

**MARINE BENTHIC HABITAT AND
SEDIMENT CHARACTERISATION
AT EACH DIFFUSER SITE**

HALIFAX REGIONAL MUNICIPALITY

PROJECT NO. 14368

REPORT TO

HALIFAX REGIONAL MUNICIPALITY

ON

**MARINE BENTHIC HABITAT AND SEDIMENT CHARACTERIZATION AT EACH
DIFFUSER SITE**

**Jacques Whitford Environment Limited
3 Spectacle Lake Drive
Dartmouth, NS B3B 1W8
Tel:(902)468-7777
Fax:(902)468-9009**

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1.0 INTRODUCTION

On behalf of Halifax Regional Municipality, Jacques Whitford Environment Limited conducted a study to characterise marine benthic and sediment quality in the vicinity of four potential outfalls or diffusers from proposed sewage treatment facilities in Halifax Harbour. The studies contribute information on the state of the existing environment which is intended to be utilized as baseline information in environmental assessment processes associated with these facilities and subsequent environmental management or monitoring requirements. In addition, this information will be made available to short listed project partners for consideration in their preliminary design and proposal preparation.

This report provides the information obtain through a field sampling program and laboratory analysis. To capitalize on opportunities to achieve efficiencies, the sediment sampling efforts at Halifax North and Dartmouth areas were shared between the geotechnical and marine biological programs.

2.0 METHODOLOGY

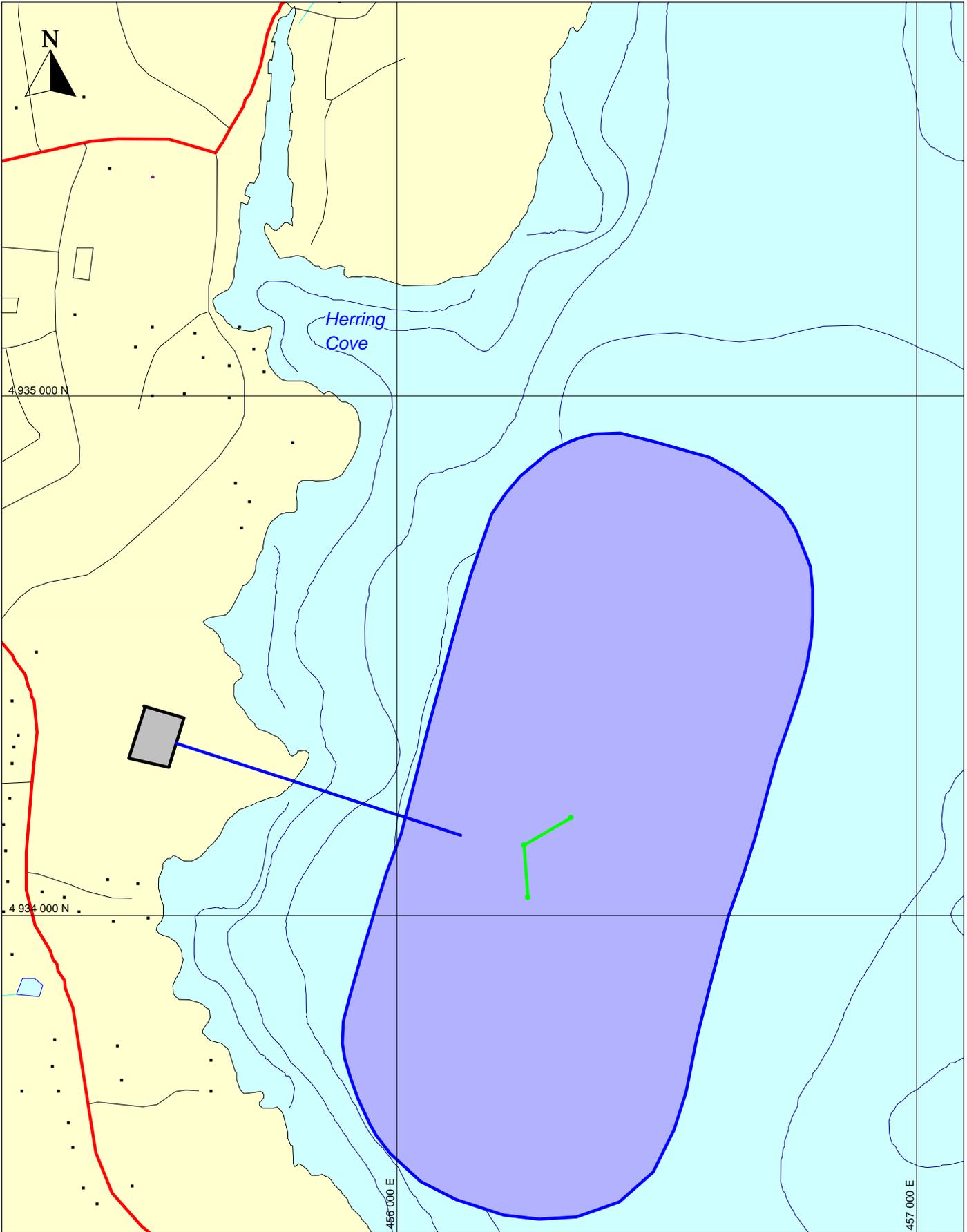
2.1 Marine Benthic Habitat and Seafloor Communities Survey

On August 26, 1999, a subtidal benthic habitat survey was undertaken at each of the four proposed outfall/diffuser areas, as depicted in Figure 1-4 modified from the Project Description for Consideration Under CEAA (HRM 1999).

Oceanographic modeling (Coastal Oceans Associates) predicts that the zone of deposition is likely to occur with 100 m of the outfall/diffuser outlet. A remotely-operated-vehicle (ROV) was employed to videotape 100 m transects perpendicular (north and south directions) to each outfall/diffuser location. Each transect consisted of a leadline set on the seafloor marked every 10 metres to provide reference.

2.2 Marine Sediment Quality

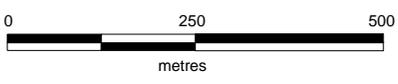
To characterise the sediment chemistry within the outfall/diffuser location and potential depositional areas, sediment grab samples were collected. Using a 0.1 m² Van Veen grab, three grab samples were collected from the Hospital Point area and from an area south of Georges Island. A grab sample was taken at the approximate outfall/diffuser location, at a point 100 north and 100 m south of the outfall/diffuser. For the Dartmouth (Woodside) and Halifax (Casino) locations Figures 3 and 4 show the geotechnical borehole locations from which surficial samples (from cores) were collected.



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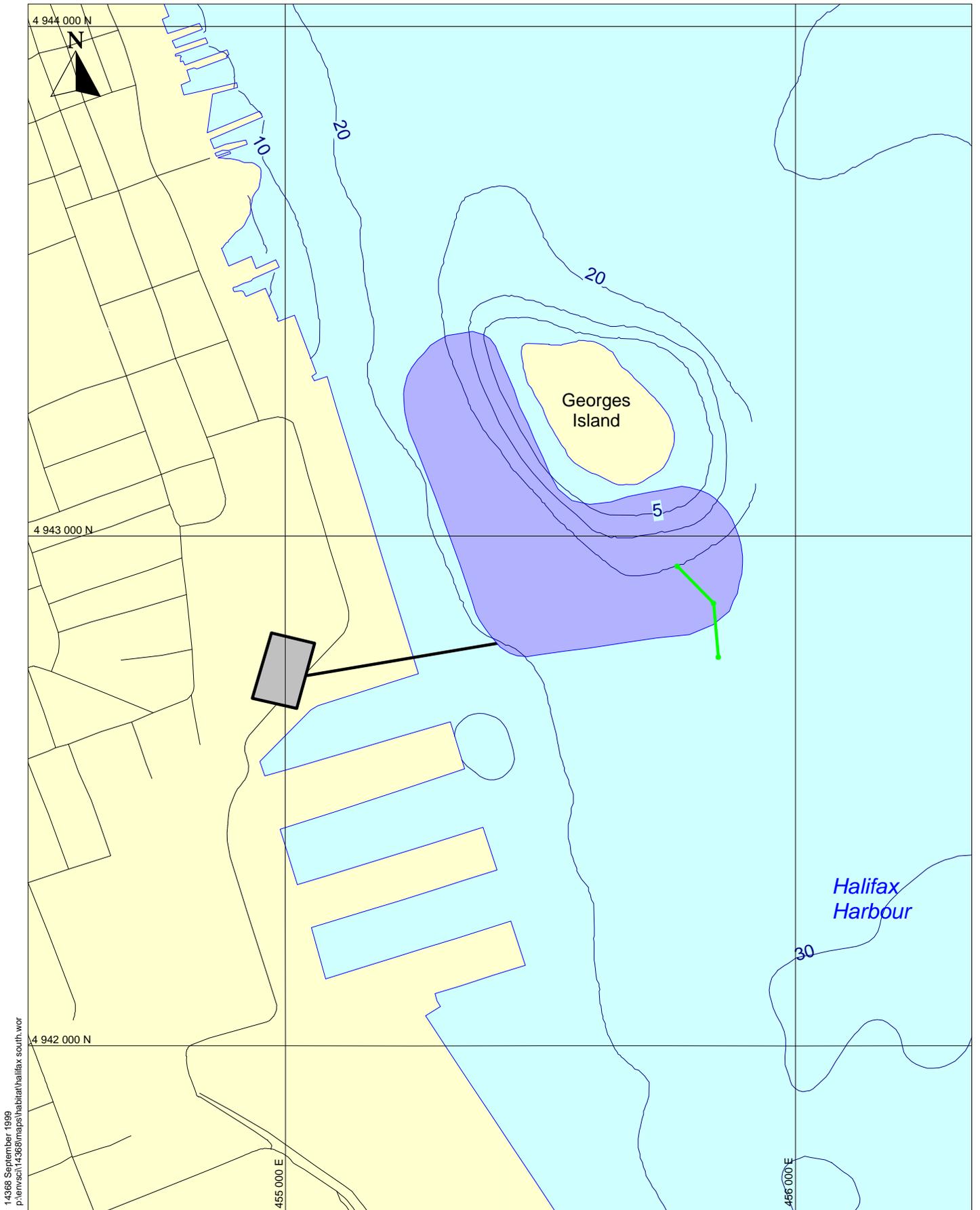
- Diffuser/Outfall
- Sewage Treatment Plant
- Grab Location



Map Projection: UTM, NAD83
 Map Zone: 20
 Scale 1 : 10 000
 Grid Spacing: 1 km
 Depth in meters

Figure 1.0
Hospital Point
Diffuser/Outfall Location

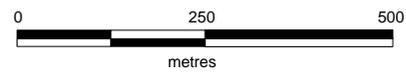




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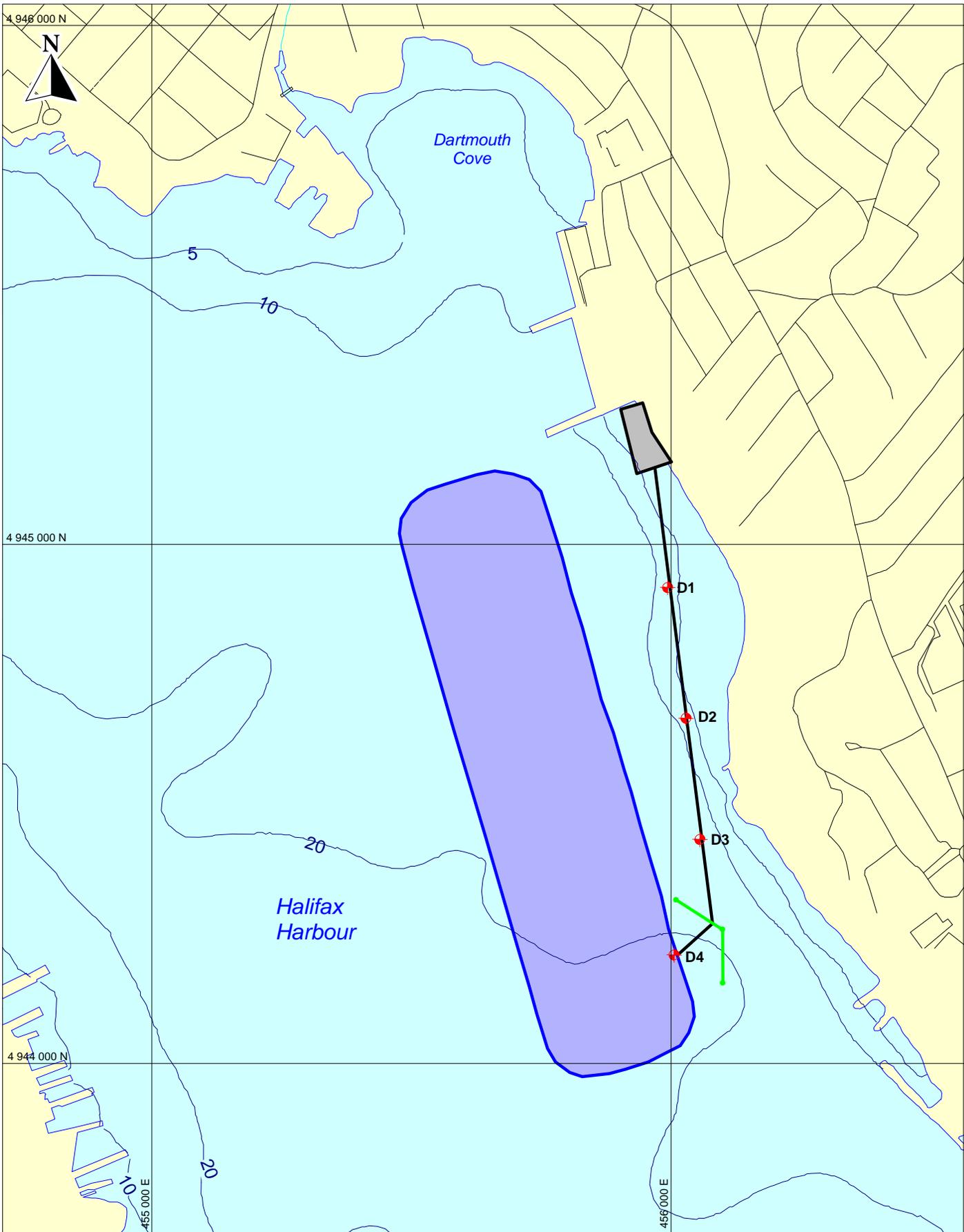
- Diffuser
- Sewage Treatment Plant
- Grab Location



Map Projection: UTM, NAD83
 Map Zone: 20
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 Grid Spacing: 1 km
 Depth in meters

Figure 2.0
Halifax South (Georges Island)
Diffuser/Outfall Location





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-  Diffuser/Outfall
-  Sewage Treatment Plant
-  Grab Location
-  Borehole Location

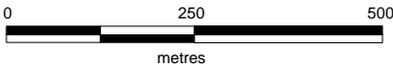
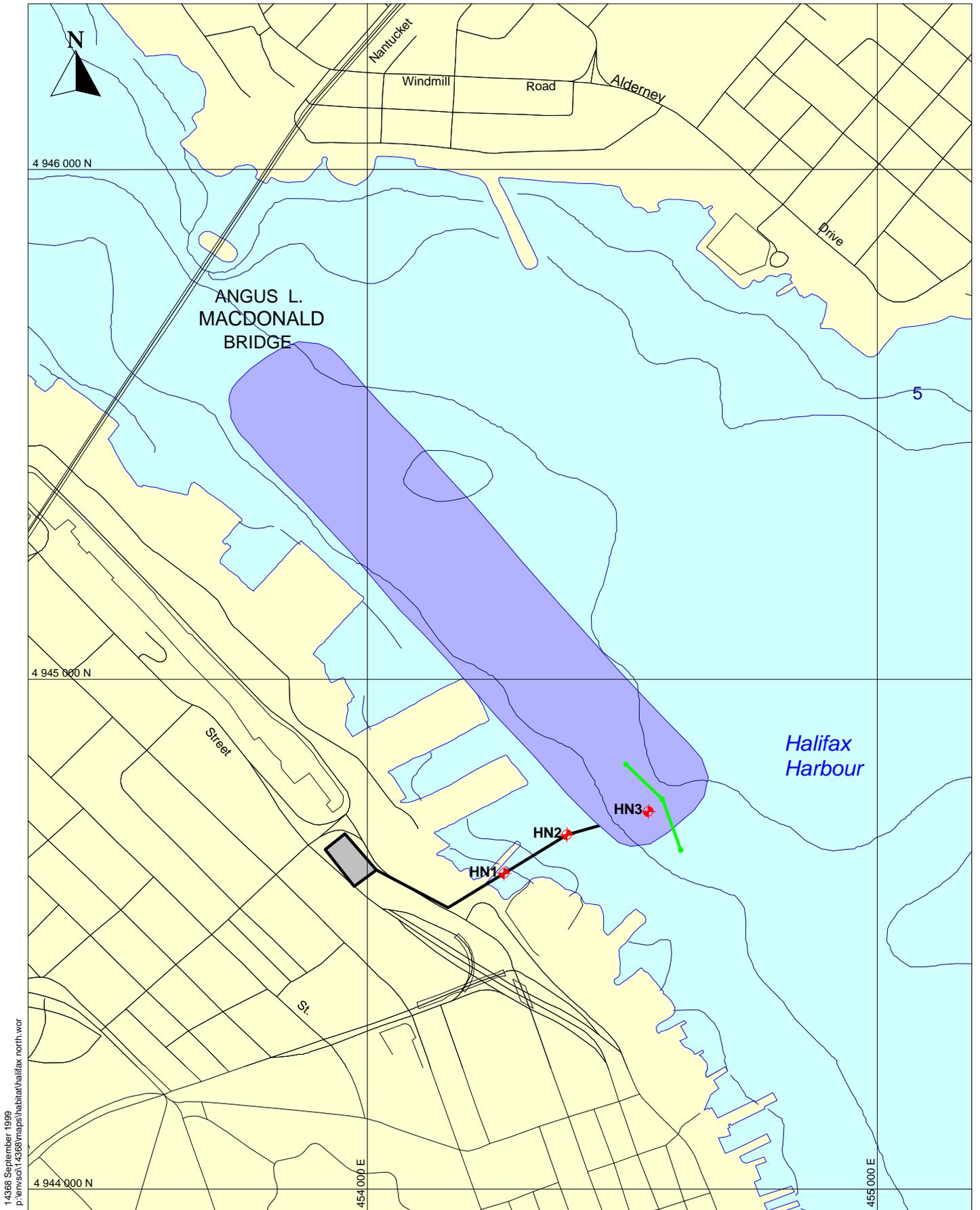


Figure 3.0
Dartmouth (Woodside)
Diffuser/Outfall Location

Map Projection: UTM, NAD83
 Map Zone: 20
 Scale 1 : 10 000
 Grid Spacing: 1 km
 Depth in metres

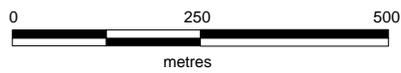




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LEGEND

- Diffuser
- Sewage Treatment Plant
- Grab Location
- Borehole Location



Map Projection: UTM, NAD83
 Map Zone: 20
 Scale 1 : 10 000
 Grid Spacing: 1 km
 Depth in meters

Figure 4.0
Halifax North (Casino)
Diffuser/Outfall Location



From the Van Veen samples, a 250 mL sample was composited of material from the top 5 cm of sediment, and sent to Philip Analytical Laboratory (a CAEL certified laboratory) in Halifax for analysis. Analysis included the ocean disposal suite (grain size, PCBs, PAHs, DDD, DDE, DDT, lead, cadmium, copper, zinc and mercury, total organic and inorganic carbon) and petroleum hydrocarbons (TPH and BTEX). A second 250 mL composite sample from each grab has been archived and frozen for future analysis, if necessary.

3.0 SURVEY AND CHEMISTRY RESULTS

3.1 Hospital Point

The marine benthic habitat 500 m offshore of Hospital Point is typical for open water nearshore environments in Nova Scotia. The sediment consist of sand and silt and is classified as transgressive sand. The bottom sediment is relatively soft and essentially without large topographic feature diversity. This area consist of a considerable region of monotonous unvegetated, featureless, sedimentary habitat. Habitat diversity is provided by small features such as polychaete tubes, fecal mounds, broken and half shells of small bivalves. On an areal basis, the bottom is dominated by infaunal organisms (e.g. polychaetes, amphipods, cumaceans, bivalves, etc.).

The underwater video survey showed a slight difference in benthic communities north and south of the outfall/diffuser area (Photos 1 and 2). To the south, brittlestars were numerous (Photo 2) indicating a siltier substrate compared to the north transect. The benthic species observed included a few scallops (*Placopecten magellanicus*), abundant sea urchin (*Strongylocentrotus droebachiensis*), hard clams such as cockles and perhaps quahaugs (*Mercenaria mercenaria*), rock crab (*Cancer irroratus*), horse mussels (*Modiolus modiolus*), starfish (*Asterias* sp.) and hermit crab (*Pagurus* sp.). The only fish observed during the survey were sculpins.

The marine sediments within 200 m of the outfall/diffuser do not exceed the *Interim Contaminant Testing Guidelines for Ocean Disposal*, with the exception of total petroleum hydrocarbons (Table 1). The presumed source of the hydrocarbons is from vessel activities in the harbour and the sewage outfall near Herring Cove. Appendix A provides the full data results from the analysis including QA/QC information.

3.2 Georges Island

The seafloor on the south side of Georges Island, within the 200 m area of the proposed diffuser location, is extremely soft and silty (Photo 3). The surface is loose and fluid permitting the survey transect line to sink in some areas. The sediments consist predominantly of silt and clay (Table 2). Along the south transect within the first 15 m, a large depositional mound occurs with a smaller undulation further along. This

Table 1 Marine Sediment Chemistry at Hospital Point

Parameter	Units	EQL	Diffuser Area	100 m North	100 m South	Ocean Disposal Limits
Cadmium	mg/kg	0.3	nd	nd	nd	0.6
Copper	mg/kg	2.0	11	11	14	81.0
Zinc	mg/kg	2.0	46	42	49	160.0
Lead	mg/kg	0.5	19	17	19	66.0
Mercury	mg/kg	0.01	0.04	0.03	0.04	0.75
Total Organic Carbon	g/kg	0.1	5.6	6.7	7.9	
Total Inorganic Carbon	g/kg	0.1	6.5	5.5	5.0	
gravel	%	0.1	nd	nd	nd	
sand	%	0.1	54.6	46.5	26.3	
silt	%	0.1	36.5	44.3	62.5	
clay	%	0.1	8.9	9.2	11.3	
Benzene	mg/kg	0.025	nd	nd	nd	
Toluene	mg/kg	0.025	nd	nd	nd	
Ethylbenzene	mg/kg	0.025	nd	nd	nd	
Xylenes	mg/kg	0.05	nd	nd	nd	
Total Petroleum Hydrocarbons	mg/kg	32.5	66.3	42.2	62.3	10.0
Total PAHs	mg/kg	0.05	nd	nd	0.65	2.5
PCBs	µg/kg	10.0	nd	nd	nd	100
DDE	µg/kg	10.0	nd	nd	nd	100
DDT	µg/kg	10.0	nd	nd	nd	100
DDD	µg/kg	10.0	nd	nd	nd	100

* TPH is lube oil fraction

Bolded text shows exceedances of the Interim Contaminant Testing Guidelines for Ocean Disposal

Table 2 Marine Sediment Chemistry South of Georges Island						
Parameter	Units	EQL	Diffuser Area	100 m North	100 m South	Ocean Disposal Guidelines
Cadmium	mg/kg	0.3	0.4	0.4	0.4	0.6
Copper	mg/kg	2.0	66.0	62	61	81
Lead	mg/kg	0.5	110	110	120	66
Zinc	mg/kg	2.0	170	160	170	160
Mercury	mg/kg	0.01	0.55	1.1	0.51	0.75
Total Organic Carbon	g/kg	0.1	35.9	30.5	32.6	
Total Inorganic Carbon	g/kg	0.1	3.4	3.7	4.5	
gravel	%	0.1	nd	nd	nd	
sand	%	0.1	9.1	9.9	13.6	
silt	%	0.1	47.1	48.1	45.3	
clay	%	0.1	43.8	41.9	41.1	
Benzene	mg/kg	0.025	nd	nd	nd	
Toluene	mg/kg	0.025	nd	nd	nd	
Ethylbenzene	mg/kg	0.025	nd	nd	nd	
Xylenes	mg/kg	0.05	nd	nd	nd	
Total Petroleum Hydrocarbons	mg/kg	32.5	1040	1110	1370	10.0
Total PAHs	mg/kg	0.5	6.36	17.3	12.8	2.5
PCBs	µg/kg	10.0	83.8	132	108	100
DDE	µg/kg	10.0	nd	nd	nd	100
DDT	µg/kg	10.0	nd	nd	nd	100
DDD	µg/kg	10.0	nd	nd	nd	100

* PCB is Aroclor 1260; TPH is lube oil fraction

Bolded text shows exceedances of the Interim Contaminant Testing Guidelines for Ocean Disposal



Photo 1: Benthic Habitat at Hospital Point



Photo 2: Benthic Habitat at Hospital Point





Photo 3: Benthic Habitat at Georges Island



feature may be an artifact of anchoring, propellor wash or tidal current deposition of fines. The area is devoid of any firm substrate therefore there is no established epifaunal community. Anaerobic sediment occurred in black patches.

The areas along the transect lines were depauperate of visible sea life. The diversity of organisms is very low and included polychaete fanworms, a rock crab, starfish and a sea anemone (*Metridium senile*) attached to litter. The dominant benthic community consists entirely of infaunal organisms and largely of the polychaete species. Patches of drifting and decomposing seaweed indicate the area may be a depositional zone in the harbour.

The sediment chemistry data in Table 2 show significant contamination in this area. Lead exceeds the Ocean Disposal Limits by two times and zinc is borderline. Mercury concentration exceeds *Interim Contaminant Testing Guidelines for Ocean Disposal* on the north end, however, the other sites are also elevated. The organic chemistry is very high: total petroleum hydrocarbons exceed the limits by an order of magnitude; total PAHs exceed the limits by three to six times and PCBS are exceeded by two orders of magnitude. Neither pesticides or BTEX were detected. Appendix A provides the full data results from the analysis including QA/QC information.

3.3 Dartmouth (Woodside)

The benthic habitat north and south of the diffuser (between borehole 3 and 4) is composed of a very loose and fluid surficial sediment. Table 3 shows the grain size distribution; the sediment consists predominantly of silt.

A sculpin and a small flatfish were the only fish observed. Starfish were the only numerous epifaunal organism; as with soft bottom areas, polychaete worms are the most prolific animal that live in such habitats (Photo 4). Along the north transect, a large metallic object (debris) provides a hard surface for dense colonisation by sea anemones and seaweed (*Desmarestia aculeata*).

Table 3 provides the concentrations of metals and organics in the analyzed samples. Chemistry analysis of the outfall/diffuser and conduit areas show two different bottom types. Sample D2 was taken in a gravel area where fine materials have not accumulated or have been scoured away (e.g. vessels). No exceedances in metal concentrations were evident at this location. Lead exceeds the guideline limits at all other sites. At locations D3 and D4, zinc and mercury concentrations are at or exceed the *Interim Contaminant Testing Guidelines for Ocean Disposal*. The concentrations of PAHs, petroleum hydrocarbons and PCBs in the analyzed samples far exceed the interim screening limits.

Table 3 Marine Sediment Chemistry at Woodside							
Parameter	Units	EQL	D1	D2	D3	D4	Ocean Disposal Guidelines
Cadmium	mg/kg	0.3	0.5	0.3	0.7	0.4	0.6
Copper	mg/kg	2.0	72	19	68	58	81
Lead	mg/kg	0.5	140	16	160	150	66
Zinc	mg/kg	2.0	150	59	180	160	160
Mercury	mg/kg	0.01	1.1	0.04	0.97	0.85	0.75
Total Organic Carbon	g/kg	0.1	47	31.3	45.5	26.9	
Total Inorganic Carbon	g/kg	0.1	13	2.4	6.0	0.2	
gravel	%	0.1	nd	60.5	nd	nd	
sand	%	0.1	23.5	17.6	8.3	6.3	
silt	%	0.1	50.2	15.3	61.6	61.5	
clay	%	0.1	26.3	6.6	30.1	32.2	
Benzene	mg/kg	0.025	nd	nd	nd	nd	
Toluene	mg/kg	0.025	nd	nd	nd	nd	
Ethylbenzene	mg/kg	0.025	nd	nd	nd	nd	
Xylenes	mg/kg	0.05	nd	nd	nd	nd	
Total Petroleum Hydrocarbons	mg/kg	32.5	2120	1830	2440	1950	10.0
Total PAHs	mg/kg	0.05	17.19	18.82	14.2	9.19	2.5
PCBs	µg/kg	10.0	143	63.3	95.3	164	100
DDE	µg/kg	10.0	nd	nd	nd	nd	100
DDT	µg/kg	10.0	nd	nd	nd	nd	100
DDD	µg/kg	10.0	nd	nd	nd	nd	100

* PCB is Aroclor 1260; TPH is lube oil fraction

Bolded text shows exceedances of the Interim Contaminant Testing Guidelines for Ocean Disposal

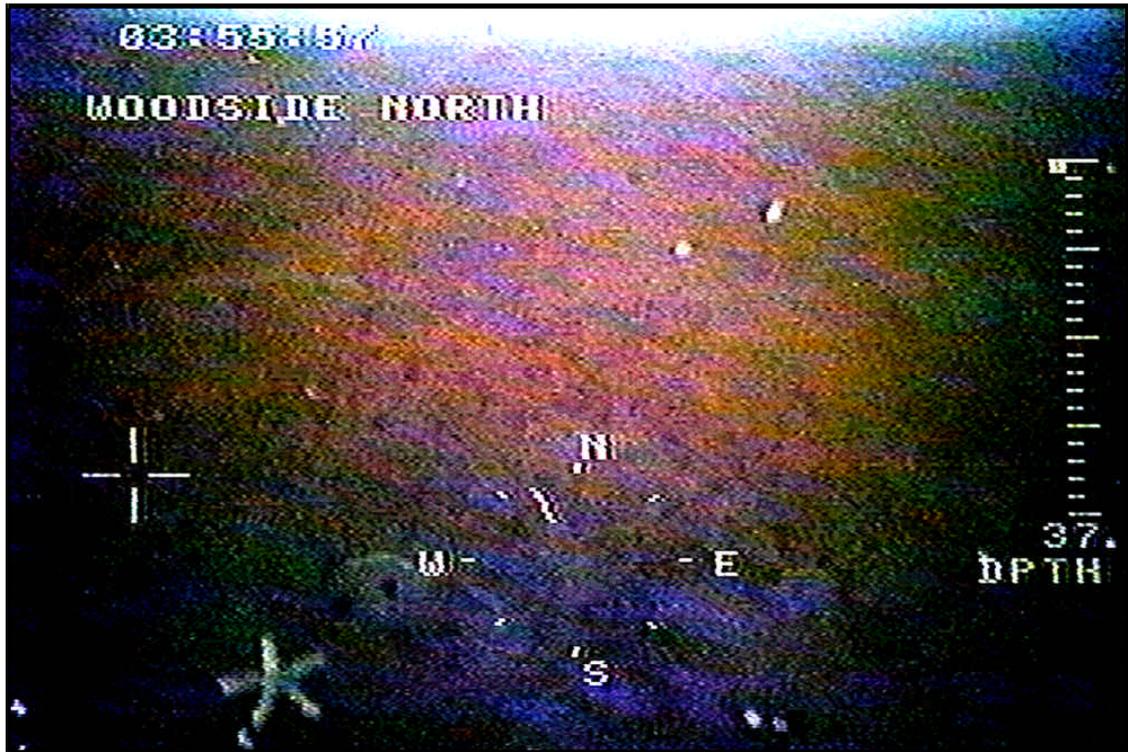


Photo 4: Benthic Habitat at Dartmouth (off NS Hospital)



3.4 Halifax (North)

The substrate in the outfall/diffuser area consists of a silty, clayey sand with much less flocculated material than observed on the Dartmouth side. The bottom is flat with no natural hard surfaces for colonisation by epiphytic plants or epifaunal animals. Photo 5 provides a view of the substrate in the surveyed area.

As with other areas of the harbour, the benthic community consists of an infaunal group of organisms dominated by polychaetes. Litter provides a substrate for sea anemones. The starfish (*Henricia sanguinolenta* and *Asterias* sp.) are the most abundant epifaunal animal.

Table 4 provides the concentrations of metals and organics in the analysed samples. The concentrations of all the assessed exceed the *Interim Contaminant Testing Guidelines for Ocean Disposal*. Location HN1 exhibits the highest concentrations which reflects its close proximity to an existing sewer outfall.

The concentrations of BTEX are non-detectable at HN1 and HN2, however, all four analytes were detected at HN3. There are no specific disposal limits for these parameters. At each sampling location, total PAHs exceed the *Interim Contaminant Testing Guidelines for Ocean Disposal*. The concentration of petroleum hydrocarbons exceed the guideline, but are not detected at location HN3.

PCBs and para-para DDE pesticide concentration exceeds their limits only at HN1. This location was the only one where pesticides were detected. Appendix A provides the full data results from the analysis including QA/QC information.

4.0 SUMMARY

Of the four locations surveyed and tested, the Hospital Point site shows the least amount of anthropogenic contamination from the discharge of wastes and the most diverse seafloor community. Significant contamination of the sediments by PCBs and PAHs at the Dartmouth, Halifax and Georges Island sites must be considered during the construction phase of the pipelines and diffusers, if these sites are chosen. Further analysis may be required by Environment Canada if ocean disposal or sidecasting of this material is considered.

Table 4 Marine Sediment Chemistry at Karlsen Wharf/Casino Area						
Parameter	Units	EQL	HN1	HN2	HN3	Ocean Disposal Guidelines
Cadmium	mg/kg	0.3	4.7	0.6	0.6	0.6
Copper	mg/kg	2.0	290	87	81	81
Lead	mg/kg	0.5	1000	310	280	66
Zinc	mg/kg	2.0	1100	260	210	160
Mercury	mg/kg	0.01	5.3	0.91	1.5	0.75
Total Organic Carbon	g/kg	0.1	112.0	20.6	49.3	
Total Inorganic Carbon	g/kg	0.1	26.6	5.4	13.1	
gravel	%	0.1	nd	nd	nd	
sand	%	0.1	27.7	6.8	25.0	
silt	%	0.1	45.6	68.3	47.9	
clay	%	0.1	26.8	24.9	27.0	
Benzene	mg/kg	0.025	nd	nd	0.255	
Toluene	mg/kg	0.025	nd	nd	0.634	
Ethylbenzene	mg/kg	0.025	nd	nd	0.168	
Xylenes	mg/kg	0.05	nd	nd	1.39	
Total Petroleum Hydrocarbons	mg/kg	32.5	8230	1290	nd	10.0
Total PAHs	mg/kg	0.05	270.1	81.65	1044.3	2.5
PCBs	µg/kg	10.0	3870	98	nd	100
DDE	µg/kg	10.0	77.4	nd	nd	100
DDT	µg/kg	10.0	nd	nd	nd	100
DDD	µg/kg	10.0	nd	nd	nd	100

* PCB is Aroclor 1260; TPH is lube oil fraction

Bolded text shows exceedances of the Interim Contaminant Testing Guidelines for Ocean Disposal

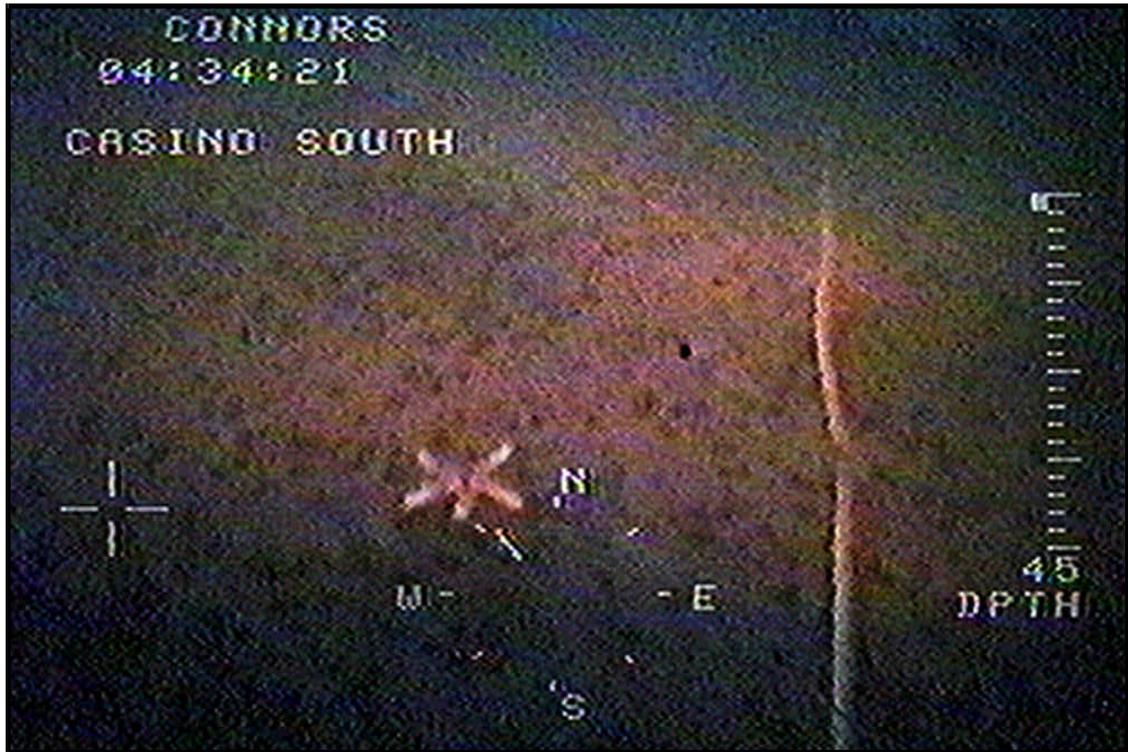


Photo 5: Benthic Habitat at Halifax (off Casino)