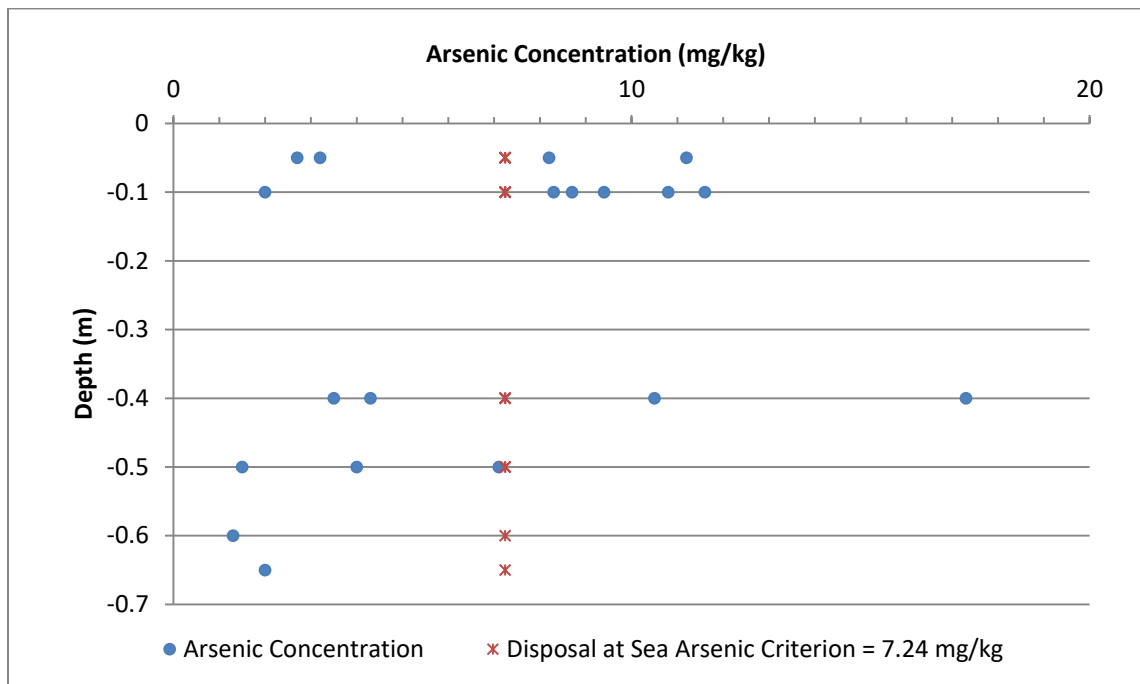


Figure 4-2 Cadmium Concentrations with Depth – Campbell River Harbour

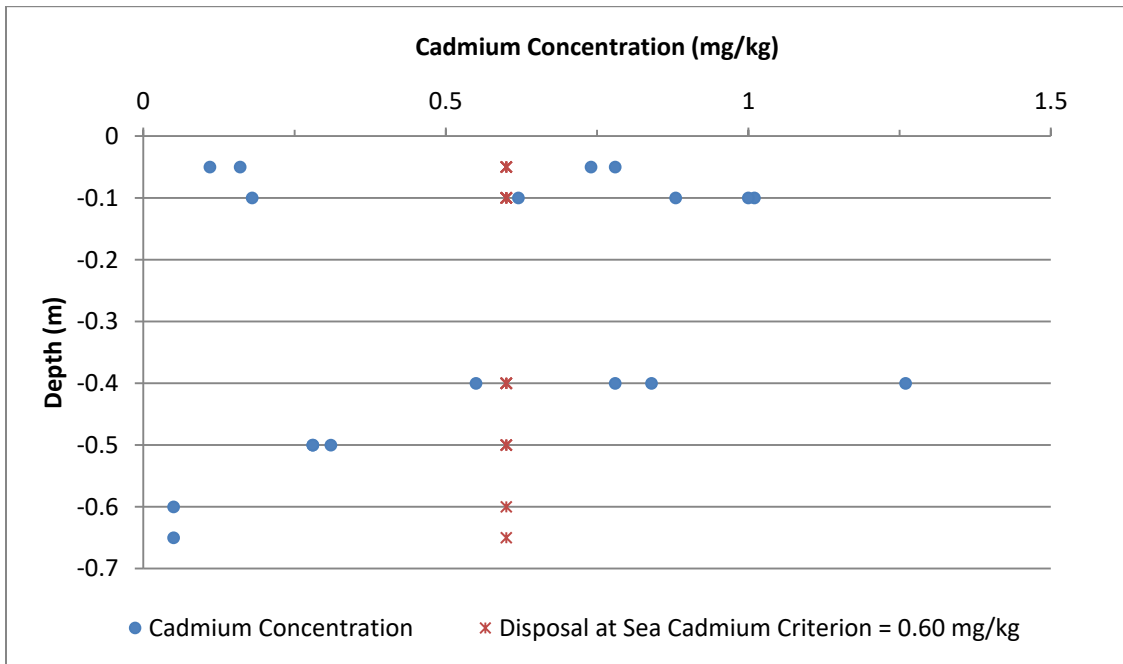


Figure 4-3 Copper Concentrations with Depth – Campbell River Harbour

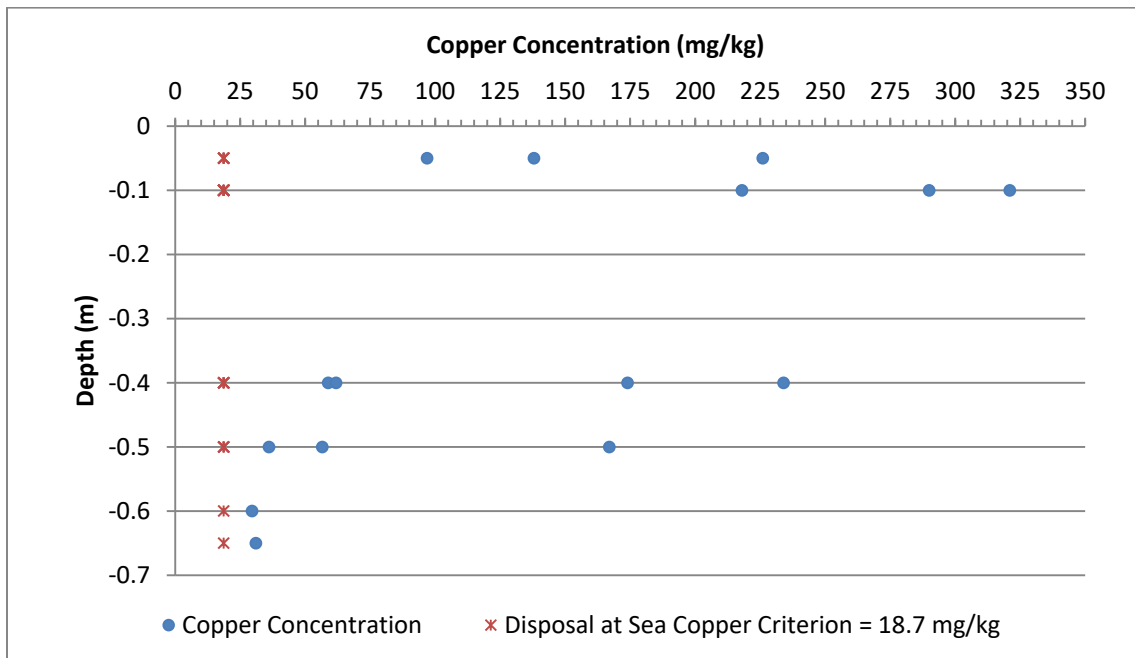


Figure 4-4 Mercury Concentrations with Depth – Campbell River Harbour

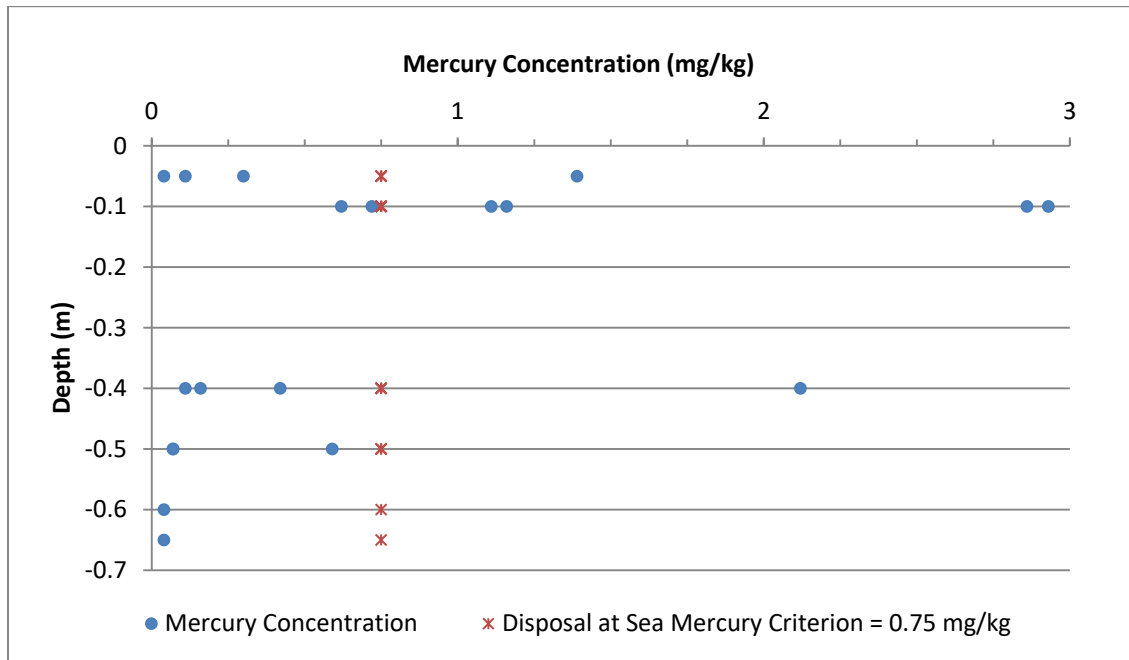


Figure 4-5 Lead Concentrations with Depth – Campbell River Harbour

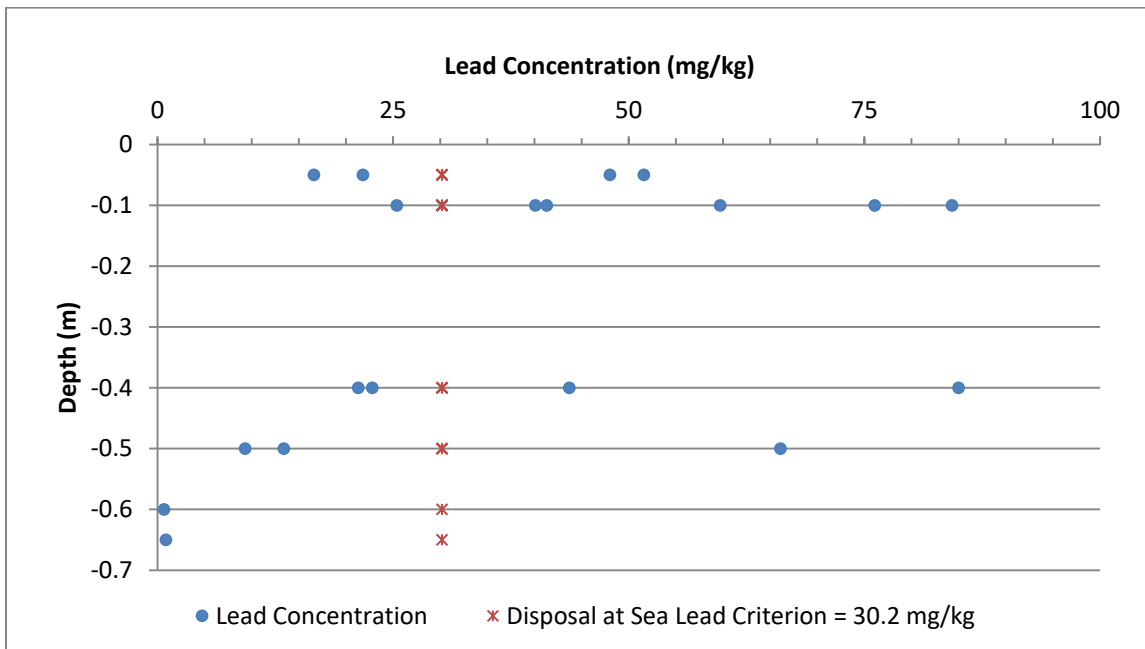
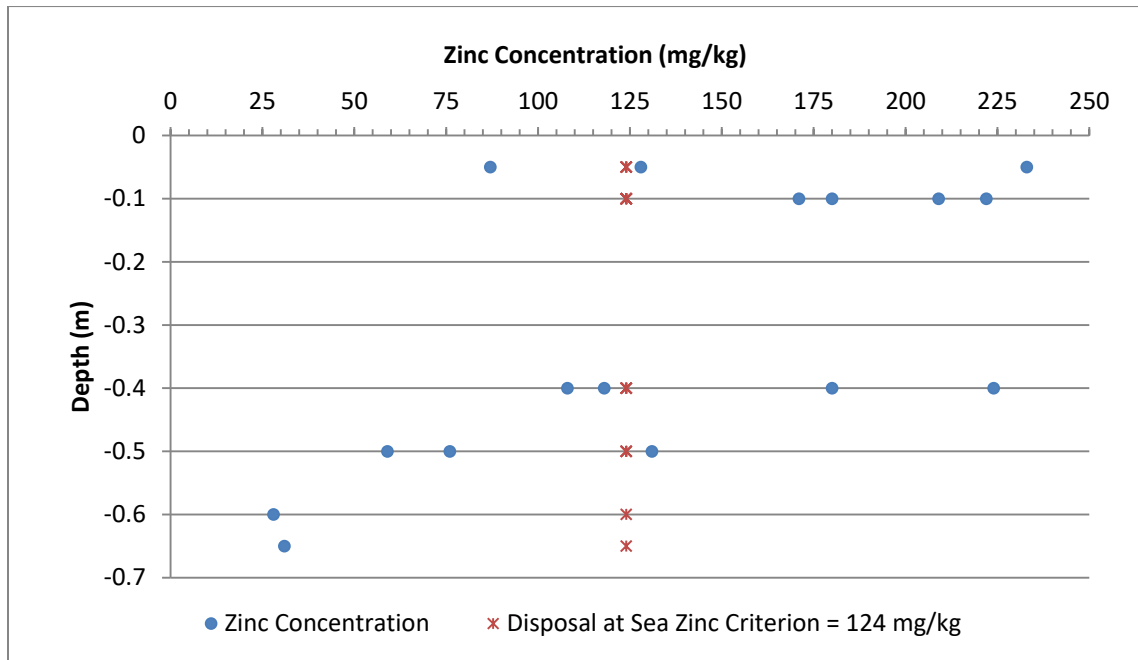


Figure 4-6 Zinc Concentrations with Depth – Campbell River Harbour



4.3 Bioassay Results

The results of the three marine sediment toxicity tests for samples SEDCOMP-1, SEDCOMP-2 and SEDCOMP-3 within the dredge cut are summarized below. The full report will be provided with the application package for disposal at sea.

4.3.1 10-d Marine Amphipod Acute Lethality Test

The results for the 10 day lethality test on *Eohostorius estuarius* are provided in Table 4-3.

Table 4-3 Results for 10-d Marine Amphipod Acute Lethality Test

Sample ID	Survival (%) Mean +/- SD	Reburial (%)	Pass/Fail
Control Sediment	100.0 +/- 0.0	100	-
SEDCOMP16-01	100.0 +/- 0.0	99	Pass
SEDCOMP16-02	98.0 +/- 4.5	100	Pass
SEDCOMP16-03	99.0 +/- 2.2	100	Pass

The range of differences in mean survival from the control survival rate was reported to be up to 2.0 +/- 4.5% with a non-significant effect. The failure criteria for the marine amphipod test (Environment Canada, 2014) are greater than 20% lower mean survival and statistically significant difference ($p < 0.05$) from control sediment. Based on these requirements and the test data, all three sediment samples were considered to pass the Tier II Disposal at Sea marine amphipod test requirements.

4.3.2 96-h Echinoderm Larval Development Test

The results for the 96-hour echinoderm larval development test are provided in Table 4-4.

Table 4-4 Results for 96-h Echinoderm Larval Development Test

Sample ID	Normal Surviving Larvae (%) Mean +/- SD	Pass/Fail
Control Seawater	67.2 +/- 8.2	-
Control Sediment	68.2 +/- 9.1	-
SEDCOMP16-01	67.2 +/- 6.4	Pass
SEDCOMP16-02	68.8 +/- 7.3	Pass
SEDCOMP16-03	66.1 +/- 8.9	Pass

The range in difference of mean % normal surviving larvae between control sediment and the three test samples was up to 2.1 % with a standard deviation of +/- 8.9 %. The failure criteria provided by Environment Canada in August 2014 for the echinoderm larval development test are greater than 30% lower mean survival and statistically significant difference ($p < 0.05$) from control sediment. Based on these requirements and the test data, all three sediment samples were considered to pass the Tier II Disposal at Sea echinoderm larval development test requirements.

4.3.3 Solid-phase Microtox

The results for the Solid-phase Microtox test are provided in Table 4-5.

Table 4-5 Results for Solid-phase Microtox Test

Sample ID	IC ₅₀ and 95% CL (mg/L Dry Weight)	Pass/Fail
Control Sediment	>146,147	-
SEDCOMP16-01	14,262 (8,032 – 25,325)	Pass
SEDCOMP16-02	3,277 (2,235 – 4,805)	Pass
SEDCOMP16-03	6,182 (2,834 – 13,484)	Pass

The range in inhibition concentrations estimated to cause a 50% inhibition of algal light production was between 3,277 and 14,262 mg/L. The 95% confidence interval limits for these concentrations are provided in Table 4-5. The failure criteria provided by Environment Canada in August 2014 for the solid-phase Microtox test are less than 1,000 mg/L of test sediment corrected to dry weight lower mean survival and statistically significant difference ($p < 0.05$) from control sediment. Based on these requirements and the test data, all three sediment samples were considered to pass the Tier II Disposal at Sea echinoderm solid-phase Microtox test requirements.

5. DISCUSSION

From the review of the data, there are elevated concentrations of metals and PAHs primarily within the upper 0.5 m of the dredge footprint, but with passing results for the sediment toxicity tests partially supported by AVS/SEM data from historic sampling efforts. Considering these data, SCH is planning to remove the first 0.5 m of sediment with elevated metal and PAH concentrations for upland disposal.

For the remaining sediment, SCH is requesting dispose up to 10,000m³ of dredge material (below the top 0.5m in the dredge cut) at a suitable disposal at sea site such as Cape Mudge.

6. REFERENCES

- CANTEST. 2001. Analysis Report for Group Number 10827015. Reported to Pottinger Gaherty Ltd. Environmental Consultants. October 10, 2001.
- Environment Canada. 2014. P74 Disposal at Sea Bioassay Interpretation (Pass/Fail Criteria).
- Maxxam. 2016. Certificate of Analysis. Project # B618457. Reported to Keystone Environmental Ltd. March 22, 2016. Report #: R3938908.
- Nautilus. 2016. Marine Sediment Toxicity Testing – Final Report. Work Order # 16353-16355. Reported to Keystone Environmental Ltd. May 24, 2016.
- CARO. 2016a. Certificate of Analysis. Work Order # 6100057. Reported to SNC-Lavalin Inc. November 8, 2016.
- CARO. 2016b. Certificate of Analysis. Work Order # 6101130. Reported to SNC-Lavalin Inc. November 8, 2016.

7. LIMITATIONS

This report has been prepared and reviewed by Keystone Environmental Ltd. approved personnel who have the credentials and knowledge of the applicable public laws, regulations and/or policies which apply to this report. Findings presented in this report are based upon (i) reviews of available documentation and discussions with available personnel and regulatory representatives, (ii) review of available records and the terms and conditions for the planned construction, and (iii) observations of the Project sites and surrounding lands. The findings of

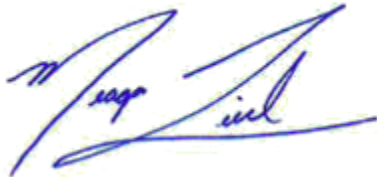
this report only pertain to the scope of work provided by Public Services and Procurement Canada and Small Craft Harbours. This report has been prepared solely for the internal use of Public Services and Procurement Canada/Small Craft Harbours and for review by Environment and Climate Change Canada, pursuant to the agreement between Keystone Environmental Ltd. and the Public Services and Procurement Canada. By using the report, Public Services and Procurement Canada/Small Craft Harbours and Environment and Climate Change Canada agree that they will review and use the report in its entirety. Any use, reliance or decisions made based on this report by other parties without prior written approval by Keystone Environmental Ltd. are the responsibility of such parties and Keystone Environmental Ltd. accepts no responsibility for damages, if any, suffered by other parties as a result of decisions made or actions based on this report.

We look forward to your response, please contact the undersigned if you have any questions or require additional information.

Sincerely,

Keystone Environmental Ltd.

Prepared by:



Meagan Leicht, B.Sc., B.I.T
Aquatic Biologist



Dave Langill, B.Sc.
Aquatic Biologist

Reviewed By:



Warren Appleton, B.Sc., R.P.Bio.
Project Manager/Senior Aquatic Biologist

\\key-fs2012\Common\13600-13699\13628 PSPC Campbell River\Phase 108 Campbell River\Report\13628 170922 DAS Sediment Assessment Report.docx

ATTACHMENTS:

- Figure
- Analytical Tables

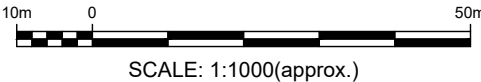
FIGURE



LEGEND

- DREDGE AREA
- EXISTING STRUCTURES
- - - - HIGH WATER LEVEL
- - - - LOW WATER LEVEL
- 5 — BATHYMETRIC CONTOUR LINE (m)
- × KEYSTONE SEDIMENT SAMPLE (2016)

NOTES:
 1. THIS DRAWING IS FOR GENERAL INFORMATION ONLY.
 2. DATE OF AERIAL PHOTO IS 2014.
 3. BATHYMETRY BASED ON VJA ENGINEERING DRAWING; PROJECT NO. 215134, SHEET 001.
 4. ELEVATIONS ARE IN METERS AND ARE TO TIDE AND CHART DATUM.
 5. HIGH WATER LEVEL IS +4.8m, LOW WATER LEVEL IS 0.2m.



Campbell River Harbour
 Campbell River, B C
 Small Craft Harbours

REVISION No.	DATE	PROJECT No.
00	Mar. 2016	12914-102

Figure 6
 Sediment Sample Locations



ANALYTICAL TABLES

GLOSSARY: SEDIMENT ANALYTICAL RESULTS

SCH Campbell River
 Fisheries and Oceans Canada
 Project #: 13628-108
 September 20, 2017

List of Acronyms

BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CSR	British Columbia Contaminated Sites Regulation
EPHs₁₀₋₁₉	Extractable Petroleum Hydrocarbons (carbon range 10 to 19)
EPHs₁₉₋₃₂	Extractable Petroleum Hydrocarbons (carbon range 19 to 32)
HEPHs	Heavy Extractable Petroleum Hydrocarbons (corrected for PAH)
HMW-PAHs	Heavy Molecular Weight Polycyclic Aromatic Hydrocarbons
HWR	British Columbia Hazardous Waste Regulation
IL	Industrial Land Use
LEPHs	Light Extractable Petroleum Hydrocarbons (corrected for PAH)
LMW-PAHs	Light Molecular Weight Polycyclic Aromatic Hydrocarbons
MS	Maximum Spread
n/s	Not Applicable
n/s	No Standard
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
RDL	Reported Detection Limit
RPD	Relative Percent Difference
TEQ	Toxicity Equivalence Quotient
VHs₆₋₁₀	Volatile Petroleum Hydrocarbons (carbon range 6 to 10)
VPHs	Volatile Petroleum Hydrocarbons (corrected for BTEX)
Sch. 7	Schedule 7 Standards Triggering Contaminated Soil Relocation Agreements
Non-ag	Soil Relocation to Non-agricultural Land

List of Symbols

<	Concentration is less than the laboratory reported detection limit
*	Laboratory reported detection limit is greater than applicable standard/guideline
--	Sample was not analyzed for the specified constituent
a	BC CSR Matrix Numerical Soil Standards (BC CSR Schedule 5) site specific factors: <i>1 Intake of contaminated soil</i> <i>3 Toxicity to soil invertebrates and plants</i>
b	CSR standard is pH dependent
c	CSR standard for hexavalent chromium (Cr VI) used for conservativeness
d	Calculated as sum of LEPHs and HEPHs

List of Units

mbg	Metres below grade
mg/kg	Milligrams per kilogram
µg/g	Micrograms per gram
pg/g	Picograms per gram

Soil Exceedances

125	Exceeds Disposal at Sea Criteria
125	Exceeds CCME PELs
125	Exceeds CSR Sch. 7 Standards
125	Exceeds CSR IL Standards

TABLE 1: SEDIMENT ANALYTICAL RESULTS
TOTAL METALS
 SCH Campbell River
 Fisheries and Oceans Canada
 Project #: 13628-108
 September 20, 2017

Disposal at Sea Criteria CEPA, EC	CCME PELs	SAMPLE ID DATE SAMPLED LAB CERTIFICATE LAB SAMPLE ID	Units	SED16-13	SED16-14	SED16-25	SED16-26	SED16-27	SED16-28	SED16-29	SED16-32	SED16-34	SED16-36	SED16-38	SED16-39	SED16-40	PS06021-SE003	PS06021-SE004
				01-Mar-16 K005598 OG5213	01-Mar-16 K005598 OG5214	01-Mar-16 K005599 OG5260	01-Mar-16 K005599 OG5287	01-Mar-16 K005599 OG5251	01-Mar-16 K005599 OG5252	01-Mar-16 K005599 OG5253	01-Mar-16 K005599 OG5258	01-Mar-16 K005599 OG5258	01-Mar-16 K005599 OG5260	01-Mar-16 K005594 OG5287	01-Mar-16 K005594 OG5260	01-Mar-16 K005594 OG5287	29-Sep-16 6100057 6100057-03	29-Sep-16 6100057 6100057-04
n/s	n/s	pH	--	7.83	7.55	8.35	8.00	8.25	8.00	8.04	7.99	7.96	7.85	8.05	8.33	8.25		

Disposal at Sea Criteria CEPA, EC	CCME PELs	SAMPLE ID DATE SAMPLED LAB CERTIFICATE LAB SAMPLE ID	Units	SED16-13	SED16-14	SED16-25	SED16-26	SED16-27	SED16-28	SED16-29	SED16-32	SED16-34	SED16-36	SED16-38	SED16-39	SED16-40	PS06021-SE003	PS06021-SE004
n/s	n/a	aluminum	mg/kg	13100	14000	9860	9590	10600	11400	11500	8400	13100	10300	13800	10900	11000		
n/s	n/a	antimony	mg/kg	0.53	0.80	0.15	0.91	0.18	0.55	0.37	0.18	4.32	0.38	4.03	0.87	0.46		
7.24	41.6	arsenic	mg/kg	6.25	9.18	2.22	3.93	2.74	3.84	3.62	2.84	11.20	4.19	7.39	5.7	5.36	3.2	2.0
n/s	n/a	barium	mg/kg	22.8	30.5	22.3	13.5	12.1	23.1	15.8	15.5	27.3	21.5	23.2	13.5	17.8		
n/s	n/a	beryllium	mg/kg	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40		
0.60	4.2	cadmium	mg/kg	0.901	1.10	0.357	0.411	0.464	0.698	0.672	0.455	0.845	0.547	1.45	0.688	0.786	0.160	0.05
52.3	160	chromium (total)	mg/kg	23.9	28.2	15.8	18.9	15	19.2	17.7	14.5	22.1	17.8	26.3	18.9	19.8		
n/s	n/a	cobalt	mg/kg	8.07	8.22	6.93	7.10	6.71	6.92	6.86	5.29	7.83	6.05	7.74	7.51	7.01		
18.7	108	copper	mg/kg	115	151	65.9	46.3	39.3	64.8	74.1	43.3	137	75.4	183	72.3	138	138	31
30.2	112	lead	mg/kg	41.5	46.3	4.59	99.7	9.81	23.5	19	18.9	27.3	17.8	40.3	16.4	15.9	16.6	0.9
n/s	n/a	manganese	mg/kg	213	223	173	174	173	182	180	138	204	157	215	187	180		
0.75	0.70	mercury	mg/kg	0.179	0.293	<0.050	<0.050	<0.050	0.218	0.109	0.051	0.113	0.096	0.202	0.105	0.169	0.110	<0.04
n/s	n/a	molybdenum	mg/kg	2.76	5.60	0.30	1.02	0.53	1.26	2.75	0.76	3.15	1.29	3.54	1.77	1.38		
n/s	n/a	nickel	mg/kg	15.8	16.8	11.6	13.8	11.2	13.8	12.9	9.63	14.8	11.3	16.6	15.1	14.4		
n/s	n/a	selenium	mg/kg	<0.50	0.89	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.59	<0.50	0.84	<0.50	<0.50	<0.50
n/s	n/a	silver	mg/kg	0.206	0.267	0.081	0.073	0.09	0.129	0.13	0.088	0.175	0.147	0.229	0.103	0.196		
n/s	n/a	strontium	mg/kg	41.3	47.4	30.0	27.0	34.7	33.7	29.5	25.7	39.9	31.6	39.4	39.0	41.1		
n/s	n/a	tin	mg/kg	3.38	4.59	0.59	1.17	0.8	3.81	1.44	1.21	3.27	1.81	4.17	1.55	3.83		
n/s	n/a	titanium	mg/kg	1990	2000	1790	1650	1680	1750	1750	1390	1760	1490	1750	1880	1900		
n/s	n/a	vanadium	mg/kg	83.2	88.0	87.4	78.8	77.9	79.3	76.1	64.2	78.7	65.4	80.6	81.3	84.2		
124	271	zinc	mg/kg	141	160	53.5	63.7	95.9	110	101	54.5	134	98.9	226	141	138	128	31

Disposal at Sea Criteria CEPA, EC	CCME PELs	SAMPLE ID DATE SAMPLED LAB CERTIFICATE LAB SAMPLE ID	Units	PS06021-SE005	PS06021-SE006	PS06021-SE007	PS06021-SE008	PS06021-SE015	PS06021-SE016	PS06021-SE019	PS06021-SE020	PS06021-SE021	PS06021-SE022	PS06021-SE023	PS06021-SE024	PS06021-SE025	PS06021-SE026	PS06021-SE027	PS06021-SE028	PS06021-SE036
				29-Sep-16 6100057 6100057-05	29-Sep-16 6100057 6100057-06	29-Sep-16 6100057 6100057-07	29-Sep-16 6100057 6100057-08	14-Oct-16 6101130 6101130-02	14-Oct-16 6101130 6101130-03	14-Oct-16 6101130 6101130-06	14-Oct-16 6101130 6101130-07	14-Oct-16 6101130 6101130-08	14-Oct-16 6101130 6101130-09	14-Oct-16 6101130 6101130-10	14-Oct-16 6101130 6101130-11	14-Oct-16 6101130 6101130-12	14-Oct-16 6101130 6101130-13	14-Oct-16 6101130 6101130-14	14-Oct-16 6101130 6101130-14	14-Oct-16 6101130 6101130-24
n/s	n/s	pH	--																	

Disposal at Sea Criteria CEPA, EC	CCME PELs	SAMPLE ID DATE SAMPLED LAB CERTIFICATE LAB SAMPLE ID	Units	PS06021-SE005	PS06021-SE006	PS06021-SE007	PS06021-SE008	PS06021-SE015	PS06021-SE016	PS06021-SE019	PS06021-SE020	PS06021-SE021	PS06021-SE022	PS06021-SE023	PS06021-SE024	PS06021-SE025	PS06021-SE026	PS06021-SE027	PS06021-SE028	PS06021-SE036
n/s	n/a	aluminum	mg/kg																	
n/s	n/a	antimony	mg/kg																	
7.24	41.6	arsenic	mg/kg	2.7	7.1	11.2	4.0	2	1.3	11.6	1.5	8.3	3.5	10.8	10.5	8.7	17.3	9.4	4.3	8.2
n/s	n/a	barium	mg/kg																	
n/s	n/a	beryllium	mg/kg																	
0.60	4.2	cadmium	mg/kg	0.110	0.28	0.740	0.280	0.18	0.05	5.28	0.31	1.01	0.78	0.88	0.55	0.62	1.26	1.00	0.84	0.78
52.3	160	chromium (total)	mg/kg																	
n/s	n/a	cobalt	mg/kg																	
18.7	108	copper	mg/kg	96.9	167	228.0	58.6	321	29.6	4700	36.1	218	58.9	1930	234	290	174	667	61.9	1180
30.2	112	lead	mg/kg	21.8	66.1	48.0	13.4	25.4	0.7	84.3	9.3	40.1	21.3	76.1	43.7	41.3	85	59.7	22.8	51.6
n/s	n/a	manganese	mg/kg																	
0.75	0.70	mercury	mg/kg	<0.04	0.590	0.30	0.07	1.16	0.04	2.93	0.07	1.11	0.16	2.86	2.12	0.62	0.42	0.72	0.11	1.39
n/s	n/a	molybdenum	mg/kg																	
n/s	n/a	nickel	mg/kg																	
n/s	n/a	selenium	mg/kg																	
n/s	n/a	silver	mg/kg																	
n/s	n/a	strontium	mg/kg																	
n/s	n/a	tin	mg/kg																	
n/s	n/a	titanium	mg/kg																	
n/s	n/a	vanadium	mg/kg																	
124	271	zinc	mg/kg	87	131	88.3	100.0	209	28	2620	59	171	108	554	180	180	224	222	118	672

Soil Exceedances	Exceeds Disposal at Sea Criteria
125	Exceeds CCME PELs
125	Exceeds CSR Sch. 7 Standards

**TABLE 2: SEDIMENT ANALYTICAL RESULTS
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)**

SCH Campbell River
Fisheries and Oceans Canada
Project #: 13628-108
September 20, 2017

Disposal at Sea Criteria CEPA, EC	CCME PELs	SAMPLE ID DATE SAMPLED LAB CERTIFICATE LAB SAMPLE ID	Units	SED16-13	SED16-14	SED16-25	SED16-26	SED16-27	SED16-28	SED16-29	SED16-32	SED16-34	SED16-36	SED16-38	SED16-39	SED16-40	PS06021-SE003
				01-Mar-16 K006598 OG5213	01-Mar-16 K006598 OG5214	01-Mar-16 K006599 OG5260	01-Mar-16 K006599 OG5287	01-Mar-16 K006599 OG5251	01-Mar-16 K006599 OG5252	01-Mar-16 K006599 OG5253	01-Mar-16 K006599 OG5258	01-Mar-16 K006599 OG5260	01-Mar-16 K006594 OG5287	01-Mar-16 K006594 OG5260	01-Mar-16 K006594 OG5287	01-Mar-16 K006594 OG5287	29-Sep-16 6100057 6100057-03
Polycyclic Aromatic Hydrocarbons																	
n/s	n/s	Naphthalene	mg/kg	0.055	0.029	<-0.0050 (2)	0.0062 (2)	0.016	0.02	0.04	0.0076 (1)	0.033	0.04	0.068	0.011 (1)	0.48 (1)	0.574
n/s	n/s	2-Methylnaphthalene	mg/kg	0.044	0.022	<-0.0050 (2)	0.013 (2)	0.018	0.027	0.036	0.0062 (2)	0.031	0.038	0.03	0.0072 (1)	0.14 (1)	0.236
n/s	0.128	Acenaphthylene	mg/kg	0.071	0.12	0.023 (2)	0.0040 (2)	0.034	0.18	0.086	0.016 (2)	0.034	0.034	0.06	0.054 (1)	0.12 (1)	0.412
n/s	0.0689	Acenaphthene	mg/kg	0.10	0.057	0.0063 (2)	0.0092 (2)	0.048	0.093	0.1	0.0090 (2)	0.094	0.049	0.067	0.072 (1)	0.13 (1)	21.5
n/s	0.144	Fluorene	mg/kg	0.12	0.089	0.017 (2)	0.22 (2)	0.16	0.15	0.14	0.019 (2)	0.079	0.068	0.09	0.072 (1)	0.16 (1)	15.3
n/s	0.544	Phenanthrene	mg/kg	0.60	0.50	0.087 (2)	0.90 (2)	0.94	0.8	1.5	0.17 (2)	0.33	0.75	0.49	0.40 (1)	6.0 (1)	71.9
n/s	0.245	Anthracene	mg/kg	0.40	0.34	0.079 (2)	0.38 (2)	0.26	0.81	0.39	0.048 (2)	0.27	0.18	0.45	0.15 (1)	0.44 (1)	13.4
n/s	1.494	Fluoranthene	mg/kg	1.9	1.5	0.95 (2)	0.43 (2)	1.7	4.7	7.2	0.49 (2)	1.1	1.4	1.7	2.8 (2)	11 (2)	71.0
n/s	1.398	Pyrene	mg/kg	1.8	1.5	0.48 (2)	0.24 (2)	1.6	3.4	5.7	0.38 (2)	1.3	1.1	1.6	2.0 (2)	6.7 (2)	45.5
n/s	0.682	Benzo(a)anthracene	mg/kg	0.88	0.60	0.34 (2)	0.088 (2)	0.26	1.5	1.4	0.18 (2)	0.6	0.44	0.78	0.72 (2)	1.8 (2)	9.3
n/s	0.646	Chrysene	mg/kg	1.8	1.3	0.42 (2)	0.13 (2)	0.65	3	2.7	0.27 (2)	0.97	0.9	1.5	1.2 (2)	4.4 (2)	19.3
n/s	n/s	Benzo(b)fluoranthene	mg/kg	1.9	1.6	0.37 (2)	0.13 (2)	0.67	3	2.4	0.43 (2)	1.1	0.88	1.7	1.1 (2)	3.9 (2)	
n/s	n/s	Benzo(k)fluoranthene	mg/kg	1.2	1.1	0.23 (2)	0.080 (2)	0.44	1.9	1.5	0.29 (2)	0.71	0.59	1.2	0.73 (2)	2.7 (2)	5.920
n/s	n/s	Benzo(i)perylene	mg/kg	0.54	0.48	0.13 (2)	0.043 (2)	0.18	0.89	0.76	0.13 (2)	0.31	0.23	0.45	0.35 (2)	1.1 (2)	4.020
n/s	0.763	Benzo(a)pyrene	mg/kg	0.96	0.68	0.18 (2)	0.062 (2)	0.29	1.4	1.1	0.17 (2)	0.51	0.38	0.75	0.53 (2)	1.5 (2)	4.570
n/s	n/s	Indeno(1,2,3-cd)pyrene	mg/kg	0.47	0.34	0.062 (2)	0.026 (2)	0.11	0.6	0.48	0.10 (2)	0.25	0.2	0.4	0.21 (2)	0.71 (2)	1.070
n/s	0.135	Dibenzo(a,h)anthracene	mg/kg	0.15	0.095	0.018 (2)	0.0070 (2)	0.033	0.17	0.14	0.029 (2)	0.07	0.057	0.12	0.064 (2)	0.19 (2)	0.214
n/s	n/s	Benzo(g,h)perylene	mg/kg	0.50	0.35	0.055 (2)	0.033 (2)	0.11	0.53	0.47	0.11 (2)	0.26	0.21	0.41	0.22 (2)	0.70 (2)	0.770
n/s	n/s	Low Molecular Weight PAH's	ug/g	1.4	1.2	0.21	1.5	1.5	2	2.3	0.28	0.88	1.2	1.3	0.76	7.5	
n/s	n/s	High Molecular Weight PAH's	ug/g	7.6	5.7	2.4	0.96	4.6	14	18	1.5	4.6	4.3	6.5	7.3	25	
2.50	n/s	Total PAH	ug/g	9	6.9	2.6	2.5	6.0	16	21	1.8	5.4	5.5	7.7	8.1	33	264
n/s	n/s	IARC	--														
n/s	n/s	PAH TEQ	--														

Soil Exceedances

125	Exceeds Disposal at Sea Criteria
125	Exceeds CCME PELs
125	Exceeds CSR Sch. 7 Standards

**TABLE 3: SEDIMENT ANALYTICAL RESULTS
POLYCHLORINATED BIPHENYLS (PCBs)**
SCH Campbell River
Fisheries and Oceans Canada
Project #: 13628-103
September 20, 2017

Disposal at Sea Criteria CEPA, EC	CCME PELs	SAMPLE ID	Units	SED16-13	SED16-14	SED16-25	SED16-26	SED16-27	SED16-28	SED16-29	SED16-32	SED16-34	SED16-35	SED16-36	SED16-39	SED16-40	PS06021-SE003	PS06021-SE004
				01-Mar-16 K006598 OG5213	01-Mar-16 K006598 OG5214	01-Mar-16 K006599 OG5260	01-Mar-16 K006599 OG5267	01-Mar-16 K006599 OG5251	01-Mar-16 K006599 OG5252	01-Mar-16 K006599 OG5253	01-Mar-16 K006599 OG5258	01-Mar-16 K006599 OG5258	01-Mar-16 K006599 OG5260	01-Mar-16 K006599 OG5260	01-Mar-16 K006594 OG5267	01-Mar-16 K006594 OG5260	01-Mar-16 K006594 OG5287	29-Sep-16 6100057-03
Polychlorinated Biphenyls																		
n/s		Aroclor 1242	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.020	<0.020	<0.020	<0.10	<0.020	<0.10 (1)	<0.020	<0.10	<0.10		
n/s		Aroclor 1248	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.020	<0.020	<0.020	<0.10	<0.020	<0.10 (1)	<0.020	<0.10	<0.10		
n/s	0.709	Aroclor 1254	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.020	<0.020	<0.020	0.098	<0.10 (1)	<0.020	<0.10	<0.10			
n/s		Aroclor 1260	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.020	<0.020	0.028	<0.10	<0.020	0.026	<0.10	<0.10			
0.1	0.189	Total PCB	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.020	<0.020	0.028	<0.10	0.098	0.066 (1)	0.026	<0.10	<0.10		

SAMPLE ID	Units	PS06021-SE005	PS06021-SE006	PS06021-SE007	SO6021-SE00	PS06021-SE015	PS06021-SE016	PS06021-SE019	PS06021-SE020	PS06021-SE021	PS06021-SE022	PS06021-SE023	PS06021-SE024	PS06021-SE025	PS06021-SE026	PS06021-SE027	PS06021-SE028	PS06021-SE036
		29-Sep-16 6100057 6100057-05	29-Sep-16 6100057 6100057-06	29-Sep-16 6100057 6100057-07	29-Sep-16 6100057 6100057-08	14-Oct-16 6101130 6101130-02	14-Oct-16 6101130 6101130-03	14-Oct-16 6101130 6101130-06	14-Oct-16 6101130 6101130-07	14-Oct-16 6101130 6101130-08	14-Oct-16 6101130 6101130-09	14-Oct-16 6101130 6101130-10	14-Oct-16 6101130 6101130-11	14-Oct-16 6101130 6101130-12	14-Oct-16 6101130 6101130-13	14-Oct-16 6101130 6101130-14	14-Oct-16 6101130 6101130-14	14-Oct-16 6101130 6101130-24
Polychlorinated Biphenyls																		
Aroclor 1242	mg/kg																	
Aroclor 1248	mg/kg																	
Aroclor 1254	mg/kg																	
Aroclor 1260	mg/kg																	
Total PCB	mg/kg																	

Soil Exceedances	
125	Exceeds Disposal at Sea Criteria
125	Exceeds CCME PELs
125	Exceeds CSR Sch. 7 Standards

TABLE 4: SEDIMENT ANALYTICAL RESULTS
PARTICLE SIZE DISTRIBUTION
SCH Campbell River
Fisheries and Oceans Canada
Project #: 13628-108
September 20, 2017

SAMPLE ID	Units	SED16-27	SED16-28	SED16-29	SED16-34	SED16-36	SED16-38
DATE SAMPLED		01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16
LAB CERTIFICATE		K006599	K006599	K006599	K006599	K006599	K006599
LAB SAMPLE ID		OG5251	OG5252	OG5253	OG5258	OG5260	OG5287

Pasticle Size Distribution

<2.00mm, Sieve #10	%	72.61	92.85	99.67	89.69	98.86	91.51
<0.250mm, Sieve #60	%	57.51	87.45	92.92	85.65	80.59	86.33
<0.125mm, Sieve #120	%	18.19	44.42	41.51	48.71	38.43	56.41
<0.063mm Pipette	%	5.54	19.84	13.62	25.03	15.97	32.92
<0.004mm Pipette	%	1.86	6.26	3.52	8.12	4.66	10.82
>2.00mm	%	27.39	7.15	0.33	10.31	1.14	8.5
<2.00mm & >0.063mm	%	67.07	73.01	86.05	64.66	82.89	58.58
<0.063mm & >0.004mm	%	3.69	13.58	10.1	16.91	11.32	22.11
<0.004mm	%	1.86	6.26	3.52	8.12	4.66	10.82
% Sand <2.00mm & >0.063mm	%	92.37	78.63	86.34	72.09	83.84	64.02
% Silt <0.063mm & >0.004mm	%	5.08	14.63	10.14	18.86	11.45	24.16
% Clay <0.004mm	%	2.56	6.74	3.53	9.05	4.71	11.82
TEXTURE		Sand	Loamy Sand	Loamy Sand	Sandy Loam	Loamy Sand	Sandy Loam

TABLE 5: SEDIMENT ANALYTICAL RESULTS

TOTAL ORGANIC CARBON

SCH Tofino

Fisheries and Oceans Canada

Project #: 13628-108

September 20, 2017

SAMPLE ID	Units	SED16-13	SED16-14	SED16-25	SED16-26	SED16-27	SED16-28
DATE SAMPLED		01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16
LAB CERTIFICATE		K006598	K006598	K006599	K006599	K006599	K006599
LAB SAMPLE ID (TOC)		CBX100	CBX101	CBX104	CBX105	CAP660	CAP661
LAB SAMPLE ID (MOISTURE)		OG5213	OG5214	OG5260	OG5287	OG5251	OG5252
Physical Properties							
Total Organic Carbon	mg/kg	18000	27000	850	2100	4000	6600
Moisture	%	54	52	21	25	20	36

SAMPLE ID	Units	SED16-29	SED16-32	SED16-34	SED16-36	SED16-38	SED16-39	SED16-40
DATE SAMPLED		01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16
LAB CERTIFICATE		K006599	K006599	K006599	K006599	K006594	K006594	K006594
LAB SAMPLE ID (TOC)		CAP662	CBX106	CAP663	CAP664	CAP665	CBX107	CBX108
LAB SAMPLE ID (MOISTURE)		OG5253	OG5258	OG5258	OG5260	OG5287	OG5260	OG5287
Physical Properties								
Total Organic Carbon	mg/kg	8500	7700	20000	8500	17000	2500	4000
Moisture	%	36	30	47	41	53	26	30

**TABLE 6: SEDIMENT ANALYTICAL RESULTS
SOLUBLE SODIUM AND CHLORIDE**

SCH Campbell River
Fisheries and Oceans Canada
Project #: 13628-108
September 20, 2017

CSR Schedule 7	SAMPLE ID	Units	SED16-27	SED16-28	SED16-29	SED16-34	SED16-36	SED16-38	PS06021-SE003
Standards	DATE SAMPLED		01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	01-Mar-16	29-Sep-16
	LAB CERTIFICATE		K006599	K006599	K006599	K006599	K006599	K006594	6100057
	LAB SAMPLE ID		OG5251	OG5252	OG5253	OG5258	OG5260	OG5287	6100057-03
Pasticle Size Distribution									
ANIONS									
	Soluble Chloride (Cl)	mg/L	6970 (1)	9950 (1)	5880 (1)	13300 (1)	9410 (1)	10900 (1)	
Calculated Parameters									
35	Soluble Chloride (Cl)	mg/kg	4140	7600	4570	13800	7070	13900	3530
200	Soluble Sodium (Na)	mg/kg	2560	4420	2790	7840	4120	8150	2470
Soluble Parameters									
	Saturation %	%	59.4	76.4	77.7	104	75.1	128	
	Soluble Sodium (Na)	mg/L	4310	5790	3590	7560	5490	6360	

Soil Exceedances

125 Exceeds CSR Sch. 7 Standards

**TABLE 7: SEDIMENT ANALYTICAL RESULTS
TOXICITY CHARACTERISTIC LEACHING PROCEDURE METALS**

SCH Campbell River
Fisheries and Oceans Canada
Project #: 13628-108
September 20, 2017

TCLP Leachate Quality
Standards
BC Hazardous Waste Regulation

SAMPLE ID	Units	SED16-38
DATE SAMPLED		01-Mar-16
LAB CERTIFICATE		K006594
LAB SAMPLE ID		OG5287
TCLP Extraction Procedure		
Initial pH of Sample	pH	8.67
pH after HCl	pH	1.47
Final pH of Leachate	pH	5.01
pH of Leaching Fluid	pH	4.95

n/a
2.5
100
n/a
500
0.5
5.0
n/a
100
n/a
5.0
0.10
n/a
n/a
1.0
5.0
n/a
10
n/a
500
n/a

TCLP Metals		
LEACHATE Antimony (Sb)	mg/L	<0.10
LEACHATE Arsenic (As)	mg/L	<0.10
LEACHATE Barium (Ba)	mg/L	<0.10
LEACHATE Beryllium (Be)	mg/L	<0.10
LEACHATE Boron (B)	mg/L	0.63
LEACHATE Cadmium (Cd)	mg/L	<0.10
LEACHATE Chromium (Cr)	mg/L	<0.10
LEACHATE Cobalt (Co)	mg/L	<0.10
LEACHATE Copper (Cu)	mg/L	0.13
LEACHATE Iron (Fe)	mg/L	6.40
LEACHATE Lead (Pb)	mg/L	<0.10
LEACHATE Mercury (Hg)	mg/L	<0.0020
LEACHATE Molybdenum (Mo)	mg/L	<0.10
LEACHATE Nickel (Ni)	mg/L	<0.10
LEACHATE Selenium (Se)	mg/L	<0.10
LEACHATE Silver (Ag)	mg/L	<0.10
LEACHATE Thallium (Tl)	mg/L	<0.10
LEACHATE Uranium (U)	mg/L	<0.10
LEACHATE Vanadium (V)	mg/L	<0.10
LEACHATE Zinc (Zn)	mg/L	1.60
LEACHATE Zirconium (Zr)	mg/L	<0.10

Soil Exceedances

125

Exceeds HWR Standards