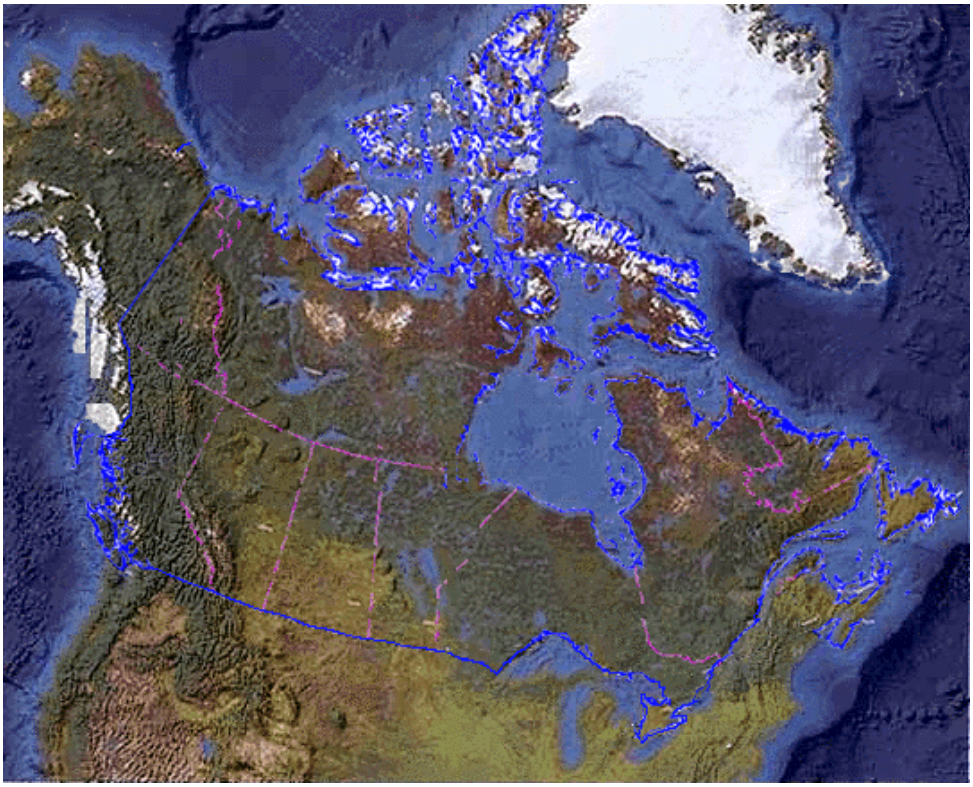
Compendium of Monitoring Activities at Disposal at Sea Sites in 2003-2004.



Disposal at Sea Program
Marine Environment Branch
National Programs Directorate
Environmental Protection Service
Environment Canada

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Cover: Relief map of Canada courtesy of Geological Survey of Canada.

Summary

Each year, Environment Canada conducts representative monitoring at disposal at sea sites. This is one of the measures in place to protect Canada's marine environment under the Canadian Environmental Protection Act, 1999 (CEPA) and meet our international commitments under the London Convention 1972 and its 1996 Protocol on preventing marine pollution by controlling the disposal of wastes at sea. This report provides a technical summary of monitoring activities conducted in the year 2003 amounting to a total of 14 disposal sites. Data from three other sites, one in Hudson's Bay and two in the Maritimes, are still being processed and will be presented in the 2004 Compendium.

In the Atlantic Region, 3 disposal sites were examined. A physical survey of the seafloor at the Summerside disposal site, Prince Edward Island, found the dredge spoils were within the permitted disposal site locations and that large quantities of dredge material still remained on site. Work at the Yarmouth Harbour, Nova Scotia, found dredged material at recently used parts of the site, with less material found at older parts of the site. Analysis for PCBs, PAHs and metals were below Lower Action Limits and showed no signs of contamination. Results of a bathymetric survey conducted in 2003 at the Miramichi Disposal Sites in New Brunswick are still being processed and will be reported for the 2004 Compendium.

Work in the Quebec Region examined the physical stability of 5 sites in the Magdalen Islands. The five sites were found to be relatively stable, with the exception of GI-2 (Grosse Ile) where sediment loss of over 97% of the material disposed of since 1994 has occurred. Another disposal site, CM-7 (Cap-aux-Meules) should also be monitored. The study made a number of recommendations for future permit conditions and monitoring priorities to ensure dredged material remains stable. One site from these five sites, PB-8 (Point Basse), was further examined to address concerns about potential contamination by PAHs and possible sediment toxicity. No PAHs were found, metals were below Lower Action Limits and national guidelines. Preliminary results from toxicity tests (Amphipod, Echinoid, and Microtox) found no toxic effects. Final toxicity test data will be presented for the 2004 Compendium.

Work was initiated in the Prairie and Northern Region to examine the site stability of the Port of Churchill disposal site. As well some earlier sonar data, previously unavailable, is reported.

In the Pacific and Yukon Region chemical and biological testing was conducted on sediment samples taken at 6 sites. Of these 6 sites, 2 were the subject of video surveys by the ROPOS submersible. Data from all these sites is continuing to be processed and will be presented for the 2004 Compendium.

Comments

Comments may be sent to:
Paul Topping
Marine Protection Programs Division
Marine Environment Branch
National Programs Directorate
Environmental Protection Service
Environment Canada
Ottawa, Ontario
K1A 0H3

Tel.: 819-953-0663
Fax: 819-953-0913
Email: paul.topping@ec.gc.ca
Web site: www.ec.gc.ca/seadisposal

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Introduction

Canada is a maritime nation. It possesses 243,790 km of coastline, the longest of any nation in the world, and has a vital interest in preserving a healthy marine environment. Though by world standards the Canadian maritime environment is relatively uncontaminated, Canada's territorial waters do have some problems, especially in harbours, estuaries and near shore areas.

Canada regulates disposal at sea through a permit system under the Canadian Environmental Protection Act, 1999 (CEPA). This is one of the measures in place to protect Canada's marine environment and meet our international obligations under the London Convention 1972 and its 1996 Protocol on preventing marine pollution by controlling the disposal of wastes at sea.

CEPA requires Environment Canada to monitor representative disposal at sea sites each year. This is conducted in accordance with national monitoring guidelines and dependant on available resources from the disposal fees collected. In order to respond to Canada's national and international reporting obligations, this National Compendium of Monitoring Activities, based on regional reports, is produced annually.

Role of monitoring

Besides being required by law, disposal site monitoring allows permittees continued access to suitable disposal sites by helping to ensure that the permit conditions were met and the use of the site has not caused unacceptable or unpredicted impacts. It verifies that assumptions made during the permit review and site selection process were correct and sufficient to protect the marine environment and human health. Monitoring allows Environment Canada to gather information and take appropriate action to manage the sites in an environmentally sound manner.

Monitoring also plays a critical role in reviewing the overall adequacy of controls. Information compiled nationally and regionally, over time, provides the basis to assess whether the disposal at sea regulatory controls, guidelines and permit conditions are adequate to protect the marine environment and human health.

Experience gained with monitoring may also point to the need for research to develop better monitoring tools, or to refine the monitoring program, on specific environmental, health or public concerns. It is also expected that monitoring will uncover gaps in our understanding of impacts, particularly in the area of cause and effect relationships.

In order to increase the level of involvement of stakeholders, annual meetings with clients and other interested parties provide additional comments on past monitoring and better indication of Regional priorities for future assessments. The annual meetings also ensure Environment Canada’s decisions concerning monitoring activities are carried out in an open and transparent manner.

Finally, Environment Canada’s disposal site monitoring, reporting and communication with stakeholders are activities critical to fulfilling the federal and international obligation to apply the Precautionary Principle in administering CEPA.

Conducting monitoring studies

Monitoring a disposal at sea sites is conducted according to national guidelines. Activities carried out in a given year are based on available resources and can involve an assessment of the physical, chemical and biological features. The impact hypotheses generated by permit reviews form the basis of subsequent monitoring.

Physical monitoring relates to the collection of relevant geological information for determining the area of deposition, delineating the disposal site boundaries, studying the accumulation of dredged material within the area of deposition, and documenting evidence of sediment transport from the disposal site.

Biological and chemical assessments are undertaken concurrently and the monitoring design for these parameters takes into account the size and dispersal characteristics of the site. Chemical monitoring is aimed at measuring the levels of chemicals in sediments and comparing them to lower action levels set out by the Disposal at Sea Regulations or other national screening levels for additional parameters of concern.

CEPA Lower Action Levels.

Lower Action Levels for chemicals in sediments
(Disposal at Sea Regulations)
(mg/kg, dry weight)

Chemical	Current Level
Cadmium	0.6
Mercury	0.75
total PCBs	0.1
total PAHs	2.5

Biological monitoring is primarily centred on biological testing in the laboratory and benthic community surveys. The biological test methods currently used for sediment assessment include:

- an acute toxicity test using marine or estuarine amphipods (the end point is lethality);
- a fertilization assay using echinoids (the endpoint is significant reduction in fertilization);
- a toxicity test using a photoluminescent bacteria, the Microtox® solid-phase test (the end point is significant reduction in bioluminescence);
- a bedded sediment bioaccumulation test using bivalves (the end point is significant bioaccumulation).

Integrative assessment

If sediments are below the lower action levels, or other national screening levels, for contaminants and pass all biological tests, no further action is required. However, if levels of contaminants or biological test results demonstrate a cause for concern then the first step is to verify compliance with the terms of the permits issued since the site was last monitored.

The second step will generally involve checking potential sources of pollutants and conducting further site characterization. After considering this information, the following hierarchy of interpretative guidance can be applied to the concurrent chemical and toxicological data:
if sediments at the disposal site contain substances in excess of national screening levels (including lower action levels), pass the acute toxicity test, but fail one sublethal or bioaccumulation test: consideration could be given to modifying further use of the site and investigating the long term stability of the material onsite;

- if the sediments contain substances below the national screening levels, yet fail any of the biological tests, then further investigation would be required to determine if this is the result of either a confounding factor such as laboratory anomaly, or the presence of a contaminant not included in the chemical screening; or
- if the sediments contain substances in excess of the national screening levels and either fail the acute test or fail two (or more) additional tests including the sublethal tests and the bioaccumulation test: further monitoring, site closure or remediation could be considered.

As well, cursory benthic community surveys can be used as a general sediment quality indicator. The overall assessment of the disposal site considers all available information from physical, chemical and biological monitoring.

Intensity of monitoring

Monitoring at every disposal site is not considered necessary, as current knowledge of impacts related to disposal of dredged material allows for good assessments to be drawn from representative disposal sites. In addition, the program attempts to ensure that the major sites (>100,000 m3 of dredged materials/year) are monitored on at least a five year cycle. The monitoring of other sites is determined by triggers set out in the national monitoring guidelines which are based on volume, proximity to sensitive areas, or level of concern. The number of sites monitored in a year and the parameters measured at each site depend on the available resources through the collection of fees from permittees.

Reporting

Canada's Disposal at Sea Program is administered through regional offices which are largely responsible for the permit review process, as well as for planning, conducting and reporting on monitoring studies undertaken in their administrative areas. This compendium, based on regional detailed reports, is now produced annually to respond to Canada's national and international reporting obligations. Readers may request detailed information on any of the monitoring activities in this compendium, from the appropriate regional office.

Atlantic Region: Summerside, Prince Edward Island

Background

Figure 1. Location of Summerside

Summerside harbour is located on the south-western shore of Prince Edward Island, adjacent to the Northumberland Strait (See Figure 1). Dredging activities have occurred in Summerside Harbour for more than thirty years. The material from the dredging operations has been placed west of the shipping channel, in Bedeque Bay, in water depths of approximately 2-5 metres. The quantities of material dredged from the harbour have been relatively small (ranging from 15,000 to 35,000 cubic metres), with a total of approximately 80,500 cubic metres of material disposed of at several approved offshore disposal sites. There are four disposal sites in the area (A, B, C, and D). Site A has not be used since 1992, while sites B, C and D are all located together within a general area northeast of site A. Most of the recent disposal activities have occurred in the area of sites B, C, and D. Concerns about the proximity of the disposal sites to productive lobster fishing grounds and nearby aquaculture sites, as well as concerns about potential heavy metal and PAH contamination of the dredged material, have triggered monitoring of the disposal sites. Before examining the chemical impacts or potential toxicity, a physical study is required to examine if the dredged material remained on site or if there are sediment transport concerns.

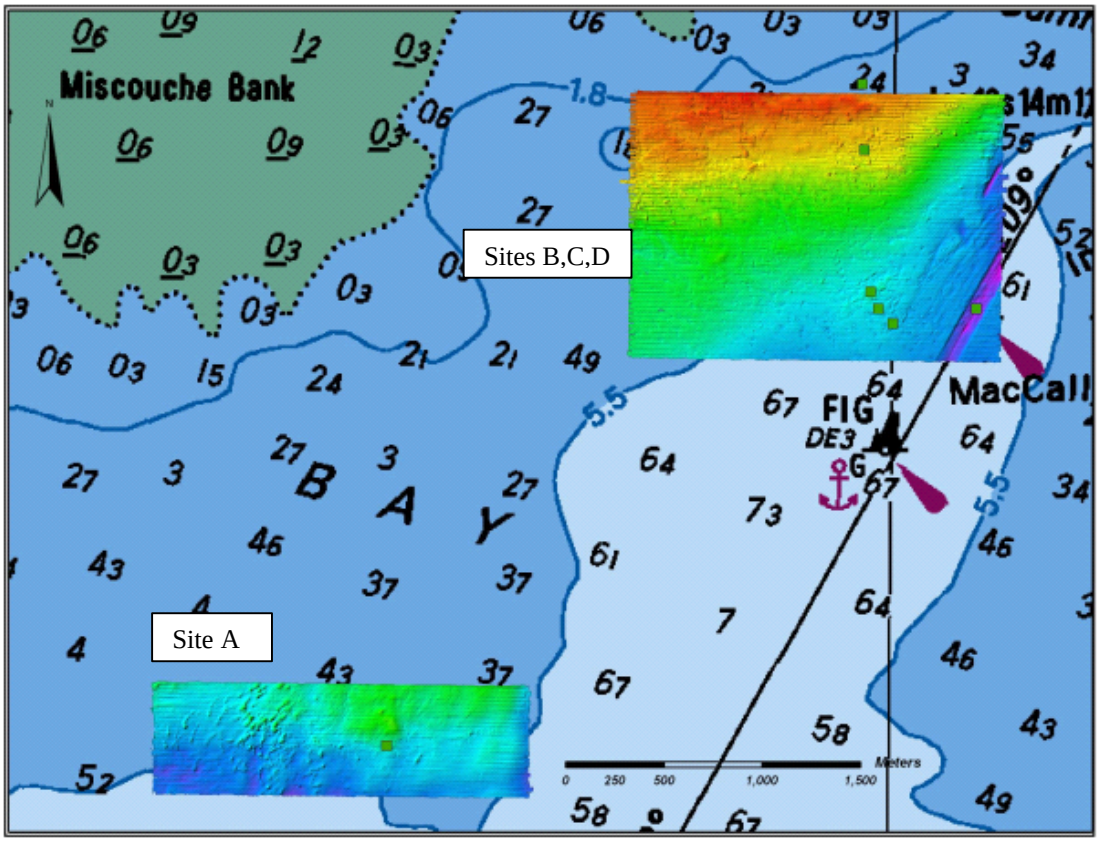


Figure 2. Multibeam and disposal site locations, Summerside, PEI

Impact Hypothesis

Disposal was conducted within the boundary of the designated disposal site and had created a disposal area that is stable in the local dynamic physical marine environment.

Monitoring Conducted

The 2003 monitoring work at Summerside was conducted by the Geological Survey of Canada (GSC). Data collected included multibeam bathymetry, side-scan sonar and sub-bottom profiler (see Figure 2). The sediment samples were collected by the Department of Fisheries and Oceans (DFO).

Results and Conclusions

The multibeam bathymetry indicate a large cluster of dredge spoils near the most recently used, active sites (sites B, C and D) (See Figure 3). The spoil piles are linear or arc shaped, indicating disposal from a moving vessel. Multibeam collected at site A shows the presence of a large concentration of dredge spoils (See Figure 4). These spoils appear in discrete piles and are therefore likely coarse-grained in nature, given the dynamic currents and wave conditions at this site.

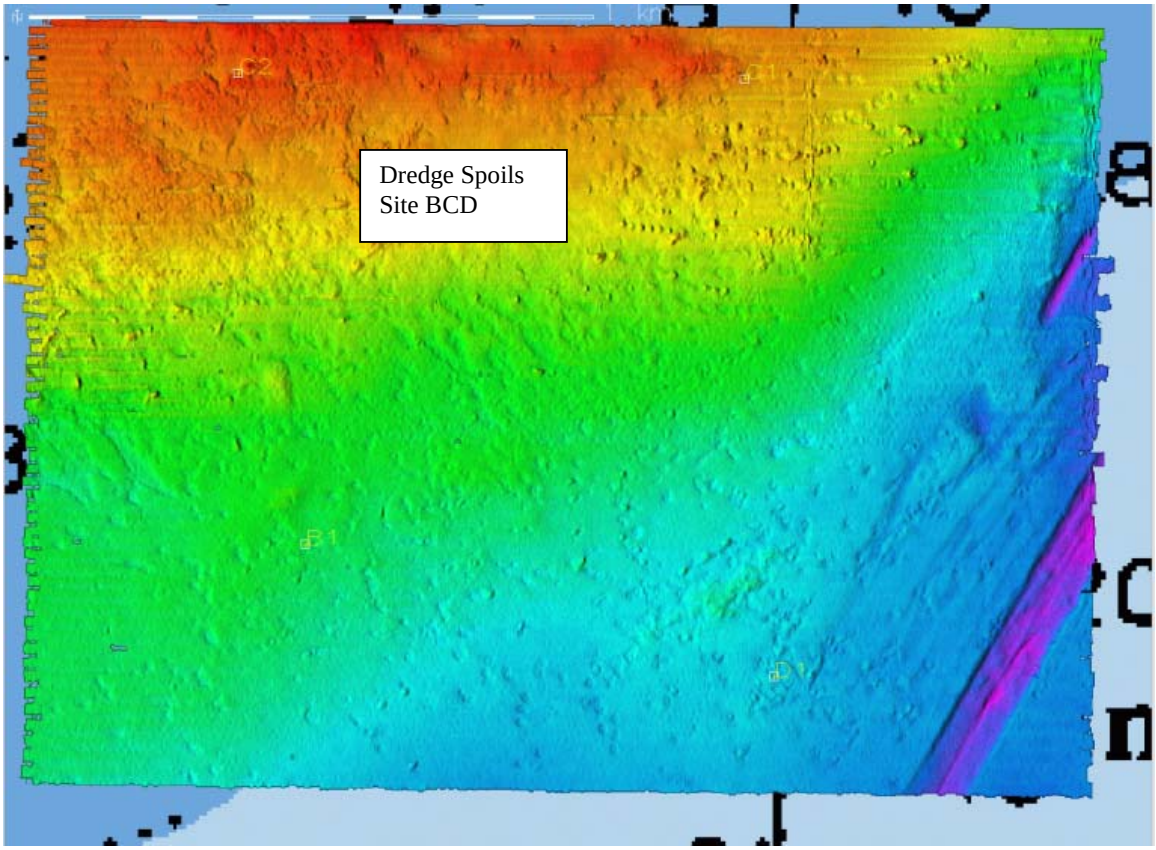


Figure 3. Disposal Sites B, C, and D

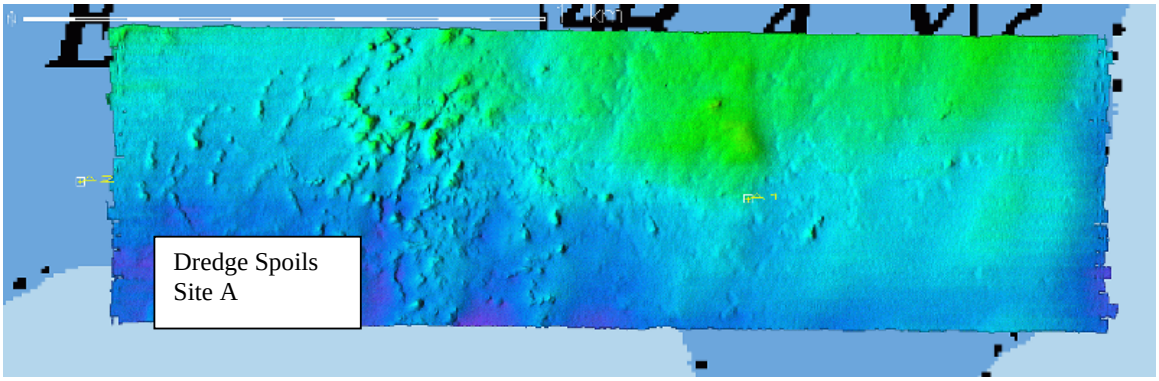


Figure 4. Disposal Site A

The locations of the dredge spoils are consistent with the permitted disposal site locations. The multibeam surveys also indicate that large quantities of dredge material still remain at the disposal sites. Analysis and interpretation of the collected data is still underway and further results will be forthcoming.

Acknowledgements

Environment Canada would like to thank Russell Parrott and the Geological Survey of Canada for their work collecting the geophysical data. Environment Canada would also like to thank Tim Milligan and the Department of Fisheries and Oceans for the collection of sediment samples.

Atlantic Region: Miramichi Disposal Sites, New Brunswick

Background

The Miramichi River is situated on the eastern shore of northern New Brunswick. Shipping on the Miramichi River historically occurred via a 5-metre deep channel that was largely natural and required little maintenance. Due to increased commercial demands, a major dredging operation was conducted from 1981-1983 to widen and deepen the channel to accommodate a vessel draft of 7.6 metres. Over six million cubic metres of material was removed from the channel and disposed of at three designated disposal sites. Dredged material with elevated cadmium levels was disposed of and capped with clean sediment at site A, located farthest upriver. The other two sites, B and C, were situated incrementally along the river to receive the remainder of the dredged material. Between 1989 and 1994, disposal sites B and C received an additional 550,000 cubic metres and 106,300 cubic metres respectively from maintenance dredging operations. Depths at the disposal sites vary from 3-10 metres. A physical study is required to confirm the stability of the site.

Impact Hypothesis

Disposal was conducted within the boundary of the designated disposal site and had created a disposal area that is stable in the local dynamic physical marine environment.

Monitoring Conducted

A three-year monitoring program that included bathymetric surveying, water quality sampling, geophysical and sediment chemistry, and fish and benthic biota surveys, was conducted after the dredging operations in 1981-1983. Apart from a few limited studies, there have been no monitoring activities carried out at the sites since the late 1980's.

The Miramichi disposal sites were triggered for inclusion in the 2003/2004 monitoring program after being determined to meet selection criteria set out in the Environment Canada Disposal Site Monitoring Guidelines. The Geological Survey of Canada collected Acoustic Doppler Current Profiler (ADCP) and Conductivity, Temperature, Depth (CTD) measurements at Disposal Site A and B in the Miramichi estuary. The Department of Fisheries and Oceans collected sediment samples concurrently at these locations. Weather delays in Summerside, Prince Edward Island resulted in the Miramichi survey being truncated. As such, geophysical surveys, including multibeam and sidescan sonar, are postponed until next year.

The results of the sediment samples and current measurements from the 2003 monitoring will be combined with the monitoring activities planned for the coming year and collectively will be used to assess the impact hypothesis.

Results and Conclusions

Results will be forthcoming following collection and analysis of the 2004 monitoring data.

Acknowledgements

Environment Canada would like to thank Russell Parrott and the Geological Survey of Canada for their work collecting monitoring data. EC would also like to thank Tim Milligan and the Department of Fisheries and Oceans for the collection of sediment samples.

Atlantic Region: Yarmouth Harbour, Nova Scotia,

Background

Yarmouth Harbour is located in the southwest corner of Nova Scotia. Since 1976, more than a million cubic metres of sediment has been dredged from the shipping channels and inner harbour of Yarmouth, Nova Scotia. Most of the dredged materials were disposed of at a designated disposal site (5 – 10 metres depth) near the mouth of Outer False Harbour, adjacent to Yarmouth Sound (See Figure 6). This site was described as hard-packed sandy bottom with exposed gravel patches, pebbles, rocks, shell and plant debris. Biological sampling indicated that the abundance, number of species, diversity and biomass were low and uniform between stations. Another disposal site (21 – 22 metres depth) located in Yarmouth outer channel was used only once or twice in the late 1970's. While other sites were cited in the Disposal at Sea Program records, there is no record indicating they have been used. From the geological setting, it is evident that the two designated sites would be exposed to large waves during periods when winds blow from a southerly direction.

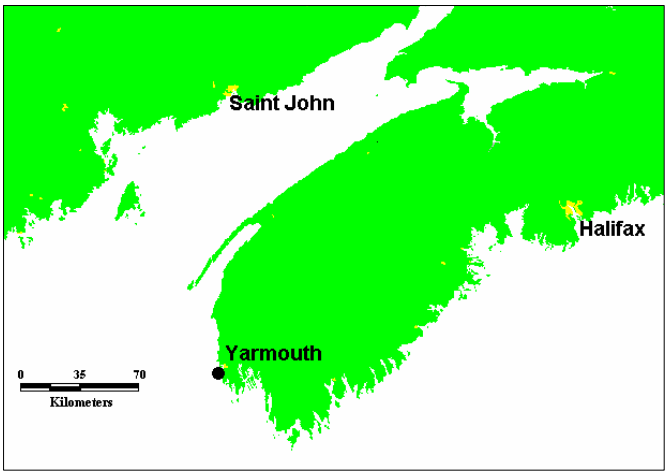


Figure 5. Location of Yarmouth Harbour

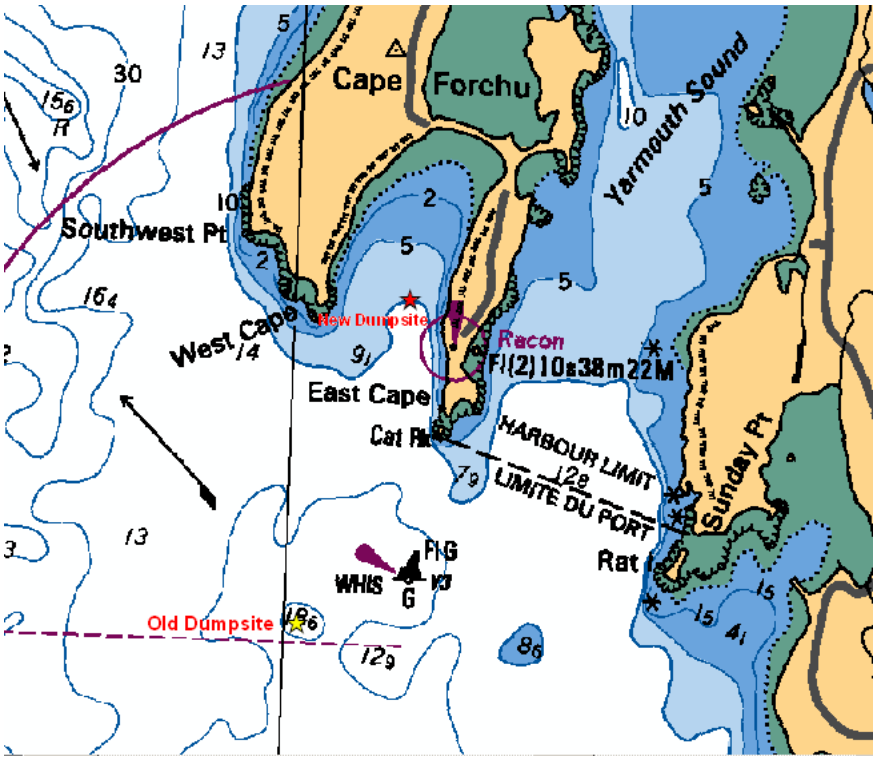


Figure 6. Disposal Sites, Yarmouth Harbour

Impact Hypothesis

The disposal site is a dispersive site. Dispersion of disposed materials from the site did not pose a long term concern to the surrounding environment.

Monitoring Conducted

Yarmouth was monitored in 2003 due to "possible effects on nearby sensitive areas, including habitats, or potential conflicts with other nearby uses of the sea" (Disposal Site Monitoring Guidelines). Chemical analyses of the dredged materials conducted in the past by permit applicants indicated that some of the sediment samples, especially those collected from wharves inside the harbour contained elevated concentrations of cadmium and petroleum hydrocarbons.

The 2003 monitoring work for Yarmouth Harbour was conducted by the Geological Survey of Canada. Data collected included multibeam, sidescan sonar, sub-bottom profiler, seafloor photographs, underwater video, and grab samples (see Figure 7). This data facilitates the testing of permit assessment predictions and the impact hypothesis for the Yarmouth Harbour Disposal Site.

Results and Conclusions

The multibeam and sidescan sonar data indicates that a large portion of the seafloor at the disposal sites and the surrounding area consists of areas of bedrock and coarse sediment infilled by finer sediment. Fine sediment appears to have accumulated along the eastern side of the approaches to the harbour. Parallel ridges of coarse material, similar to ribbed moraines observed on other Nova Scotia nearshore and offshore multibeam data, appear along the western side of the surveyed area. Dredge spoils are visible at the most recently used disposal site that is located to the west of Yarmouth Sound. The presence of distinct spoil piles is less evident at the historic dredge disposal locations.

Sample results for sediments collected near the disposal site indicate that PCBs, PAHs and selected metal concentrations are all at or below screening criteria and show no indication of contamination. Seafloor photographs and video support the multibeam and sidescan sonar data suggesting the seabed consists of areas of bedrock and coarse sediment overlain with fine grained sediment. Further analysis of the data will be conducted to help facilitate testing of the impact hypothesis.

Acknowledgements

Environment Canada would like to thank Russell Parrott and the Geological Survey of Canada for their work collecting the geophysical data.

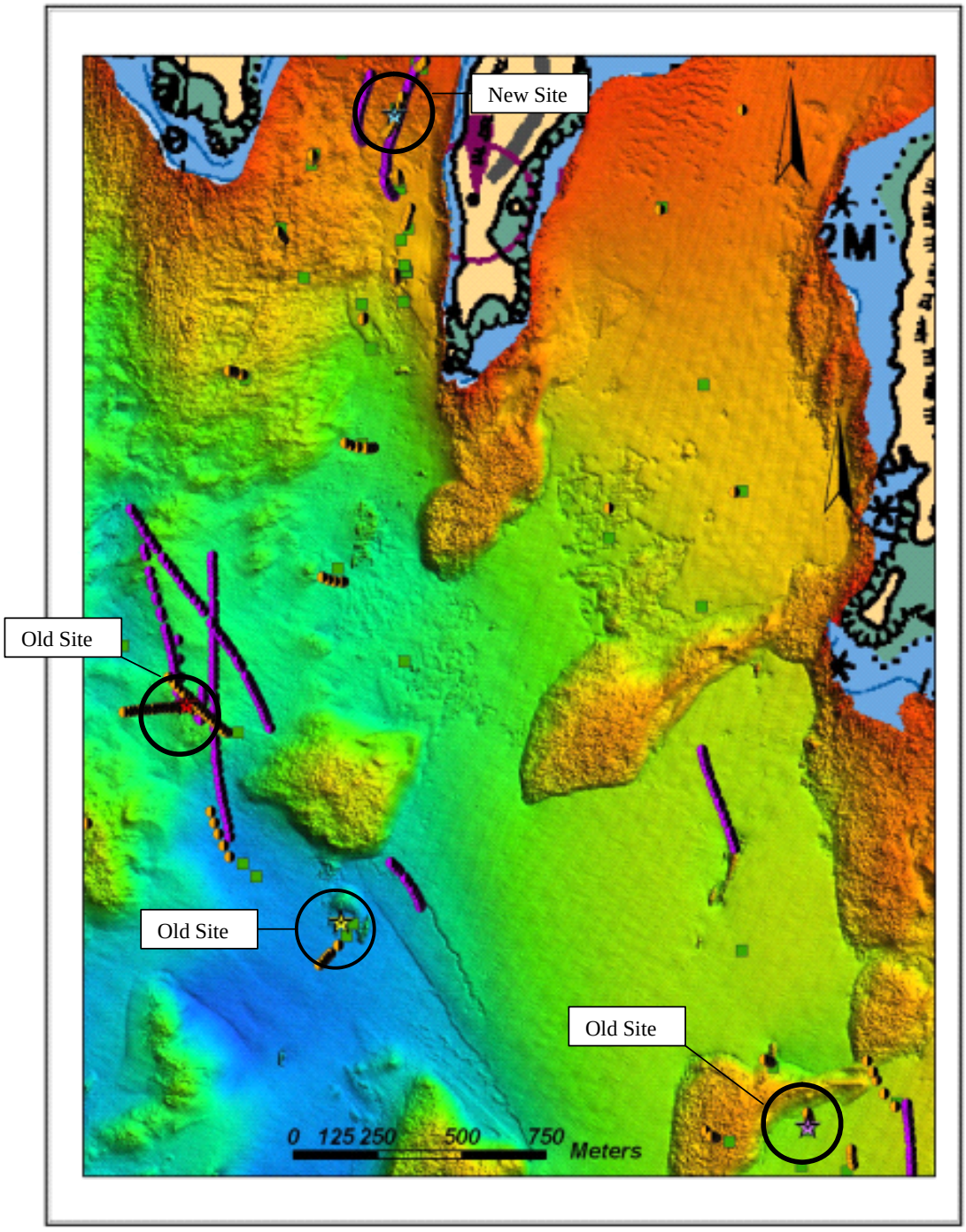


Figure 7. Multibeam and Data Collection Locations, Yarmouth Harbour and Approaches

Quebec Region: Stability of Five Disposal Sites in the Magdalen Islands

Background

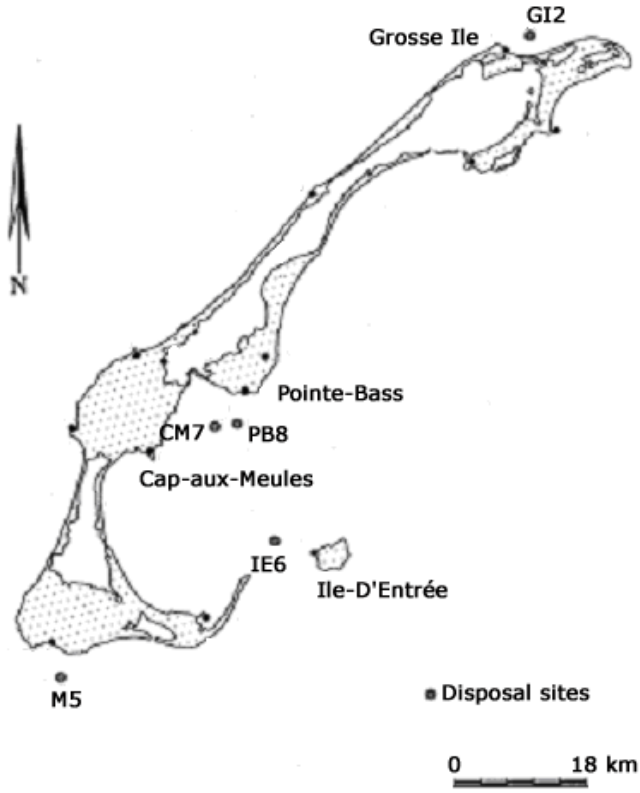


Figure 8. Location of disposal sites studied.

Location	CM-7 (Cap-aux-Meules) 47° 22,00' N; 61° 49,10' W GI-2 (Grosse-Île) 47° 37,85' N; 61° 29,60' W IE-6 (L'Île-d'Entrée) 47° 17,19' N; 61° 45,60' W M-5 (Millerand) 47° 11,80' N; 61° 58,60' W PB-8 (Pointe-Basse) 47° 22,10' N; 61° 47,75' W
Depth	Varies by site, see Table 1
Material	Dredged material
Quantity	Varies by site, see Table 1
Status	Active
Concerns	Possible resuspension, erosion, or transport of dredged material in quantities that may impact surrounding habitat, marine life present (i.e. impacts on migration, fish spawning and breeding) and fisheries.

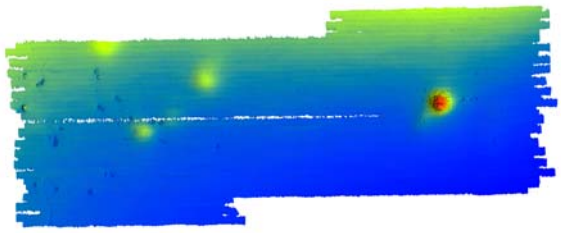
Table 1. Area, average width, mound height and depth of disposal sites

Disposal site – Harbour of origin of the sediment		Area (m^2)	Average width	Mound height	Average depth (relative to CD*)
M-5	Millerand	21,450	147 m	3.0 m	21.0 m
IE-6	L'Île-d'Entrée	35,480	188 m	4.0 m	8.4 m
GI-2	Grosse-Île	8,143	90 m	0.25 m	7.2 m
PB-8	Pointe-Basse	56,130	237 m	3.7 m	12.0 m
CM-7	Cap-aux-Meules†	114,130	338 m	0.8 m	12.5 m

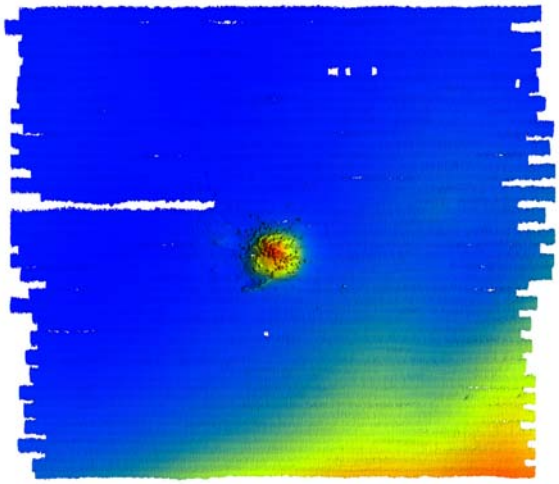
* Chart datum (CD).
† Site consisting of three mounds.

In August 2001, an acoustic survey of the five disposal sites in the Magdalen Islands was carried out. An area of 1 km^2 located roughly in the centre of the disposal site was surveyed. As part of the project, which was carried out in partnership with the Canadian Hydrographic Service (CHS), surveys were conducted using a CHS vessel equipped with a SIMRAD EM-3000 multibeam system and various other equipment, including a DGPS. In addition to bathymetric data, this system was used to obtain acoustic reflectivity data and images of the ocean floor relief. With these two types

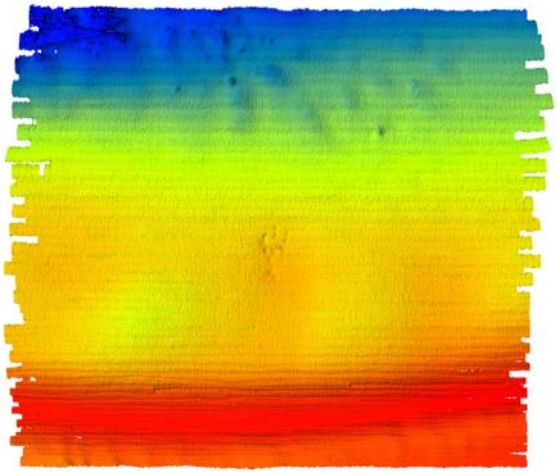
of data, it was possible in most cases to accurately locate and delineate the sediment mounds for a future physical monitoring study (Figure 9).



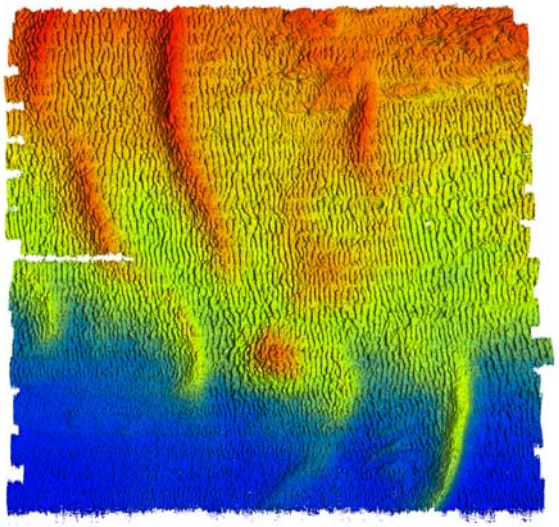
Left: CM-7 (Cap-aux-Meules) with its three mounds
Right: PB-8 (Pointe-Basse)



IE-6 (L'Île-d'Entrée)



GI-2 (Grosse-Île)



M-5 (Millerand)

Figure 9. Illuminated bathymetry based on multibeam surveys of August 2001 (source: Fisheries and Oceans Canada – Canadian Hydrographic Service, 2002)

Impact Hypothesis

The general objective of the study was to evaluate the behaviour of the material disposed at the sites in response to various forces. The study program should address the following questions:

- on the basis of available data, are the sediments disposed at the sites stable?
- if the sediments are not stable, can their instability be quantified?

The specific objective of the study was to assess the stability of the dredged material disposed of at the five sites in the Magdalen Islands, and, on the basis of available bathymetry and reflectivity data, to determine the quantities disposed of and certain physicochemical characteristics.

Parameters Measured

On considering the hypothesis that hydraulic and hydrodynamic forces at these sites are the main source of potential movement of the dredged material, the study program to answer these questions comprised the following:

- estimating the wave generation at disposal sites from wind data available at the Cap-aux-Meules station;
- retrieving data on currents from the Canadian Hydrographic Service in the areas of the disposal site;
- evaluating the stability of the sediment as a function of the hydraulic and hydrodynamic forces and available grain size data;
- estimating the quantity of sediments still present at the site on the basis of the available bathymetry data and data on the volume of sediment disposed of at each site.

Resuspension

When sediments become resuspended in the water column, they are available for transport over some distance in the direction of the current. We based our calculation of the resuspension of sediments at the sites on the work of Y. Ouellet who, in 1999, studied sediment movement under the effect of waves at Depot D in the Magdalen Islands. Only wave-induced currents were considered a source of sediment destabilization.

The principal parameters to be considered in calculating resuspension are: wave period, height and duration, average water depth at the site, and average grain size (D_{50}) of the sediments at the surface. The characteristics of the waves at each disposal site were generated using a parametric model. The average depth at the disposal site is available from the survey. The average grain size of the sediments disposed of at the five sites can be calculated using the grain size analyses conducted over the years.

Sediment dispersion

Sediment dispersion occurs as a result of drifting and rolling on the sea floor. In the case of well defined disposal sites, as is this case, the spread of sediments results in an increase in the area of the mound, gentler slopes and a reduction in the height of the mound.

The dispersion of the sediments was calculated on the basis of the work of Y. Ouellet at Depot D. The data required for the calculations are essentially the same as those required for calculating resuspension. The results obtained are expressed in metres/season, and represent a dispersion of sediments as a result of drifting on the sea floor in the direction of wave-induced currents. Significant assumptions are used in the calculations, which means that the spread value calculated by this method is necessarily overestimated compared to actual observations.

Bathymetry analysis

Volumes of dredged material disposed of at the sites

The data on volumes of dredged material disposed of at the sites come from Environment Canada. The data has been collected since 1976 and comes from different sources.

Survey plans and cross-section profiles

On the basis of August 2001 bathymetric survey data, a cross-section of each disposal site was produced, showing the height of the mound and the size of its radius (see Figure 10).

Generation of an initial bathymetry

We did not have survey data dating back to before the first disposal operations at the sites (most of which date back to the early 1980s). As a result, we had no choice but to reconstitute the so-called "initial" conditions by eliminating the volume of dredged material remaining at the site from the 2001 bathymetry. This was done using MapInfo and AutoCad (CivilCad) software. The result obtained corresponds to what can be called the "initial" bathymetry, in that it does not include the sediments that have been placed there over the years.

Calculation of volumes remaining at the sites

Once the initial bathymetries are generated, the distribution of the volumes of dredged material remaining at each site in August 2001 can be calculated on the basis of bathymetry differentials.

Observations and results

Evaluation of stability by analysis of volumes

The volumes of material disposed of at the sites over the years are dispersed by spreading or are transported off site by resuspension and transport in the water column. Table 2 presents a comparison of the volumes of material disposed of at the sites. Column 5 presents the percentage of sediment transported off-site since the start of disposal operations, obtained by bathymetric study and from available information on the disposal operations. The percentage of sediment loss per season varies significantly from site to site. Site GI-2 is highly unstable, with close to 100% sediment loss in just eight seasons (12.2% per season). The other sites are relatively stable: at M-5, approximately 65% sediment loss after 16 disposal seasons (4.1% per season), at site IE-6 only 32% sediment loss after 16 disposal seasons (2% per season). Sediment loss at CM-7 and PB-8, which are very close to one another, was 40.3% and 33.0% respectively after 14 and 17 seasons (2.9% and 1.9% per season). The last column shows the ranking, in increasing order, of stability of the five sites.

Table 2. Quantity of sediment loss estimated by volumes disposed and bathymetry

Disposal site – Harbour of origin of the sediments	Volume of sediments disposed (m^3)*	Number of disposal seasons	Volume remaining at the site in August 2001 (m^3)†	% of sediment loss	Stability index
GI-2 - Grosse-Île	17 954	8	448	97.5 %	1
CM-7 - Cap-aux-Meules	51 404	14	30,687	40.3%	3
M-5 - Millerand	87 676 (avant 1991) 67 813 (1991 et après)	5 11	53,687	65.5%	3
PB-8 - Pointe-Basse	88 628	17	58,851	33.0%	4
IE-6 – L'Île-d'Entrée	53 754	16	36,411	32.3%	4

* All scow volumes were converted to place volumes using a void ratio of 1.3.
† Based on the bathymetric surveys of August 2001.

Visual evaluation of the stability of the sites

A qualitative evaluation of the relative stability of the sites can be made on the basis of a visual assessment of the theoretical cross-sections of the sites. This method can be applied to all sites under study because the sediment was placed at a single location at the sites (even though there are three mounds at site CM-7). A site with a clear, well-defined shape or with a triangular cross-section appears to be more stable than a site with an ill-defined shape or wide, flat cross-section.

For example, site IE-6 appears, at first glance, to be more stable than site GI-2. Not only is the cross-section of site IE-6 virtually triangular (Figure 3), but also the survey plan shows a well-defined site (Figure 10) compared to the cross-section and survey plan of site GI-2 (Figure 11 and Figure 9). Table 3 presents a visual description of the cross-section profiles, site survey, and site stability.

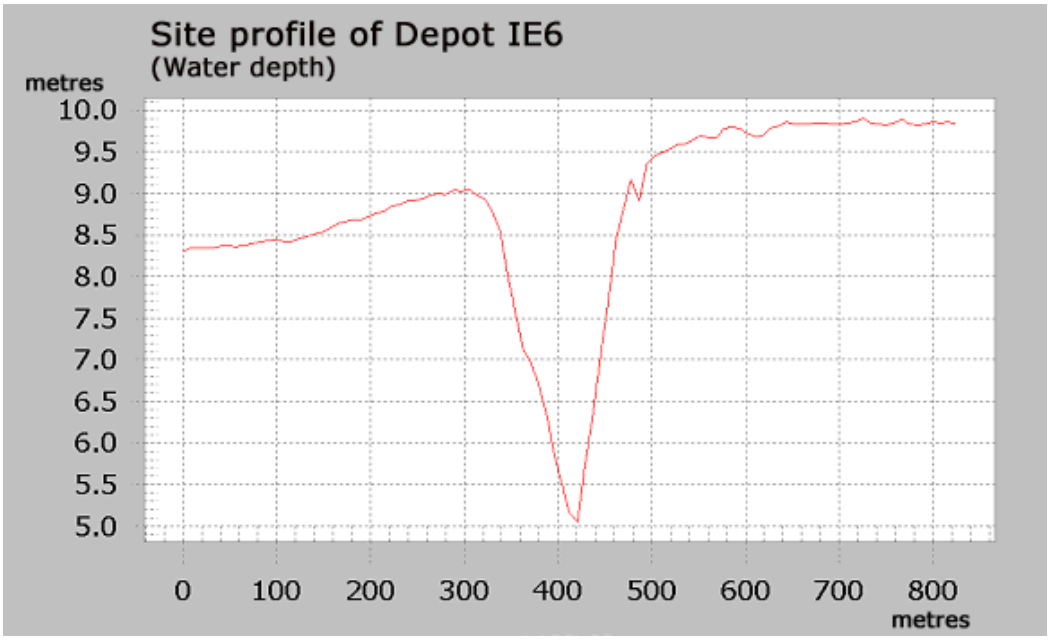


Figure 10. Cross-section profile of IE-6 site depth in metres.

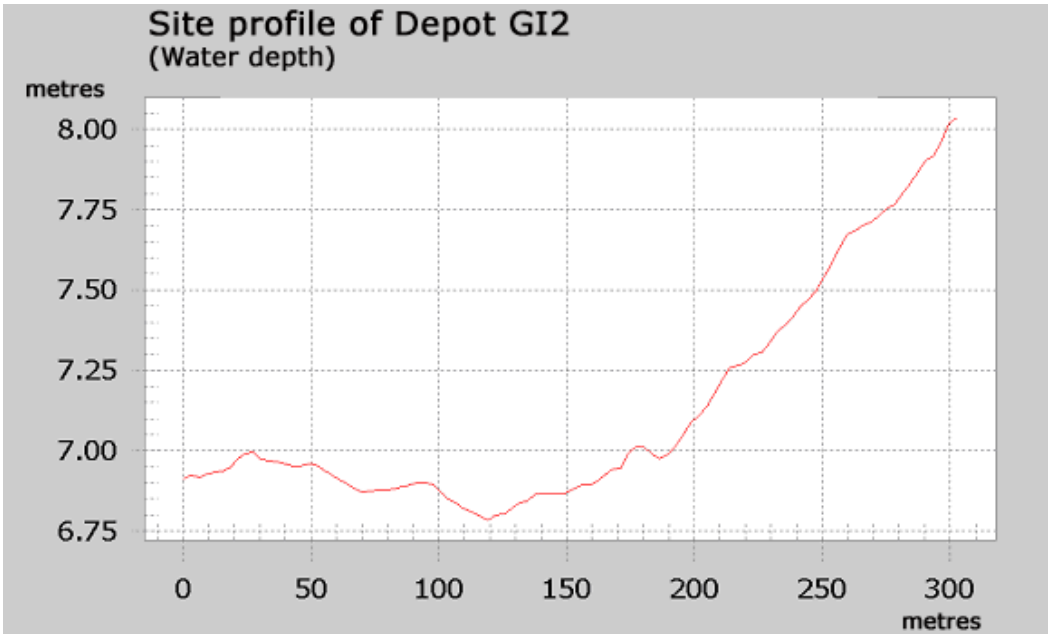


Figure 11. Cross-section profile of GI-2 site in metres

Table 3. Visual descriptions of cross section profiles, site survey and stability

Disposal site – Harbour of origin of the sediment	Description of the cross-section profile	Site description on the basis of the survey	Visual assessment of the stability of the site	Stability index
GI-2 – Grosse-Île	Very flat	Highly ill-defined	Very poor	1
CM-7 – Cap-aux-Meules	Flat	Moderately well-defined	Average	2
M-5 – Millerand	Triangular	Well-defined	Good	3
PB-8 – Pointe-Basse	Triangular	Well-defined	Good	4
IE-6 – L'Île-d'Entrée	Perfectly triangular	Very well-defined	Very good	5

Evaluation of stability by analysis of resuspension potential

Table 4 presents the volumes potentially resuspended for all sites studied. The data used for M-5 are those of 1991 and after, given that the grain-size of the sediment currently dredged no longer corresponds to that of the sediment dredged prior to 1991. With respect to resuspension potential, the sites are ranked as follows, in decreasing order: GI-2, IE-6, CM-7, PB-8 and M-5.

Table 4. Results of the calculations of resuspension potential

Disposal site – Harbour of origin of the sediment	Average diameter D_{50} (mm)	Average depth (m)	Average width (m)	Unit volume resuspended each season (per m of width of site) (m^3/m)	Stability index
GI-2 – Grosse-Île	0.35	7.85	90	153	1
IE-6 – L'Île-d'Entrée	0.16	9.05	188	72	2
CM-7 – Cap-aux-Meules	0.17	13.15	338	64	3
PB-8 – Pointe-Basse	0.28	12.65	237	38	4
M-5 – Millerand	0.41	21.65	147	32	5

Evaluation of stability by analysis of theoretical spread

Table 5 presents the results on sediment dispersion. With respect to dispersion, the sites are ranked as follows, in decreasing order: GI-2, CM-7, PB-8, M-5 and IE-6.

Table 5. Estimated sediment dispersion

Disposal site – Harbour of origin of the sediment	Average diameter D_{50}	Average water depth	Direction of maximum dispersion	Maximum dispersion	Stability index
GI-2 – Grosse-Île	0.35 mm	7.85 m	SSE	3,650 m	1
CM-7 – Cap-aux-Meules	0.17 mm	13.15 m	W	257 m	2
PB-8 – Pointe-Basse	0.28 mm	12.65 m	W	62 m	3
M-5 – Millerand	0.41 mm	21.65 m	E	25 m	4-5
IE-6 – L'Île-d'Entrée	0.16 mm	9.05 m	WSW	16 m	4-5

Overall evaluation of the stability of the sites

The three different methods used to assess the stability of the sites demonstrated that M-5, IE-6 and PB-8 were the most stable (Table 6), followed by CM-7 and finally GI-2. The latter was found to be the least stable site on the basis of the three criteria used.

This relative comparison must be considered against the assessment of the sediment volumes (Table 2 and second column of Table 6), which is the sole indicator based on measurements, albeit not as precise as desired. At site GI-2, sediment loss appears to have been over 97% after just eight seasons, which indicates particularly high instability, whereas at site IE-6, close to 68% of the sediment disposed of there in the last 16 years still appears to be present, which indicates a generally high stability. The multi-criteria analysis therefore appears to be validated by the observations of sediment volumes remaining at the sites.

By comparing the theoretical calculations of resuspension and spread, it could be said that the calculations of spread are more consistent with the observations. The ranking based on resuspension potential (column 4) is further from the final multi-criteria ranking (particularly with respect to sites IE-6 and CM-7) than the ranking based on spread. This disparity could very well be due to the arbitrary rate used in the calculation of resuspension.

Table 6. Multi-criteria ranking of sites by order of increasing stability

Site/Criterion	Stability of sediments (percentage of sediment loss per season)	Visual assessment of survey plan cross-sections	Resuspension potential	Theoretical spread	Overall ranking (based on 3 preceding columns)
GI-2 – Grosse-Île	1	1	1	1	**3**
CM-7 – Cap-aux-Meules	3	2	2.5	2	**6.5**
PB-8 – Pointe-Basse	4	3.5	4.5	3	**11**
IE-6 – L'Île-d'Entrée	4	5	2.5	4.5	**12**
M-5 – Millerand	3	3.5	4.5	4.5	**12.5**
TOTAL	15	15	15	15	**45**

Note: the higher the figure, the greater the stability.

Conclusions

The environmental impact of the instability of disposal sites depends on the volume of sediment loss, sediment quality and sediment transport towards biological resources. The results obtained with the models are perfectly consistent with the bathymetric representations and survey data. The five dredged material disposal sites in the Magdalen Islands analyzed are relatively stable, with the exception of GI-2, where sediment loss of over 97% of the material disposed of since 1994 has occurred. Another disposal site, i.e., CM-7, should also be monitored.

The study made a number of recommendations for site managers and those responsible for monitoring:

- Give priority to deep-water disposal sites (10 m and over);
- Give priority to disposal over a larger area rather than in a specific localized site only (reducing the height of the mound reduces the vulnerability of the sediment to movement by shifting and results in gentler slopes);
- Locate the biological resources near site GI-2 off Grosse-Île in order to determine whether they could be affected by dredged material transported from this site;
- If required, relocate site GI-2 to deeper water, particularly if it is located near a biological resource.

Quebec Region: Environmental monitoring at site PB-8 containing dredged material from Pointe-Basse harbour

Figure 12 . Pointe-Basse harbour

Facts about the site

Location	Disposal site PB-8, located 2.4 km south of Pointe-Basse harbour. Coordinates: 47°22.10'N, 61°47.75'W (NAD83).
Depth	16 m
Material	Dredged material.
Quantity	Site used since 1985. Approximately 125,000 m^3 of sediment were disposed of at the site at the time the study was conducted. All sediment is from dredging activities in Pointe-Basse harbour, except for 42,500 m^3 dredged from Cap-aux-Meules harbour in 1985.
Status	Open.
Concerns	The dredged material disposed of at the site may have been contaminated with PAHs in the past, which may have resulted in toxicity at the disposal site.

Background

Most of the dredged material disposed of at site PB-8 in the Magdalen Islands came from Pointe-Basse harbour. Between 1985 and 2001, approximately 125,000 m3 scow measure of dredged material was disposed of at the site.

In August 2001, bathymetric surveys were conducted at site PB-8 at Pointe-Basse. The surveys were conducted using a CHS vessel equipped with a SIMRAD EM-3000 multibeam system and various other equipment, including a DGPS. In addition to bathymetric data, this system was used to obtain acoustic reflectivity data and images of the ocean floor relief. With these two types of data, it was possible in most cases to accurately locate and delineate the sediment mounds at site PB-8 (Figure 14 and Figure 9 in the previous section).

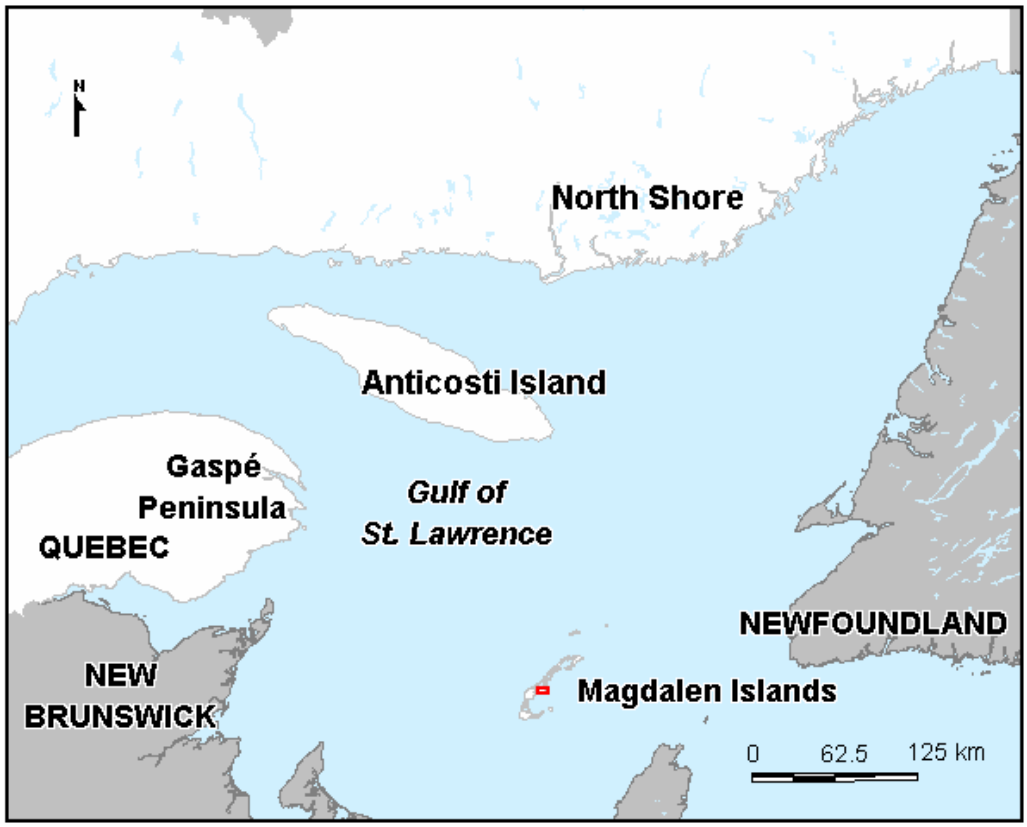


Figure 13. Location of the study area

Figure 14. Bathymetric survey of disposal site PB-8 (source: Fisheries and Oceans Canada – Canadian Hydrographic Service, 2002)

Site PB-8 was selected for an environmental monitoring study in 2003-2004 for two reasons: first, the recent chemical characterizations of sediment from the dredged site, i.e., Pointe-Basse harbour, indicated significant exceedances in PAHs relative to the maximum concentration established under the Disposal at Sea Regulations, and second, the site is representative of existing disposal sites in this area. The maximum total PAH concentration observed corresponds to 42.15 mg/kg. Previous characterizations revealed no exceedances and, in response to this finding, an exclusion zone was created.

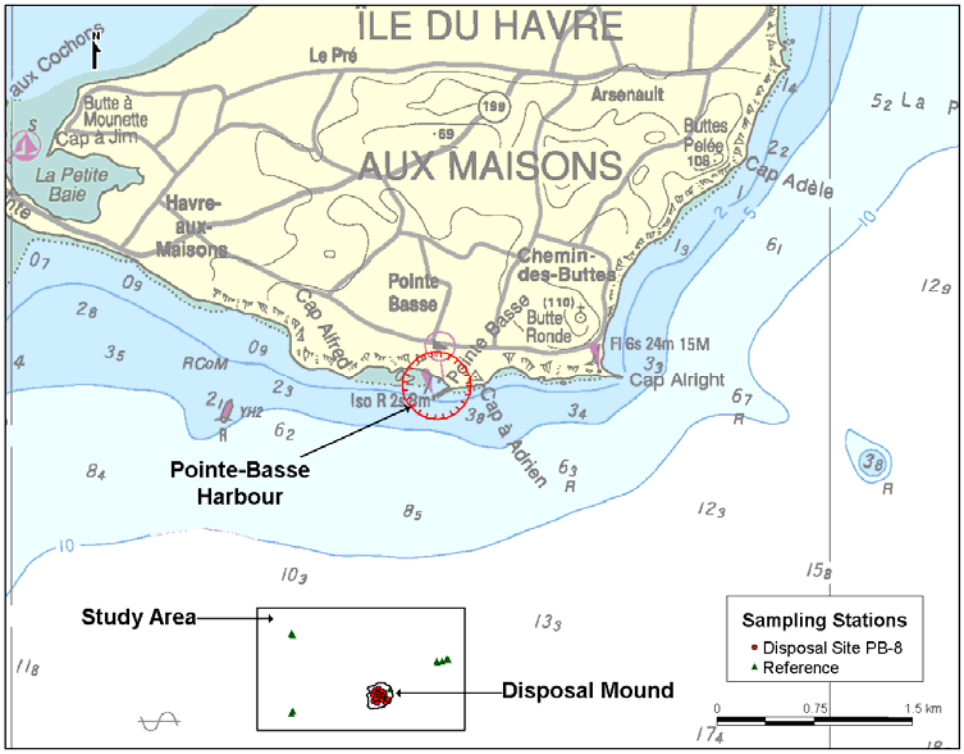


Figure 15. Location of Pointe-Basse harbour, site PB-8 and sampled stations

Hypotheses tested

The disposal of dredged material does not result in: (1) PAH or other contaminant loadings in the sediment at the disposal site, (2) contaminant absorption by biota, or (3) adverse effects on biota.

Parameters measured

The field work was carried out in September 2003 by the regional team of the Disposal at Sea Program. We sampled sediment at 19 stations at site PB-8 and at 5 stations at the two reference sites. The samples were subjected to physicochemical evaluation: analyses of PAHs, metals, TOC and grain size. Given the lack of PAHs in the sediments from the site, we limited the sea urchin fertilization tests and amphipod survival tests, as well as the analysis of associated support variables (ammonia nitrogen, sulphides and redox potential) to three stations at the site and to three reference sites. Solid-phase Microtox™ assays were performed at 10 stations at the disposal site and at 5 stations at the reference site.

Observations and results

The impact is evaluated by comparing the results with the quality standards or criteria (for chemistry) and the pass-fail criteria (for toxicity), and with the results from the reference sites. The results show that there is no PAH contamination of sediment at the disposal site, contrary to what

we feared from the data on the chemical characterization of dredged material. Similarly, metal concentrations at the disposal site were below the CEPA standards or the interim CCME sediment quality guidelines. The toxicological analyses reflected the lack of contamination: no stations at the site exceeded the criteria established for the program.

The analysis and interpretation of the physicochemical and ecotoxicological data using appropriate statistical tests, as required, will be carried out in fiscal 2004-2005. A poster, backgrounder and complete report will be prepared.

Conclusions

The initial results indicate that site PB-8 is free of both chemical (PAHs, metals) and toxicological (bacteria, sea urchins, amphipods) contamination. The more detailed analysis and interpretation of the results will be carried out in 2004-2005. The final report is scheduled for completion by March 31, 2005.

Prairie and Northern Region: Churchill

Background

In 1999, Hudson Bay Port Corporation (HBPC) proposed to redevelop Churchill Harbour, including dredging to remove accumulated sediments. The proposal indicated that approximately 1.2 million m^3 of spoil would be dredged from Churchill Harbour and the channel approaching it. Disposal at sea was found to be the only viable option and HBPC applied for an Ocean Disposal Permit in 1999.

During the permit assessment, it became clear that the existing disposal site near Churchill was inadequate to contain the predicted 1.2 million m^3 of spoil. Several alternate sites were evaluated and a suitable new site was selected approximately 3 km from the harbour mouth at 14 - 17 metres depth. It was a 700 by 700 metre square, with the western half having sediments from disposal activities in the late 1970's, thus similar to the dredge spoil (60-95% sand). The sediments became gradually finer and more uniform toward the east.

The even distribution of sediment over the site was considered crucial to prevent a navigation hazard for incoming ships. To ensure this, the proponent divided the site into 21 sectors, each to receive a predetermined amount of spoil. The even distribution of spoil would maintain a minimum water depth of nine metres and reduce the amount of material available for off site transport. The area was characterized as having relatively low transport potential with only 5% of the spoil likely to be disturbed during a 30 year storm event.

During the 2000 dredging season, 74,170 m^3 of material were disposed of at the site. A second permit was granted in 2001 for the disposal of a further 60,220 m^3. Ultimately 134,390 m^3 of material was disposed of with most of the material being placed in sectors 2, 12 and 20 (See figure 16).

The Fisheries Act Authorization for this project required habitat compensation in the form of larger material (gravel, rocks, etc.) placed in a reef like structure within the disposal area. Placement of the coarse material was requested in order to increase habitat diversity in an effort to encourage recolonization. The coarse material was also expected to aid in site stabilization.

Monitoring conducted

The permit required the proponent to monitor the site during disposal and to provide a post dredging multi-beam sonar survey of the site. Monitoring by Environment Canada began in 2002, and was scheduled to include the collection of sediment cores and underwater filming of the sea floor as well as another multi-beam sonar survey of the disposal site. Weather and logistical problems prevented both the collection of sediment cores and filming the bottom but a multi-beam sonar survey was completed

In 2003, Environment Canada visited the site to assess site stability and re-colonization of benthic organisms. This work is part of an overall project to examine the site at least three times to determine stability and benthic populations.

Results

Underwater Video Footage

Several hours of video footage were obtained in August 2003. Filming effort was concentrated on sites representative of 3 bottom types: (1) Control area (undisturbed sea floor), (2) sea floor affected by disposal and (3) the transition area in between (1) and (2. A fourth area that was capped with

cobble was also filmed to assess if benthic organisms were colonizing the hard substrate more rapidly than the sand bottom.

Site	Material	Topography	Benthos	Other
1. Control area	Sand	Predominantly level topography with small sand waves running parallel to the shoreline.	Very little benthic life observed.	Some accumulation of detritus between sand waves.
2. Disposal area	Sand with small amount of larger material.	Less regular than in the control area with some disturbance evident from disposal activities. Spoil piles appeared to be smoothed and rounded by erosion. Sand ripples running were observed running parallel to the shoreline.	Some mussels were observed lying on the seabed as were some cobble with well established benthic communities living on them. It is most likely that these were dredged from the bottom of the harbour.	Some accumulation of detritus between sand waves.
3. Transition area	Sand	Gentle undulations flattening out as the camera moved away from the disposal area.	None observed	No notable difference in the appearance of the sand between the deposition area and the control area.
4. Capped area	Sand with cobble distributed over the surface.	Gently undulating surface with some evidence of disturbance from disposal activities. Cobble was clearly exposed through the surrounding sand.	Very little benthos observed.	No evidence that benthic re-colonization was occurring more quickly at this site.

Multi-Beam Sonar Surveys

Multi beam sonar surveys were carried out in 2001 and 2002 and are reported in this report as data was not available for previous monitoring compendia. Comparison of these sonar surveys (Figures 16 and 17) revealed a shift of about 0.5 m on average between the two surveys with the majority of the losses occurring in sector 20 which was the steepest of the 3 piles. This shift is likely due to settling and slumping of the spoil piles and minor transport of material. The comparison showed widespread deposition of minor amounts of material within the disposal site. The maximum change noted by the sonar was -2.6 m to + 0.8 m, however, analysis revealed that these large changes in elevation were limited to the area around the ice scour noted in Figure 17. There was no evidence of large scale offsite transport of material.

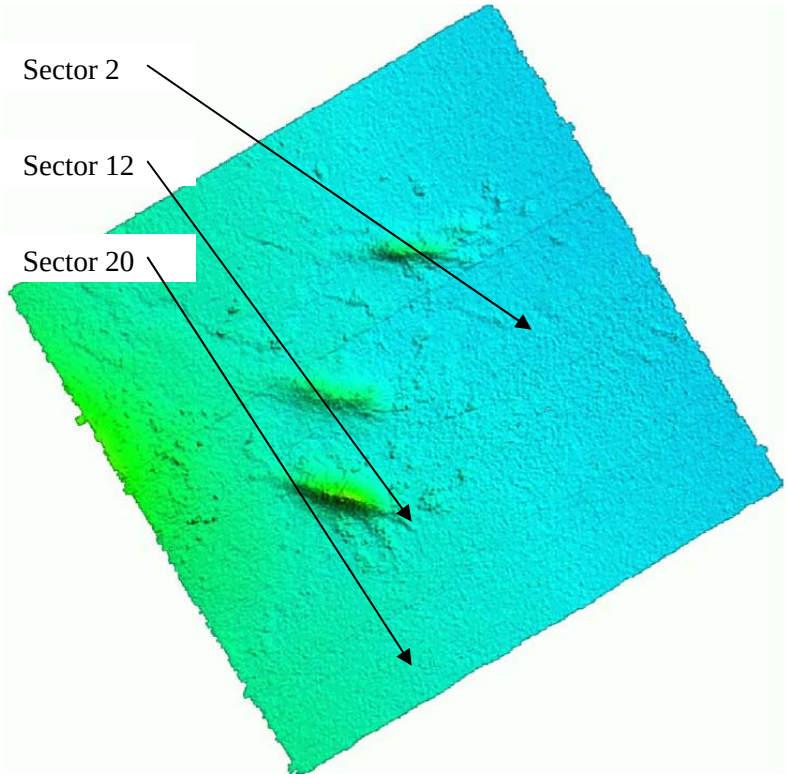


Figure 16. 2002 multi beam sonar image of the disposal site. 3 distinct piles of spoil can be seen in locations corresponding to disposal site sectors #2, 12 and 20

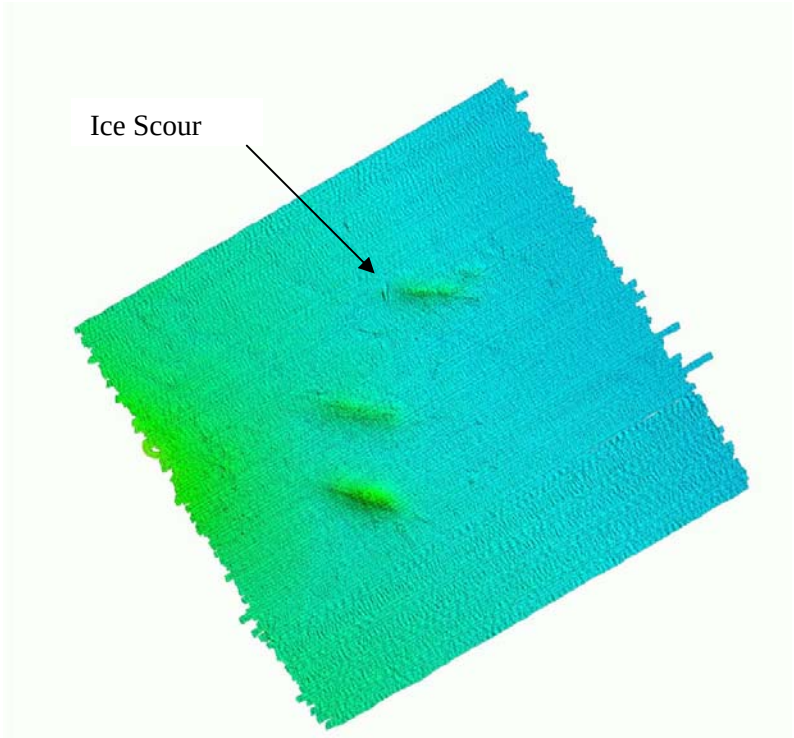


Figure 17. 2002 multi beam sonar survey of the disposal site. The weather was somewhat rougher during this scan which translated in to a rippled appearance on the seabed. Ice scour dimensions – 2.6 m deep with a 0.8 m shoulder.

Conclusions

Sonar images and underwater video suggest that the material is settling and that the site is stable with relatively little off site transport by wave action or currents. However the presence of an ice scour in the disposal area clearly indicates that there is the potential for material could be moved by ice keels during the winter.

Though no significant benthic re-colonization was observed on either the sand or on the hard substrate it must be noted that the control site also supported a very limited benthic community. These observations suggest that the benthic community in the area is limited overall and that it is will take some time for the disturbed area to recover.

Pacific and Yukon Region: Thormanby Island

Background

Thormanby Island ocean disposal site was designated in 1980. The total volume of dredged material disposed of at the site is approximately 13 585 cubic metres. The site is located in 384 metres of water in the south portion of Malaspina Strait. The majority of the material disposed of at the site results from maintenance dredging at marinas as well as gravel loading facilities on the Sunshine Coast.

Impact Hypothesis

Disposal of dredged material does not result in a significant increase in trace contaminant levels in the sediments at designated sites.

Monitoring Conducted

In June 2003, sediment chemistry samples were collected with a Smith-McIntyre grab sampler at pre-determined station locations. Samples were analysed for trace metal concentrations, organics (not completed), TOC (not completed) and particle size distribution. Analysis found no results exceeded the Lower Action Levels of the Disposal at Sea Regulations.

The sediment chemistry data will be added to the monitoring database and compared with survey result from 1997. Sediment chemistry, particle size and TOC will also be used to monitor the distribution of material disposed of at the site and the surrounding areas.

Table 7. Trace metal and particle sizes of samples from Thormanby Island.

Station Number	Type	Depth (cm)		Sample Number	Hg (μg/g)	Cd (μg/g)	Cu (μg/g)	Pb (μg/g)	Zn (μg/g)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	grab	0	5	25	0.12	0.42	35.10	15.00	97.10	0.00	1.70	30.50	67.80
2	grab	0	5	26	0.12	0.46	41.60	14.00	112.00	0.00	2.80	27.10	70.10
3	grab	0	5	31	0.12	0.47	51.20	37.00	135.00	0.00	5.50	28.00	66.50
4	grab	0	5	32	0.12	0.51	46.20	21.00	128.00	0.00	4.60	30.40	65.00
5	core	0	5	34	0.07	0.89	70.20	21.00	168.00	0.00	0.40	23.90	75.70
5	core	10	20	35	0.06	0.53	37.90	11.00	94.80	0.00	0.50	220.40	79.10
5	core	30	40	36	0.05	0.44	29.00	9.00	117.00	0.00	0.20	19.00	80.80
5	core	60	70	37	0.06	0.49	33.80	9.00	94.10	0.00	0.20	20.10	79.70
5	core	90	10 0	38	0.06	0.65	58.50	14.00	118.00	0.00	0.30	20.60	79.10
5	core	0	12 13	39	0.06	0.57	38.70	9.00	95.00	0.00	0.30	18.70	81.00
5	grab	0	5	33	0.12	0.49	58.50	27.00	130.00	0.00	1.10	31.10	67.80
6	grab	0	5	30	0.12	0.43	41.30	21.00	124.00	0.00	0.50	27.90	71.60
6	grab	0	5	30 dup						0.00	0.70	26.60	72.70
7	grab	0	5	27	0.13	0.71	37.50	13.00	104.00	0.00	1.10	33.20	65.70
8	grab	0	5	28	0.12	0.56	41.50	22.00	127.00	0.00	1.00	28.60	70.40
9	grab	0	5	29	0.12	0.44	41.50	22.00	127.00	0.00	0.70	32.00	67.30
10	grab	0	5	40	0.13	0.43	46.50	23.00	135.00	0.00	0.50	21.70	77.80

Pacific and Yukon Region: Comox

Background

The Comox ocean disposal site was designated in 1977. To date, the total volume of dredged material disposed of at the site has been approximately 90 918 cubic metres. The site is located in 190 metres of water in the northern section of the Strait of Georgia. The majority of the material disposed of at the site results from maintenance dredging at sawmills and log handling facilities on

the north and central sections of Vancouver Island. Several loadsites have been rejected or stratified following pre-load testing due to trace metal or organic contaminant levels above the screening criteria.

Impact Hypothesis

Disposal of dredged material does not result in a significant increase in trace contaminant levels in the sediments at designated sites.

Monitoring Conducted

In June 2003, sediment chemistry samples were collected with a Smith-McIntyre grab sampler at pre-determined station locations. Samples were analysed for trace metal concentrations, organics (not completed), TOC (not completed) and particle size distribution. Analysis found no results exceeded the Lower Action Levels of the Disposal at Sea Regulations.

The sediment chemistry data will be added to the monitoring database and compared with survey result from 2000. Sediment chemistry, particle size and TOC will also be used to monitor the distribution of material disposed of at the site and the surrounding areas.

Table 8. Trace metal and particle sizes of samples from Comox (Cape Lazo)

Station Number	Type	Depth (cm)		Sample Number	Hg (μg/g)	Cd (μg/g)	Cu (μg/g)	Pb (μg/g)	Zn (μg/g)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	grab	0	5	23	0.07	0.20	36.90	-8.00	61.40	9.80	22.90	34.30	33.10
2	grab	0	5	22	0.06	0.30	41.60	-8.00	65.30	30.80	19.60	22.60	27.00
3	grab	0	5	21	0.07	0.19	44.00	-8.00	66.70	22.80	25.60	20.50	31.00
4	grab	0	5	14	0.06	0.16	50.80	-8.00	79.70	15.70	26.80	30.30	27.10
5	core	0	5	16	0.08	0.35	52.60	-8.00	80.70	2.40	27.70	36.90	33.00
5	core	10	20	17	0.04	0.24	25.40	-8.00	58.40	1.50	17.20	40.40	41.00
5	core	30	40	18	0.03	0.16	16.90	-8.00	50.20	0.00	12.90	40.40	46.70
5	core	50	60	19	0.03	0.30	23.30	-8.00	48.70	0.00	6.70	42.10	51.20
5	grab	0	5	15	0.07	0.22	42.60	-8.00	68.60	8.00	39.40	26.70	25.90
6	grab	0	5	20	0.06	0.20	33.60	-8.00	62.50	27.60	25.20	21.40	25.70
7	grab	0	5	13	0.05	0.24	35.10	-8.00	61.30	0.00	49.70	25.50	24.80
8	grab	0	5	12	0.06	0.37	43.00	-8.00	68.40	20.30	25.00	29.40	25.20
9	grab	0	5	11	0.06	0.38	41.60	-8.00	65.90	0.00	28.50	38.70	32.80
10	grab	0	5	24	0.07	0.18	41.90	-8.00	67.00	6.80	23.50	29.90	39.80

Pacific and Yukon Region: Victoria

Background

The Victoria ocean disposal site has been in use since 1970 when it was designated for use by the provincial Ministry of Transport in British Columbia. To date, the total volume of dredged and excavated material disposed of at the site is approximately 296 544 cubic metres. The site is located in 90 metres of water in the south of the city of Victoria. The majority of the material disposed of at the site results from maintenance dredging at marinas and commercial properties near Victoria. Several loadsites have been rejected or stratified following pre-load testing due to trace metal or organic contaminant levels above the screening criteria.

Impact Hypothesis

Disposal of dredged material does not result in a significant increase in trace contaminant levels in the sediments at designated sites.

Monitoring Conducted

In June 2003, sediment chemistry samples were collected with a Smith-McIntyre grab sampler at pre-determined station locations. Samples were analysed for trace metal concentrations, organics (not completed), TOC (not completed) and particle size distribution. Analysis found no results exceeded the Lower Action Levels of the Disposal at Sea Regulations.

The sediment chemistry data will be added to the monitoring database and compared with survey result from 1996. Sediment chemistry, particle size and TOC will also be used to monitor the distribution of material disposed of at the site and the surrounding areas.

The Department of Fisheries and Oceans remotely operated submersible ROPOS was scheduled to be deployed at the site in October 2003. The survey was cancelled due to time constraints due to poor weather conditions and will be rescheduled for the next fiscal year.

Table 9. Trace metal and particle sizes of samples from Victoria

Station Number	Type	Depth (cm)		Sample Number	Hg (μg/g)	Cd (μg/g)	Cu (μg/g)	Pb (μg/g)	Zn (μg/g)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	grab	0	5	1	0.16	0.16	19.10	-8.00	61.90	43.50	39.30	9.70	7.60
2	grab	0	5	2	0.05	0.24	19.40	10.00	72.60	30.40	53.50	8.80	7.20
3	grab	0	5	3	0.05	0.40	294.00	11.00	87.50	16.50	68.80	8.50	6.30
4	grab	0	5	6	0.05	0.24	21.00	-8.00	65.10	34.10	47.50	8.80	9.50
5	grab	0	5	5	0.04	0.26	17.90	-8.00	59.30	43.00	45.70	4.60	6.70
6	grab	0	5	4	0.05	0.41	63.20	-8.00	74.20	21.30	67.90	6.10	4.60
7	grab	0	5	7	0.04	0.21	12.30	10.00	47.90	20.40	68.20	6.20	5.20
8	grab	0	5	8	0.04	0.34	21.50	-8.00	60.70	14.10	73.90	7.60	4.60
9	grab	0	5	9	0.04	0.33	17.40	-8.00	58.20	23.70	70.00	3.70	2.50
10	grab	0	5	10	0.02	0.20	10.90	-8.00	52.30	6.00	81.60	6.40	6.00

Pacific and Yukon Region: Porlier Pass

Background

The Porlier Pass ocean disposal site was designated in 1978. To date, the total volume of dredged material disposed of at the site is approximately 197 074 cubic metres. The site is located in 176 metres of water in the Strait of Georgia. The majority of the material disposed of at the site results from maintenance dredging at sawmills and log handling facilities on southern Vancouver Island. Several loadsites have been rejected or stratified following pre-load testing due to trace metal or organic contaminant levels above the screening criteria.

Impact Hypothesis

Disposal of dredged material does not result in a significant increase in trace contaminant levels in the sediments at designated sites.

Monitoring Conducted

In June 2003, sediment chemistry samples were collected with a Smith-McIntyre grab sampler at pre-determined station locations. Samples were analysed for trace metal concentrations, organics (not completed), TOC (not completed), AVS/SEM (not compiled) and particle size distribution.

The sediment chemistry data will be added to the monitoring database and compared with survey result from 2000. Sediment chemistry, particle size and TOC will also be used to monitor the distribution of material disposed of at the site and the surrounding areas.

AVS/SEM will be used to evaluate the potential for bioavailability of trace metal contaminants in the sediment at the disposal site.

Table 10. Trace metal and particle sizes of samples from Porlier Pass

Station Number	Type	Depth (cm)		Sample Number	Hg (μg/g)	Cd (μg/g)	Cu (μg/g)	Pb (μg/g)	Zn (μg/g)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	grab	0	5	86	0.07	0.29	39.70	19.00	97.60	0.00	3.60	47.50	48.90
2	grab	0	5	87	0.08	0.27	37.50	15.00	101.00	1.60	2.60	46.20	49.60
3	grab	0	5	88	0.07	0.26	37.20	15.00	96.80	2.90	9.60	43.70	43.70
4	grab	0	5	98	0.07	0.26	37.80	17.00	103.00	11.10	8.90	40.10	39.90
5	core	0	5	92	0.06	0.62	63.00	18.00	144.00	19.00	10.10	36.30	34.50
5	core	10	20	93	0.09	0.33	40.60	21.00	111.00	0.00	2.50	48.30	49.20
5	core	30	40	94	0.08	0.26	39.10	19.00	105.00	0.00	1.20	47.20	51.60
5	core	60	70	95	0.05	0.43	31.90	15.00	93.90	0.00	1.70	47.20	51.10
5	core	90	100	96	0.05	0.46	32.10	14.00	95.70	0.00	1.70	42.90	55.40
5	core	120	127	97	0.05	0.28	33.20	15.00	96.50	0.00	1.00	43.90	55.10
5	grab	0	5	91	0.07	0.33	36.50	17.00	113.00	9.00	8.20	41.90	40.90
6	grab	0	5	90	0.08	0.30	37.30	14.00	98.40	3.50	4.30	46.00	46.30
7	grab	0	5	100	0.07	0.37	36.50	17.00	101.00	0.50	5.10	46.00	48.40
8	grab	0	5	101	0.07	0.37	37.50	18.00	104.00	1.30	6.60	45.10	47.00
9	grab	0	5	102	0.07	0.87	36.10	17.00	101.00	0.00	6.20	47.70	46.10
10	grab	0	5	104	0.06	0.30	31.40	17.00	95.40	0.00	18.20	26.70	55.10
10	grab	0	5	105	0.07	0.26	31.10	17.00	96.00	0.00	12.80	31.60	55.60
10	grab	0	5	105 dup						0.00	13.80	29.60	56.60
10	grab	0	5	106	0.06	0.27	33.20	20.00	99.10	11.40	10.20	35.70	42.70

In October 2003, the Department of Fisheries and Oceans remotely operated submersible ROPOS was used to conduct physical monitoring work at the site. The survey was designed to provide real-time records of the benthic conditions at the disposal site. The transect lines are georeferenced to allow future surveys to be carried out for comparative purposes. The video records are used to record conditions (i.e. biological and geophysical changes and any currents related effects) of the disposal site and the surrounding area and are being processed. Still digital camera images and Interactive-Realtime-Logging images were are collected and are being processed. Poor weather conditions at the time of the ROPOS dives limited the bottom time at this site.

Pacific and Yukon Region: Five Finger Island

Background

The Five Finger Island ocean disposal site was designated in 1978. To date, the total volume of dredged material disposed of at the site is approximately 243 660 cubic metres. The site is located in 271 metres of water in the Strait of Georgia. The majority of the material disposed of at the site results from maintenance dredging at sawmills and log handling facilities on southern Vancouver Island. Several loadsites have been rejected or stratified following pre-load testing due to trace metal or organic contaminant levels above the screening criteria.

Impact Hypothesis

Disposal of dredged material does not result in a significant increase in trace contaminant levels in the sediments at designated sites.

Monitoring Conducted

In June 2003, sediment chemistry samples were collected with a Smith-McIntyre grab sampler at pre-determined station locations. Samples were analysed for trace metal concentrations, organics (not completed), TOC (not completed), AVS/SEM (not compiled) and particle size distribution. Analysis found no results exceeded the Lower Action Levels of the Disposal at Sea Regulations.

The sediment chemistry data will be added to the monitoring database and compared with survey result from 1999. Sediment chemistry, particle size and TOC will also be used to monitor the distribution of material disposed of at the site and the surrounding areas. AVS/SEM will be used to evaluate the potential for bioavailability of trace metal contaminants in the sediment at the disposal site.

Table 11. Trace metal and particle sizes of samples from Five Finger Island

Station Number	Type	Depth (cm)		Sample Number	Hg (ug/g)	Cd (ug/g)	Cu (ug/g)	Pb (ug/g)	Zn (ug/g)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	grab	0	5	70	0.13	0.49	49.50	26.00	131.00	2.10	5.10	24.70	68.30
1	grab	0	5	71	0.13	0.52	52.20	29.00	146.00	1.00	8.30	24.60	66.30
1	grab	0	5	72	0.13	0.49	52.90	27.00	143.00	0.00	12.70	22.60	64.70
2	grab	0	5	74	0.12	0.51	51.50	29.00	152.00	5.40	12.00	20.10	62.40
2	grab	0	5	75	0.12	0.61	50.90	27.00	142.00	4.90	12.50	27.30	55.30
2	grab	0	5	76	0.10	0.48	40.60	22.00	123.00	1.70	29.70	16.90	51.70
3	grab	0	5	78	0.10	0.55	44.60	22.00	139.00	13.20	31.30	14.80	40.60
3	grab	0	5	79	0.12	0.42	46.30	24.00	133.00	1.30	19.00	19.50	60.20
3	grab	0	5	80	0.10	0.55	45.60	25.00	146.00	9.80	27.80	21.60	40.80
4	grab	0	5	53	0.11	0.48	44.20	24.00	127.00	26.90	20.50	13.80	38.80
4	grab	0	5	54	0.11	0.48	45.30	24.00	122.00	27.10	22.00	12.20	38.60
4	grab	0	5	55	0.11	0.41	43.60	24.00	120.00	18.20	25.60	14.30	42.00
5	core	0	5	61	0.06	0.33	35.80	13.00	97.50	1.80	0.90	22.20	75.10
5	core	10	20	62	0.06	0.28	33.70	13.00	117.00	0.00	1.10	22.90	76.00
5	core	30	40	63	0.05	0.64	38.50	13.00	122.00	0.00	1.20	22.30	76.50
5	core	60	70	64	0.06	0.28	39.20	13.00	100.00	0.00	0.90	20.80	78.30
5	core	90	100	65	0.06	0.49	34.90	13.00	100.00	0.00	0.90	21.50	77.60
5	grab	0	5	57	0.10	0.54	44.00	22.00	111.00	35.50	17.10	12.60	34.90
5	grab	0	5	58	0.09	0.72	42.80	23.00	113.00	47.90	16.50	9.20	26.40
5	grab	0	5	59	0.08	0.72	39.20	19.00	96.30	77.80	9.30	3.80	9.10
6	grab	0	5	66	0.12	0.46	46.80	22.00	117.00	13.80	33.70	13.80	38.80
6	grab	0	5	67	0.11	0.39	46.30	24.00	124.00	11.60	28.50	13.90	46.00
6	grab	0	5	68	0.12	0.20	47.90	24.00	122.00	16.80	25.40	14.60	43.30
7	grab	0	5	49	0.12	0.45	44.00	21.00	113.00	0.00	12.00	22.80	65.20
7	grab	0	5	50	0.12	0.46	41.70	17.00	106.00	2.50	24.80	14.70	58.00
7	grab	0	5	51	0.12	0.46	54.70	26.00	125.00	8.70	13.70	18.50	59.00
8	Grab	0	5	45	0.10	0.21	65.00	22.00	111.00	14.50	32.30	10.90	42.20
8	Grab	0	5	45 dup						14.50	30.30	12.10	43.10
8	Grab	0	5	46	0.10	0.37	36.70	17.00	102.00	25.80	27.00	9.30	37.80
8	Grab	0	5	47	0.12	0.44	66.50	18.00	116.00	4.90	28.10	17.10	50.00
9	grab	0	5	41	0.11	0.50	50.10	23.00	109.00	6.40	25.60	19.30	48.70
9	grab	0	5	42	0.12	0.44	43.40	18.00	105.00	6.90	19.90	19.70	53.40
9	grab	0	5	43	0.10	0.41	38.20	14.00	103.00	9.10	22.60	20.50	47.90
10	grab	0	5	82	0.10	0.55	53.40	27.00	140.00	1.80	3.70	23.40	71.20
10	grab	0	5	83	0.14	0.52	49.50	27.00	143.00	0.00	4.10	23.90	72.00
10	grab	0	5	84	0.13	0.44	48.80	26.00	134.00	0.00	4.00	23.60	72.40

In October 2003, the Department of Fisheries and Oceans remotely operated submersible ROPOS was used to conduct physical monitoring work at the site. The survey was designed to provide real-time records of the benthic conditions at the disposal site. The transect lines are georeferenced to allow future surveys to be carried out for comparative purposes. The video records are used to

record conditions (i.e. biological and geophysical changes and any currents related effects) of the disposal site and the surrounding area and are being processed. Still digital camera images and Interactive-Realtime-Logging images were are collected and are being processed.

Figure 18. Image of the seafloor at Five Finger Island Disposal Site, October 2003.

Pacific and Yukon Region: Point Grey

In June 2003, sediment chemistry samples were collected with a Smith-McIntyre grab sampler at pre-determined station locations. Samples were analysed for trace metal concentrations, organics (not completed), TOC (not completed) and particle size distribution. Analysis found no results exceeded the Lower Action Levels of the Disposal at Sea Regulations.

The sediment chemistry data will be added to the monitoring database and compared with survey result from 1997. Sediment chemistry, particle size and TOC will also be used to monitor the distribution of material disposed of at the site and the surrounding areas.

Table 12. Trace metal and particle sizes of samples from Point Grey

Station Number	Type	Depth (cm)		Sample Number	Hg (ug/g)	Cd (ug/g)	Cu (ug/g)	Pb (ug/g)	Zn (ug/g)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	grab	0	5	128	0.08	0.34	37.10	16.00	97.90	0.00	4.60	49.50	45.90
2	grab	0	5	108	0.10	0.23	44.00	19.00	102.00	0.00	1.80	54.40	43.80
3	grab	0	5	115	0.06	0.31	32.40	12.00	83.80	0.00	30.60	52.40	17.00
4	grab	0	5	116	0.08	0.21	36.80	16.00	96.80	0.00	1.50	53.90	44.60
5	grab	0	5	137	0.07	0.35	33.00	12.00	93.10	0.00	1.40	51.20	47.40
6	grab	0	5	138	0.08	0.31	34.00	13.00	96.10	1.40	0.80	49.40	48.50
7	grab	0	5	144	0.08	0.37	37.10	14.00	102.00	0.10	2.50	43.40	54.10
8	grab	0	5	127	0.09	0.31	42.40	21.00	110.00	0.00	2.90	43.20	53.90
9	grab	0	5	129	0.07	0.32	33.50	16.00	93.00	0.00	12.30	46.00	41.70
10	grab	0	5	109	0.08	0.41	38.70	18.00	97.40	0.00	3.80	51.70	44.50
11	grab	0	5	114	0.08	0.29	39.80	17.00	104.00	0.00	1.40	54.70	43.90
12	grab	0	5	117	0.07	0.46	35.40	15.00	98.40	0.00	1.20	54.20	44.60
13	grab	0	5	136	0.08	0.33	34.40	12.00	97.30	0.00	1.00	54.00	45.00
14	grab	0	5	139	0.08	0.26	34.40	13.00	95.60	0.00	1.40	50.00	48.60
15	grab	0	5	145	0.08	0.31	35.60	14.00	97.40	0.00	7.30	42.20	50.50
16	grab	0	5	126	0.09	0.33	40.50	20.00	107.00	0.00	4.60	43.70	51.70
17	grab	0	5	130	0.07	0.40	33.00	15.00	91.10	0.00	18.20	43.40	38.40
18	grab	0	5	110	0.08	0.23	38.70	20.00	104.00	0.00	6.80	48.60	44.60
19	grab	0	5	113	0.07	0.26	38.30	17.00	97.50	0.00	2.40	48.90	48.70
20	grab	0	5	118	0.08	0.47	33.60	15.00	96.00	0.00	2.20	51.10	46.70
21	grab	0	5	135	0.08	0.58	33.30	10.00	93.00	0.00	2.60	52.50	44.90
21	grab	0	5	135 dup						0.00	2.80	51.80	45.40
22	grab	0	5	140	0.08	0.24	34.60	13.00	96.00	0.00	5.50	46.20	48.30
23	grab	0	5	146	0.08	0.38	34.60	14.00	92.40	1.30	15.10	37.70	45.90
24	grab	0	5	125	0.09	0.64	38.70	18.00	103.00	0.00	8.40	42.50	49.10
25	grab	0	5	131	0.06	0.24	31.60	14.00	87.20	0.00	35.30	35.70	29.00
26	grab	0	5	111	0.04	0.14	24.60	23.00	65.00	2.90	59.30	23.50	14.40
27	grab	0	5	112	0.06	0.35	29.10	14.00	80.70	0.00	34.30	41.70	24.00
28	grab	0	5	119	0.07	0.22	33.90	15.00	94.80	0.00	11.20	50.10	38.70
29	grab	0	5	134	0.07	0.43	33.80	11.00	90.90	0.00	7.50	50.30	42.20
30	grab	0	5	141	0.07	0.34	33.30	11.00	91.40	0.00	13.30	43.50	43.20
31	grab	0	5	147	0.08	0.34	34.50	12.00	87.10	0.00	22.00	37.10	40.90
32	grab	0	5	124	0.07	0.72	40.10	15.00	100.00	0.00	22.00	41.90	36.10
33	grab	0	5	123	0.06	0.64	29.70	13.00	78.50	5.80	37.90	31.50	24.70
34	grab	0	5	122	0.04	0.42	25.50	14.00	64.10	10.60	56.20	20.50	12.70
35	grab	0	5	121	0.04	0.37	26.20	14.00	73.60	10.90	43.00	30.20	15.90
36	grab	0	5	120	0.05	0.75	30.30	13.00	83.60	21.90	36.20	24.70	17.30
36	grab	0	5	120 dup						21.90	36.30	25.60	16.30
37	grab	0	5	133	0.06	0.52	39.50	18.00	110.00	0.00	22.00	50.60	27.40
38	grab	0	5	142	0.06	0.32	33.70	10.00	84.20	0.70	27.70	38.90	32.70
39	grab	0	5	148	0.06	0.22	29.40	10.00	82.30	11.70	30.20	31.60	26.50
40	grab	0	5	132	0.06	0.22	31.20	15.00	88.00	0.00	33.20	37.30	29.50
41	grab	0	5	143	0.07	0.33	33.10	11.00	84.50	2.80	36.80	36.30	24.10

Annex 1. Monitoring Expenditures

In March 1999, pursuant to Treasury Board policy on cost recovery, Environment Canada introduced a monitoring fee of $470 per 1000$m^3$ of dredged or excavated material. This fee is known as a "right or privilege" fee and is meant to provide Canadians with a fair return for use of public resources. Proceeds from this fee are used to cover the cost of disposal site monitoring, thus allowing environmentally sound management and allowing users continued access to their disposal sites.

Part of Environment Canada's commitment to the regulated community was to provide an annual summary of revenues and expenditures related to disposal site monitoring. The figures below represent the fifth year of cost recovery. In the 2003-2004 fiscal year, Environment Canada collected slightly less than the previous fiscal year, amounting to just over $1.36 million. Total net cost to the federal government amounted to $108,598. Environment Canada had a surplus of $198,749 which was carried over into the following year. Surpluses in the monitoring fund are used to offset costs in years when revenue is low due to reduced dredging activity.

Monitoring Expenditures 2003-2004

Atlantic Region	$333,000
Quebec Region	$114,200
Prairie and Northern Region	$410,000
Pacific and Yukon Region	$41,000
Headquarters	$20,000
Environment Canada indirect expenditures	$247,000
Sub total expenditures for Environment Canada	$1,165,200
In-kind support from other federal departments	$306,750
Total expenditures for federal government	$1,471,950
Resources Recovered 2003-2004	
Monitoring Fees	$1,363,949
Net Expenditures 2003-2004	
Resources collected over federal government costs	-$108,002
Net Environment Canada surplus	$198,749

Annex 2. Offices for the Disposal at Sea Program

The Disposal at Sea Program Offices are located in the following Environment Canada offices.

Atlantic Region-Maritimes
Disposal at Sea Program
Environmental Protection Branch
Environment Canada
45 Alderney Drive, 4th Floor
Dartmouth, Nova Scotia
B2Y 2N6

Atlantic Region-Newfoundland and Labrador
Disposal at Sea Program
Environmental Protection Branch
Environment Canada
6 Bruce Street, Mount Pearl
Newfoundland and Labrador
A1N 4T3

Quebec Region
Disposal at Sea Program
Environmental Protection Branch
Environment Canada
105 McGill Street, 4th Floor
Montreal, Quebec
H2Y 2E7

Prairie and Northern Region
Disposal at Sea Program
Environmental Protection Branch
Environment Canada
5204 - 50th Avenue, Suite 301
Yellowknife, Northwest Territories
X1A 1E2

Pacific and Yukon Region
Disposal at Sea Program
Environmental Protection Branch
Environment Canada
201 - 401 Burrard Street
Vancouver, British Columbia
V6C 3S5

National Capital Region
Disposal at Sea Program
Environmental Protection Service
Environment Canada
351 St. Joseph Boulevard, 12th Floor
Hull, Quebec
K1A 0H3

Further details may be found on-line at the Program's web site www.ec.gc.ca/seadisposal/