
Centredale Manor Restoration Project

North Providence, Rhode Island

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Executive Summary

The Centredale Manor Restoration Project (Centredale Manor) site is in North Providence, Rhode Island. The site encompasses the Centredale Manor property and contaminated sediment downstream of the property. Past industrial operations at the Centredale Manor property include textile manufacturing, chemical manufacturing, and drum recycling. Soil, sediment, and surface water at the site are contaminated with dioxins, PCBs, PAHs, pesticides, and metals. The primary contaminants of concern at the Centredale Manor site are dioxins. The habitat of concern to NOAA is the Woonasquatucket River, where American eel are found adjacent to the Centredale Manor property. Surface water runoff and periodic flooding of the Woonasquatucket River are the primary pathways for contaminant migration from the Centredale Manor property to NOAA trust resources.

Site Background

The Centredale Manor Restoration Project (Centredale Manor) site is on the east bank of the Woonasquatucket River in North Providence, Rhode Island (Figure 1). The site encompasses both the Centredale Manor property itself and contaminated sediment in the Woonasquatucket River downstream of the property. The Centredale Manor property is approximately 3.6 ha (9 acres) in area. The property boundary could not be determined from the documents reviewed for this report. Contaminated sediment from the Woonasquatucket River that is associated with the Centredale Manor property has been documented in Allendale Pond and Lymansville Mill Pond (Figure 1) (Batelle 2003a).

From approximately 1921 to 1940, textiles were manufactured at the Centredale Manor property. Between 1943 and 1971, a chemical manufacturing facility and a drum recycling facility operated at the property. Chemical manufacturing records indicated that hexachlorophene was manufactured on the property and trichlorophenols were shipped to the property. In the early 1970s, a large fire destroyed most of the structures at the site. The only structures currently on the property are the Centredale Manor Apartments and the Brook Village Apartments, which were constructed after the fire. During excavation for construction of the apartment buildings, approximately 400 drums were removed from the property. Drums labels indicated that they might have contained halogenated solvents, polychlorinated biphenyls (PCBs), and inks (Tetra Tech 1999). No further details regarding past activities at the property were available for review at the time of this report.

Allendale Dam, which is on the Woonasquatucket River approximately 457 m (1,500 ft) downstream of the Centredale Manor property, creates Allendale Pond (Figures 1 and 2). In 1991, the Allendale Dam was breached as a result of poor maintenance and its age. The breach in the dam allowed contaminated sediment associated with the Centredale Manor property to migrate downstream into Lymansville Mill Pond (Figure 1).

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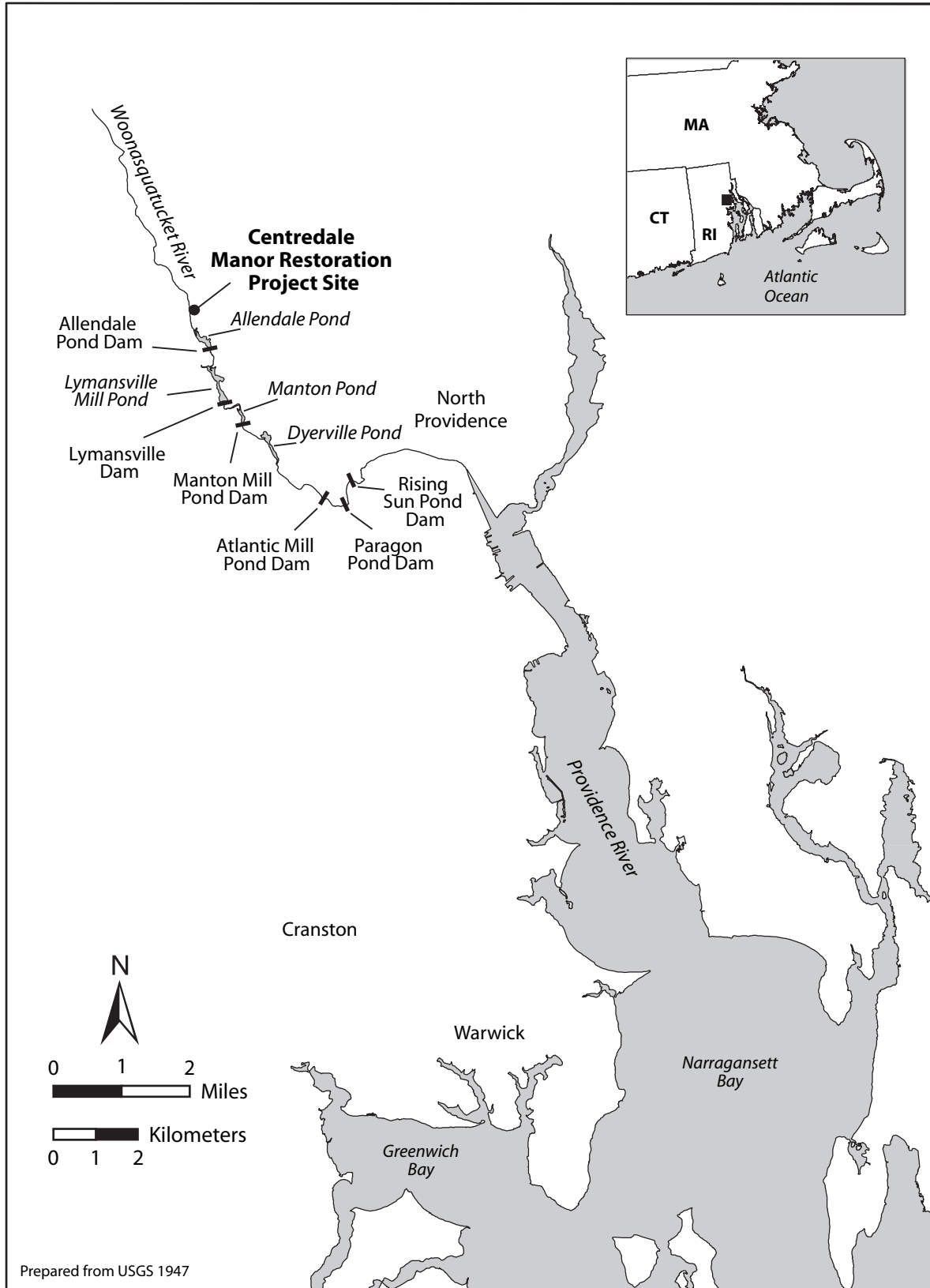


Figure 1. Location of the Centredale Manor Restoration Project site, North Providence, Rhode Island.

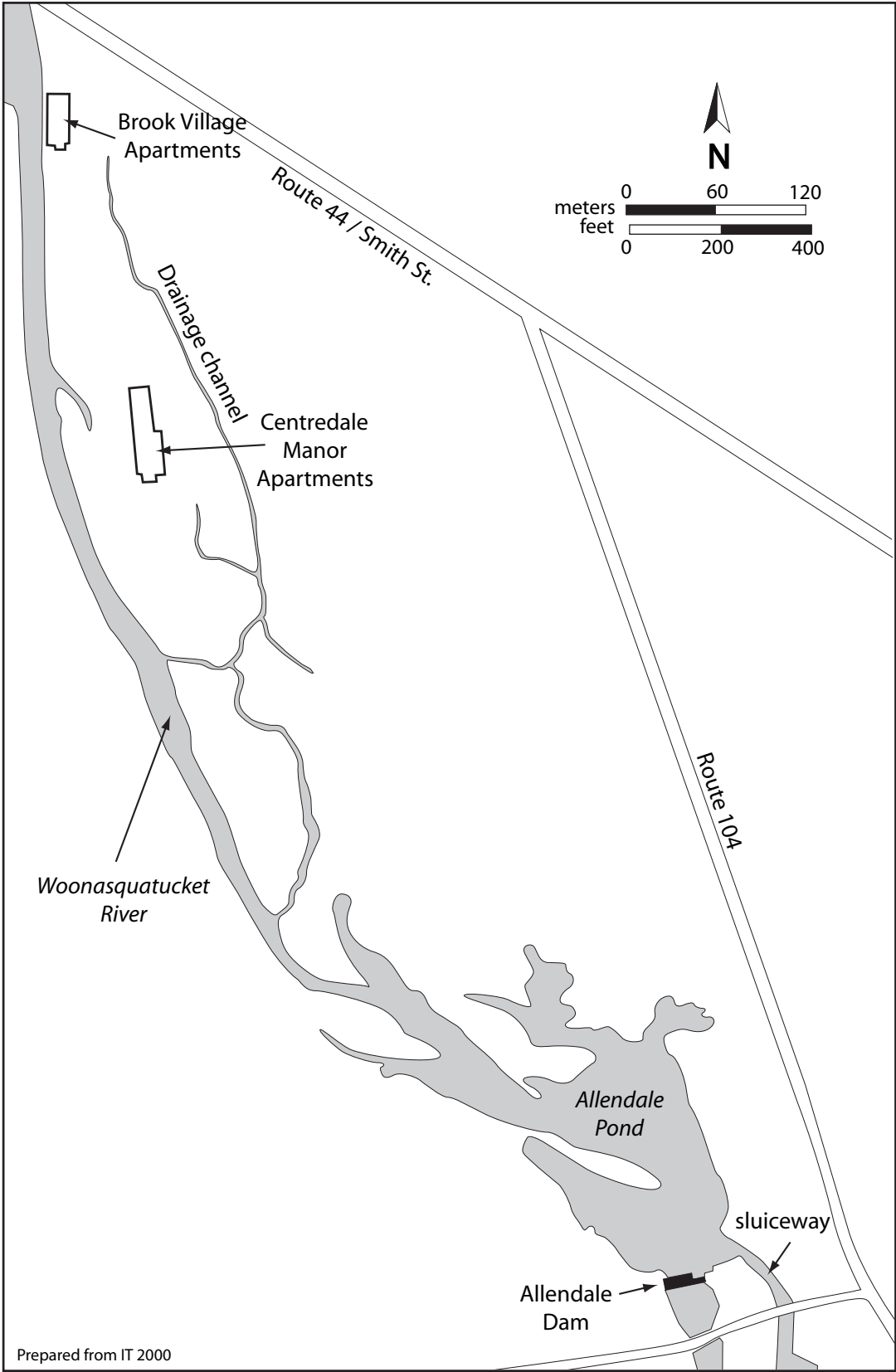


Figure 2. Detail of the Centredale Manor property.

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Several investigations have been conducted to determine the extent of contamination at the site. The U.S. Environmental Protection Agency's (USEPA) collected surface soil samples from the site in February 1999 (Lockheed Martin 1999). Additional sediment and soil samples were collected as part of an expanded site inspection by the USEPA, which was completed in March 1999. In 1999, the USEPA also initiated a remedial investigation (RI). The RI is still in progress; activities completed by the time of this report include restoration of the Allendale Dam, removal of contaminated soil from residential and recreational areas in the floodplain of the Woonasquatucket River, and capping of contaminated soil at the Centredale Manor property (USEPA 2005a). A contractor working on behalf of the U.S. Army Corps of Engineers has completed draft human health and ecological risk assessments for the Centredale Manor site (Batelle 2003a). The USEPA placed the site on the National Priorities List in February 2000 (USEPA 2000).

Surface water runoff and periodic flooding of the Woonasquatucket River are the primary pathways for contaminant migration from the Centredale Manor property to NOAA trust resources. A large portion of the property is within the 10-year floodplain of the Woonasquatucket River. A drainage channel runs along the eastern side of the property and connects to the Woonasquatucket River approximately 0.5 km (0.3 mi) downstream (Figure 2). The property is generally flat with a slight slope to the east toward the drainage channel. Surface water from the property discharges into the Woonasquatucket River via the drainage channel and at several other points along the east bank of the river (Weston 1999a).

NOAA Trust Resources

The habitat of concern to NOAA is the Woonasquatucket River, which discharges into the Providence River estuary. In the general vicinity of the Centredale Manor property, the Woonasquatucket River is non-tidal and highly variable in width, riffle, run and pool habitats, and sediment substrate types. Six lowhead dams, which are impassable to anadromous fish, are present on the river downstream of the Centredale Manor property (Lapin 2000; Figure 1). These dams range in height from 2.9 m (9.5 ft) to 4.6 m (15 ft). The dams nearest the site are the Allendale Dam and Lymansville Mill Dam, which are 4.6 m (15 ft) and 4.0 m (13 ft) high, respectively. The Woonasquatucket River is relatively low gradient and typically contains a community of resident warm-water fish such as bluegill, bullhead catfish, chain pickerel, largemouth bass, pumpkinseed, and shiners. However, cold-water fish such as rainbow trout and white sucker have also been reported in the river (Weston 1999a).

The primary species of concern to NOAA is the catadromous American eel, which is present throughout the river, including areas adjacent to the site (Lapin 2000; Weston 1999a). Eel enter freshwater streams and lakes as juveniles and reside in these areas through adulthood. During their residence period, eel are capable of traversing lowhead dams and small waterfalls that act as obstructions to most anadromous fish. Anadromous fish are not present in the Woonasquatucket River because of the lowhead dams (Lapin 2000).

Recreational fishing for freshwater fish species occurs in the Woonasquatucket River (Weston 1999a). There is no commercial fishery on the river. In 1996, after the collection and chemical analysis of eel tissue from the river, the Rhode Island Department of Health (RIDOH) issued a fish consumption advisory (Weston 1999a). The advisory is still in effect and recommends against the consumption of all fish from the lower Woonasquatucket River because of elevated concentrations of dioxins, PCBs, and mercury (RIDOH 2005).

Site-Related Contamination

The USEPA collected 209 surface soil samples from the site in February 1999 (Lockheed Martin 1999). In March 1999, 39 sediment samples and 28 soil samples were collected from the site as part of an expanded site inspection conducted by the USEPA. In addition, 581 soil and sediment samples were collected for the final site inspection report completed in March 2000 (IT 2000). Additional groundwater, surface water, and sediment samples were collected to support the ecological and human health risk assessments, although the exact numbers could not be determined from the documents reviewed for this report. Although the samples were analyzed for metals, polycyclic aromatic hydrocarbons (PAHs), pesticides, PCBs, and dioxins/furans, the test results for metals and pesticides in groundwater were not available in the documents reviewed for this report. The primary contaminants of concern to NOAA at the Centredale Manor site are dioxins. Contaminants of secondary concern are PAHs, PCBs, metals, and pesticides.

Table 1 summarizes the maximum concentrations of contaminants of concern to NOAA and compares them to appropriate screening guidelines. Site-specific or regionally specific screening guidelines are always used when available. In the absence of such guidance, the screening guidelines for water are the ambient water quality criteria (AWQC; USEPA 2002). The screening guidelines for sediment are the probable effects concentrations (PECs; MacDonald et al. 2000). The screening guidelines for soil are the Oak Ridge National Laboratory final preliminary remediation goals (ORNL-PRGs; Efrogmson et al. 1997), and the USEPA's ecological soil screening guidelines (USEPA 2005b). Any exceptions to these screening guidelines are noted in Table 1. Only concentrations that exceeded the screening guidelines are discussed below.

Surface Water

Ten metals were detected in surface water samples collected from the Centredale Manor site, five of them at concentrations that exceeded the AWQC (Table 1). The maximum concentrations of chromium, selenium, and zinc were detected in a sample collected from the north end of Allendale Pond (Figures 1 and 2). Concentrations of chromium, selenium, and zinc exceeded the AWQC by factors of four, four, and two, respectively (Table 1). The maximum concentrations of copper and lead were detected in a sample collected from the drainage channel east of the Centredale Manor Apartments (Figure 2). Concentrations of copper and lead exceeded the screening guideline by one order of magnitude.

Fifteen PAHs were detected in surface water samples collected at the site. The maximum PAH concentrations were all detected in one sample collected from the Woonasquatucket River west of the Centredale Manor Apartments (Figure 2). Acenaphthene and naphthalene concentrations were below the AWQC (Table 1). Screening guidelines are not currently available for comparison to the concentrations of the other 13 PAHs detected in the surface water samples (Table 1).

Five pesticides were detected in surface water samples collected at the site, two of them at concentrations that exceeded the screening guidelines (Table 1). The maximum concentration of 4,4'-DDT, which occurred in a sample of surface water from Lymanville Mill Pond (Figure 1), exceeded the AWQC by one order of magnitude (Table 1). The maximum concentration of endrin was detected in a sample collected from the drainage channel east of the Centredale Manor Apartments (Figure 2). Endrin concentrations exceeded the screening guidelines by a factor of six.

The maximum concentrations of PCBs and dioxins/furans were detected in surface water samples collected from the Woonasquatucket River west of the Centredale Manor Apartments (Figure 2). Concentrations of PCBs exceeded the screening guidelines by two orders of magnitude, while the concentrations of dioxins/furans exceeded the screening guideline by six orders of magnitude (Table 1).

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Table 1. Maximum concentrations of contaminants of concern to NOAA at the Centredale Manor site (Lockheed Martin 1999; Weston 1999b; IT 2000; Batelle 2003a; Batelle 2003b; Batelle 2004). Contaminant values in bold exceed or are equal to screening guidelines.

Contaminant	Soil (mg/kg)		Ground-water	Water (µg/L)		Sediment (mg/kg)	
	Soil	ORNL-PRG ^a		Surface Water	AWQC ^b	Sediment	PEC ^c
METALS/INORGANICS							
Arsenic	49	9.9	NAv	13	150	18	33
Cadmium	180	0.36 ^d	NAv	0.029	0.25 ^e	24	4.98
Chromium ^f	470	0.4	NAv	42	11	54	111
Copper	930	60	NAv	91	9 ^e	1100	149
Lead	3200	40.5	NAv	220	2.5 ^e	1100	128
Mercury	7.4	0.00051	NAv	0.0039	0.77 ^g	3.6	1.06
Nickel	31	30	NAv	34	52 ^e	4.5	48.6
Selenium	10	0.21	NAv	11	5.0 ^h	3.8	NA
Silver	36	2	NAv	1.8	3.2 ^{ei}	15	4.5 ^j
Zinc	3300	8.5	NAv	500	120 ^e	2100	459
PAHs							
Acenaphthene	4.3	20	ND	0.0015	520 ^k	1.8	0.290 ^j
Acenaphthylene	4.4	NA	ND	0.0013	NA	0.97	0.160 ^j
Anthracene	3.4	NA	ND	0.00097	NA	1.8	0.845
Benz(a)anthracene	7.3	NA	0.22	0.0025	NA	8.4	1.05
Benzo(a)pyrene	7.1	NA	ND	0.0025	NA	9.2	1.45
Benzo(b)fluoranthene	10	NA	0.17	0.0035	NA	13	NA
Benzo(k)fluoranthene	7.1	NA	ND	0.0036	NA	9.2	13.4 ^j
Chrysene	9.3	NA	0.28	0.0051	NA	11	1.29
Dibenz(a,h)anthracene	1.5	NA	ND	0.00046	NA	2.6	0.1 ^j
Fluoranthene	22	NA	0.81	0.014	NA	20	2.23
Fluorene	2.8	NA	ND	ND	NA	0.93	0.536
Indeno(1,2,3-cd)pyrene	4.2	NA	ND	0.00225	NA	6.8	0.330 ^j
2-Methylnaphthalene	1.6	NA	ND	0.0015	NA	0.14	NA
Naphthalene	84	NA	11	0.0077	620 ^k	0.19	0.561
Phenanthrene	25	NA	0.77	0.0056	NA	12	1.17
Pyrene	17	NA	0.61	0.0096	NA	16	1.52
PESTICIDES/PCBs							
Aldrin	1.2	NA	NAv	0.069	3.0 ⁱ	0.00058	0.040 ^j
Chlordane	0.35	NA	NAv	ND	0.0043	0.074	0.0176
4,4'-DDD	1.2	NA	NAv	ND	0.6 ^{ik}	0.052	0.028
4,4'-DDE	2.2	NA	NAv	0.0043	1050 ^{ik}	0.2	0.0313
4,4'-DDT	0.41	NA	NAv	0.01	0.001 ^l	0.022	0.0629
Dieldrin	9.9	0.000032 ^d	NAv	ND	0.056	0.11	0.0618
Endrin	2.1	NA	NAv	0.21	0.036	0.028	0.207
Gamma-BHC (Lindane)	0.0028	NA	NAv	0.00083	0.95 ⁱ	0.006	0.00499
Heptachlor	0.0034	NA	NAv	ND	0.0038	0.0044	0.010 ^j
Heptachlor Epoxide	0.013	NA	NAv	ND	0.0038	0.006	0.016
Total PCBs	1300	0.371	NAv	4.6	0.014	27	0.676
DIOXINS/FURANS							
TEQ (Toxic Equivalent Value) ^m	0.14	3.15x10 ⁻⁶	0.0015	0.013	1.0x10 ^{-8k}	0.073	8.8x10 ^{-6j}

Table 1 continued on next page

Table 1, *cont.*

a:	Oak Ridge National Laboratory (ORNL) final preliminary remediation goals (PRG) for ecological endpoints (Efroymsen et al. 1997).
b:	Ambient water quality criteria for the protection of aquatic organisms (USEPA 2002). Freshwater chronic criteria presented.
c:	Probable Effects Concentration (PEC). Concentration above which adverse effects are likely to be frequently observed (MacDonald et al. 2000).
d:	Ecological soil screening guidelines (USEPA 2005b).
e:	Criterion expressed as a function of total hardness; concentrations shown correspond to hardness of 100 mg/L CaCO ₃ .
f:	Screening guidelines represent concentrations for Cr ⁺⁶ .
g:	Derived from inorganic, but applied to total mercury.
h:	Criterion expressed as total recoverable metal.
i:	Chronic criterion not available; acute criterion presented.
j:	Freshwater upper effects threshold (UET) for bioassays. The UET represents the concentration above which adverse biological impacts would be expected.
k:	Lowest observable effects level (LOEL) (USEPA 1986).
l:	Expressed as total DDT.
m:	Maximum toxic equivalent value (TEQ) is provided. Each dioxin/furan is assigned a toxic equivalency factor (TEF) relative to 2,3,7,8-tetrachlorodibenzodioxin, which is the most toxic in this group of compounds. In order to determine the toxicity of a mixture of dioxin/furan compounds, the measured concentration of the individual dioxin/furans is multiplied by its assigned TEF. The results are summed to produce a TEQ.
NA:	Screening guidelines not available.
NAv:	Result not available from the information reviewed.
ND:	Not detected.

Sediment

Ten metals were detected in sediment samples collected from the Centredale Manor site, eight of them at concentrations that exceeded the PECs (Table 1). The maximum concentrations of lead, mercury, and selenium were detected in sediment samples collected from Allendale Pond (Figures 1 and 2). Lead concentrations exceeded the PECs by a factor of eight and mercury exceeded by a factor of three (Table 1). No screening guideline is currently available for comparison to the selenium concentrations detected in the sediment samples collected (Table 1).

The maximum concentrations of zinc and silver were detected in sediment samples collected from Lymansville Mill Pond (Figure 1). Zinc concentrations exceeded the PEC by a factor of four; silver exceeded the upper effects threshold (UET) by a factor of three (Table 1).

The maximum concentrations of cadmium and copper were detected in a sample collected from the Woonasquatucket River between Lymansville Mill Pond and Manton Pond (Figure 2). Copper concentrations exceeded the PEC by a factor of seven; cadmium concentrations exceeded by a factor of five (Table 1).

Sixteen PAHs were detected in sediment samples collected from the Centredale Manor site, 13 of them at concentrations that exceeded the PECs (Table 1). The maximum concentrations of 12 of the 16 PAHs (anthracene, benz(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, acenaphthylene, and 2-methylnaphthalene) were detected in sediment samples collected from Allendale Pond (Figures 1 and 2). Concentrations of dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene exceeded the PECs by one order of magnitude; fluoranthene exceeded the PEC a factor of nine; benz(a)anthracene and chrysene exceeded the PECs by a factor of eight; acenaphthylene and benzo(a)pyrene exceeded the PECs by a factor of six; anthracene exceeded the PEC by a factor of

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two; fluorene just exceeded the PEC (Table 1). Screening guidelines are not currently available for comparison to the concentrations of 2-methylnaphthalene detected in sediment samples.

The maximum concentrations of acenaphthene and benzo(b)fluoranthene were detected in a sample collected from the Woonasquatucket River between Lymansville Mill Pond and Manton Pond (Figure 2). Acenaphthene concentrations exceeded the PEC by a factor of six; screening guidelines are not currently available for comparison to the concentrations of benzo(b)fluoranthene (Table 1).

Ten pesticides were detected in sediment samples collected from the Centredale Manor site, eight of them at concentrations that exceeded the PECs (Table 1). The maximum concentrations of chlordane, 4,4'-DDE, dieldrin, and endrin were detected in samples collected from Allendale Pond (Figures 1 and 2). Concentrations of endrin exceeded the PEC by one order of magnitude; 4,4'-DDE exceeded by a factor of six; chlordane exceeded the PEC by a factor of four; and dieldrin exceeded the PEC by a factor of two (Table 1).

The maximum concentration of gamma-BHC was detected in a sample collected from the Woonasquatucket River between Allendale Pond and Lymansville Mill Pond (Figure 1). Gamma-BHC concentrations just exceeded the PEC (Table 1).

The maximum concentration of 4,4'-DDD was detected in a sample collected from the Woonasquatucket River between Lymansville Mill Pond and Manton Pond (Figure 2). Concentrations of 4,4'-DDD exceeded the PEC by a factor of two (Table 1).

PCBs were detected in sediment at concentrations that exceeded the screening guidelines (Table 1). The maximum concentration of PCBs, which was detected in a sample collected from Allendale Pond (Figures 1 and 2), exceeded the PEC by one order of magnitude (Table 1).

Dioxins/furans were detected in sediment downstream of the Centredale Manor property as far south as Dyerville Pond, which is approximately 3.7 km (2.3 mi) downstream of the site (Figure 1). Dioxins/furans were detected at concentrations that exceeded the screening guidelines (Table 1). The maximum concentrations of dioxins/furans were detected in a sample collected from Allendale Pond, and exceeded the PEC by three orders of magnitude (Table 1). Dioxins/furans were detected in sediment collected near the Manton Dam (Figure 1), approximately 2.6 km (1.6 mi) downstream of the Centredale Manor property, at concentrations that exceeded the PEC by at least two orders of magnitude.

Groundwater

Seven PAHs were detected in groundwater samples collected at the Centredale Manor site. Maximum concentrations of benz(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were detected in a groundwater sample collected from a monitoring well approximately 76 m (250 ft) south of the Brook Village Apartments (Figure 2). The maximum concentration of naphthalene was detected in a groundwater sample collected just north of the Centredale Manor Apartments. Naphthalene was detected at concentrations below the screening guideline (Table 1). No screening guidelines are currently available for comparison to the other PAHs that were detected in the groundwater samples (Table 1).

The maximum concentration of dioxins/furans in groundwater was detected in a sample collected 61 m (200 ft) south of the Brook Village Apartments, and exceeded the screening guideline by five orders of magnitude (Figure 2; Table 1).

Soil

Ten metals were detected in soil samples collected from the Centredale Manor site at concentrations that exceeded the screening guidelines. Maximum concentrations of cadmium, copper, mercury, and selenium were detected in soil samples collected between the Brook Village Apartments and the Centredale Manor Apartments (Figure 2). Mercury concentrations exceeded the screening guidelines by four orders of magnitude, cadmium by two orders of magnitude, and copper and selenium by one order of magnitude (Table 1).

Maximum concentrations of lead, silver, and zinc were detected in soil samples collected south of the Centredale Manor Apartments (Figure 2). Lead and silver concentrations exceeded the screening guidelines by one order of magnitude; zinc exceeded the screening guideline by two orders of magnitude (Table 1).

The maximum concentration of arsenic was detected in a soil sample collected between the Centredale Manor Apartments and the Woonasquatucket River (Figure 2). Arsenic concentrations exceeded the screening guideline by a factor of five (Table 1).

The maximum concentration of chromium was detected in a soil sample collected from the flood plain of the Woonasquatucket River approximately 229 m (750 ft) southeast of the Centredale Manor Apartments. Chromium concentrations exceeded the screening guidelines by three orders of magnitude (Table 1).

The maximum concentration of nickel was detected in a soil sample collected east of the Centredale Manor Apartments (Figure 2). Nickel concentrations just exceeded the screening guidelines (Table 1).

Sixteen PAHs were detected in soil samples collected at the Centredale Manor site. The maximum concentrations of acenaphthene and naphthalene were detected in soil samples collected between the Brook Village Apartments and the Centredale Manor Apartments (Figure 2). Acenaphthene concentrations were below the screening guideline (Table 1). No screening guidelines are currently available for comparison to the other 15 PAHs that were detected in the soil samples (Table 1).

The maximum concentrations of acenaphthylene, benzo(a)pyrene, and benzo(b)fluoranthene were detected in a soil sample collected south of the Centredale Manor Apartments (Figure 2).

The maximum concentrations of anthracene, benz(a)anthracene, fluoranthene, fluorene, phenanthrene, and pyrene were detected in soil samples collected from the Lymansville Mill Pond floodplain (Figure 2).

The maximum concentrations of benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and 2-methylnaphthalene were detected in a soil sample collected north-east of the Centredale Manor Apartments (Figure 2).

Ten pesticides were detected in soil samples collected at the Centredale Manor site. The maximum concentrations of aldrin, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, and endrin were detected in soil samples collected between the Centredale Manor Apartments and the Brook Village Apartments (Figure 2). Dieldrin concentrations exceeded the screening guideline by four orders of magnitude (Table 1). No screening guidelines are currently available for comparison to the other nine pesticides detected in soil (Table 1).

The maximum concentrations of chlordane and gamma-BHC were detected in soil samples collected north and east of the Centredale Manor Apartments, respectively (Figure 2).

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The maximum concentrations of heptachlor and heptachlor epoxide were detected in soil samples collected within floodplain of the Lymansville Mill Pond (Figure 2).

PCBs and dioxins/furans were detected in soil samples collected throughout the property at concentrations that exceeded the screening guidelines (Table 1). The maximum concentrations of PCBs and dioxins/furans were detected in a sample collected approximately 90 m (300 ft) south of the Centredale Manor Apartments (Figure 2). PCBs concentrations exceeded the screening guidelines by three orders of magnitude; dioxins/furans exceeded the screening guideline by four orders of magnitude (Table 1).

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