CONTAMINANT DISTRIBUTION IN SEDIMENTS AND GROUND WATER ON AND NEAR GRASSY ISLAND

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(Determination of chemical concentrations of selected metals and inorganic and organic compounds at selected sites in the sediment and ground water on and near Grassy Island, Wyandotte National Wildlife Refuge, Detroit River, Wyandotte, Michigan)

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Conversion Factors, Abbreviated Water Quality Units, and Vertical Datum

Multiply	By	To Obtain
	Length	
centimeter (cm)	.3937	inch
meter (m)	3.281	foot
	Area	
hectare (ha)	2.471	acre
	Flow (volume per unit time)	
cubic meter per second (m^3/s)	35.31	cubic foot per second
centimeter per second (cm/s)	10^5	gallons per day per foot squared ($gal/day/ft^2$)

Temperature

Degree Celsius (°C) may be converted to degree Fahrenheit (°F) by use of the following equation:

$$°F = (1.8 \times °C) + 32$$

Abbreviated water-quality units

Chemical concentrations are given in metric units. Chemical concentration is given in milligrams per liter (mg/L), micrograms per liter (µg/L), and milligrams per kilogram (mg/kg). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as a weight (milligrams) of solute per unit volume (liter) of water. Likewise, micrograms per liter is a unit expressing the concentration of chemical constituents in solution as a weight (micrograms) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million. Milligrams per kilogram is a unit expressing the concentration of chemical constituents as dry weight (milligrams) of analyte per unit weight (kilograms) of dry sediment.

Vertical Datum

In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Contaminant Distribution in Sediments and Ground Water on and near Grassy Island

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EXECUTIVE SUMMARY

In April 1997, samples of soil were collected at 10 sites, distributed in a grid over Grassy Island for analysis of pesticides, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and heavy metals. The objective of the project was to characterize the chemical composition and distribution of contaminants in sediments at various depths and locations on the Island, and to investigate the potential for contaminant transport in ground water. Sediment samples were collected at 2 offshore sites and 8 onshore sites; water samples were collected at 1 offshore and 4 onshore sites. Water levels were measured at all sites. A total of 30 samples were collected for analysis.

Analyses of sediment samples were made for 28 pesticides, of which 25 were detected; analyses of sediment samples were made for 64 semivolatile organic compounds, of which 24 were detected; and analyses of sediment samples were made for 33 volatile organic compounds, of which 9 were detected. Analyses of sediment samples were made for 23 metals, of which 9 were detected.

Analyses of water samples were made for 28 pesticides, of which 11 were detected; analyses of water were made for 64 semivolatile organic compounds, of which 6 were detected; and analyses of water were made for 33 volatile organic compound, of which 4 were detected. Analyses of water samples were made for 23 metals, of which 16 were detected.

Water levels were measured in an attempt to determine hydraulic gradients on Grassy Island. In general water levels in the river sediments were lower than those in the sediments situated between the inner and outer dikes; likewise, water levels in the sediments between the dikes were lower than were water levels in the sediments within the inner dike. Average water levels were all below land surface.

Contaminant concentrations show little, if any, trend with depth. Native parent materials generally contain only background levels of most trace metals, although the level of some organic contaminants is elevated. Using guidelines developed by the Michigan Department of Environmental Quality, the sediments were rated with respect to their level of contamination. Sediments were found to range from not impacted by arsenic and manganese, to extremely contaminated by mercury. They were moderately impacted by chromium and iron, and severely contaminated by lead and zinc. Sediments were found to be extremely contaminated by polychlorinated biphenyls and polycyclic aromatic hydrocarbons.

Contaminant concentrations in water exceeded United States Environmental Protection Agency (U.S. EPA) safe-drinking water guidelines for cadmium, iron, lead, and manganese. They were also exceeded for aluminum at 3 sites and barium at 1 site. Contaminant concentrations in water also exceed the guidelines for polychlorinated biphenyls.

There are 2 surface-water impoundments on Grassy Island with the potential to transmit contaminants off the Island during periods of precipitation and overland flow. There is an overflow weir on the northeast corner of the Island. Large numbers of waterfowl were observed on these impoundments. These surface-water impoundments were not sampled.

Additional samples of sediments and water are needed upstream, downstream, lateral to, and on the Island. Further studies of water quality are needed to identify the contaminants, if any, that are present in ponded surface water, and in water being discharged from the Island through the overflow weir. Event sampling of surface-water flow and quality in overland runoff and at the overflow weir is needed to document any connection between ponds on the north end of the Island and the overflow weir, and to document the quality and quantity of discharges to the Detroit River through the weir. Additional piezometers and wells are needed on the Island, around its perimeter, and in the Detroit River to determine the ground-water surface and the potential for movement of ground water into either the Detroit River or underlying sediments.

INTRODUCTION

Grassy Island is part of the Wyandotte Unit of the Shiawassee National Wildlife Refuge (NWR) and administered by the Shiawassee NWR. Located in the Detroit River (fig. 1), it was selected in 1995 by the U.S. Department of the Interior as a hazardous materials management (HAZMAT) demonstration site for clean up of Federal lands. In fiscal 1997 and 1998, the U.S. Fish and Wildlife Service (USFWS) Refuge Clean-Up Fund provided funding for a study of sediment and water quality on and near Grassy Island.

This report summarizes results of sediment and water sampling conducted by the U.S. Geological Survey (USGS) on and near Grassy Island in May and June 1997. Sediment and water samples were collected for the analysis of selected physical and chemical parameters in an attempt to determine (1) the distribution of contaminants in both sediments and ground water, (2) whether contaminants were being transported off of the Island into surrounding sediments and waters, and (3) the potential for exposure of fish and wildlife to contaminants contained on-site. Results of laboratory analyses are presented in tables at the end of the report.

PREVIOUS WORK

Scientific work prior to 1997 on Grassy Island and in the Detroit River in the area surrounding Grassy Island was summarized by the USGS Biological Resources Division (BRD) (Manny, 1999a). In April 1997, samples of soil were collected at 40 sites, distributed in a grid over Grassy Island for analysis of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals by the BRD (Manny, 1999b). At the time of this project, an investigation of wild-celery tuber abundance in shoals surrounding Grassy Island was being conducted by BRD (Manny, 1999b).

STUDY METHODS

Borings were made by hand auger at 10 sites both on and offshore of the Island. Eight sites are located on Grassy Island (fig. 1) and 2 sites are located offshore of the Island, one each on the north and south ends of the Island. From these borings sediment samples were collected at intervals representing the unsaturated zone, the saturated zone, and at some sites native parent material. Sediment samples were split for duplicate analysis at two sites (7GI 8 and 7GI 10).

Water samples were collected offshore at the south end of the Island, both from a piezometer and from the Detroit River. Water samples were collected at 4 on-shore sites (7GI 4, 7GI 5, 7GI 6 and 7GI 11). Water samples were split for duplicate analysis at 1 site (7GI 11).

Sediment samples were collected from holes dug with a hand auger using a 14

cm-diameter (5.5 in) bucket. Holes were dug until water was observed in the hole. All materials removed from the hole above the water level were then placed into a stainless steel bowl that had been washed with deionized water (DIW), rinsed with hexane, triple rinsed with organic solvent free water and allowed to air dry. The sample was homogenized, using a stainless steel spoon that had been cleaned in the same manner as the core barrel and the bowl, and then split into sample jars. The jars were then sealed, labeled, and placed into a cooler with ice to chill and maintain them at approximately 4 °C (39 °F).

The hole was then continued below the water level until the sidewalls were no longer competent. At this point, a 13.3 cm (5.24 in) outside-diameter polyvinyl chloride (PVC) casing was inserted into the hole and pushed until resistance stopped down-hole progress. A 6.4-cm diameter (2.52 in), 61 cm (24 in) long split-spoon core barrel was then inserted into the PVC casing and coring continued until the core barrel was full. Each time the core barrel was full, the casing was driven down past the end of the core barrel and the core barrel was then extracted from the hole. In this way, slumping of the hole was prevented, and the material in the core barrel was representative of the depth through which it was driven.

At approximately 2.5-3 m (8-10 ft) below ground-surface, a second sample was collected. Prior to and after collecting the sample, the core barrel was disassembled and cleaned with DIW, rinsed with hexane, triple rinsed with organic solvent free water, and allowed to air dry. When the core-barrel components were dry, the core barrel was reassembled and inserted into the casing to obtain a sample. The core barrel was driven into the sediment until full and then extracted from the hole. Upon extraction, the barrel was disassembled and the contents emptied into a stainless steel bowl, processed, and sampled as described previously.

Sediment samples were also collected at approximately 4.3-4.9 m (14-16 ft) depth, and in some holes at approximately 5.8-6.4 m (19-21 ft) depth. This last depth was typically in a material that by appearance and texture was identified as parent material, or sediment that was present prior to deposition of fill materials on Grassy Island.

Upon completion of sediment sampling, a short riser, if needed, was added to each PVC casing and a cap was installed to prevent foreign material from entering the well. A small annulus was created around the casing at ground surface, and bentonite-clay well seal was placed in the annulus and built up on the ground surface around the casing to prevent the infiltration of water around the casing.

Samples of river-bottom sediments were collected both upstream and downstream of the Island by use of a clay auger. The auger was turned into the bottom of the river to 1.5 times the length of the auger bucket (about 60 cm) and extracted. The river-bottom sediments were dense enough that little, if any, loss was experienced during transport through the water column. When on the boat, river-bottom sediment was composited, processed, and sampled as described above.

Piezometers (see for example Freeze and Cherry, 1979, p. 23) were installed in the river both upstream and downstream of the Island by use of stainless steel drive points. Drive points were attached to 1 m (3.3 ft) lengths of number 10 slot stainless steel well screen, which were in turn attached to 3 m (10 ft) lengths of stainless steel pipe. Drive points, screens, and pipe were then driven into the river-bottom sediments with a drive shoe until refusal. At all times the top of the casing for each piezometer was above the level of the river. All threaded joints were sealed with

Teflon® tape and turned tight with chain wrenches. Casings were left about 1 m (3.3 ft) above the water surface and capped with stainless steel, threaded caps. After installation of each piezometer, all water was pumped from the piezometer so that subsequent water observed in the piezometer would be from the river-bottom sediments, and not the river. This was confirmed by observation of water levels in both the piezometer and the river, and by observing the recovery rates of water levels in the piezometers after pumping water out.

At 4 of the onshore sites, water samples were collected from the well at a later date. Water samples were collected by placing a length of Teflon™ lined tubing into the casing to below the water surface. This tubing was then connected to a peristaltic pump, which lifted water from the well. Water from the well was discharged to the ground about 10 m (33 ft) from the casing. All tubing was precleaned by pumping a solution of 5 percent nitric acid into the tubing and allowing the acid solution to stand in the tubing for 1 hour. The tubing was then triple rinsed with DIW, washed with one tubing volume of methanol, triple rinsed with DIW, and allowed to dry.

The peristaltic pump was run long enough to discharge the equivalent of 3 well volumes of water before samples were collected. At one site the well did not recharge fast enough to allow this purging to take place, and all water was pumped from the well. This well was capped and allowed to recover overnight, and then pumped again. It was then allowed to recover overnight again, and pumped a third time. After allowing recovery overnight a third time, the well was pumped and the water collected into appropriate sample containers for laboratory analysis. Each container was capped and placed in a cooler with ice to maintain sample temperature at approximately 4 °C (39 °F). In this manner enough water was collected to complete all required analyses.

All samples were labeled in the field as they were collected, and stored under controlled conditions at a stable temperature (4 °C (39 °F)). At the end of each week of fieldwork, samples were packed with ice in an insulated cooler and shipped via overnight courier to the contract laboratory at Texas A&M University (TAMU). This laboratory is under contract to USFWS and reports to the Patuxent Analytical Control Facility (PACF) Contract Laboratory Program (CLP). A laboratory quality assurance plan is on file at the East Lansing Field Office (ELFO) of USFWS for this laboratory. All analytical results from this laboratory were reported to PACF and subsequently to ELFO. After review by ELFO personnel the results were transmitted to the USGS, Water Resources Division (WRD) for analysis and interpretation.

DATA COLLECTION AND ANALYSIS

Thirty samples of sediment were collected at 10 locations, and analyzed in the laboratory for the presence of trace metals, semivolatile and volatile organics, and pesticides (table 1). Seven samples of water were collected at 5 locations, and were analyzed in the laboratory for the presence of trace metals, semivolatile and volatile organics, and pesticides (table 1). Because not all analytes listed in table 1 were detected in the samples, only those analytes that were detected are shown in subsequent tables of results.

Sediment

Boreholes were completed at 8 onshore sites and 2 offshore sites (figure 1). Onshore sites were cased and capped for future use. The location of each site was recorded for future reference using global positioning system (GPS) coordinates. A

list of both sediment and water sample sites is given in table 2.

The number of sediment samples collected at each site varied from 1 to 4, depending on the location of the site. Only 1 sample was collected from each offshore site; a minimum of 3 samples were collected at each onshore site, with either parent material samples or split samples collected at 4 of the sites. Lithologic descriptions of the sediment samples and their depths below land surface are presented in table 3.

Laboratory analyses were made on each sediment sample for metals, semivolatile and volatile organics, and pesticides. The complete list of analytes is given in table 1. Results of these analyses are given in tables 4 through 7. Only those analytes that were detected above the method-reporting limit are listed in tables 4 through 7. All other analytes listed in table 1, but not in tables 4 through 7 were either not present, or were present in quantities above the method detection limit but below the method-reporting limit.

Of 23 metals for which analyses were made, 9 were detected in sediment samples (table 4). The most commonly detected metals were aluminum, iron, lead, manganese and mercury. Arsenic, chromium, and zinc were also frequently detected. Analyses were made for 64 semivolatile organic compounds, of which 23 were detected (table 5). Analyses were made for 33 volatile organic compounds, of which 9 were detected (table 6). Of these 9 volatile organic compounds detected, 5 of them were detected in only 1 sample (1 compound detected) or 2 samples (4 compounds detected). Analyses were made for 28 pesticides, of which 25 were detected (table 7); however, 13 of the pesticides detected were in 4 or fewer samples.

Water

Piezometers were installed at 2 locations, 1 each upstream and downstream of the Island (sites 7GI 2 and 7GI 13). The location of each site was recorded for future reference using GPS coordinates. The location of these sites and the types of samples collected at these sites are given in table 2.

A water sample was collected at site 7GI 13, but not at site 7GI 2. An attempt was made to collect a sample at site 7GI 2 but the piezometer was not capable of producing sufficient water for sampling. At site 7GI 13 a water sample was collected from the piezometer, and from the river near the piezometer. This was done for comparative purposes in an attempt to determine if the water in the piezometer was truly from the parent materials, to determine if there was any leakage in the piezometer joints, and to determine if measured differences between river water and ground water were statistically valid.

Additional water samples were collected from sites 7GI 4, 7GI 5, 7GI 6, and 7GI 11. The sample from 7GI 11 was split into 2 samples for comparative purposes. Samples at each of these sites were collected as previously described from the PVC casing that was installed in each borehole.

Laboratory analyses were made on each water sample for metals, semivolatile and volatile organics, and pesticides. The complete list of analytes is given in table 1. Results of water analyses are given in tables 8 through 11. Only those analytes that were present above the method-reporting limit are shown in tables 8 through 11; all other analytes listed in table 1 but not in tables 8 through 11 either were not present or were present in quantities below the method-reporting limit.

Of 23 metals for which analyses were conducted, 16 were detected in water samples (table 8). The most commonly detected

metals were aluminum, calcium, iron, magnesium, manganese, sodium and zinc. Analyses were made for 64 semivolatile organic compounds, of which 6 were detected (table 9). Of these 6 semivolatile organic compounds detected, 4 of them were detected in only 1 or 2 samples. Analyses were made for 33 volatile organic compounds, of which 4 were detected (table 10). Analyses were made for 27 pesticides, of which 11 were detected (table 11); however, 7 of the pesticides detected were in 2 or fewer samples.

Water Levels

Water levels were measured in an attempt to determine hydraulic gradients on the Island. Sites 7GI 2 and 7GI 13 (figure 1) are located in the Detroit River, and sites 7GI 3 and 7GI 4 are located between the outer and inner dike. All other sites are located within the inner dike. Water levels are shown in the table below, and represent the average water level measured at the each site. Between 1 and 8 water levels were measured, depending on when the piezometer was installed.

Average water levels and land surface altitude at piezometer sites on Grassy Island. [Altitude in meters above sea level]

Well number	Land surface altitude	Average water level altitude
GI12	173.65	172.30
7GI3	175.81	175.98
7GI4A	176.46	175.98
7GI5A	177.78	176.26
7GI6	178.43	177.92
7GI7	178.76	177.38
7GI8	179.74	178.14
7GI9	179.09	177.49
7GI10	179.74	178.50
7GI11	179.09	178.92
7GI13	172.73	174.95

Land surface within the outer dike was approximately 1 m (3.3 ft) above the level of the Detroit River at the time the wells were installed and water levels measured (figure 2). The top of the inner dike is about 6.1 m (20 ft) higher than the top of the outer dike (Ray Timm, Geographic Information & Solutions, Inc., personal commun., 1998). The land surface within the inner dike is about 4.6 m (15 ft) higher than that within the outer dike (Ray Timm, GI&S, inc., oral commun., 1998).

In general, water levels in the river sediments were lower than those in the sediments situated between the dikes. Likewise, water levels in the sediments between the dikes were lower than were water levels in the sediments within the inner dike. At three locations within the inner dike, one or more water levels were measured that were above the land surface. Average water levels were all below land surface. All of these water level measurements indicate that there is a hydraulic gradient from within the inner dike toward the area within the outer dike, and consequently to the Detroit River.

DISTRIBUTION OF CONTAMINANTS

In general, recent studies of sediments on and near Grassy Island have found them to be grossly contaminated (Ostaszewski, 1997; Manny, 1999b) with metals, semivolatile and volatile organic compounds, pesticides, and aroclors (PCBs). Historical studies of the Island and surrounding waters and sediments have produced mixed findings (Manny, 1999a). Beyer and Stafford (1993) found that earthworms and soils on Grassy Island contained elevated concentrations of cadmium, copper, and lead, with levels in earthworms several times those in the surrounding soils. Best and others (1992) found elevated concentrations of some heavy metals and aroclors (PCBs) in pond sediments. Concentrations of chlordane, DDE, DDD, phenanthrene, and benzo (g,h,i)perylene exceeded criteria established to protect ground water, and aroclor (PCB) and chlordane levels exceeded criteria established to

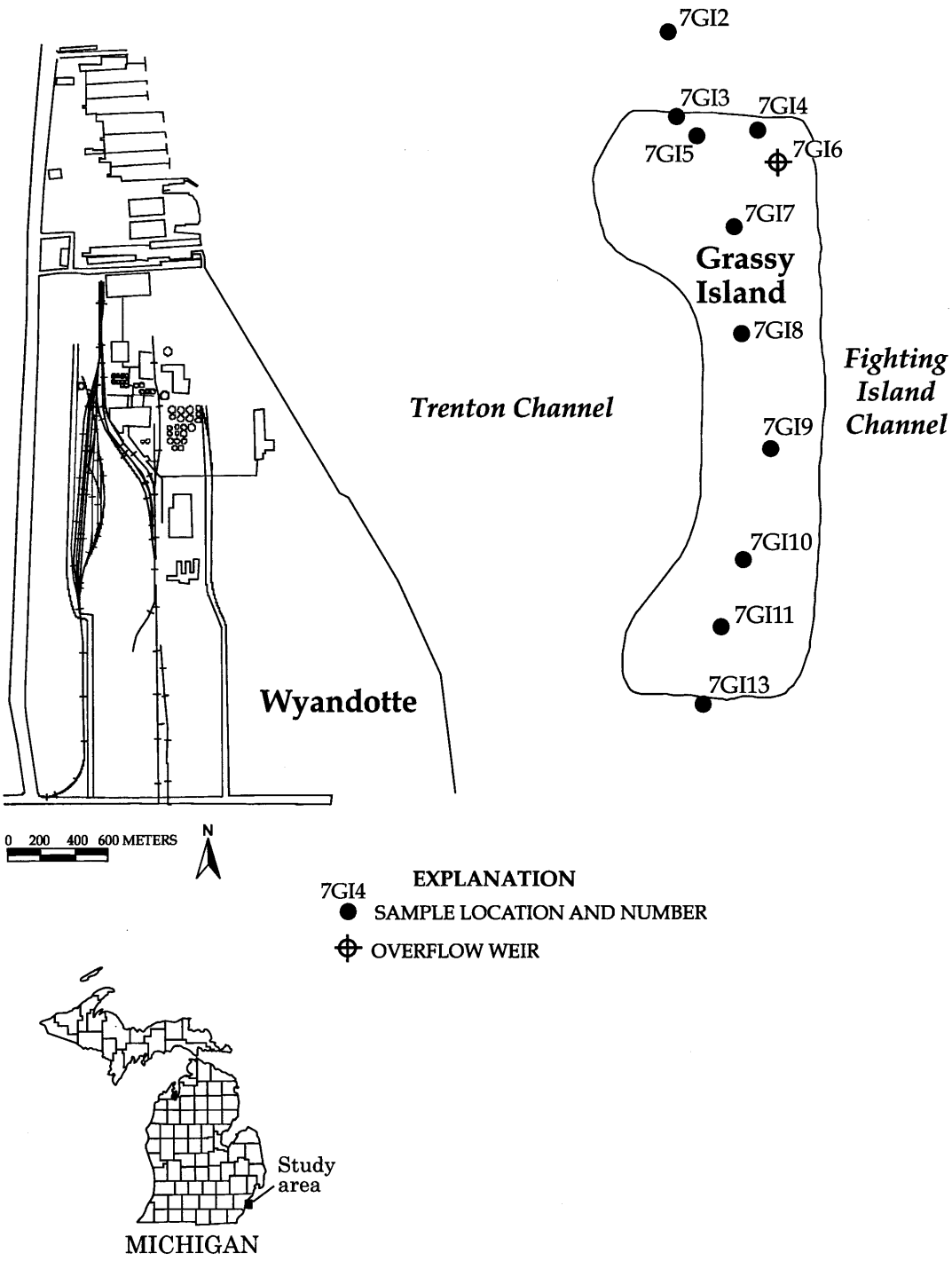

Figure 1. Map showing sample locations on Grassy Island, Michigan.

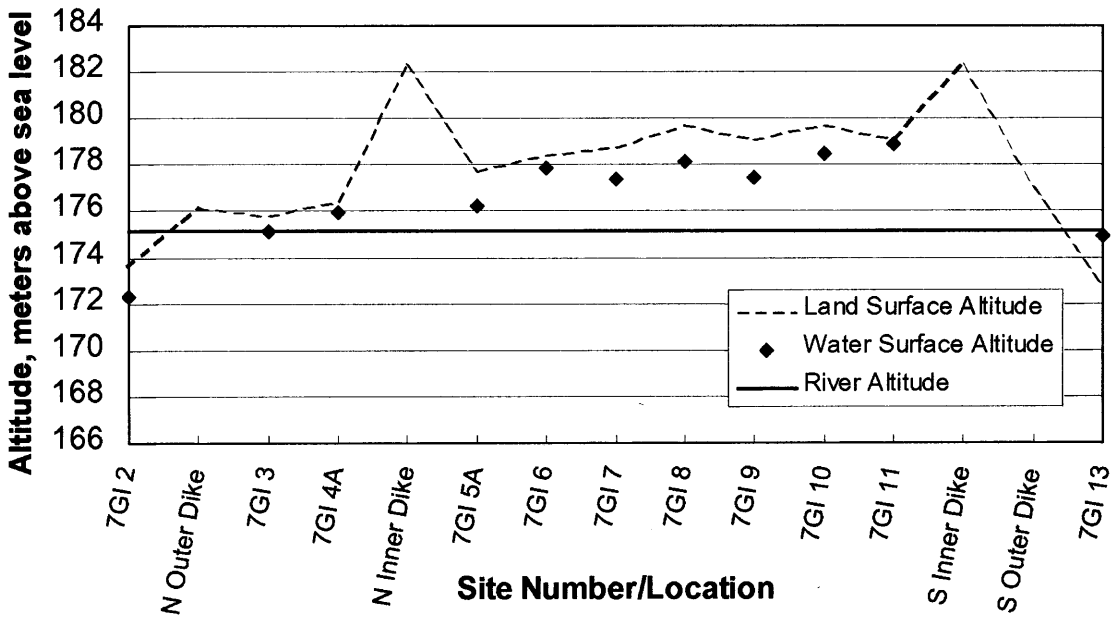

Figure 2. Generalized cross-section showing average water levels in piezometers on and near Grassy Island, land surface altitude, and average Detroit River altitude May-June, 1998.

protect surface water. Best and others (1992) and Eisler (1988) found elevated levels of aroclors (PCBs), DDT, and mercury in tissue and organ samples from waterfowl taken on the Island.

Other studies, however, have had contradictory findings, and lead to mixed conclusions about the level of contamination in surrounding sediments and waters. Thornley and Hamdy (1984) found only mercury in sediments immediately upstream and downstream of Grassy Island. A study for the U.S. Army Corps of Engineers (Environmental Research Group, 1983) found no contamination of sediments immediately next to the Island and in other nearshore sediments in the shipping channel east of the Island; however, U.S. EPA studies in 1987 and again in 1991 (U.S. Environmental Protection Agency, 1987, 1991) contradict these findings. These U.S. EPA studies found that there was "some impact to sediments" from oil and grease, heavy metals, PAHs, and PCBs. However, a later study by Besser and others (1996) of sediments from the same area concurs with the earlier findings of Thornley and Hamdy (1984), and concludes that "sediments of the Fighting Island reference site were not toxic...and included pollution-intolerant taxa." Finally, a study by Environment Canada (1997) found that concentrations of DDE and PCBs in Herring Gull eggs have "decreased significantly, to less than 15 percent of their 1971 values," indicating that levels of organochlorine contaminants have decreased in Detroit River fish consumed by Herring Gulls.

Lewis (1991) used geophysical methods to survey the southwest corner of the Island and detected possible buried drums at a depth of 6-9 m (20-30 ft). This finding is of interest as a possible source of organic contaminants. No further work was completed to confirm or refute these findings.

Contaminants in sediment

Aluminum, iron, lead, manganese, mercury, and zinc were the most commonly detected metals in sediments, generally present at levels tens to hundreds of times greater than the method-reporting limit. Contaminant concentrations show little, if any, trend with either depth or location. For example, iron concentrations tend to increase with depth at sites 8, 9, and 10, but at sites 5, 6, and 11, after increasing from the surface (unsaturated) to the first sample at depth (saturated), iron concentrations then decrease with subsequently deeper samples through the saturated zone. Lead behaves similarly, but at different sites. Lead concentrations increase with depth at sites 5 and 10, but decrease at sites 4, 8, and 9, and increase and then decrease at sites 6 and 11. At site 7, lead concentrations decrease from the surface (unsaturated) to the first sample in the saturated zone, then increase again deeper in the saturated zone. More extensive sampling, both vertically and laterally, might show presently undetected patterns to contaminant distribution.

Native parent materials generally contain only background levels of most trace metals, and do not appear to be impacted by overlying materials. Although arsenic was reported in the parent material samples, it was detected below the method-reporting limit of 10 μg/kg, and was not present in 2 of the 5 native parent material samples. The median arsenic level present in native parent materials was 1.65 μg/kg, with a mean level of 1.21 μg/kg. Lead was reported present in 3 of 5 native parent material samples, with a median level of 2.09 μg/kg, which is below the method reporting limit of 3 μg/kg. The mean level, 2.92 μg/kg, is also below the method-reporting limit. Mercury was present in all but one of the sediment samples from the Island, but was not present in any of the native parent material samples.

At site 5, 11 of 23 detected semivolatile organic compounds were detected in the native parent sample material, and at site 11, 6 of 23 detected semivolatile organic compounds were detected in the native parent sample material. At site 5 the concentrations range from less than twice the reporting limit for 4-chlorophenylphenylether (609 µg/kg detected, 330 µg/kg reporting limit) to over 7 times the reporting limit for fluoranthene (2471 µg/kg detected, 330 µg/kg method reporting limit). At site 11, all values are less than twice the method-reporting limit.

The volatile organic compound methylene chloride was detected in 3 of 5 native parent material samples. In general, methylene chloride was either present in every sample from a site (sites 2,4,6,7,8, and 13) or not present in any samples from a site (sites 5 and 9). It was present in one of two split samples from site 10, and all but the native parent material samples at site 11.

Only 2 other substances were present in any native parent material samples. They were 4-methyl-2-pentanone, which was present in native parent material from site 11 at 3 times the method-reporting limit, and 2-hexanone, which was present in native parent material from site 4 at 6 times the method-reporting limit. In general, volatile organic compounds were present in few of the samples, and generally at depth when they were detected.

From 1993-96, Ostaszewski (1997) studied sediment chemistry in the Trenton Channel, which lies along the west side of Grassy Island (figure 1). One result of this study was a classification of contaminated sediments. Ostaszewski's table A (1997), lists parameters and guideline levels used to evaluate Trenton Channel project sediment results. These guidelines have been applied to sediments collected on and near Grassy Island for this project. The quantification limits (QL) and aquatic life guide-

Parameters and guideline levels used to evaluate Trenton Channel Project sediment results. (from Ostaszewski, 1997).

Bioaccumulative Parameters	Symbol	QL[1]		Note (ppm d.w.)[2]
Mercury	Hg	0.1		USEPA Method 245.1/7470.7471
Polychlorinated Biphenols(*sic*)	PCBs	0.33		USEPA Method 608/8081
Toxic Parameters		Aquatic Life Guidelines (ppm d.w.)		
Parameter	Symbol	ERM[3]	SEL[4]	Note
Arsenic	As	85		
Cadmium	Cd	9.6		
Chromium	Cr	145		
Copper	Cu	390		
Iron	Fe		40000	
Nickel	Ni	50		
Manganese	Mn		1100	
Lead	Pb	110		
Zinc	Zn	270		
Oil and Grease	O & G		1500	
Polyaromatic Hydrocarbons	PAHs	35		Sum of 12 PAHs

1. Q.L. – quantification limit
2. ppm d.w. – parts per million, drinking water
3. ERM – effects range median guideline
4. SEL – severe effects level

lines given by Ostaszewski (1997) are in ppm, as are the results of the sediment analyses for this study. The numbers are therefore directly comparable.

Exceedances were calculated for all analytes, following the method of Ostaszewski (1997), for 7 metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Exceedances are defined by Ostaszewski (1997) as the sum of detections for all analytes that exceed the quantification limit (QL), the effects range median guidelines (ERM - Long and Morgan, 1990), or the severe effect levels (SEL - Persaud and others, 1993), divided by the QL, ERM, or SEL. Ostaszewski (1997) then divided the results into 5 categories, also shown below.

Sediments on Grassy Island were found to range from not impacted by arsenic and manganese, to extremely contaminated by mercury. They were moderately impacted by chromium and iron, and severely contaminated by lead and zinc. Although arsenic was detected in 16 of 30 samples for which it was analyzed, it was not present at levels equal to or greater than the ERM, and therefor the sediments, by Ostaszewski's criteria, are not impacted. Likewise for manganese, which was detected in 26 of 30 samples for which it was analyzed. Ostaszewski did not establish parameters and guideline levels for evaluating contamination by aluminum or selenium.

PAHs, the sum of 16 organic contaminants for which analyses were made, were found at levels that cause the sediments to be classified as extremely contaminated. PCBs, the sum of 6 aroclors, were present at levels that cause the sediments to be classified as extremely contaminated.

No pesticides or aroclors (PCBs) were detected in any samples of native parent material. In general, pesticides and aroclors were noticeably absent most samples except for samples taken in the saturated zone at sites 10 and 11. Both of these sites contained numerous pesticides and aroclors, generally at the deepest and second from deepest samples at site 10, and at the first saturated sample at site 11.

Classifications of contaminated sediment sites as applied to the Trenton Channel Project sediment survey results (1993-1996). (from Ostaszewski, 1997).

Not Impacted
Summed Toxic ERM/SEL[1] and Bioaccumulative QL[2] Exceedances less than one, (<1)

Impacted
Summed Toxic ERM/SEL and Bioaccumulative QL Exceedances between 1 and 15

Moderately Impacted
Summed Toxic ERM/SEL and Bioaccumulative QL Exceedances between 15 and 30

Severely Contaminated
Summed Toxic ERM/SEL and Bioaccumulative QL Exceedances between 30 and 60

Extremely Contaminated
Summed Toxic ERM/SEL and Bioaccumulative QL Exceedances greater than sixty, (>60)

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1. ERM/SEL – Effects Range Median/Severe Effects Level
2. QL – Quantification Limit

Contaminants in Water

Aluminum, calcium, chromium, copper, iron, magnesium, manganese, sodium, and zinc were the most commonly detected metals in water. In water, concentrations of trace metals followed those of the sediments from which the water was extracted. Aluminum, calcium, chromium, copper, iron, magnesium, manganese, potassium, sodium, and zinc were the most frequently reported trace metals in water samples. Calcium, iron, magnesium, sodium, and zinc were the only metals reported in the one sample of river water. Arsenic and barium were present only in the split samples from site 11; mercury was reported in water from site 5, although at only slightly more than the method-reporting limit (0.23634 µg/L reported, 0.2 µg/L method-reporting limit).

Although the classification system developed by Ostaszewski (1997) was for sediments, it was applied to the results obtained for chemical analyses of water for this study. In addition, results of analyses were compared to U.S. EPA drinking water standards (USEPA, 1996). Using the classification of Ostaszewski, all water samples would be classified as not impacted. Using data from table 8, comparison to U.S. EPA drinking water standards indicates that cadmium, iron, lead, and manganese exceed these standards at 1, 5, 3 and 4 sites respectively. In addition, drinking water standards are established for aluminum and barium; aluminum concentrations in water exceed these standards at 3 sites and barium concentrations exceed these standards at 1 site. The Michigan Department of Public Health has established an objectionable level for sodium of 250 mg/L. Comparing the objectionable level to data from table 8 indicates that sodium concentrations in water do not exceed this level.

Phenol was the only semivolatile organic compound reported in water not originating on the Island. In general, semivolatile organic compounds were reported at or slightly above the method-reporting limit for those compounds that were detected. Bis(2-Ethylhexyl)phthalate was the most commonly detected semivolatile organic compound, present in water samples from all but sites 6 and 13.

As with sediment sample results, methylene chloride was the most commonly detected volatile organic compound, reported in all water samples except that from the Detroit River. Acetone was the second most commonly detected volatile organic compound in water. Acetone was reported at such high concentrations in sample 7GI 13Wp that a rerun was requested from the lab. As of this writing, results of this rerun have not been received. Comparing PAH concentrations to the ERM and Ostaszewski's contaminant classification indicates that waters are not impacted with respect to PAHs. There is no USEPA drinking water primary or secondary maximum contaminant level established for PAHs.

No pesticides or aroclors (PCBs) were detected in the water sample from the Detroit River. Only aroclors were detected in the water sample from the river piezometer, and then only at the method-reporting limit. Site 7GI 5 was the only site with notable aroclor concentrations reported. At all other sites, aroclor concentrations, when reported, were at the method-reporting limit. Comparing aroclor concentrations to the QL and Ostaszewski's contaminant classification indicates that the waters are not impacted; however, the sum of aroclors does exceed the USEPA drinking water standards for PCBs. The pesticide gamma chlordane was reported in water samples from 3 sites, again at the method-reporting limit.

Of greater concern are surface impoundments of water on the Island and their

potential to transmit contaminants off the Island during periods of precipitation and overland flow. Currently there is an overflow weir and discharge chamber on the northeast corner of the Island. This weir and discharge chamber is connected to a pipe that discharges surface flows into the Detroit River at an indeterminate point. Flow of water into this system is apparently by ground water seepage, and during periods of precipitation, possibly by overland flow. A water quality sample was collected from the weir but was not analyzed because of budget limitations.

There is a small surface impoundment of water that flows into the weir; however, at the northwest end of the Island and the southern end of the Island there are large areas (greater than 1 h (3 acres)) of standing water. This water may discharge through the weir, although it is more likely that these ponded waters increase in volume by precipitation and overland runoff, and lose content by evaporation and transpiration, not discharge through the weir. No obvious areas of seepage through the containment dikes were observed, nor were there any obvious areas of breaching or failure.

Large numbers of waterfowl were observed on these ponds. It is likely that some of these waterfowl use the Island as a nesting area and raise their broods on the Island (Douglas Spencer, USFWS, oral commun., 1997; Bruce Manny, written commun., 1997, 1998; Dave Best, USFWS, written commun., 1998). Other migratory birds were also observed on the Island, along with deer and groundhogs. Numerous groundhog burrows were noted at locations along the upper dike, generally near the top of the dike and at a level well above any ponded water.

In general, the data collected for this study indicate that contaminants on Grassy Island are contained in the sediments on the Island and are not moving from the Island to the surrounding sediments or waters at detectable levels. Native parent materials are generally identified as glaciolacustrine clays, which have low hydraulic conductivities (10^{-7}-10^{-10} cm/s (10^{-2}-10^{-5} gal/day/ft^2); Freeze and Cherry, 1979, p. #29) and thus are poor conduits for the transmission of contaminants. Most contaminants reported in the sediments and water on the Island are found neither in the parent materials, nor in the water of the Detroit River immediately downstream of the Island. Because of the low hydraulic conductivity of the underlying sediments on the Island, it is unlikely that surface water is able to infiltrate into the ground-water system, and therefore is also unlikely that the ground water is moving laterally or vertically through the Island in significant quantities. It is more likely that the precipitation that falls on the Island is transported into and through the more permeable surface materials, from which it is directly evaporated into the atmosphere or incorporated into vegetation, from which it evapotranspires into the atmosphere.

ADDITIONAL DATA AND STUDY NEEDS

Soils and Sediments

In order to make statements about the connection between Island soils, the nature of contaminated dredge spoils placed on the Island, and the underlying substrate, additional geophysical investigations and additional drilling of cores are needed. To fully compare the quality of sediments and water on the Island to those in the surrounding riverine environment, additional samples are needed upstream from, downstream from, and lateral to the Island. Studies of contaminants in the vegetation growing on the Island should be made to determine what role, if any, vegetation plays in the movement of contaminants from the sediments to ground water, sur-

face water, and wildlife. It is likely that phragmites, laurel, cottonwood, willow and other plants are vectors for chemical exchange between sediments, ground water, surface water, the atmosphere, and wildlife. Plants could also function as a mechanism for movement of semivolatile and volatile contaminants in the root zone. The contaminant content of soil and sediment-dwelling invertebrates should also be sampled.

Surface water

Surface-water altitudes and flow measurements would be needed to study the relation between ground and surface water on the Island. To determine what, if any, connection there is between ground and surface-water quality, further studies of water quality are needed to identify the contaminants, if any, that are present in ponded surface water on the Island and in water being discharged from the island through the weir. Event sampling of surface-water flow and quality in overland runoff and at the discharge weir is needed to document any connection between ponds on the north end of the Island and the overflow weir, and to document the quality and quantity of discharges to the Detroit River through the weir.

Ground Water

Only generalized ground-water levels were collected during this project, and it is therefore not possible to make quantifiable statements about the direction or rate and volume of ground- and surface-water flow. The data collected met the limited needs of this study to assess baseline concentrations of selected contaminants in water. However, if further study is to be made of ground-water and surface-water movement and transport of contaminants on the Island, additional data collection sites will be required for more thorough monitoring of ground-water levels. Additional piezometers and wells are needed on the Island, around its perimeter, and in the Detroit River to determine, on a finer scale, the ground-water surface and the potential for movement of ground water into either the Detroit River or underlying sediments. Water levels will need to be measured on a more frequent and regular, long-term basis in order to develop a map of the ground-water surface.

Atmosphere

Atmospheric monitoring (wet and dry precipitation) should also be studied to determine current transport and depositional patterns of airborne contaminants over the Island. The US EPA (1974) characterized the section of river in which Grassy Island is located as an area of heavy steel and chemical manufacturing. A number of industries upwind from the Island likely discharge significant amounts of contaminants into the air. These contaminants are then transported over the Island by prevailing winds and may be deposited on the Island by gravity and precipitation.

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Table 1. Trace metals, semivolatile and volatile organic compounds, and pesticides for which laboratory analyses were made in samples from Grassy Island. Detection limits are given in μg/L (parts per billion, or ppb) for water and μg/kg dry weight (ppb) for sediments. Trace metal detection limits are expressed as instrument detection limits obtained for pure water. Detection limits for sediments are adjusted for the amount of sample analyzed and percent moisture (dry weight). The water and sediment detection limits for metals and volatile organics are the same

Trace Metals (detection limit)		
Aluminum (200)	Cobalt (50)	Potassium (5000)
Antimony (60)	Copper (25)	Selenium (5)
Arsenic (10)	Iron (100)	Silver (10)
Barium (200)	Lead (3)	Sodium (5000)
Beryllium (5)	Magnesium (5000)	Thallium (10)
Cadmium (5)	Manganese (15)	Vanadium (50)
Calcium (5000)	Mercury (0.2)	Zinc (20)
Chromium (10)	Nickel (40)	

Semivolatile Organics (detection limit water/detection limit sediment)	
Phenol (10/330)	Acenaphthene (10/330)
bis(2-chloroethyl)ether (10/330)	2,4-Dinitrophenol (10/830)
2-Chlorophenol (10/330)	4-Ntirophenol(10/830)
1,3-Dichlorobenzene (10/330)	Dibenzofuran (10/330)
1,4-Dichlorobenzene (10/330)	2,4-Dinitrotoluene(10/330)
1,2-Dichlorobenzene (10/330)	Diethylphthalate (10/330)
2-Methylphenol (10/330)	4-chlorophenyl-phenylether (10/330)
2,2'-oxybis(1-Chloropropane) (10/330)	Fluorene (10/330)
4-Methylphenol (10/330)	4-Ntiroaniline (10/830)
N-Nitroso-di-n-propylamine (10/330)	4,6-Dinitro-2-methylphenol (10/830)
Hexachloroethane (10/330)	N-Nitrosodiphenylamine (10/330)
Nitrobenzene (10/330)	4-Bromophenyl-phenylether (10/330)
Isophorone (10/330)	Hexachlorobenzene (10/330)
2-Nitrophenol (10/330)	Pentachlorophenol (10/830)
2,4-Dimethylphenol (10/330)	Phenanthrene (10/330)
bis(2-Chloroethoxy)methane (10/330)	Anthracene (10/330)
2,4-Dichlorophenol (10/330)	Carbazole (10/330)
1,2,4-Trichlorobenzene (10/330)	Di-n-butylphthalate (10/330)
Naphthalene (10/330)	Fluoranthene (10/330)
4-Chloroaniline (10/330)	Pyrene (10/330)
Hexachlorobutadiene (10/330)	Butylbenzylphthalate (10/330)
4-Chloro-3-Methylphenol (10/330)	3,3'-Dichlorobenzidine (10/330)
2-Methylnaphthalene (10/330)	Benzo(a)anthracene (10/330)
Hexachlorocyclopentadiene (10/330)	Chrysene (10/330)
2,4,6-Trichlorophenol (10/330)	bis(2-Ethylhexyl)phthalate (10/330)
2,4,5-Trichlorophenol (10/830)	Di-n-octylphthalate (10/330)

Table 1. Trace metals, semivolatile and volatile organic compounds, and pesticides for which laboratory analyses were made in samples from Grassy Island – Continued

Semivolatile Organics – continued (detection limit water/detection limit sediment)	
2-Chloronaphthalene (10/330)	Benzo(b)fluoranthene (10/330)
2-Nitroaniline (10/830)	Benzo(k)fluoranthene (10/330)
Dimethylphthalate (10/330)	Benzo(a)pyrene (10/330)
Acenaphthylene (10/330)	Indeno(1,2,3-cd)pyrene (10/330)
2,6-Dinitrotoluene (10/330)	Dibenz(a,h)anthracene (10/330)
3-Nitroaniline (10/830)	Benzo(g,h,i)perylene (10/330)

Volatile Organics (detection limit)	
Chloromethane (10)	cis-1,3-Dichloropropene (10)
Bromomethane (10)	Trichloroethene (10)
Vinyl Chloride (10)	Dibromochloromethane (10)
Chloroethane (10)	1,1,2-Trichloroethane (10)
Methylene Chloride (10)	Benzene (10)
Acetone (10)	trans-1,3-Dichloropropene (10)
Carbon Disulfide (10)	Bromoform (10)
1,1-Dichloroethene (10)	4-Methyl-2-Pentanone (10)
1,1-Dichloroethane (10)	2-Hexanone (10)
1,2-Dichloroethene (total) (10)	Tetrachloroethene (10)
Chloroform (10)	1,1,2,2-Tetrachloroethane (10)
1,2-Dichloroethane (10)	Toluene (10)
2-Butanone (10)	Chlorobenzene (10)
1,1,1-Trichloroethane (10)	Ethylbenzene (10)
Carbon Tetrachloride (10)	Styrene (10)
Bromodichloromethane (10)	Xylene (total) (10)
1,2-Dichloropropane (10)	

Pesticides (detection limit water/detection limit sediment)	
alpha-BHC (0.05/1.7)	4, 4'-DDT (0.10/3.3)
beta-BHC (0.05/1.7)	Methoxychlor (0.50/17.0)
delta-BHC (0.05/1.7)	Endrin ketone (0.10/3.3)
gamma-BHC (Lindane) (0.05/1.7)	Endrin aldehyde (0.10/3.3)
Heptachlor (0.05/1.7)	Alpha-Chlordane (0.05/1.7)
Aldrin (0.05/1.7)	Gamma-Chlordane (0.05/1.7)
Heptachlor epoxide (0.05/1.7)	Toxaphene (5.0/170.0)
Endosulfan I (0.05/1.7)	Aroclor-1016 (1.0/33.0)
Dieldrin (0.10/3.3)	Aroclor-1221 (2.0/67.0)
4,4'-DDE (0.10/3.3)	Aroclor-1232 (1.0/33.0)
Endrin (0.10/3.3)	Aroclor-1242 (1.0/33.0)
Endosulfan II (0.10/3.3)	Aroclor-1248 (1.0/33.0)
4,4'-DDD (0.10/3.3)	Aroclor-1254 (1.0/33.0)
Endosulfan sulfate (0.10/3.3)	Aroclor-1260 (1.0/33.0)

Table 2. Sample site name, location, and types of samples collected

[SP, sediment, parent material; S1, sediment, first sample, unsaturated zone; S2, sediment, second sample, saturated zone; S3, sediment, third sample, saturated zone; W, water sample; A and B designate split samples; p designates piezometer sample; r designates river-water sample]

Site Name	Site Location		Sample Designation
	Latitude	Longitude	
7GI 2	42 13 55.87	83 08 07.71	SP
7GI 4	42 13 46[1]	83 08 03[1]	S1, S2, S3, W
7GI 5	42 13 44.10	83 08 07.90	S1, S2, S3, SP, W
7GI 6	42 13 45[1]	83 08 03[1]	S1, S2, S3, W
7GI 7	42 13 33.74	83 08 05.16	S1, S2, S3
7GI 8	42 13 26.13	83 08 03.82	S1, S2, S3A, S3B
7GI 9	42 13 18.21	83 08 03.11	S1, S2, S3
7GI 10	42 13 14.70	83 08 04.59	S1, S2A, S2B, S3
7GI 11	42 13 09.59	83 08 07.10	S1, S2, S3, SP, WA, WB
7GI 13	42 13 06.85	83 08 08.55	SP, Wp, Wr

[1]Latitude and longitude not verified for this site.

Table 3. Lithologic description of bore holes and depths at which samples were collected

Borehole Number	Fill Description	Thickness (meters)	Depth (meters)
7GI 2	Light blue, glacio-lacustrine clay, small clasts.	0.25	0 - 0.25
7GI 4	Light to dark brown, loamy soil, many roots.	0.61	.25 - .61
	Coarse gravel and sand in black clay.	0.30	.61 - .91
	Dark black, oily clay with some sand and sparse gravel. Near bottom of interval sand about 30 %.	0.61	.91 - 1.52
	Red "brick-like" material, mixed with dense blue clay.	0.30	1.52 -1.82
	Light blue to gray clay, very dense, well formed.	0.61	1.82- 2.43
	Light blue to gray clay, very dense, some sand and small pebbles.	0.31	2.43 -2.74
	Light-blue clay, sand about 30-40%.	0.61	2.74 - 3.35
	Light-blue clay with dark brown organic inclusions, lime chips, possibly small shell fragments.	0.31	3.35 - 3.66
7GI 5	Medium to dark brown, humic soil with abundant decomposing plant material, very moist.	1.22	0 - 1.22
	Dark blue-gray clay, soft to very soft, clings to auger surface. Strong petroleum scent at approximately 2.9-m total depth.	1.98	1.22 - 3.20
	Black, sandy clay. Very dense, difficult to penetrate.	0.15	3.20 - 3.35
	Black, medium to coarse sand, some 2.5-5 cm stones.	0.61	3.35 - 3.96
	Dark black, soft clay, 60%, medium-coarse gravel, 40%.	0.30	3.96 - 4.26
	Medium to fine gravel, coarse sand, 75%, dense, blue-gray clay 25 %	0.61	4.26 - 4.88

Table 3. Lithologic description of bore holes and depths at which samples were collected – Continued

7GI5 continued	Blue clay, dense, 50-70%, coarse, black sand, 35-45 %, 2.5-5 cm stones, 5%.	0.30	4.88 - 5.18
	Green-blue, very dense, hard clay. Some 1 cm stones, < 5%.	0.61	5.18 - 5.79
	Green-blue, very soft clay. Abundant limestone chips and small shell fragments.	0.61	5.79 - 6.40
7GI 6	Dark blue to black clay, semi-liquid, soft, near liquid consistency.	2.13	0 - 2.13
	Dark blue to black clay, semi-liquid, soft, near liquid consistency, petroleum odor.	0.61	2.13 - 2.74
	Dark blue to black clay, semi-liquid, soft, near liquid consistency. Color lightens with depth to light gray.	3.05	2.74 - 5.79
	Light gray clay mixed with sand, gravel, possibly some shell fragments.	.61	5.79 - 6.40
7GI 7	Brown, loose, loamy soil, abundant earth worms.	0.15	0 - 0.15
	Light gray to brown, loose, loamy soil with abundant organic matter and earth worms.	0.76	.15 - .91
	Blue gray, dense clay. Small roots and rust runners. Very low moisture content, moisture increases with depth.	0.46	.91 - 1.37
	Brown, semi-liquid, loamy clay with some small roots.	0.61	1.37 - 1.98
	Blue gray, dense, well compacted clay. Slight odor.	1.22	1.98 - 3.20
	Black sand, very fine, dense, difficult to drive split spoon.	0.46	3.20 - 3.66
	Black sand, very fine, dense, semi-liquid.	0.30	3.66 - 3.96
	Black sand, very fine, some small rocks and blue clay.	1.22	3.96 - 5.18
	Light blue, dense clay with clasts.	0.61	5.18 - 5.79
7GI 8	Brown, loose, loamy soil, abundant tree roots and organic matter.	0.30	0 - 0.30
	Brown to gray, light, loose, sandy loam soil, some clay.	0.91	.30 - 1.21
	Rust covered gravel and small stones, moist.	0.46	1.21 - 1.67
	Brown to gray, light clay	1.07	1.67 - 2.74
	Black, sandy clay. Strong petroleum odor.	0.61	2.74 - 3.35
	Black to gray, sandy clay, slight petroleum odor.	0.31	3.35 - 3.66
	Black, liquid clay with some sand.	1.52	3.66 - 5.18
	Dark black, liquid clay with some sand. No odor.	0.31	5.18 - 5.49
7GI 9	Light brown, rust red, loamy soil.	0.08	0 - 0.08
	Light brown, sandy, loose, loamy soil. Abundant earth worms, multi-legged insects, beetles, and other unidentified insects.	1.14	.08 - 1.22
	Brown, sandy clay soil, moist.	0.46	1.22 - 1.68
	Brown, sandy clay soil, semi-liquid, water can be seen flowing down side of borehole. Crumbly texture.	0.61	1.68 - 2.29
	Blue to black clay, medium density, soft. Maintains shape, "breaks" along planes with sufficient pressure. Yields water upon pressure.	0.46	2.29 - 2.75
	Dark black, very soft clay. Semi-liquid, will not hold shape.	0.91	2.75 - 3.66

Table 3. Lithologic description of bore holes and depths at which samples were collected – Continued

7GI 10	Light brown to light red, sandy, loamy soil with some black sand. Numerous small roots and organic plant material.	1.22	0 - 1.22
	Steel gray to blue, dense, hard clay. Fragments of glass, rusted metal flakes, some sand. Semi-liquid.	1.07	1.22 - 2.29
	Dark black to gray, dense, hard clay. Fragments of orange plastic, glass, some stones. Strong petroleum odor.	0.46	2.29 - 2.75
	Dark black, liquid clay.	0.61	2.75 - 3.36
	Dark black, liquid "sludge," very foul smelling – combination of petroleum and decaying matter.	0.61	3.36 - 3.97
	Dark black, liquid "sludge" with strong petroleum odor. Oily blue sheen evident on liquid oozing from sample.	0.61	3.97 -4.58
7GI 11	Brown, loamy, organic rich soil with some sand and gravel.	0.20	0 - 0.20
	Brown sand and gravel, equal proportions. Semi-liquid.	0.10	.20 - .30
	Brown to buff, streaked with black mix of sand, shells, and gravel. 80% sand, 10 % silt and clay, 5% gravel, 5% shells. Black streaks have strong petroleum odor.	2.13	.30 - 2.43
	Black, soft clay with strong petroleum odor.	0.31	2.43 -2.74
	Black, oily clay with pieces of wood. Strong petroleum odor.	0.92	2.74 -3.66
	Brown, grading to black, woody material mixed with clay, sand, and shells. Shells are mainly ostracods and mollusks.	0.61	3.66 -4.27
	Black, oily clay (85%) mixed with sand and gravel (15%). Still some small shell and wood fragments.	0.61	4.27 -4.88
	Green clay and sand, some small stones. Dense and well consolidated.	0.30	4.88 -5.18
	Light green-blue-gray clay with less than 10% sand.	0.30	5.18 - 5.48
7GI 13	Light blue, glaciolacustrine clay, small clasts.	0.25	0 - 0.25

Table 4. Results of analyses for metals in sediments, Grassy Island. Detection limits are given in parentheses below name of analyte. Trace metal detection limits and results, in mg/kg, milligrams per kilogram; also, parts per million or ppm, are expressed as instrument detection limits obtained for pure water. Detection limits and results for sediments are adjusted for the amount of sample analyzed and percent moisture, and reported as dry weight; --, not detected. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Sample Depth (meters below surface)	Aluminum (200)	Arsenic (10)	Chromium (10)	Iron (100)	Lead (3)
7GI 2SP	F17382	5.18	10882.50	--	--	12140.80	9.41
7GI 4S1	F17371	0.91	10321.00	--	--	21143.80	36.94
7GI 4S2	F17372	2.74	8846.70	11.60	--	17013.60	3.32
7GI 4SP	F17373	3.66	15053.80	--	--	22254.20	3.10
7GI 5S1	F17384	.30	15493.90	--	196.50	39992.10	325.60
7GI 5S2	F17385	3.05	15996.80	--	232.20	57340.10	404.30
7GI 5S3	F17386	4.57	15996.80	13.22	--	10929.40	--
7GI 5SP	F17387	6.10	--	--	--	11219.80	--
7GI 6S1	F17368	.30	15929.90	22.50	256.58	47369.30	58.50
7GI 6S2	F17369	2.44	15866.50	--	306.20	70199.10	530.10
7GI 6S3	F17370	6.10	8409.10	13.20	--	22151.80	30.26
7GI 7S1	F17374	1.22	13529.60	11.81	198.46	44526.09	245.10
7GI 7S2	F17375	3.35	4738.80	--	--	--	15.08
7GI 7S3	F17376	6.10	15538.30	15.90	212.60	53718.99	277.10
7GI 8S1	F17377	.91	5058.10	12.40	--	33769.90	77.90
7GI 8S2	F17378	3.66	6244.00	--	--	36381.50	39.80
7GI 8S3	F17379	5.49	8370.40	--	--	42880.70	--
7GI 8S3B		5.49	--	--	--	--	--
7GI 9S1	F17397	.30	--	17.70	204.40	38878.90	403.50
7GI 9S2	F17398	2.44	15031.70	--	218.70	42600.70	393.10
7GI 9S3	F17399	3.96	8905.10	--	223.70	71181.00	349.90
7GI 10S1	F17388	.91	--	--	199.30	31901.40	194.50
7GI 10S2A	F17389	1.52	--	16.13	--	36652.70	231.80
7GI 10S2B		1.52	--	--	--	--	--
7GI 10S3	F17391	4.27	13989.00	--	246.70	68519.10	459.30
7GI 11S1	F17392	.15	--	--	--	32610.00	119.40
7GI 11S2	F17393	2.44	12896.00	13.23	247.70	74912.90	526.10
7GI 11S3	F17394	4.57	4647.50	14.13	--	24834.60	98.10
7GI 11SP	F17395	5.49	--	--	--	13876.00	--
7GI 13SP	F17383	3.66	9509.00	--	--	19021.30	--

Table 4. Results of analyses for metals in sediments, Grassy Island – Continued

Field ID	Manganese (15)	Mercury (0.2)	Selenium (5)	Zinc (20)
7GI 2SP	--	--	--	--
7GI 4S1	539.40	--	--	--
7GI 4S2	298.80	--	--	--
7GI 4SP	--	--	--	--
7GI 5S1	718.70	0.73	--	867.50
7GI 5S2	831.60	.80	--	1143.50
7GI 5S3	339.00	--	--	--
7GI 5SP	271.20	--	--	--
7GI 6S1	1050.70	.94	--	1081.60
7GI 6S2	811.50	1.18	--	1284.10
7GI 6S3	410.90	--	--	--
7GI 7S1	766.15	.81	--	848.20
7GI 7S2	256.50	--	--	--
7GI 7S3	846.57	.84	--	1264.30
7GI 8S1	542.90	.55	--	354.50
7GI 8S2	688.70	.50	--	559.70
7GI 8S3	737.20	.55	--	655.00
7GI 8S3B	--	--	--	--
7GI 9S1	566.10	.95	--	951.70
7GI 9S2	599.60	.74	--	945.30
7GI 9S3	710.40	.83	--	805.90
7GI 10S1	937.70	.86	--	399.10
7GI 10S2A	668.90	1.41	--	621.50
7GI 10S2B	--	--	--	--
7GI 10S3	848.80	.87	--	1255.90
7GI 11S1	805.80	.26	--	311.10
7GI 11S2	879.70	.91	--	1486.00
7GI 11S3	353.60	--	--	--
7GI 11SP	348.10	--	--	--
7GI 13SP	372.20	--	--	--

Table 5. Results of analyses for semivolatile organic compounds in sediments, Grassy Island. Detection limits are given in parentheses below name of analyte. Sediment sample detection limits and results in µg/kg (micrograms per kilogram, or ppb, dry weight of sample); --, not detected. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Sample Depth (meters below surface)	Phenol (330)	Isophorone (330)	2-Nitrophenol (330)	Naphthalene (330)
7GI 2SP	F17382	5.18	--	--	--	--
7GI 4S1	F17371	0.91	--	--	--	--
7GI 4S2	F17372	2.74	--	--	--	--
7GI 4SP	F17373	3.66	--	--	--	--
7GI 5S1	F17384	.30	--	--	--	3467
7GI 5S2	F17385	3.05	--	--	--	11341
7GI 5S3	F17386	4.57	--	--	--	--
7GI 5SP	F17387	6.10	--	--	--	--
7GI 6S1	F17368	.30	--	--	--	1852
7GI 6S2	F17369	2.44	--	1168	--	10685
7GI 6S3	F17370	6.10	--	--	--	424
7GI 7S1	F17374	1.22	651	--	--	4094
7GI 7S2	F17375	3.35	--	--	--	457
7GI 7S3	F17376	6.10	--	--	--	11905
7GI 8S1	F17377	.91	--	--	--	2692
7GI 8S2	F17378	3.66	--	--	867	831
7GI 8S3	F17379	5.49	--	--	--	11387
7GI 8S3B		5.49	--	--	--	--
7GI 9S1	F17397	.30	--	--	--	--
7GI 9S2	F17398	2.44	--	--	--	13999
7GI 9S3	F17399	3.96	--	1491	--	7792
7GI 10S1	F17388	.91	--	--	--	2413
7GI 10S2A	F17389	1.52	--	--	--	11367
7GI 10S2B		1.52	--	--	--	7705
7GI 10S3	F17391	4.27	--	--	--	11646
7GI 11S1	F17392	.15	--	--	--	2851
7GI 11S2	F17393	2.44	--	--	--	10156
7GI 11S3	F17394	4.57	--	--	--	2239
7GI 11SP	F17395	5.49	--	--	--	--
7GI 13SP	F17383	3.66	--	--	--	--

Table 5. Results of analyses for semivolatile organic compounds in sediments, Grassy Island – Continued

Field ID	Acenaphthene (330)	Dibenzofuran (330)	4-chlorophenyl-phenylether (330)	N-Nitroso-diphenylamine (1) (330)
7GI 2SP	--	--	--	--
7GI 4S1	--	--	--	--
7GI 4S2	--	--	--	--
7GI 4SP	--	--	--	--
7GI 5S1	794	1223	927	554
7GI 5S2	4931	2646	4657	--
7GI 5S3	--	--	421	--
7GI 5SP	--	--	609	--
7GI 6S1	--	674	--	--
7GI 6S2	868	1446	1086	5414
7GI 6S3	--	--	526	--
7GI 7S1	--	607	560	--
7GI 7S2	--	--	--	--
7GI 7S3	6359	--	--	--
7GI 8S1	664	609	927	--
7GI 8S2	4747	--	--	--
7GI 8S3	9514	6321	8973	2281
7GI 8S3B	--	--	--	--
7GI 9S1	780	901	720	--
7GI 9S2	27858	9644	14518	--
7GI 9S3	23864	17975	21224	7560
7GI 10S1	559	580	786	--
7GI 10S2A	3868	2840	4005	--
7GI 10S2B	2688	1887	2633	--
7GI 10S3	7343	3480	5893	--
7GI 11S1	618	669	744	--
7GI 11S2	8255	3516	6141	--
7GI 11S3	1858	805	1453	978
7GI 11SP	--	--	--	--
7GI 13SP	--	--	--	--

Table 5. Results of analyses for semivolatile organic compounds in sediments, Grassy Island – Continued

Field ID	Phenanthrene (330)	Anthracene (330)	Carbazole (330)	Fluor-anthene (330)	Pyrene (330)	Benzo(a) anthracene (330)
7GI 2SP	--	--	--	--	--	--
7GI 4S1	917	--	--	1282	1555	897
7GI 4S2	--	--	--	585	888	489
7GI 4SP	--	--	--	--	--	--
7GI 5S1	8006	4143	843	4858	9004	5496
7GI 5S2	9401	4227	--	8345	11717	6536
7GI 5S3	922	439	--	811	1372	509
7GI 5SP	1916	895	--	2471	2007	1342
7GI 6S1	3011	1008	--	1439	6768	2575
7GI 6S2	33821	7006	844	16830	34364	12765
7GI 6S3	1750	671	--	1381	1597	1057
7GI 7S1	3979	1434	--	3002	7876	4046
7GI 7S2	740	--	--	768	876	--
7GI 7S3	--	--	--	--	--	--
7GI 8S1	5622	2731	--	6194	11712	7211
7GI 8S2	--	--	--	--	--	--
7GI 8S3	86513	27040	7738	51767	65807	31605
7GI 8S3B	--	--	--	--	--	--
7GI 9S1	4359	2548	821	3095	8695	6582
7GI 9S2	31311	14156	9607	24925	46358	29326
7GI 9S3	165694	60790	33334	65498	52036	31006
7GI 10S1	3937	1896	478	2602	5905	3296
7GI 10S2A	6940	4617	982	8251	10358	6855
7GI 10S2B	5419	3504	902	6152	9638	5535
7GI 10S3	25413	9758	2206	9981	12850	9914
7GI 11S1	4128	2059	1087	5246	9138	7288
7GI 11S2	28857	8575	2119	10487	10530	6721
7GI 11S3	5112	1639	457	1922	3031	1367
7GI 11SP	--	--	--	444	491	431
7GI 13SP	--	--	--	--	--	--

Table 5. Results of analyses for semivolatile organic compounds in sediments, Grassy Island – Continued

Field ID	Chrysene (330)	bis(2-Ethylhexyl) phthalate (330)	Di-n-octylphthalate (330)	Benzo(b) fluoranthene (330)	Benzo(k) fluoranthene (330)
7GI 2SP	--	--	--	--	--
7GI 4S1	817	--	--	918	--
7GI 4S2	422	--	--	--	--
7GI 4SP	--	--	--	--	--
7GI 5S1	6925	4653	--	4876	3607
7GI 5S2	8485	8321	--	5291	3395
7GI 5S3	649	--	--	499	--
7GI 5SP	1394	650	--	1397	1050
7GI 6S1	2116	622	701	17393	18028
7GI 6S2	9203	13103	--	8428	1214
7GI 6S3	959	--	--	916	--
7GI 7S1	3581	891	--	5269	1238
7GI 7S2	--	--	--	429	--
7GI 7S3	--	--	--	--	--
7GI 8S1	6116	--	--	7591	1863
7GI 8S2	--	--	--	--	--
7GI 8S3	23501	5600	--	19215	4213
7GI 8S3B	--	--	--	--	--
7GI 9S1	7793	2332	--	5686	3366
7GI 9S2	33257	9317	--	14928	29957
7GI 9S3	39018	4741	--	21634	14875
7GI 10S1	4008	1135	--	4088	2816
7GI 10S2A	8524	7295	--	6006	2776
7GI 10S2B	6419	5641	--	3906	2847
7GI 10S3	11406	8721	--	7198	6843
7GI 11S1	7072	--	--	7953	5453
7GI 11S2	9212	8360	--	7323	4550
7GI 11S3	1765	1403	--	1036	902
7GI 11SP	602	--	--	434	--
7GI 13SP	--	--	--	--	--

Table 5. Results of analyses for semivolatile organic compounds in sediments, Grassy Island – Continued

Field ID	Benzo(a) pyrene (330)	Indeno(1,2,3-cd) pyrene (330)	Dibenz(a,h) anthracene (330)	Benzo(g,h,i) perylene (330)
7GI 2SP	1076	--	--	--
7GI 4S1	873	515	--	542
7GI 4S2	--	--	--	--
7GI 4SP	--	--	--	--
7GI 5S1	5444	8138	1786	10337
7GI 5S2	6090	6587	--	8072
7GI 5S3	--	--	--	--
7GI 5SP	1010	--	--	--
7GI 6S1	29157	171774	35304	47475
7GI 6S2	8661	11316	2000	14129
7GI 6S3	895	534	--	690
7GI 7S1	4965	7069	1668	9253
7GI 7S2	--	--	--	--
7GI 7S3	--	--	--	--
7GI 8S1	5992	5261	1644	6700
7GI 8S2	--	--	--	--
7GI 8S3	18023	22360	6423	25832
7GI 8S3B	--	--	--	--
7GI 9S1	5524	6459	532	8558
7GI 9S2	14714	13526	3250	16300
7GI 9S3	26649	24052	5707	28040
7GI 10S1	4587	5920	1173	7401
7GI 10S2A	5650	6527	1670	7983
7GI 10S2B	4371	4790	1127	5633
7GI 10S3	9967	9665	2710	11671
7GI 11S1	6070	8229	1763	10324
7GI 11S2	7988	7794	--	10501
7GI 11S3	1211	1078	--	1319
7GI 11SP	509	--	--	--
7GI 13SP	--	--	--	--

Table 6. Results of analyses for volatile organic compounds in sediments, Grassy Island. Detection limits are given in parentheses below name of analyte. Sediment sample detection limits and results in µg/kg (micrograms per kilogram, or ppb, dry weight of sample); --, not detected. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Sample Depth (meters below surface)	Methylene Chloride (10)	Acetone (10)	Carbon Disulfide (10)	Benzene (10)	4-Methyl-2-Pentanone (10)
7GI 2SP	F17382	5.18	78	--	--	--	--
7GI 4S1	F17371	0.91	93	--	--	--	--
7GI 4S2	F17372	2.74	68	--	--	--	--
7GI 4SP	F17373	3.66	84	--	--	--	--
7GI 5S1	F17384	.30	--	--	--	--	--
7GI 5S2	F17385	3.05	--	--	--	--	104
7GI 5S3	F17386	4.57	--	--	--	--	--
7GI 5SP	F17387	6.10	--	--	--	--	--
7GI 6S1	F17368	.30	107	--	--	--	--
7GI 6S2	F17369	2.44	134	80	--	33	--
7GI 6S3	F17370	6.10	102	139	24		--
7GI 7S1	F17374	1.22	129	--	--	--	--
7GI 7S2	F17375	3.35	124	193	--	--	--
7GI 7S3	F17376	6.10	72	111	--	--	--
7GI 8S1	F17377	.91	94	--	--	--	--
7GI 8S2	F17378	3.66	86	132	--	--	--
7GI 8S3	F17379	5.49	80	--	--	--	--
7GI 8S3B		5.49	64	--	--	--	--
7GI 9S1	F17397	.30	--	--	--	--	--
7GI 9S2	F17398	2.44	--	--	--	--	145
7GI 9S3	F17399	3.96	--	--	--	34	322
7GI 10S1	F17388	.91	--	--	--	--	174
7GI 10S2A	F17389	1.52	90	--	--	--	10438
7GI 10S2B		1.52	--	--	--	--	1173
7GI 10S3	F17391	4.27	--	564	--	--	9954
7GI 11S1	F17392	.15	92	--	--	--	14047
7GI 11S2	F17393	2.44	83	231	--	--	168
7GI 11S3	F17394	4.57	64	167	--	--	--
7GI 11SP	F17395	5.49	--	92	--	--	31
7GI 13SP	F17383	3.66	124	--	--	--	--

Table 6. Results of analyses for volatile organic compounds in sediments, Grassy Island – Continued

Field ID	2-Hexanone (10)	Toluene (10)	Ethylbenzene (10)	Xylene (total) (10)
7GI 2SP	--	--	--	--
7GI 4S1	--	--	--	--
7GI 4S2	16	--	--	--
7GI 4SP	62	--	--	--
7GI 5S1	--	--	--	--
7GI 5S2	--	--	--	--
7GI 5S3	--	--	--	--
7GI 5SP	--	--	--	--
7GI 6S1	--	--	--	--
7GI 6S2	--	--	--	81
7GI 6S3	--	--	43	122
7GI 7S1	--	--	--	--
7GI 7S2	--	--	--	--
7GI 7S3	--	--	--	--
7GI 8S1	--	--	--	--
7GI 8S2	--	--	--	--
7GI 8S3	--	19	--	--
7GI 8S3B	--	--	--	--
7GI 9S1	--	--	--	--
7GI 9S2	--	--	--	--
7GI 9S3	--	--	93	400
7GI 10S1	--	--	--	--
7GI 10S2A	--	--	--	--
7GI 10S2B	--	--	--	--
7GI 10S3	--	--	--	93
7GI 11S1	--	--	--	--
7GI 11S2	--	--	--	68
7GI 11S3	--	--	--	36
7GI 11SP	--	--	--	--
7GI 13SP	--	--	--	--

Table 7. Results of analyses for pesticides and aroclors (PCBs) in sediments, Grassy Island. Detection limits are given in parentheses below name of analyte. Sediment sample detection limits and results in µg/kg (micrograms per kilogram, or ppb, dry weight of sample); --, not detected. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Sample Depth (meters below surface)	alpha-BHC (1.7)	beta-BHC (1.7)	delta-BHC (1.7)	gamma-BHC (Lindane) (1.7)	Aldrin (1.7)
7GI 2SP	F17382	5.18	--	--	--	--	--
7GI 4S1	F17371	0.91	--	--	--	--	--
7GI 4S2	F17372	2.74	--	--	--	--	--
7GI 4SP	F17373	3.66	--	--	--	--	--
7GI 5S1	F17384	.30	--	--	--	--	--
7GI 5S2	F17385	3.05	--	--	--	--	--
7GI 5S3	F17386	4.57	--	--	--	--	--
7GI 5SP	F17387	6.10	--	--	--	--	--
7GI 6S1	F17368	.30	--	--	--	--	--
7GI 6S2	F17369	2.44	--	--	6.6	--	--
7GI 6S3	F17370	6.10	--	--	--	--	--
7GI 7S1	F17374	1.22	--	--	--	--	--
7GI 7S2	F17375	3.35	--	--	--	--	--
7GI 7S3	F17376	6.10	--	--	--	--	--
7GI 8S1	F17377	.91	--	--	--	--	--
7GI 8S2	F17378	3.66	--	--	--	--	--
7GI 8S3	F17379	5.49	--	--	--	--	--
7GI 8S3B		5.49	--	--	--	--	--
7GI 9S1	F17397	.30	--	--	--	--	--
7GI 9S2	F17398	2.44	--	--	--	--	--
7GI 9S3	F17399	3.96	--	--	--	--	--
7GI 10S1	F17388	.91	--	--	--	--	--
7GI 10S2A	F17389	1.52	--	--	--	--	--
7GI 10S2B	F17390	1.52	--	--	--	--	32.3
7GI 10S3	F17391	4.27	--	--	12.8	4.0	71.1
7GI 11S1	F17392	.15	--	--	--	--	10.6
7GI 11S2	F17393	2.44	4.8	18.6	13.1	6.1	55.3
7GI 11S3	F17394	4.57	--	--	--	--	--
7GI 11SP	F17395	5.49	--	--	--	--	--
7GI 13SP	F17383	3.66	--	--	--	--	--

Table 7. Results of analyses for pesticides and aroclors (PCBs) in sediments, Grassy Island – Continued

Field ID	Endo-sulfan I (1.7)	Dieldrin (3.3)	4,4'-DDE (3.3)	Endrin (3.3)	Endo-sulfan II (3.3)	4,4'-DDD (3.3)	Endo-sulfan sulfate (3.3)
7GI 2SP	--	--	--	--	--	--	--
7GI 4S1	--	--	--	--	--	--	--
7GI 4S2	--	--	--	--	--	--	--
7GI 4SP	--	--	--	--	--	--	--
7GI 5S1	--	--	13.4	14.8	--	13.1	--
7GI 5S2	--	--	100.9	--	--	--	22.2
7GI 5S3	--	--	--	--	--	--	--
7GI 5SP	--	--	--	--	--	--	--
7GI 6S1	--	--	--	--	--	--	--
7GI 6S2	--	--	40.3	--	--	--	--
7GI 6S3	--	--	--	--	--	--	--
7GI 7S1	--	--	--	15.9	--	--	--
7GI 7S2	--	--	--	--	--	--	--
7GI 7S3	10.9	--	69.0	--	14.3	--	--
7GI 8S1	--	--	--	--	--	--	--
7GI 8S2	--	--	12.4	--	--	39.3	--
7GI 8S3	4.2	--	--	--	--	64.5	--
7GI 8S3B	--	--	--	--	--	--	--
7GI 9S1	--	--	--	--	--	--	--
7GI 9S2	--	--	--	--	--	--	--
7GI 9S3	--	--	56.4	--		--	--
7GI 10S1	--	--	--	--	--	--	--
7GI 10S2A	--	12.9	--	--	--	--	--
7GI 10S2B	--	--	38.7	--		65.9	--
7GI 10S3	13.4	21.5	46.8	--	441.0	11.4	16.7
7GI 11S1	--	--	--	--	--	14.0	--
7GI 11S2	20.2	22.9	189.7	81.8	--	454.7	26.5
7GI 11S3	--	--	--	--	--	31.9	--
7GI 11SP	--	--	--	--	--	--	--
7GI 13SP	--	--	--	--	--	--	--

Table 7. Results of analyses for pesticides and aroclors (PCBs) in sediments, Grassy Island – Continued

Field ID	Methoxy-chlor (17.0)	Endrin ketone (3.3)	Endrin aldehyde (3.3)	alpha-Chlor-dane (1.7)	Gamma-Chlor-dane (1.7)	Toxa-phene (170.0)	Aroclor 1016 (33.0)
7GI 2SP	--	--	--	--	--	--	--
7GI 4S1	--	--	--	--	--	--	--
7GI 4S2	--	--	--	--	--	--	--
7GI 4SP	--	--	--	--	--	--	--
7GI 5S1	--	--	--	15.2	--	--	--
7GI 5S2	--	--	--	--	--	--	364
7GI 5S3	--	--	--	--	--	--	--
7GI 5SP	--	--	--	--	--	--	--
7GI 6S1	--	--	--	--	--	--	--
7GI 6S2	--	--	--	--	--	--	180
7GI 6S3	--	--	--	--	--	--	--
7GI 7S1	--	--	--	20.1	--	--	--
7GI 7S2	--	--	--	--	--	--	--
7GI 7S3	--	--	--	--	--	--	1242
7GI 8S1	--	--	--	--	--	--	--
7GI 8S2	--	--	--	11.4	--	--	750
7GI 8S3	--	--	--	13.5	--	--	--
7GI 8S3B	--	--	--	--	--	--	--
7GI 9S1	--	--	--	--	--	--	--
7GI 9S2	--	--	--	--	23.8	--	--
7GI 9S3	--	9.9	--	--	24.7	--	--
7GI 10S1	--	--	--	12.5	15.2	--	--
7GI 10S2A	--	--	--	--	--	--	1207
7GI 10S2B	--	--	10.0	19.2	11.2	--	470
7GI 10S3	--	--	29.8	33.6	39.4	--	1039
7GI 11S1	--	--	--	--	6.2	--	--
7GI 11S2	26.9	44.6	--	59.0	47.6	--	--
7GI 11S3	--	--	--	--	--	--	--
7GI 11SP	--	--	--	--	--	--	--
7GI 13SP	--	--	--	--	--	--	--

Table 7. Results of analyses for pesticides and aroclors (PCBs) in sediments, Grassy Island – Continued

Field ID	Aroclor 1221 (67.0)	Aroclor 1232 (33.0)	Aroclor 1242 (33.0)	Aroclor 1248 (33.0)	Aroclor 1254 (33.0)	Aroclor 1260 (33.0)	Sum of Aroclors
7GI 2SP	--	--	--	--	--	--	--
7GI 4S1	--	--	--	--	--	--	--
7GI 4S2	--	--	--	--	--	--	--
7GI 4SP	--	--	--	--	--	--	--
7GI 5S1	--	--	--	--	283	--	283
7GI 5S2	937	--	2976	--	1350	--	5627
7GI 5S3	--	--	--	--	--	--	--
7GI 5SP	--	--	--	--	--	--	--
7GI 6S1	--	--	--	--	--	--	--
7GI 6S2	--	--	--	--	--	--	180
7GI 6S3	--	--	--	--	--	--	--
7GI 7S1	--	--	--	--	--	--	--
7GI 7S2	--	--	--	--	--	--	--
7GI 7S3	3017	--	--	--	--	--	4259
7GI 8S1	--	--	--	--	--	--	--
7GI 8S2	1811	--	--	--	--	95	2656
7GI 8S3	2082	--	--	--	--	152	2234
7GI 8S3B	--	--	--	--	--	--	--
7GI 9S1	--	--	--	--	347	127	474
7GI 9S2	--	86	2709	--	--	--	2795
7GI 9S3	--	--	--	2015	--	134	2149
7GI 10S1	--	--	--	--	--	--	--
7GI 10S2A	1260	--	2122	1116	832	--	6537
7GI 10S2B	838	160	3042	814	724	218	6266
7GI 10S3	2301	463	9404	2006	2954	783	18950
7GI 11S1	166	369	--	2015	248	249	3047
7GI 11S2	628	1483	318	5599	800	2456	11284
7GI 11S3	141	--	--	470	--	--	611
7GI 11SP	--	--	--	--	--	--	--
7GI 13SP	--	--	--	--	--	--	--

Table 8. Results of analyses for metals in water, Grassy Island. Detection limits are given in parentheses below name of analyte. Trace metal detection limits and results, in µg/L (micrograms per liter or ppb) are expressed as instrument detection limits obtained for pure water; --, not detected. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Aluminum (200)	Arsenic (10)	Barium (200)	Cadmium (5)	Calcium (5000)	Chromium (10)	Copper (25)
7GI 4W	F17381	2509.7	--	--	--	517590.1	12.6	--
7GI 5W	F17396	3923.5	--	--	--	94824.4	51.2	58.4
7GI 6W	F17380	--	--	--	--	444140.6	--	84.7
7GI 11WA	F17400	1528.8	26.3	294.4	6.1	400715.7	29.2	46.5
7GI 11WB	F17401	1547.9	31.8	283.8	--	397028.9	29.7	27.2
7GI 13Wp	F17417	222.9	--	--	5.0	37283.0	--	--
7GI 13Wr	F17418	--	--	--	--	30192.2	--	--

Field ID	Iron (100)	Lead (3)	Magnesium (5000)	Manganese (15)	Mercury (0.2)	Nickel (40)	Potassium (5000)
7GI 4W	62153.9	17.7	231343	3935.2	--	46.4	6141.1
7GI 5W	9817.9	52.8	134297.2	220.2	0.23634	--	11671.7
7GI 6W	443.6	--	115505.2	2696.9	--	40.7	12646.5
7GI 11WA	38335.3	65.4	173213.8	430.8	--	--	26271.1
7GI 11WB	37005.2	61.6	165786.3	414.7	--	--	27357.5
7GI 13Wp	584.72	--	12081.5	49.3	--	--	--
7GI 13Wr	209.3	--	8434.0	--	--	--	--

Field ID	Sodium (5000)	Zinc (20)
7GI 4W	112274.4	99.4
7GI 5W	73252.2	15388.3
7GI 6W	28309.8	451.7
7GI 11WA	163764.4	146.0
7GI 11WB	166487.0	126.0
7GI 13Wp	7178.6	27.9
7GI 13Wr	5623.0	24.3

Table 9. Results of analyses for semivolatile organic compounds in water, Grassy Island. Detection limits are given in parentheses below name of analyte. Detection limits and results in µg/L (micrograms per liter or ppb); --, not detected. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Phenol (10)	2-Methyl-naphthalene (10)	Acenaph-thene (10)	Phenan-threne (10)	bis(2-Ethyl-hexyl)-phthalate (10)	Di-n-octyl-phthalate (10)
7GI 4W	F17381	--	--	--	--	10	--
7GI 5W	F17396	--	--	--	11	43	--
7GI 6W	F17380	--	--	--	--	--	--
7GI 11WA	F17400	--	12	--	10	192	--
7GI 11WB	F17401	--	14	11	14	52	--
7GI 13Wp	F17417	26	--	--	--	--	26
7GI 13Wr	F17418	25	--	--	--	--	--

Table 10. Results of analyses for volatile organic compounds in water, Grassy Island. Detection limits are given in parentheses below name of analyte. Detection limits and results in µg/L (micrograms per liter or ppb); --, not detected; E, exceeds calibration limits; data reported for diluted sample. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Methylene Chloride (10)	Acetone (10)	2-Butanone (10)	4-Methyl-2-Pentanone (10)
7GI 4W	F17420	50	--	--	38
7GI 5W	F17396	25	--	--	--
7GI 6W	F17419	27	29	--	--
7GI 11WA	F17400	25	48	--	838E
7GI 11WB	F17401	23	38	--	662
7GI 13Wp	F17417	26	639E	124	41
7GI 13Wr	F17418	--	20	10	35

Table 11. Results of analyses for pesticides and aroclors (PCBs) in water, Grassy Island. Detection limits are given in parentheses below name of analyte. Detection limits and results in µg/L (micrograms per liter or ppb); --, not detected. Results are given only for those analytes that were detected in one or more samples

Field ID	Lab ID	Methoxy-chlor (0.50)	Endrin ketone (0.10)	Endrin aldehyde (0.10)	alpha-Chlordane (0.05)	gamma-Chlordane (0.05)	Aroclor-1016 (1.0)
7GI 4W	F17381	--	--	--	--	--	1.0
7GI 5W	F17396	0.5	--	--	--	0.05	1.1
7GI 6W	F17380	--	0.1	0.1	--	0.05	--
7GI 11WA	F17400	--	--	--	0.05	0.05	--
7GI 11WB	F17401	--	--	--	--	0.05	--
7GI 13Wp	F17417	--	--	--	--	--	1.0
7GI 13Wr	F17418	--	--	--	--	--	--

Field ID	Aroclor1 232 (1.0)	Aroclor1 242 (1.0)	Aroclor1 248 (1.0)	Aroclor1 254 (1.0)	Aroclor1 260 (1.0)	Sum of Aroclors
7GI 4W	--	--	1.0	--	--	2.0
7GI 5W	1.9	1.4	1.4	--	1.0	6.8
7GI 6W	--	--	--	--	1.0	1.0
7GI 11WA	--	--	--	--	--	0.0
7GI 11WB	--	--	--	--	1.0	1.0
7GI 13Wp	1.0	1.0	1.0	1.0	--	5.0
7GI 13Wr	--	--	--	--	--	--