FINAL
TECHNICAL MEMORANDUM
VOLUME I - TEXT

WOONASQUATUCKET RIVER SEDIMENT INVESTIGATION

CENTREDALE MANOR RESTORATION PROJECT SITE NORTH PROVIDENCE, RHODE ISLAND

RESPONSE ACTION CONTRACT (RAC), REGION I

For
U.S. Environmental Protection Agency

By
Tetra Tech NUS, Inc.

EPA Contract No. 68-W6-0045
EPA Work Assignment No. 043-TATA-016P
TtNUS Project No. N0400

June 2000

TETRA TECH NUS, INC.

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Stephen S. Parker
Project Manager

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Program Manager

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EXECUTIVE SUMMARY

This technical memorandum has been prepared to describe the tasks and information gathered during investigations of the Woonasquatucket River near the Centredale Manor and Brook Village properties. This work was authorized by the U.S. Environmental Protection Agency (EPA) under work assignment 043-TATA-016P, Contract No. 68-W6-0045.

This effort was conducted to gather further understanding of the distribution of dioxins and other contaminants in the water and sediment of the Woonasquatucket River. Dioxins were first identified in 1998 in fish collected from this river. Since then, additional studies indicate the source may have been a former chemical manufacturing facility located on the property now occupied by the Centredale Manor and Brook Village apartment complexes.

During the period of October 1999 through December 1999, Tetra Tech NUS, Inc. (TtNUS) collected samples of soil, sediment and surface water from the Woonasquatucket River for chemical contaminants and physical parameters. The samples were gathered to augment existing data collected by EPA and others, and the data were collected such that the analytical results could be used to support full human health and ecological risk assessments if these are found to be needed in the future.

The presence of 2,3,7,8-TCDD, in the surface sediments of Allendale Pond, Lymansville Pond, the banks of the river and on residential-use property that is adjacent to these ponds is discussed in this report. Concentrations of 2,3,7,8-TCDD were found to be highest in depositional wetland areas of Allendale Pond. Dioxin concentrations decreased with distance downstream of the suspect source area. The elevated dioxin concentrations appear to be limited to the upper 2 feet of sediment in these areas, based on limited deep samples collected.

Dioxins were detected at concentrations over 1 ug/kg (parts per billion) adjacent to a number of residential properties in the Allendale area, and adjacent to two residential properties abutting Lymansville Pond. During the fall 1999 sampling effort, concentrations of dioxin were found in the aquatic sediments of Lymansville Pond between 1 and 7 ppb. Concentrations of dioxin in the sediments of Allendale pond were between 1 and 15 ppb.

Other contaminants were also found in the river sediments and water during this investigation. Contaminants included polyaromatic hydrocarbons (PAHs), other semivolatile organic compounds, pesticides and metals (Appendices A-D). A full assessment of this and other sediment data collected during previous studies will be compiled for the Engineering Evaluation/Cost Analysis under preparation for the site. Other data needs include an hydrogeologic study to determine groundwater flow around and through the soils at the Centredale Manor and Brook Village properties, and a complete contaminant distribution and analysis in groundwater and soil in and around the Centredale Manor and Brook Village properties.

1.0 PROJECT INTRODUCTION

This Technical Memorandum report has been prepared to describe the sampling and analysis program and the analytical results for the technical assistance support for the Centredale Manor Site located in North Providence, Rhode Island. This work was authorized under Work Assignment Number 043-TATA-016P, Contract No. 68-W6-0045.

The scope of work for this technical assistance involved collection and analysis of sediment, soil, and surface water samples from five specific areas within and adjacent to the Woonasquatucket River.

The study was performed to augment existing data collected, and to attempt to isolate the possible source of dioxins that have been previously identified in the river system. The data were collected such that the analytical results could be used to support full human health and ecological risk assessments if these are found to be needed in the future.

The samples were collected at and downstream of the Centredale Manor Site where dioxins, polychlorinated biphenyls (PCBs), metals, and other contaminants have previously been detected. The scope also includes collection and compilation of analytical data generated by previous investigations into a database for future evaluation purposes. The Centredale Manor Site and the study area defined for this investigation is depicted in Figure 1-1.

This technical memorandum includes five sections: this introduction; the Site Background, including a brief summary of existing data; the sampling and analysis program performed for this study; the findings of the investigation; and the summary and conclusions from the study. The chemical data from samples collected are presented in Appendices A through D and other field documentation is presented in Appendix E.

SITE LOCUS FIGURE			FIGURE 1-1
CENTREDALE MANOR RESTORATION PROJECT SITE			TETRA TECH NUS, INC.
PROVIDENCE, RHODE ISLAND			55 Jonspin Road Wilmington, MA 01887 (978)658-7899
DRAWN BY:	J. R. PICCUITO	REV.: 0	
CHECKED BY:	K. O'NIELL	DATE: MAY 22, 2000	
SCALE:	AS NOTED	ACAD NAME: DWG\0400\0630\LOCUS.DWG	

2.0 SITE BACKGROUND INFORMATION

This section presents background information for the site, including a site description, site history, and a summary of previous investigations.

This Technical Memorandum includes the results from the field investigation performed, based on EPA Work Assignment Form (WAF) Revision 0 dated July 21, 1999, the associated statement of work, and results of a scoping meeting held between EPA and TtNUS on August 4, 1999. This memorandum also includes information previously obtained from the study area by EPA during the Woonsocket River Sediment/Water Quality Analysis (EPA, July 1998), from an Expanded Site Investigation (ESI) of the Centredale Manor Site, North Providence, Rhode Island, performed by Roy F. Weston, Inc. (Weston, March 1999), as well as other data collected by the EPA Emergency Response Program.

2.1 Site Location and Description

This section presents a description of the Centredale Manor site and the study area.

The Centredale Manor is a multi-unit apartment complex that houses elderly adults. It is located at 2074 Smith Street (Route 44) in Centredale, a village of North Providence, Rhode Island. Figure 1-1 depicts the location of the site. The Centredale Manor apartment building and the adjacent apartment building known as "Brook Village", are located on the site of the former Metro-Atlantic Chemical Corporation, which operated from the 1940s to the 1970s in a former mill complex on the site. Parking lots, roadways, lawn areas, and two high-rise residential buildings currently cover the site. The Woonasquatucket River follows the west boundary of the Centredale Manor and Brook Village Properties. The remains of a raceway for the former mill complex are present on the eastern boundary of the site. The Site, as discussed in this report, consists of all contaminated areas within this area as well as any other location to which contamination from this area has come to be located or from which this contamination originated.

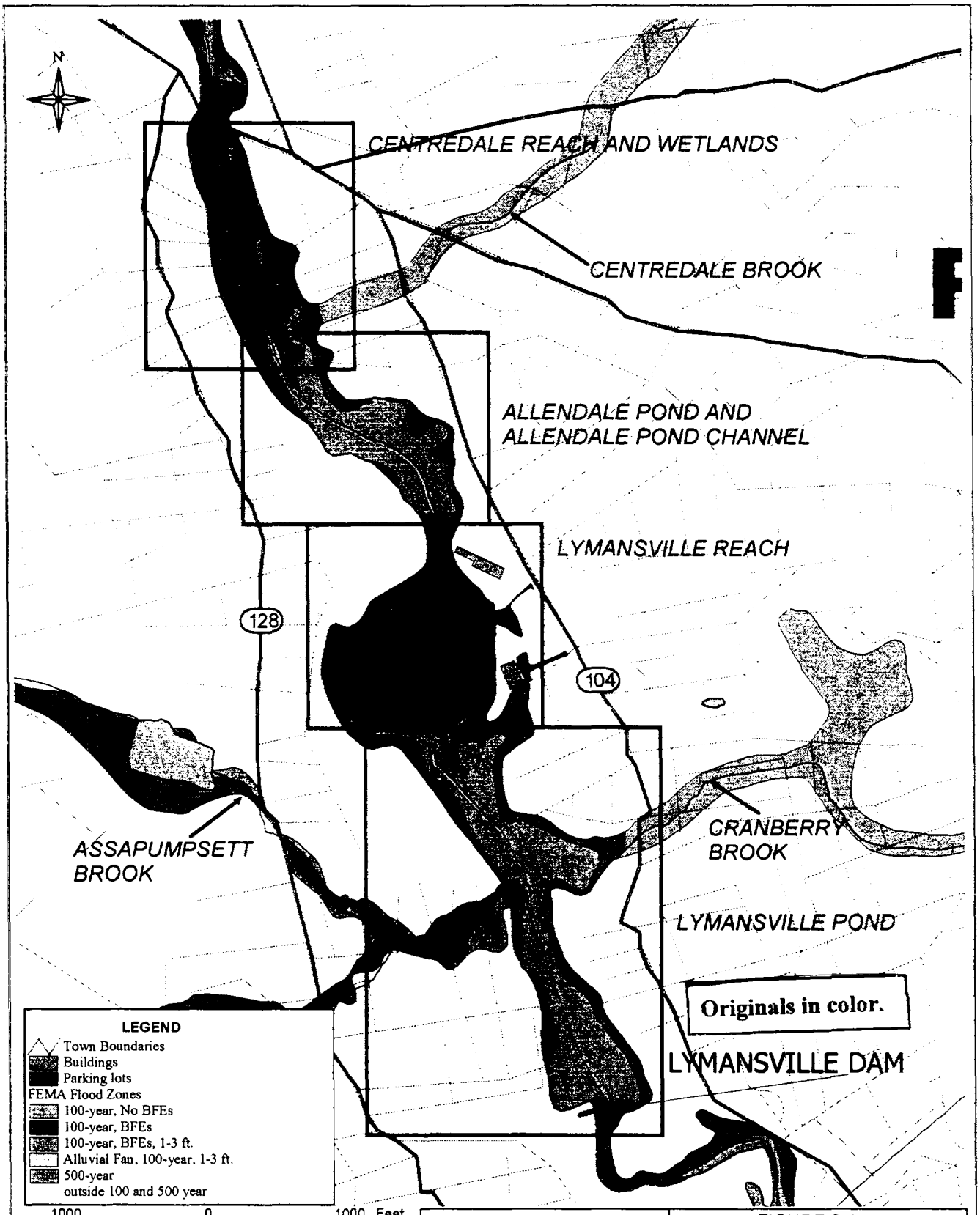
The Woonasquatucket River Sediment Investigation study area includes an area within and adjacent to the Woonsquatucket River where site contaminants were likely to have migrated.

The study area includes a 1.4-mile section of the Woonasquatucket River located between Smith Street (Route 44) and the Lymansville Dam. Specific areas that were sampled in this investigation are identified as follows: the Woonasquatucket River - Centredale Reach, Centredale wetlands, Allendale Pond, the Woonasquatucket River - Lymansville Reach and Lymansville Pond. The location of these areas is depicted in Figure 2-1.

Historical records of Metro Atlantic Chemical researched by Weston (March 1999) indicate that the site manufactured hexachlorophene and that there were shipments of trichlorophenols to the site. The mill complex was destroyed by fire in 1972. Brook village apartments were constructed in 1978. The Centredale Manor was constructed in 1982. During construction of the Centredale Manor, 400 drums and 6,000 cubic yards of contaminated soil were removed from the site. Labels indicated that the drums contained caustics, halogenated solvents, PCBs, and inks.

A Preliminary Assessment (PA) performed on the site in August 1986, by NUS/FIT determined that surface water, soil, and sediment at the Site were potentially impacted. Performance of a Supplemental Site Investigation (SSI) was recommended. The SSI was performed by NUS/FIT in 1990, and detected elevated concentrations of VOCs, SVOCs, pesticides/PCBs, and metals in 10 soil samples collected from the Site. Weston found additional rusted empty drums on the Site near the Woonasquatucket River in October 1995, while performing a Site Inspection Prioritization (SIP) investigation of the property.

A study conducted in June 1996 by the EPA Narragansett Laboratories and the Providence Urban Initiative Program (EPA, 1998) determined that elevated levels of dioxins were present in fish collected from the River. A subsequent study of the Woonasquatucket River conducted by the USEPA OEME in June 1998 found elevated concentrations of dioxins and PCBs in sediments in portions of the river and impoundments adjacent to and downstream of Centredale Manor (EPA, July 1998). Soil and sediment sampling conducted by EPA START personnel in September 1998 found dioxins at concentrations up to 10.1 ppb in sediments collected from the exposed bottom of the former Allendale Pond (Weston, March, 1999). Allendale Pond was an impoundment located immediately downstream of the Centredale Manor Site. The Mill dam containing Allendale Pond was breached in 1991, exposing the sediments. Further sampling conducted in February 1999 on the Centredale Manor property



also found elevated concentrations of dioxins in soils and sediment. Additional historical information on the Centredale Manor Site is available in the Expanded Site Inspection Report, prepared by Weston (March, 1999).

2.2 Previous Environmental Investigations

CERCLA-related investigations performed on the Centredale Manor Site included a Preliminary Assessment (PA) performed in August 1986 by NUS/FIT, a Screening Site investigation (SSI) performed in March 1990 by NUS/FIT, and a Site Inspection Prioritization (SIP) performed by Weston in October of 1995 (Weston, March 1995). These investigations concluded that soils, sediment, surface water, and groundwater had been impacted by hazardous waste disposal activities at the site. These investigations also identified heavy metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and PCBs in soil and sediment. Dioxins analysis was not performed on samples collected during these investigations.

In June 1996, EPA Narragansett Laboratory and Providence Urban Initiative personnel collected fish tissue samples from the Woonasquatucket for analysis of heavy metals, PCBs, hexachlorobenzene, pesticides, and dioxins (EPA, July 1998). Analytical results indicated the presence of elevated concentrations of dioxins in these samples, prompting the Rhode Island Department of Health (RIDOH) to issue a fish consumption advisory for the River.

Two subsequent investigations conducted sampling and analysis of soils and sediments in the vicinity of Centredale Manor. The first investigation was the Woonasquatucket River Sediment/Water Quality Analysis conducted by the OEME performed in July 1998 (OEME, July 1998). The second investigation was an Expanded Site Inspection (ESI) of the Centredale Manor conducted by Weston (Weston, March, 1999). These investigations are summarized in sections 1.1.2.1 and 1.1.2.2, respectively.

2.2.1 Woonasquatucket River Sediment/Water Quality Analysis – OEME, July 1998

This investigation involved collection and analysis of sediments for dioxins, 1,2,4,5,7,8-hexachloro(9H)xanthene (HCX), polyaromatic hydrocarbons (PAHs), PCBs, pesticides, total

organic carbon (TOC), total metals, and acid volatile sulfide/simultaneous extracted metal analysis (AVS/SEM) of copper, zinc, lead, cadmium, nickel, and mercury. Surface water was analyzed for dissolved oxygen, temperature, conductivity and pH. The purpose of the investigation was to determine the source of dioxins, HCX, and other contaminants detected in fish tissue by OEME in June 1996. Sediment and surface water samples were collected from seven impoundments of the Woonasquatucket River formed by the Esmond, Allendale, Lymansville, Manton, Dyerville, Olneyville, and the Lonigan dams. The samples were collected in depositional areas of the impoundments that had silt or clay bottoms (sediments in the Allendale Pond impoundments were exposed at the time since the dam had breached in 1991).

Dioxins and HCA were detected at all seven sample locations. The highest dioxins concentrations were detected in the sediments of the Allendale Pond and Lymansville Pond impoundments that are located adjacent to and downstream of the Centredale Manor Site, respectively. Metals were detected at all sites in varying concentrations and frequencies. The greatest cyanide concentrations (in descending order of concentration) were detected at the Esmond, Lymansville, and Allendale Pond impoundments. The highest concentrations of PAHs were detected in the Allendale Pond impoundment. The highest concentrations of PCBs were detected (in descending order of concentration) at the Dyerville, Lymansville, and Allendale dams.

The investigation report concluded that there might be multiple sources for the dioxins detected in the Woonasquatucket River. Distributions of high molecular weight dibenzo-*p*-dioxins (PCCDs) and dibenzofurans (PCDFs) indicate multiple sources associated with the use of pentachlorophenol in the wood preservative and textile industry. The presence of 2,3,7,8-tetrachloro-*p*-dioxins indicated the presence of a source between the Esmond and Allendale dams that was involved in the manufacturing of 2,4,5-trichlorophenol and hexachlorophene. Historical records indicate that the former Metro Atlantic Chemical Company received shipments of trichlorophenol and manufactured hexachlorophene at the present location of the Centredale Manor.

2.2.2 Expanded Site Inspection Centredale Manor - Weston, March 1999

In response to these findings, START initiated an Expanded Site Investigation (ESI) of the Centredale Manor Site under the direction of EPA. The ESI was initiated in June 1998, to address the presence of dioxins/furan and hexachloroxanthene (HCX) contamination on the Site, the extent of contamination in areas of potential human exposure, and potential source areas located upstream of the Site. This was the first investigation to analyze for the presence of dioxins and HCX on the Centredale Manor Site.

On September 5, 1998, START personnel collected five soil samples from the Centredale Manor Property, one soil sample from the Brook Village property, 35 sediment samples from the Woonasquatucket River, and four sediment samples from the former drainage canal. The soil and sediment samples were analyzed for dioxins, HCX, SVOCs, pesticides/PCBs, and TOC.

Analysis of these samples indicated that 12 SVOCs, 12 pesticides, one PCB (Aroclor 1254), dioxins and HCX were detected at concentrations exceeding reference values in various sediment samples collected along the Woonasquatucket River downstream of the Centredale Manor property. Five pesticides, one PCB, dioxins, and HCX were detected at concentrations exceeding reference values in the drainage channel and downstream sediment samples.

Dioxins concentrations were found to be highest near the Centredale Manor property and attenuated to less than one part per billion (ppb) at downstream locations. The highest concentration of dioxins was identified along the drainage channel adjacent to the Centredale Manor property. The maximum dioxins concentration detected in the Woonasquatucket River was found in a sample collected from the sediments of Allendale Pond (10.1 ppb). Dioxins concentrations detected in sediment samples collected upstream from the Centredale Manor Site were significantly lower than those collected adjacent to and downstream of the Site.

On January 15, 1999, START personnel collected 17 soil samples from the Centredale Manor and Brook Village properties, the Lee Romano Little league field, and the Boys and Girls club property. The soil samples with the highest dioxins concentration were those collected from the Centredale Manor property, where dioxins concentrations exceeded the 1 ppb cleanup

level for residential properties. A geophysical study was also conducted at this time on the Centredale Manor and Brook Village that found anomalies which may be buried metal objects.

2.2.3 Emergency Response Actions

USEPA Emergency and Rapid Response Service Region I (ERRS-I), supported by the IT Group, Inc., conducted a time-critical removal response. This action included an evaluation of the Centredale Manor and Brook Village properties to determine the extent of source control actions. As part of this activity, sampling and analysis was conducted from June through November 1999. Part of this evaluation was an extensive sampling program for soils and sediment from the occupied portions of the Centredale Manor and Brook Village properties and the floodplain wetlands to the south.

Samples were collected by hand auger and geoprobe(TM) drilling methods. Samples were collected from one foot intervals from the surface to either the top of the water table (at upland locations) or to method refusal (at pond sediment locations). All samples (581) were analyzed for 2,3,7,8 TCDD for quick turn-around analysis. A subset of these samples (346) were analyzed for PCBs. Limited samples (approximately 80) were also collected for analysis for a full suite of contaminants, including volatile organic compounds, semivolatile organic compounds, pesticides, herbicides, metals, and cyanide. Selected samples (64) were analyzed for PCDD and PCDF. Samples analyzed for the full set of analytes were selected randomly, and from stations where there was a highest likelihood of potential contamination.

Data was reported in the final IT Site Investigation Report (March 16, 2000). 2,3,7,8 TCDD was reported above detection limits in 74 % of the samples collected. The 2,3,7,8 TCDD isomer is generally considered the most toxic of the PCDD and PCDF (dioxin and furan) compounds that are used to calculate a toxicity equivalency value, or TEQ. However evaluation of the ERRS 1 data by IT indicated that 2,3,7,8 TCDD contributed to 98% of the TEQ. Highest concentrations of 2,3,7,8-TCDD detected during this effort (two samples at 140 ug/kg) were found immediately south of the Centredale Manor parking area and under the Brook Village parking area.

PCBs were considered a secondary concern at the site and samples were also analyzed for the PCBs as Aroclors. Results indicated that PCBs were detected at concentrations greater than the residential standards of 10 ppm in areas north, west, and south of the Centredale Manor building and in Allendale Pond. Aroclor 1254 was the most prominent PCB detected (76 percent of all samples). The highest concentrations of PCBs (1300 mg/kg) were detected in the soils immediately south of the Centredale Manor parking area.

Based on this data, a two interim containment structures, or caps, were placed on exposed soils that exhibited elevated levels of dioxin on and adjacent to the Centredale and Brook Village properties and adjacent to the river in order to reduce erosion and contaminant transport. Construction of the first cap commenced immediately after the first group of data was analyzed, and construction of the second cap is on-going as of the date of this Technical Memorandum. In addition, fences were installed to restrict access to areas where dioxins were found above the 1 ppb level.

2.3 Woonasquatucket River Sediment Investigation

As described in Section 2.2.1 of this Technical Memorandum, dioxins and other contaminants may have been transported from the Centredale Manor Site by the Woonasquatucket River and deposited in adjacent and downstream areas. RIDOH still maintains a consumption advisory on all fish caught from the River due to high dioxins concentrations.

Existing information collected on downstream contamination was insufficient to adequately characterize the risks to human health and the environment from dioxins, HCX, and other contaminants (metals, PCBs, cyanide, and PAHs) in the river sediments, riverbanks, and adjacent floodplain areas. Therefore, EPA initiated an expanded sediment investigation to begin the risk characterization process. That sediment investigation is the subject of this Technical Memorandum.

The Woonasquatucket River sediment investigation was conducted on the soil and sediment of the Woonasquatucket River and it's associated flood plains between Route 44 south to Lymansville Dam. The study focused on building on existing data presented in previous

reports described in this section to gather a better understanding where dioxins are present at concentrations that present a threat to persons or the environment.

3.0 SITE MANAGEMENT/FIELD SAMPLING PLAN

This section describes the Woonsquatucket River Sediment Investigation for determining contaminant distribution adjacent to and downstream of the Centredale Manor Restoration Project Site.

The purpose of this field sampling program was to conduct additional sampling in areas that have been impacted by contaminants released from the subject site and transported and deposited by the waters of the Woonsquatucket River. The goal of the investigation was to build on existing data available and identify the extent to which these contaminants have impacted the soils, sediments, and surface water of specific portions of the river system. In addition, the data collected for this effort will be used to perform human health and ecological risk assessments and engineering evaluations.

The following sections detail the surface water, bank and stream sediments, and residential soil sampling activities that comprised the field investigation. Figures 3-1 and 3-2 depict the locations sampled by TtNUS during this sediment investigation.

This effort was conducted in accordance with the Work Plan for Sediment Investigation (TtNUS, 10/99), the Sampling and Analysis Plan (SAP) for Woonasquatucket River Sediment Investigation (TtNUS 10/99), and supporting documents and standard operating procedures (SOPs).

Activities associated with the field investigation included:

- Residential Soil Sampling
- Bank Sediment Sampling
- Aquatic Sediment and Surface Water Sampling
- Deep (subsurface) Sediment Sampling
- Floodplain Sediment Sampling

In addition, as part of the sampling activities, the locations were surveyed using Global Positioning System (GPS) survey equipment with sub-meter accuracy. Each station location

has been incorporated into an Arcview-GIS-Database System for EPA. Selected photos from the field investigation are presented in Appendix G.

3.1 Residential Soil Sampling

The objective of the residential sampling was to determine the nature and extent of site related contamination on and adjacent to the residential properties that abut the Woonasquatucket River. In some cases, these areas include portions of Allendale Pond that were exposed due to lowering of the impounded water elevation when the Allendale Dam failed in 1991. Some of these exposed areas presently have the potential to be used as part of the residential properties.

A total of 62 residential lots were sampled during this effort. Soil samples were collected at a depth interval of 0 to 1.0 feet below ground surface (bgs) at all stations. The 0 to 1-foot depth interval was selected to be representative of residential exposures based on typical residential activities including gardening, landscaping, etc. Soil samples collected from residential lots were analyzed for metals, SVOCs, pesticides/PCBs, dioxins, and HCX.

The location of soil samples on residential lots was determined using the limits of the 100-year floodplain, distance from the site, and likelihood of deposition, etc, as guides. Because some properties had been previously sampled during the emergency response evaluation (Section 2.2.3 of this technical memorandum), each property was evaluated for additional sampling. Additional samples were collected as needed to assure there was a minimum of three samples for dioxin and HCX and a minimum of one sample for pesticides/PCBs, SVOCs, and metals from each lot. Table 3-1 presents a list of the residential lots sampled, analyses performed, and the sample identification numbers. A total of 62 locations were sampled for CLP analyses (metals, SVOCs, pesticides/PCBs) and 126 samples were collected for analyses of dioxin, and hexachloroxanthene (HCX).

Generally, at each lot, three samples were collected for dioxin/HCX analysis along a line perpendicular to the pond or river with the first sample collected nearest the water, and the remaining two samples collected along the line (generally moved upgradient in the direction of

TABLE 3-1
RESIDENTIAL SOIL SAMPLING SUMMARY
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Plat	Lot	Owner(s)[3]	Address of Lot Sampled (N. Providence, RI)	Samples Collected	
				Diox. (1)	CLP(2)
14	271	Serio, Anthony	41 Steere Ave.	CMS-506-A CMS-507-A CMS-508-A CMS-220-A RES-SS-14-271-01A	RES-SS-14-271-01
14	272	Naber, Charles	36 Steer Ave.	CMS-503-A CMS-504-A CMS-505-A CMS-223-A	RES-SS-14-272-01
14	302	Grenier, Antoniette	45 Grover St.	CMS-500-A CMS-501-A CMS-502-A CMS-222-A	RES-SS-14-302-01
14	303	Rotella, Flora E	42 Redfern St.	RES-SS-14-303-01 RES-SS-14-303-02 CMS-481-A	RES-SS-14-303-01
14	333			RES-SS-14-333-01 RES-SS-14-333-02 RES-SS-14-333-03	RES-SS-14-333-01
14	334			CMS-482-A CMS-225-A CMS-483-A,B,C	RES-SS-14-334-01
14	365	Luca, Jon W	43 George St.	RES-SS-14-365-01 RES-SS-14-365-02 RES-SS-14-365-03	RES-SS-14-365-01
14	366	Rehel, Jacqueline G	46 George St.	RES-SS-14-366-01 RES-SS-14-366-02 RES-SS-14-366-03	RES-SS-14-366-01
14	398	Fitzgerald, Virginia M	41 Stevens St.	CMS-497-A CMS-498-A CMS-499-A CMS-221	RES-SS-14-398-01
14	399	Peloquin, Joseph	44 Stevens St.	RES-SS-14-399-01 RES-SS-14-399-02 CMS-472-A	RES-SS-14-399-01
14	418	Assante, Debra R. 1079 Atwood Ave, Johnston, RI 02919	21 Aldrich St.	No Access	No Access
14	419	Asselin, Donald A	22 Aldrich St.	CMS-460-A	RES-SS-14-419-01
14	420			CMS-461-A	RES-SS-14-420-01
14	421			CMS-206	RES-SS-14-421-01

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Plat	Lot	Owner(s)[3]	Address of Lot Sampled (N. Providence, RI)	Samples Collected	
				Diox. (1)	CLP(2)
14	422	Vitullo, Joseph A	16 Aldrich St.	CMS-462-A	
				RES-SS-14-422-01	RES-SS-14-422-01
				RES-SS-14-422-02	
14	424			CMS-463-A	RES-SS-14-424-01
				RES-SS-14-424-01	
				RES-SS-14-424-02	
14	425			RES-SS-14-425-01	RES-SS-14-425-01
				RES-SS-14-425-02	
				RES-SS-14-425-03	
14	430	Sgambato, Frank or Barbara	15 Centredale Ave.	CMS-464-A	RES-SS-14-430-01
				CMS-465-A	
				CMS-224-A	
14	448	Saravo, Ettore	34 Centredale Ave.	RES-SS-14-448-01	RES-SS-14-448-01
				CMS-466-A	
				CMS-467-A	
14	449	DiLazzaro, Vincenza	578 Woonasquatucket Ave.	RES-SS-14-449-01	RES-SS-14-449-01
				RES-SS-14-449-02	
				RES-SS-14-449-03	
14	210	Cimorelli, Elsie A	566 1/2 Woonasquatucket Ave.	RES-SS-14-210-01	RES-SS-14-210-01
				RES-SS-14-210-02	
				RES-SS-14-210-03	
12	239	Cusson, Eva I	562 Woonasquatucket Ave.	CMS-484-A,B,C	RES-SS-12-239-01
				CMS-485-A	
				CMS-486-A	
				CMS-487-A,B,C	
12	240			RES-SS-12-240-01	RES-SS-12-240-01
				RES-SS-12-240-02	
12	550	Allendale Baptist Church	550 Woonasquatucket Ave.	CMS-469-A	RES-SS-12-550-01
				CMS-470-A	
				CMS-471-A	
				CMS-216-A	
12	551	Lewis, Harold E	542 Woonasquatucket Ave.	CMS-494-A	RES-SS-12-551-01
				CMS-495-A	
				CMS-496-A	
12	552	McCurdy, Ross KJ	530 Woonasquatucket Ave.	CMS-488-A	RES-SS-12-552-01
				CMS-489-A	
				CMS-490-A	
12	553	Davidow, Mary Jane	524 Woonasquatucket Ave.	CMS-491-A	RES-SS-12-553-01
				CMS-492-A	
				CMS-493-A	

TABLE 3-1
RESIDENTIAL SOIL SAMPLING SUMMARY
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Plat	Lot	Owner(s)[3]	Address of Lot Sampled (N. Providence, RI)	Samples Collected	
				Diox. (1)	CLP(2)
12	554	Carcone, Hilda E	518 Woonasquatucket Ave.	CMS-475-A CMS-476-A CMS-477-A,B,C	RES-SS-12-554-01
12	555	Richardson, Alice I	512 Woonasquatucket Ave.	RES-SS-12-555-01 CMS-473-A CMS-474-A	RES-SS-12-555-01
12	556	Dionne, Joseph and Lynn	500 Woonasquatucket Ave.	RES-SS-12-556-01 RES-SS-12-556-02 CMS-468-A	RES-SS-12-556-01
12	560	James Taylor PO Box 6051 Providence RI	Allendale Mill Apts 494 Woonasquatucket Ave	CMS-217-A CMS-218-A CMS-219-A CMS-457-A CMS-458-A CMS-459-A	RES-SS-12-560-01 RES-SS-12-560-02
12	323	Parcaro, Felix Jr.	23 Maple Ave	No Access	No Access
12	324	AAI Foster Grant		No Access	No Access
11	11	500 George Washington Highway, Smithfield Rhode Island 02917		RES-SS-11-011-01 RES-SS-11-011-02 RES-SS-11-011-03	RES-SS-11-011-01
11	12			RES-SS-11-012-01 RES-SS-11-012-02 RES-SS-11-012-03	RES-SS-11-012-01
11	419	Muscatelli, Michelina 36 Zambarano Ave.	36 Zambarano Ave.	RES-SS-11-419-01 RES-SS-11-419-02 RES-SS-11-419-03	RES-SS-11-419-01
11	420	Dipetrillo, Aleck J 37 Zambarano Ave.	37 Zambarano Ave.	RES-SS-11-420-01 RES-SS-11-420-02 RES-SS-11-420-03 RES-SS-11-420-04	RES-SS-11-420-01
11	422	Cornachione, Frank 35 Zambarano Ave.	35 Zambarano Ave.	RES-SS-11-422-01 RES-SS-11-422-02 RES-SS-11-422-03	RES-SS-11-422-01
11	423	McCoy, Richard J	18 Falco Ave.	RES-SS-11-423-01 RES-SS-11-423-02 RES-SS-11-423-03	RES-SS-11-423-01
11	424			RES-SS-11-424-01 RES-SS-11-424-02 RES-SS-11-424-03	RES-SS-11-424-01
11	425	Campanelli, Anthony J	16 Falco Ave.	RES-SS-11-425-01 RES-SS-11-425-02 RES-SS-11-425-03	RES-SS-11-425-01

TABLE 3-1
RESIDENTIAL SOIL SAMPLING SUMMARY
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Plat	Lot	Owner(s)[3]	Address of Lot Sampled (N. Providence, RI)	Samples Collected	
				Diox. (1)	CLP(2)
11	426			RES-SS-11-426-01 RES-SS-11-426-02 RES-SS-11-426-03	RES-SS-11-426-01
11	427	Cinquegrana, Mrs	14 Falco Ave.	RES-SS-11-427-01 RES-SS-11-427-02 RES-SS-11-427-03	RES-SS-11-427-01
11	428			RES-SS-11-428-01 RES-SS-11-428-02 RES-SS-11-428-03 RES-SS-11-428-G	RES-SS-11-428-01
11	429			RES-SS-11-429-01 RES-SS-11-429-02	RES-SS-11-429-01
11	430	Rapone, Filomena	12 Falco Ave.	RES-SS-11-430-01 RES-SS-11-430-02 RES-SS-11-430-03	RES-SS-11-430-01
11	431			RES-SS-11-431-01 RES-SS-11-431-02 RES-SS-11-431-03	RES-SS-11-431-01
11	432	Simmons, Raymond	10 Falco Ave.	RES-SS-11-432-01 RES-SS-11-432-02 RES-SS-11-432-03	RES-SS-11-432-01
11	433			RES-SS-11-433-01 RES-SS-11-433-02 RES-SS-11-433-03	RES-SS-11-433-01
11	486	Defelice, Mary or Robert Sousa Jr.	318 Woonasquatucket Ave.	RES-SS-11-486-01 RES-SS-11-486-02 RES-SS-11-486-03	RES-SS-11-486-01
11	328	Graham, John Lawrence	316 Woonasquatucket Ave.	RES-SS-11-328-01 RES-SS-11-328-02 RES-SS-11-328-03	RES-SS-11-328-01
11	497	Velleco, Frank C	306 Woonasquatucket Ave.	RES-SS-11-497-01 RES-SS-11-497-02 RES-SS-11-497-03	RES-SS-11-497-01
11	396	Eastlande Park Corporation 1346 Newport Ave Attleboro, MA 02703	296 Woonasquatucket Ave.	RES-SS-11-396-01 RES-SS-11-396-02 RES-SS-11-396-03	RES-SS-11-396-01
11	577	Cassisi, Denise	33 Oak St.	RES-SS-11-577-01 RES-SS-11-577-02 RES-SS-11-577-03	RES-SS-11-577-01
10 10	4 5	Pellegrino, Raymond G	28 Oak Street	RES-SS-10-004-01 RES-SS-10-004-02 RES-SS-10-004-03	RES-SS-10-004-01

TABLE 3-1
RESIDENTIAL SOIL SAMPLING SUMMARY
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Plat	Lot	Owner(s)[3]	Address of Lot Sampled (N. Providence, RI)	Samples Collected	
				Diox. (1)	CLP(2)
10	42	Testa, John J	5 Testa Drive	RES-SS-10-005-01	RES-SS-10-005-01
				RES-SS-10-005-02	
				RES-SS-10-005-03	
				RES-SS-10-042-01	RES-SS-10-042-01
				RES-SS-10-042-02	
				RES-SS-10-042-03	
10	604	Furtado, Louise	36 Allendale Avenue	RES-SS-10-604-01	RES-SS-10-604-01
				RES-SS-10-604-02	
10	44			RES-SS-10-604-03	
10	53	Deluca, Joseph	2 Eric Place	RES-SS-10-044-01	RES-SS-10-044-01
		191 Carlton St.		RES-SS-10-044-02	
10	68	North Providence, RI		RES-SS-10-044-03	
				RES-SS-10-053-01	RES-SS-10-053-01
				RES-SS-10-053-02	
				RES-SS-10-053-03	
10	74	Laurie, Duane	18 Water Street	RES-SS-10-068-01	RES-SS-10-068-01
				RES-SS-10-068-02	
				RES-SS-10-068-03	
				RES-SS-10-074-01	RES-SS-10-074-01
				RES-SS-10-074-02	
				RES-SS-10-074-03	
10	75			RES-SS-10-075-01	RES-SS-10-075-01
				RES-SS-10-075-02	
				RES-SS-10-075-03	
10	76			RES-SS-10-076-01	RES-SS-10-076-01
				RES-SS-10-076-02	
				RES-SS-10-076-03	

Note: (1) Samples identified with "CMS" identifier were collected by the IT Group, 1999
(2) CLP analysis includes analysis for SVOCs, Pesticides, PCBs, and Metals (see text)
(3) Address of lot sampled unless otherwise specd.

the home or structure, if present). Field sketches of samples collected at residential locations are presented in Appendix E.

The three dioxin/HCX samples were positioned at the top, middle, and bottom of the slope, but within the 100-year floodplain as determined by the field scientist. One grab sample for SVOCs, metals, and pesticides/PCBs was collected from the station closest to the water body.

All soil samples were collected using hand tools (stainless steel bucket augers, trowels) according to Sections 5.2 and 5.5 of TtNUS SOP SA-1.3. All sampling devices were decontaminated prior to use following the procedures specified in the Sampling and Analysis Plan (TtNUS, 10-99). The soil sample collection procedure is summarized below:

- Soil from the 0 to 1-foot depth interval was collected and placed in a decontaminated stainless steel mixing bowl. The soil was then monitored for VOCs using a portable photoionization detector (PID). VOC field screening results and a soil description were recorded on the field data collection form.

- The soil sample was thoroughly mixed and homogenized and transferred to the appropriate sample containers for laboratory analysis.

Sample areas on residential properties were repaired with topsoil to match the surrounding grade.

All sampling stations were surveyed during the sampling program using GPS (Global Positioning System) survey equipment with sub-meter accuracy. In order to avoid multiple stakes on private property, only the residential sample station that is nearest the water body was marked by a wooden stake. The stake was labeled with the sample identification number. The remaining sample stations at the residential location were located by measuring the distance from the stake. These data were recorded on the sample data sheets or in the field logbook.

3.2 Bank Sediment Sampling

Bank sediment samples from areas frequently used for recreational activities such as fishing and boat launching were collected. Bank sample stations were located during a site visit prior to the sampling event and were based on visual evidence of recreational use (i.e. worn trails or open areas along the river bank).

A total of 24 bank sediment samples were collected at eight stations (three samples at each station) along the Study Area. This includes six bank samples at two reference stations located upstream of the Route 44 bridge crossing and the subject Site. The bank sediment samples were collected from a depth interval of 0 to 0.5-foot bgs. The 0 to 0.5-foot depth interval was selected as a representative depth of sediment likely to be contacted by a person accessing a muddy shoreline for fishing, fishing from the shoreline, or launching hand-carried boats. Bank sediment samples were analyzed for SVOCs, pesticides/PCBs, dioxin, and HCX (see Table 3-2).

The three bank samples collected at each station were collected along a line perpendicular to the waterbody. The bank samples were designed as "X", "Y" and "Z", to indicate where each sample is located, relative to the waterbody. Where the bank of the river was identifiable, samples will be collected at the toe (X), mid-point (Y), and top of the bank (Z). The "X" samples were collected immediately adjacent to the water (typically within 1 foot) the "Y" and "Z" samples collected at distances ranging from approximately 3 to 23 feet further upgradient from the "X" sample location (dependent on the slope gradient). Bank samples were collected using the same equipment and following the same procedures described above for residential soil sampling.

3.3 Surface Sediment and Deep Sediment Samples

The objective of the sediment-sampling program was to determine the extent of the site related contamination in the Woonsquatucket River within the study area. The data will also be used to evaluate the bioavailability of contaminants to the receptors. Surface sediment samples were collected from a depth interval of 0 to 0.5-foot bgs at pre-determined depositional areas. These samples were analyzed for pesticides/PCBs, SVOCs, metals, TOC, grain size, acid

TABLE 3-2
SURFACE WATER AND SEDIMENT SAMPLING SUMMARY
OCTOBER THROUGH DECEMBER 1999
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Sample Depth (feet bgs [3])	Dioxin HCX	SVOC Pest/ PCBs	Total Metals	Dissolved Metals[1]	AVS/ SEM	TOC	Grain Size	Free Water	Dup ID [2]
RCC-SW-3001-01	0.5	X	X	X	X					
RCC-SD-3001-01	0-0.5	X	X	X		X	X	X	X	
RCC-FP-3001-01	0-0.5	X	X	X		X	X	X		
RCC-BK-3001X-01	0-0.5	X	X	X					X	D3
RCC-DU-102299A	0-0.5	X	X	X						D3
RCC-BK-3001Y-01	0-0.5	X	X	X						
RCC-BK-3001Z-01	0-0.5	X	X	X						
RCC-SW-3002-01	0.5	X	X	X	X					
RCC-SD-3002-01	0-0.5	X	X	X		X	X	X	X	
RCC-FP-3002-01	0-0.5	X	X	X		X	X	X	X	
RCC-BK-3002X-01	0-0.5	X	X	X					X	
RCC-BK-3002Y-01	0.0.5	X	X	X						
RCC-BK-3002Z-01	0-0.5	X	X	X						
RCC-SW-3003-01	0.5	X	X	X	X					
RCC-SD-3003-01	0-0.5	X	X	X		X	X	X		
RAB-SW-3004-01	0.5	X	X	X	X					
RAB-SD-3004-01	0-0.5	X	X	X		X	X	X	X	
RAB-FP-3004-01	0-0.5	X	X	X		X	X	X	X	
APB-BK-2003X-01	0-0.5	X	X	X					X	D2
APB-DU-102199B	0-0.5	X	X							D2
APB-BK-2003Y-01	0-0.5	X	X	X						
APB-BK-2003Z-01	0-0.5	X	X	X						
WRL-BK-2004X-01	0-0.5	X	X	X					X	
WRL-BK-2004Y-01	0-0.5	X	X	X						
WRL-BK-2004Z-01	0-0.5	X	X	X						
WRL-BK-2005X-01	0-0.5	X	X	X					X	
WRL-BK-2005Y-01	0-0.5	X	X	X						
WRL-BK-2005Z-01	0-0.5	X	X	X						
LPX-BK-2006X-0	0-0.5	X	X	X					X	
LPX-BK-2006Y-01	0-0.5	X	X	X						
LPX-BK-2006Z-01	0-0.5	X	X	X						
LPX-BK-2007X-01	0-0.5	X	X	X					X	
LPX-BK-2007Y-01	0-0.5	X	X	X						D1
LPX-DU-02199A	0-0.5	X	X	X						D1
LPX-BK-2007Z-01	0-0.5	X	X	X						
LPX-BK-2008X-01	0-0.5	X	X	X					X	
LPX-BK-2008Y-01	0-0.5	X	X	X						
LPX-BK-2008Z-01	0-0.5	X	X	X						
WRC-SW-2009-01	1.0	X	X	X	X					
WRC-SD-2009-01	0-0.5	X	X	X		X	X	X		
WRC-SW-2010-01	1.0	X	X	X	X					
WRC-SD-2010-01	0-0.5	X	X	X		X	X	X	X	

TABLE 3-2
SURFACE WATER AND SEDIMENT SAMPLING SUMMARY
OCTOBER THROUGH DECEMBER 1999
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Sample Depth (feet bgs [3])	Dioxin HCX	SVOC Pest /PCBs	Total Metals	Dissolved Metals[1]	AVS/ SEM	TOC	Grain Size	Free Water	Dup ID
WRC-SW-2011-01	1.0	X	X	X	X					D11
WRC-SW-DU-102999A	1.0			X						D11
WRC-SD-2011-000.5-01	0-0.5	X	X	X		X	X	X	X	
WRC-SD-2011-0.51.5-01	0.5-1.5	X	X	X						
WRC-SW-2012-01	0.5	X	X	X	X					
WRC-SD-2012-01	0-0.5		X	X		X	X	X	X	
WRC-SW-2013-01	1.0	X	X	X	X					
WRC-SD-2013-000.5-01	0-0.5	X	X	X		X	X	X	X	
WRC-SW-2014-01	0.5	X	X	X	X					
WRC-SD-2014-01	0-0.5	X	X	X		X	X	X	X	
WRC-SW-2015-01	0.5	X	X	X	X					
WRC-SD-2015-01	0-0.5	X	X	X		X	X	X	X	
CMW-SW-2016-01	1.0	X	X	X	X					
CMW-SD-2016-01	0-0.5	X	X	X		X	X	X	X	
CMW-SD-2017-01	0-0.5	X	X	X		X	X	X	X	D7
CMWDU-102799A	0.0.5					X	X	X		D7
CMW-SD-2018-01	0-0.5	X	X	X		X	X	X	X	
CMW-SW-2019-01	0.5	X	X	X	X					
CMW-SD-2019-01	0-0.5	X	X	X		X	X	X	X	
CMW-SW-2020-01	0.5	X	X	X	X					
CMW-SD-2020-01	0-0.5	X	X	X		X	X	X	X	
CMW-SW-2021-01	0.5	X	X	X	X					
CMW-SD-2021-01	0-0.5	X	X	X		X	X	X	X	
CMW-SW-2022-01	0.5	X	X	X	X					
CMW-SD-2022-000.5-01	0-0.5	X	X	X		X	X	X	X	
CMW-SD-2022-0.502-01	0.5-2	X	X	X						
CMW-SD-2022-022.5-01	2-2.5	X	X	X						
CMW-SW-2023-01	0.5	X	X	X	X					D8
CMW-DU-102799B	0.5	X								D8
CMW-SD-2023-01	0-0.5	X	X	X		X	X	X	X	
CMW-SW-2024-01	0.5	X	X	X	X					
CMW-SD-2024-01	0-0.5		X	X						
CMW-SW-2025-01	0.5	X	X	X	X					
CMW-SD-2025-000.5	0-0.5	X	X	X		X	X	X	X	
CMW-SD-2025-0.502	0.5-2	X	X	X						
CMW-FP-2026-000.5	0-0.5	X	X	X					X	
CMW-SD-DU-102899A	0-0.5	X	X	X		X	X	X		
CMW-FP-2026-0.502	0.5-2	X	X	X						
CMW-FP-2026-0204	2-4	X	X	X	X		X	X		
CMW-FP-2027-01	X	X	X	X		X	X	X	X	
APB-FP-2028-000.5-01	0-0.5	X	X	X		X	X	X	X	
APB-FP-2028-0.502	0.5-2	X	X	X						
APB-FP-2028-023.5	2-3.5	X	X	X						
APB-SW-2029-01	0.25	X	X	X	X					
APB-SD-2029-000.5-01	0-0.5	X	X	X		X	X	X		
APB-SD-2029-000.5-01	0-0.5	X	X	X						
APB-SD-DU-10-102999A	0-0.5	X	X	X		X	X	X		

TABLE 3-2
SURFACE WATER AND SEDIMENT SAMPLING SUMMARY
OCTOBER THROUGH DECEMBER 1999
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Sample Depth (feet bgs [3])	Dioxin HCX	SVOC Pest /PCBs	Total Metals	Dissolved Metals[1]	AVS/ SEM	TOC	Grain Size	Free Water	Dup ID
APB-SD-2029-0502-01	0.5-2	X	X	X						
APB-SD-2029-0203-01	2-3	X	X	X						
APB-SD-2030-01	0-0.5	X	X	X		X	X	X		
APB-FP-2031-01	0-0.5	X	X	X		X	X	X	X	
APB-FP-2032-01	0-0.5	X	X	X		X	X	X	X	
APB-FP-2033-000.5-01	0-0.5	X	X	X		X	X	X	X	
APB-FP-2033-0.502-01	0.5-2	X	X	X						
APB-SW-2034-01	1.0	X	X	X	X					
APB-SD-2034-01	0-0.5	X	X	X		X	X	X	X	
APC-SW-2035-01	0.5	X	X	X	X					
APC-SD-2035-000.5-01	0-0.5	X	X	X		X	X	X	X	
APC-SD-2035-0.502-01	0.5-2	X	X	X						
APC-SD-2035-0204-01	2-4	X	X	X						
APC-SD-2035-0405	4-5	X	X	X						
APC-SW-2036-01	0.5	X	X	X	X					D12
APC-SW-DU-110399A	0.5	X	X							D12
APC-SD-2036-01	0-0.5	X	X	X		X	X	X	X	D13
APC-SD-DU-110399B	0-0.5	X	X	X		X	X	X		D13
APB-SD-2037-01	0-0.5	NO	X	X		X	X	X	X	
WRL-SD-2038-01	0-0.5	X	X	X		X	X	X	X	
WRL-SW-2039-01	0.5	X	X	X	X					
WRL-SD-2039-01	0-0.5	X	X	X		X	X	X	X	
WRL-SW-2040-01	0.5	X	X	X	X					D5
WRL-DU-102599B	0.5	X	X	X						D5
WRL-SD-2040-01	0-0.5	X	X	X		X	X	X	X	D4
WRL-DU-102599A	0-0.5	X	X	X		X	X	X		D4
WRL-SW-2041-01	0.5	X	X	X	X					
WRL-SD-2041-01	0-0.5	X	X	X		X	X	X	X	
WRL-SW-2042-01	0.5	X	X	X	X					
WRL-SD-2042-01	0-0.5	X	X	X		X	X	X	X	
WRL-SW-2043-01	1.0	X	X	X	X					
WRL-SD-2043-01	0-0.5	X	X	X		X	X	X	X	
WRL-SW-2044-01	0.5	X	X	X	X					
WRL-SD-2044-000.5-01	0-0.5	X	X	X		X	X	X	X	
WRL-SD-204400.502-01	0.5-2	X	X	X						
WRL-SD-2044-0203-01	2-3	X	X	X						
LPX-SW-2045-01	0.5	X	X	X	X					D16
LPX-SW-DU-110899A	0.5	X	X							D16
LPX-SD-2045-01	0-0.5	X	X	X		X	X	X	X	
LPX-SW-2046-01	0.5	X	X	X	X					
LPX-SD-2046-000.5-01	0-0.5	X	X	X		X	X	X		
LPX-SD-2046-0.502-01	0.5-2	X	X	X						
LPX-SD-2046-0204-01	2-4	X	X	X						
LPX-SW-2047-01	1.0	X	X	X	X					
LPX-SD-2047-01	0-0.5	X	X	X		X	X	X	X	

TABLE 3-2
SURFACE WATER AND SEDIMENT SAMPLING SUMMARY
OCTOBER THROUGH DECEMBER 1999
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CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Sample Depth (feet bgs [3])	Dioxin HCX	SVOC Pest /PCBs	Total Metals	Dissolved Metals[1]	AVS/ SEM	TOC	Grain Size	Free Water	Dup ID
LPX-SW-2048-01	0.5	X	X	X	X					
LPX-SD-2048-000.5-01	0-0.5	X	X	X		X	X	X	X	D17
LPX-SD-DU-110999A	0-0.5	X	X	X		X	X	X		D17
LPX-SD-2048-0.502-01	0.5-2	X	X	X						
LPX-SD-2048-0204-01	2-4	X	X	X						
LPX-SW-2049-01	0.5	X	X	X	X					
LPX-SD-2049-01	0-0.5	X	X	X		X	X	X	X	
LPX-SW-2050-01	1.0	X	X	X	X					
LPX-SD-2050-01	0-0.5	X	X	X		X	X	X	X	
LPX-SW-2051-01	0.5	X	X	X	X					
LPX-SD-2051-01	0-0.5	X	X	X		X	X	X	X	D15
LPX-DU-110499B	0.5			X						D15
LPX-SW-2052-01	0.5	X	X	X	X					
LPX-SD-2052-000.5-01	0-0.5	X	X	X		X	X	X	X	
LPX-SD-2052-0.504	0.5-4	X	X	X						
LPX-SW-2053-01	0.5	X	X	X	X					
LPX-SD-2053-000.5-01	0-0.5	X	X	X		X	X	X	X	D14
LPX-DU-110499A	0-0.5	X	X	X						D14
LPX-SD-2053-0.502-01	0.5-2	X	X	X						
LPX-SD-2053-0204-01	2-4	X	X	X						
WRM-SD-2054-01	0-0.5	X								

NOTES:
SD = SEDIMENT SAMPLE
BK = BANK SEDIMENT SAMPLE
SW = SURFACE WATER
FP = FLOODPLAIN SEDIMENT SAMPLE
(1) – DISSOLVED (FILTERED) AQUEOUS SAMPLE
(2) – D#: DUPLICATE SAMPLE MATCH NUMBER
(3) – SURFACE WATER SAMPLE DEPTH IS PRESENTED AS FEET BELOW WATER SURFACE

volatile sulfides (AVS) and simultaneously extracted metals (SEM), dioxins, and HCX (Table 3-2). In addition, deep (subsurface) sediment samples were collected from a subset of 15 of the 50 surficial sediment stations in portions of the river with hydrological characteristics favorable to deposition.

Deep sediment samples were collected from depth intervals of 0.5 to 2-foot and 2 to 4-foot intervals.

Surface sediment samples were collected at depositional locations within ponds or river channel. Sediments collected in aquatic environments were designed as "SD" while samples collected within the floodplain were designed as "FP". Stations given the "FP" designation were those collected in areas predicted to be inundated with less than 1 foot of water less than 1 month per year. Samples given the "SD" designation were those collected in areas loosely predicted to be inundated with more than 1 foot of water more than 1 month per year, thus expecting to result in different exposure scenarios. The SD and FP designation are approximate, since actual inundation is dependant on behavior of the breach of Allendale dam and the weather conditions.

Sediment samples were collected following TtNUS SOP SA-1.2 using an Ekman dredge for the surficial sediment samples and core tubes (with Lexan liners) for deep sediment samples. Hand tools such as stainless steel bucket auger and scoop were used at exposed sediment locations. Core tubes were driven by hand until refusal. Typically, refusal occurred when dense sands or gravel were encountered.

AVS/SEM samples (surface interval only) were collected first, immediately after the dredge or core tube was opened, from an undisturbed portion of the first grab from each station. If necessary, multiple grabs were collected for sufficient sample volume for the remaining parameters. The composite sample material was placed into a stainless steel mixing bowl and thoroughly homogenized by hand using a decontaminated scoop or large mixing spoon. After mixing, the sample was transferred to the appropriate sample containers for laboratory analysis. An additional aliquot (4 to 8 ounces) was collected for field determination of free water as described below.

Sediment Free Water Content Determination:

A separate aliquot of sediment was collected from the sediment surface interval for the determination of free water. Free water content of surficial sediment was determined gravimetrically and was obtained by the following procedure. The wet weight of the sample was first determined (to the nearest 0.1 gram) using an analytical balance. The sediment was then transferred to a Buchner funnel assembly lined with a glass fiber filter and allowed to drain freely for 60 seconds. Whatman 934-AH glass microfiber filters with a 1.5-µm pore size were used for the filtration. After approximately 60 seconds of free draining, a vacuum pump was operated for 5 minutes to increase the removal of the free water from the sediment.

After filtration, the processed sediment was weighed and the percentage of free water was calculated using the following formula:

$$\text{Percent Free Water} = \frac{\text{Sediment wet weight} - \text{Sediment dry weight}}{\text{Sediment wet weight}} \times 100$$

The results of the free water determination are presented in Table 3-3.

3.4 Surface Water Sampling

Surface water grab samples were collected from 36 stations associated with the sediment samples (which correspond to 36 out of the 50 sediment stations). Surface water sample stations are presented on Figure 3-2. Surface water samples were collected before the sediment samples at each station. Surface water samples were collected following Section 5.3.5 of TtNUS SOG SA-1.2 and the following guidelines:

- The water depth was carefully measured at the station location, not to disturb the sediment.

TABLE 3-3
FREE WATER DETERMINATION
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

SAMPLE I.D.	Wet Wgt. (g)	Dry Wgt. (g)	Water Lost (g)	Percent Water
LPX-BK-2007X-01	187.61	160.1	27.51	14.7
LPX-BK-2008X-01	109.98	109.98	0	0.0
LPX-BK-2006X-01	154.12	123.83	30.29	19.7
WRL-BK-2005X-01	165.43	138.27	27.16	16.4
WRL-BK-2004X-01	113.48	103	10.48	9.2
WRL-BK-2003X-01	138.08	138.08	0	0.0
RCC-BK-3001X-01	162.88	122.53	40.35	24.8
RCC-BK-3002X-01	170.85	164.16	6.69	3.9
CMW-SD-2017-01	173.09	142.42	30.67	17.7
CMW-SD-2018-01	130.96	112.25	18.71	14.3
CMW-SD-2016-01	165.89	150.61	15.28	9.2
CMW-SD-2022-01	187.35	105.19	82.16	43.9
WRL-SD-2038-01	174.96	174.96	0	0.0
APB-SD-2037-01	172.83	109.47	63.36	36.7
WRL-SD-2039-01	146.57	89.44	57.13	39.0
WRL-SD-2040-01	183.57	175.12	8.45	4.6
WRL-SD-2041-01	159.25	120.89	38.36	24.1
WRC-SD-2010-01	152.67	123.83	28.84	18.9
WRC-SD-2015-01	148.55	105.69	42.86	28.9
WRC-SD-2014-01	185.67	166.03	19.64	10.6
WRC-SD-2009-01	168.33	156.39	11.94	7.1
WRC-SD-2013-01	151.45	127.57	23.88	15.8
WRC-SD-2012-01	176.74	134	42.74	24.2
WRC-SD-2011-01	189.27	163.63	25.64	13.5
WRL-SD-2042-01	138.71	106.72	31.99	23.1
APC-SD-2036-01	152.36	96.47	55.89	36.7
APB-SD-2034-01	171.84	121.23	50.61	29.5
LPX-SD-2051-01	151.33	92.9	58.43	38.6
APC-SD-2035-01	159.15	119.06	40.09	25.2
LPX-SD-2052-01	145.28	85.62	59.66	41.1
LPX-SD-2053-01	167.69	99.93	67.76	40.4
CMW-FP-2027-01	167.4	166.71	0.69	0.4
WRL-SD-2044-01	162.1	93.96	68.14	42.0
WRL-SD-2043-01	146.72	91.58	55.14	37.6
LPX-SD-2046-01	143.25	101.47	41.78	29.2
LPX-SD-2049-01	97.64	82.71	14.93	15.3
RCC-SD-3001-01	160.47	137.45	23.02	14.3
RAB-SD-3004-01	167.71	129.85	37.86	22.6
RCC-FP-3002-01	149.13	145.06	4.07	2.7
RAB-FP-3004-01	149.41	132.9	16.51	11.1
RCC-SD-3002-01	140.24	83.29	56.95	40.6
LPX-SD-2048-000.5	131.63	78.63	53	40.3
LPX-SD-2047-01	132.23	77.34	54.89	41.5
LPX-SD-2045-01	160.14	110.63	49.51	30.9

TABLE 3-3
FREE WATER DETERMINATION
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

SAMPLE I.D.	Wet Wgt. (g)	Dry Wgt. (g)	Water Lost (g)	Percent Water
APB-FP-2032-01	162.84	131.56	31.28	19.2
APB-FP-2031-01	131.05	99.84	31.21	23.8
LPX-SD-2050-01	143.73	57.78	85.95	59.8
APB-FP-2028-01	149.05	140.68	8.37	5.6
CMW-FP-2026-01	103.71	101.08	2.63	2.5
CMW-SD-2025-01	158.85	138.35	20.5	12.9
APB-FP-2033-01	137.2	116.79	20.41	14.9

- The sample collection bottle was inverted and lowered to the desired depth (approximately 1 foot above the sediment surface) and then slowly turned upright to a 45 degree angle with the mouth of the bottle facing upstream to fill the sample collection bottle. The water was transferred to the appropriate sample containers and preserved in accordance with the SAP procedures. Water depth at surface water stations sampled during this effort did not exceed two feet.

- The pH, specific conductivity, temperature, turbidity, and dissolved oxygen (DO) data sampling device used, date and time of collection, and name of samplers were recorded on the field data sheets (Appendix E).

The surface water samples were analyzed for pesticides/PCBs, SVOCs, metals (total and dissolved). dioxins and HCX (Table 3-2).

3.5 Reference Area Sampling

Four stations were sampled as reference locations for the Woonsquatucket River Sediment Investigation. Samples collected at the reference stations included two upstream of the Route 44-bridge crossing, one station at Centredale Brook, and one station at Assapumpsett Brook in Johnston, Rhode Island. Centredale Brook and Assapumsett Brook are tributaries to the Woonsquatucket River. These reference sample stations include a total of four surface water samples, four aquatic sediments, three floodplain sediments, and two bank sediments. Reference stations were sampled for the same analytical parameters as the onsite study area samples (Table 3-2).

3.6 Sample Location Survey

All soil, sediment and surface water sampling stations were surveyed using Global Positioning System (GPS) equipment to sub-meter accuracy. Locations information was converted to Rhode Island State Plane Coordinates (NAD 1983) for mapping and stored in the project data management system.

TARGET SHEET

THE MATERIAL DESCRIBED BELOW
WAS NOT SCANNED BECAUSE:

(X) OVERSIZED

() NON-PAPER MEDIA

() OTHER:

DESCRIPTION: DOC# 6771, FIGURE 3-1, SAMPLE LOCATIONS.

THE OMITTED MATERIAL IS AVAILABLE FOR REVIEW,
BY APPOINTMENT,
AT THE US EPA NEW ENGLAND SUPERFUND RECORDS CENTER,
BOSTON, MA

TARGET SHEET

THE MATERIAL DESCRIBED BELOW
WAS NOT SCANNED BECAUSE:

(X) OVERSIZED

() NON-PAPER MEDIA

() OTHER:

DESCRIPTION: DOC# 6771, FIGURE 3-2, SURFACE WATER SAMPLE LOCATIONS.

THE OMITTED MATERIAL IS AVAILABLE FOR REVIEW,
BY APPOINTMENT,
AT THE US EPA NEW ENGLAND SUPERFUND RECORDS CENTER,
BOSTON, MA

4.0 FINDINGS OF THE INVESTIGATION

This section presents a description of the results of the field investigation activities performed by TtNUS for the Woonasquatucket River Sediment Investigation.

Residential soil results are presented in Appendix A. Bank sediment results in Appendix B and aquatic/floodplain sediment results in Appendix C. Surface water results are included in Appendix D. Appendix E and F include the sample collection records and the Woonasquatucket River flow data, respectively.

4.1 Site Conditions

This section provides a general overview of the conditions encountered during the investigations of the site. General site description and history are presented in Section 3.0.

4.1.1 Woonasquatucket River

The Woonasquatucket River flows in a southeasterly direction through relatively flat and level terrain in the area of the Centredale Manor and Brook Village Properties. Two impoundments, held by the Allendale Dam and Lymansville Dam, are located within the study area. The Allendale Dam had a partial breach in 1991 that has significantly lowered the water level in Allendale Pond. The surrounding area is a densely populated mix of suburban residential and light industrial/manufacturing facilities northwest of Providence, Rhode Island.

The Woonasquatucket River drainage area is approximately 38.5 square miles. Approximately 8.5 miles downstream of the site, the Woonasquatucket River discharges to Providence Harbor in Narragansett Bay. Selected historical flow data from a USGS gauging station located near the site is presented in Appendix F (USGS 2000). Staff gauge readings were collected by the field team during the sampling event and are also presented in Appendix F.

For the purposes of this report, the study area has been separated into six sections termed "reaches", which are defined by, among other parameters, changes in river configuration, impounding structures, and stream junctures. Reaches are identified as RCC, WRC, APB/APC, WRL, LPX, and WRM, (as defined in the Sampling and Analysis Plan, TtNUS 10-99) which

follow in order from upstream to downstream. Tributaries, such as RAB and CMW are discussed separately. The limits of each reach are outlined below.

Reach RCC includes an approximately 1,000-foot long portion of the river upstream of the Route 44 (Smith Street) bridge crossing. This area, upgradient of the site, is considered a reference reach for this study. Most of this reach of the river has a low current velocity and the bottom substrate is composed predominantly of sand. However, just upstream of the Route 44-bridge crossing (150 to 200 feet), the river current velocity increases and the substrate in this area is comprised mostly of cobbles, boulders, and gravel. A collapsed stone dam is present in this area. Floodplain and wetland habitats border portions of the east and west shorelines where the reference samples were collected in this reach. A flow control gate and boulder/soil berm is located approximately 100 feet upstream of the bridge crossing. The gate system appears similar to raceway control gates that are present at the Allendale Pond raceway. It appears that this gate may have controlled flow to stream that borders the site's eastern border.

Reach WRC extends from the Route 44 bridge crossing, past the Centredale Manor property, to the upper section of the old Allendale Pond (see Figure 3-1). The channel of the river downstream of the Route 44 crossing appears to have modified (straightening and desnagging) for approximately 500 feet. Increased current velocity and a gravel, cobble, and sand substrate are present in the straightened channel. The eastern bank side of the portion of the site along the river was armored with cobble during recent remedial activities at the site in late 1999. An abandoned railway bed is located on the river's western bank top.

Reach APB/APC includes the open water and wetland areas of Allendale Pond (see Figure 3-1). The APC identifier indicates samples collected in the main river flow channel of the pond area while the APB identifier represents samples collected outside the main channel flow. The APB area also represents areas that had been flooded prior to the Allendale Dam breach in 1991. These exposed areas of the pond bottom have been colonized by wetland and upland vegetation. Some of these exposed areas are flooded during periods of high water (i.e. heavy rains, spring flooding). The substrate in areas of higher flow (APC) generally consisted of sand while the APB portions consisted of sands and silt with a high percentage of organic material.

Reach WRL begins immediately south of the Allendale Dam and extends to the start of the open water of Lymansville Pond (see Figure 3-1). The upper portion of this reach has a cobble/gravel substrate and an increase in current velocity where the river appears to have been channeled for approximately 800 feet. The Allendale Mill raceway from Allendale Pond reconnects to the river approximately 550 feet downstream of the dam. A relatively large upland/forested wetland complex is located on the western edge of the river. South of the straight channel area, the current velocity slows and the river becomes very braided as it meanders through a relatively large vegetated shrub and emergent wetland. In this area the channel becomes very diffuse and is not navigable by canoe.

The LPX reach includes the open water area of Lymansville Pond that is located south of the shrub and persistent vegetated wetland (see Figure 3-1). The pond substrate is primarily comprised of sand with depositional areas containing silts and organic matter. Two streams discharge to the pond and include Assapumpsett Brook (RAB tributary) and Cranberry Brook. Large depositional sandy deltas were observed at the discharge points of both streams. Water depth in the pond is shallow and ranges in depth from approximately 1 to 5 feet. Immediately downstream of the Lymansville Dam (Reach WRM) is a forested wetland.

Tributaries

Reach CMW is a tributary to the river and is a small stream/wetland area located on the eastern border of the Centredale Manor property (see Figure 3-1). This stream receives stormwater discharge from a culvert located at the northeastern corner of the Centredale Manor property. The stream discharges to the Woonasquatucket River through a wetland area south of the Centredale Manor property. It appears that the upper portion of the stream is intermittent and relies on stormwater discharge. However, flow was observed in the portion of the stream downgradient of the Centredale Apartment building during the November 1999 sampling event.

It appears that the CMW stream may have been historically connected to waterflow control gate described above in the RCC reach. A small backwater connection (sample station CMW-SD-2024) connects this stream to the river immediately south of the new remedial cap area on the property's southern border. No flow was apparent in this connection during low water events in October and November 1999. Centredale Brook discharges to the CMW

stream approximately 200 feet north of the CMW and backwater stream confluence. Centredale Brook is culverted for most of its length through the residential properties near the river.

Assapumpsett Brook (Reach RAB) is a small stream that discharges to Lymansville Pond (see Figure 3-1). Immediately upstream of the discharge point to the pond the brook has a relatively steep gradient and fast current with few depositional areas. Upstream of a small impoundment (where the reference sample was collected), the stream generally has a sandy substrate and low current velocity. This area is a forested-scrub/shrub wetland with a relatively wide floodplain and less disturbance than the area surrounding the Woonasquatucket River.

Cranberry Brook discharges to a cove located on the eastern side of Lymansville Pond. The brook appears to be culverted for it's entire length. A fairly large depositional sand delta has formed at the discharge point in Lymansville Pond.

4.2 Sample Analysis

Analytical results for all parameters tested for in the Woonasquatucket River Sediment Investigation are provided in Appendices as follows:

Appendix A: Residential Soil Sampling Results
Appendix B: Bank Sediment Sampling Results
Appendix C: Aquatic and Floodplain Sediment Sampling Results
Appendix D: Surface Water Sampling Results

Tier II validation following EPA Region I Guidelines was conducted by TtNUS for CLP and DAS laboratory data from the sampling event. Tier III data validation was performed by EPA for the dioxins data results. Data validation resulted in the qualification of some data. Qualification of data is described in data validation memoranda submitted to EPA.

The reviewed data, as summarized in the data validation memoranda, are presented in the Appendices data tables. Some compounds have estimated values or raised detection limits due to factors such as blank contamination and dilutions. Overall, the data was found to be of sufficient and acceptable quality to be used as qualified for the purposes of quantified risk analysis under the Risk Assessment Guidance for Superfund (RAGS) document and its amendments.

4.3 Contaminant Distribution

For this investigation, soil samples were collected from residential properties; sediment samples from the Woonasquatucket River, associated wetlands, river banks, and contributing tributaries; and surface water from the river and contributing tributaries. Sediment samples were further broken down into three subsections including bank samples, permanently inundated sediments that are typically flooded during most times of the year, and floodplain sediments that are typically flooded only in the spring and during significant rain events.

Contaminants selected for discussion for this Technical Memorandum include polychlorinated biphenyls (PCBs) and the dioxin compound (2,3,7,8-tetrachlorodibenzo-p-dioxin, also referenced to as 2,3,7,8-TCDD). The PCBs detected in the environmental samples collected from the Study area consisted primarily of Aroclor 1254, but Aroclor 1242 and Aroclor 1260 were also detected on some residential properties. PCBs are derived from anthropogenic sources and are extremely stable chemicals with a wide range of physical properties. They have been historically used in plasticizers, adhesives, lubricants, heat transfer fluids, and as dielectric fluids in transformers and capacitors.

Dioxins are a group of anthropogenic chemical compounds formed as by-products through a number of activities including combustion, certain types of herbicide manufacture, chlorine bleaching of pulp and paper, and other industrial processes. The "dioxin" portions of this discussion refer to the compound 2,3,7,8-TCDD. This is only one of a number of related compounds, known as dioxins and furans. The 2,3,7,8-TCDD compound is believed to be the most toxic, and may pose an increased risk of cancer and other health effects. Dioxins results are expressed in a Toxicity Equivalency Quotient, or TEQ. The TEQ considers all the related compounds and their relative toxicity. The TEQ values are dominated by the 2,3,7,8-TCDD compound (generally constituting 85 percent to 100 percent of the TEQ). Since this is the case at the subject site, the comparisons made within this section focus on 2,3,7,8-TCDD.

Terminology for Evaluating Analytical Data

In order to evaluate the distribution of contamination in the study area, and determine its relationship to possible releases from the Site, data generated from analysis of field samples are typically compared to background concentrations and reviewed in relation to the data

collected throughout an entire area of concern. Definitions of the terms used to describe and compare the contaminant concentrations in the following sections are as follows:

- elevated - detected at a concentration either greater than its corresponding average background concentration, or greater than a specified concentration if no average background concentration was determined

- high, higher, or highest - detected in one location at one or more orders of magnitude greater than at another location

- comparable - detected in one location at the same order of magnitude as another location

- low or lower - detected in one location at one or more orders of magnitude less than another location

4.3.1 Background Concentrations

To assess whether contaminants detected in the study area are related to or are the result of past disposal activities or releases, it is necessary to compare the analytical results for on-site samples with those obtained from locations that are unlikely to have been affected by past site activities. In this way, on-site chemical presence may be attributed to naturally occurring sources (such as metals in soils), contamination that is pervasive in an area, i.e., pesticides in agricultural communities, upstream sources of contamination, etc., or to site-related occurrences.

For purposes of evaluating the contamination distribution, the average background concentrations serve as a basis to identify elevated contaminant concentrations in samples collected within the study area. If contaminant concentrations exceeded the average background concentrations, a contaminant source was suspected and the contaminant concentrations were considered "elevated." Because of the commercial/industrial nature of the East Providence/Johnston area, contaminant concentrations below the average background levels are not considered representative of an affected area and, therefore, did not warrant

further discussion in the evaluation of contaminant distribution. This was found to be the case only for PCBs in bank sediment.

Background sediment and surface water samples were collected from various locations including two Woonasquatucket River stations upstream of the Site and two tributaries to the Woonasquatucket River.

Averaging the numerical data from reference station samples (The numerical averages were calculated as the arithmetic average of the detected concentrations and half the detection limits for those compounds/analytes reported as undetected) developed average background concentrations. The summary statistics for background concentrations for PCBs and dioxin are presented in Table 4-1.

4.3.2 Residential Soil Contaminant Distribution

Positive dioxin results for residential soil samples (positive values reported above method quantitation limit) were found in 122 of 126 residential soil samples collected during this sampling effort (Figures 4-1, 4-2, and 4-3). Positive dioxin results ranged from 0.00026 to 57 ug/Kg (Table 4-2). High results for dioxin (greater than 1.0 µg/kg) were found in 16 of the 122 positive results. Most of these results (14 of 16) were detected on properties adjacent to Allendale Pond and its associated wetlands. Two were detected at the edge of water in depositional areas of Lymansville Pond.

PCBs as total Aroclors were detected at 37 of 61 residential soil samples collected (Figures 4-1, 4-2, and 4-3). Total Aroclor ranged from 30 to 48,000 µg/Kg with the highest results (greater than 1,000 µg/Kg) detected from 8 of 61 total Aroclor positive results (Table 4-2). Five of these stations, which include RES-SS-555-01, RES-SS-14-303-01, RES-SS-14-333-01 RES-SS-14-449-01 RES-SS-14-449-02 also had high dioxin results. Aroclors detected in residential soil samples included Aroclor 1242, Aroclor-1254, and Aroclor-1260.

In the Allendale pond areas, elevated concentrations of dioxins and PCBs in residential soil samples were noted to be elevated in areas that were likely to have been inundated with water prior to the Allendale Dam breach in 1991. In the Lymansville pond areas, elevated concentrations of dioxins and PCBs in residential soil samples were limited to those closest to

the waters edge. In general, concentrations of dioxin and PCBs were noted to decrease with elevation from the former (Allendale) and current (Lymansville) pond shorelines.

4.3.3 Bank Sediment Contaminant Distribution

To evaluate the bank sediment analytical results, the data were compared with average bank sediment background concentrations for PCBs and dioxins. Summary statistics are presented in Table 4-3 for bank sediment samples. PCBs were not detected in the bank sediment samples at levels greater than background. The average concentration of total PCBs in the background bank stations was 190 µg/kg. Dioxins, however, were found above background as discussed in the paragraphs that follow. Bank sediment dioxin results are depicted on Figures 4-1 and 4-2.

4.3.3.1 Dioxin Distribution in Bank Sediments

2,3,7,8-TCDD was detected at elevated levels at each of the six bank sediment stations ("X" designation) located downstream of the Site. Elevated values of contamination ranged from 0.0577 to 2.930(J) ug/Kg (Figures 4-1, 4-2, and 4-3 and Table 4-3). The average bank sediment background level for TCDD was 0.0132 ug/Kg.

2,3,7,8 TCDD was detected above background levels in 11 of the 18 bank sediment samples collected (three per location) downstream of the site. Generally, the highest TCDD level at a station was near to the water body. However, at station WRL-BK-2004, located in a wetland complex south of the Allendale Dam, the higher dioxin concentrations were found in samples collected further from the river (sample with z designations). The bank at this area had a low slope gradient and the "Y" sample location elevation (from the river water elevation at the time of sampling) was approximately 1.5 to 2 feet and the horizontal distance from the river was approximately 11 feet. The "Z" sample collection elevation (from the river water level) was approximately 3 feet above the water surface with the horizontal distance from the river approximately 24 feet.

TABLE 4-1
BACKGROUND SAMPLE SUMMARY STATISTICS
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Parameter	Matrix	Total Number of Detects	Number of Samples Counted	Average	Units	Standard Deviation	Maximum Value Location
2,3,7,8-TCDD	BK	5	6	0.0132	ug/kg	17.95941025	RCC-BK-3002
Aroclor, Total	BK	4	6	190	ug/Kg	174.4432334	RCC-BK-3001
2,3,7,8-TCDD	SD	4	4	0.003	ug/Kg	2.952925103	RCC-SD-3002
Aroclor, Total	SD	2	4	89	ug/Kg	83.17188527	RCC-SD-3002
2,3,7,8-TCDD	FP	3	3	0.030	ug/Kg	48.95367742	RCC-FP-3002
Aroclor, Total	FP	3	3	210	ug/Kg	239.255094	RCC-FP-3002

Aroclors or 2,3,7,8-TCDD were not detected in background surface water station samples
BK - bank sediment sample
SD - aquatic surface and subsurface sediment sample
FP - floodplain sediment sample

TABLE 4-2
RESIDENTIAL SAMPLE DATA SUMMARY
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Boring Identification	Sample Matrix	Depth Interval (ft. bgs)	Sample Identification	2,3,7,8-TCDD µg/Kg Results > 1000 µg/Kg	2,3,7,8-TCDD Site Action Limit (1) µg/Kg	Aroclor (Total) ug/Kg Results > 10000 µg/Kg	Total Aroclors RIDEM Direct Exposure Criteria (2) µg/Kg
RES-11-396-01	Soil	0.0-1.0	RES-SS-11-396-01	1.06 EB$	1.0		10000
RES-11-425-01	Soil	0.0-1.0	RES-SS-11-425-01-MAX	1.49	1.0		10000
RES-12-240-01	Soil	0.0-1.0	RES-SS-12-240-01-MAX	15.05	1.0		10000
RES-12-240-02	Soil	0.0-1.0	RES-SS-12-240-02	10.59 JEB$	1.0		10000
RES-12-555-01	Soil	0.0-1.0	RES-SS-12-555-01-MAX	3.18	1.0		10000
RES-14-303-01	Soil	0.0-1.0	RES-SS-14-303-01	4.03 J$	1.0	48000	10000
RES-14-303-02	Soil	0.0-1.0	RES-SS-14-303-02	10.52 J	1.0		10000
RES-14-333-01	Soil	0.0-1.0	RES-SS-14-333-01	1.29 J$	1.0		10000
RES-14-333-03	Soil	0.0-1.0	RES-SS-14-333-03	2.33 J	1.0		10000
RES-14-366-02	Soil	0.0-1.0	RES-SS-14-366-02	5.35 J$	1.0		10000
RES-14-424-02	Soil	0.0-1.0	RES-SS-14-424-02	1.64 J$	1.0		10000
RES-14-425-01	Soil	0.0-1.0	RES-SS-14-425-01	1.91 $	1.0		10000
RES-14-448-01	Soil	0.0-1.0	RES-SS-14-448-01	10.53 J$	1.0		10000
RES-14-449-01	Soil	0.0-1.0	RES-SS-14-449-01	2.88 J$	1.0		10000
RES-14-449-02	Soil	0.0-1.0	RES-SS-14-449-02	6.67 J$	1.0		10000
RES-14-449-03	Soil	0.0-1.0	RES-SS-14-449-03-MAX	57.31	1.0		10000

(1) Site Action Limit (IT Group January 2000)
(2) RIDEM Direct Exposure Criteria - (Rhode Island Department of Environmental Management Division of Site Remediation March 31, 1993, Amended August 1996 DEM-DSR-01-93)
ft. bgs - feet below ground surface
MAX - Duplicate sample station where highest duplicate sample results are reported
J - Estimate value as a result of data validation
EB - equipment blank contamination noted
$ - value reported from 1:100 dilution
TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin

TABLE 4-3
BANK SAMPLE DATA SUMMARY
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Sample Matrix	Station Location	Depth Interval (ft. bgs)	2,3,7,8-TCDD Results>Background µg/Kg	Average 2,3,7,8-TCDD Background µg/Kg	Aroclor (Total) Results>Background µg/Kg	Average Aroclors Background ug/Kg
APB-BK-2003X-01-MAX	Sediment	APB-BK-2003	0.0-0.5	0.118	0.0132	-	190
APB-BK-2003Y-01	Sediment	APB-BK-2003	0.0-0.5	0.173	0.0132	-	190
LPX-BK-2006X-01	Sediment	LPX-BK-2006	0.0-0.5	0.840 $	0.0132	-	190
LPX-BK-2006Y-01	Sediment	LPX-BK-2006	0.0-0.5	0.058	0.0132	-	190
LPX-BK-2007X-01	Sediment	LPX-BK-2007	0.0-0.5	1.01 $	0.0132	-	190
LPX-BK-2008X-01	Sediment	LPX-BK-2008	0.0-0.5	0.313	0.0132	-	190
WRL-BK-2004X-01	Sediment	WRL-BK-2004	0.0-0.5	0.966 $	0.0132	-	190
WRL-BK-2004Y-01	Sediment	WRL-BK-2004	0.0-0.5	0.374 $	0.0132	-	190
WRL-BK-2004Z-01	Sediment	WRL-BK-2004	0.0-0.5	2.93 J$	0.0132	-	190
WRL-BK-2005X-01	Sediment	WRL-BK-2005	0.0-0.5	0.945 $	0.0132	-	190
WRL-BK-2005Y-01	Sediment	WRL-BK-2005	0.0-0.5	0.864	0.0132	-	190

TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin
ft. bgs - feet below ground surface
MAX - Duplicate sample station where highest duplicate sample results are reported
J - Estimate value as a result of data validation
$ - value reported from 1:100 dilution
- indicates that no value was observed above average bank sediment background level

4.3.4 Aquatic (Flooded) and Floodplain Sediment Contaminant Distribution

To evaluate the analytical results, the aquatic and floodplain sediment data were separately compared with average background concentrations (aquatic and floodplain, respectively) for PCBs and dioxins. Aquatic and floodplain sediment dioxin and PCB results are depicted on Figures 4-1 and 4-2.

Definitions of terms related to sampling depths and media are as follows:

surface samples – Samples collected at depths of up to 0.5 feet below ground surface (bgs)
subsurface samples – Samples collected at depths of greater than 0.5 feet bgs.

4.3.4.1 Aquatic Sediment Dioxin Distribution

2,3,7,8-TCDD was detected at elevated levels at 31 of 52 surface sediment samples collected from the study area south of the Route 44 crossing. These results are from the 0 to 0.5-foot bgs depth interval. Elevated contamination values ranged from 0.0063 to 8.3(J) ug/Kg (Table 4-4 and Figures 4-1 and 4-2). The average river sediment background level for dioxin was 0.003 ug/Kg. 2,3,7,8-TCDD was not detected above background in any of the deeper sediment samples collected (below 0.5 feet bgs).

Generally, high dioxin concentrations were found in aquatic sediments throughout the study area. Two of the three highest dioxin levels in aquatic sediments were collected at river stations WRC-SD-2014 (8.3J ug/Kg) and WRC-SD-2015 (7.3J ug/Kg) located in small depositional areas at the present edge of the river channel (Figure 4-1).

4.3.4.2 Aquatic Sediment PCB Distribution

PCBs were detected at elevated levels above background in 20 of 52 aquatic sediment samples collected in the study area south of the Route 44 crossing. Elevated PCB contamination values ranged from 97 to 2410 µg/Kg (Table 4-4 and Figures 4-1 and 4-2). The only PCB detected in the aquatic sediments was Aroclor 1254. The average river sediment background level for PCB was 89 µg/Kg. Positive PCB results above background were only found in the surface interval

TABLE 4-4
AQUATIC SEDIMENT DATA SUMMARY
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Boring Station	Sample Matrix	Depth Interval (ft. bgs)	2,3,7,8-TCDD Results > Background µg/Kg	Average 2,3,7-8 TCDD Background µg/Kg	Aroclor (Total) Results > Background ug/Kg	Average Aroclors Background ug/Kg
APB-SD-2029-000.5-01-MAX	APB-SD-2029	Aquatic Sediment	0.0-0.5	0.326	0.003	-	89
APB-SD-2034-01	APB-SD-2034	Aquatic Sediment	0.0-0.5	2.01 J$	0.003	136	89
APB-SD-2037-01	APB-SD-2037	Aquatic Sediment	0.0-0.5	-	0.003	1200	89
APC-SD-2035-000.5-01	APC-SD-2035	Aquatic Sediment	0.0-0.5	3.11 $	0.003	216	89
APC-SD-2036-01-MAX	APC-SD-2036	Aquatic Sediment	0.0-0.5	3.27	0.003	160	89
CMW-SD-2018-01	CMW-SD-2018	Aquatic Sediment	0.0-0.5	0.215	0.003	-	89
CMW-SD-2023-01	CMW-SD-2023	Aquatic Sediment	0.0-0.5	0.021 J$	0.003	-	89
CMW-SD-2024-01	CMW-SD-2024	Aquatic Sediment	0.0-0.5	0.747 $	0.003	315	89
CMW-SD-2025-000.5-01	CMW-SD-2025	Aquatic Sediment	0.0-0.5	0.939 $	0.003	400	89
LPX-SD-2045-01	LPX-SD-2045	Aquatic Sediment	0.0-0.5	7.61 J$	0.003	211	89
LPX-SD-2046-000.5-01	LPX-SD-2046	Aquatic Sediment	0.0-0.5	7.11 J$	0.003	178	89
LPX-SD-2047-01	LPX-SD-2047	Aquatic Sediment	0.0-0.5	4.13 J$	0.003	118	89
LPX-SD-2048-000.5-01-MAX	LPX-SD-2048	Aquatic Sediment	0.0-0.5	0.374	0.003	267	89
LPX-SD-2049-01	LPX-SD-2049	Aquatic Sediment	0.0-0.5	0.029 J	0.003	-	89
LPX-SD-2050-01	LPX-SD-2050	Aquatic Sediment	0.0-0.5	6.19 J$	0.003	147	89
LPX-SD-2051-01	LPX-SD-2051	Aquatic Sediment	0.0-0.5	4.03 J$	0.003	-	89
LPX-SD-2052-000.5-01	LPX-SD-2052	Aquatic Sediment	0.0-0.5	4.35 J$	0.003	97	89
LPX-SD-2053-000.5-01-MAX	LPX-SD-2053	Aquatic Sediment	0.0-0.5	0.756	0.003	153	89
WRC-SD-2009-01	WRC-SD-2009	Aquatic Sediment	0.0-0.5	0.006	0.003	190	89
WRC-SD-2010-01	WRC-SD-2010	Aquatic Sediment	0.0-0.5	0.194	0.003	444	89
WRC-SD-2011-000.5-01	WRC-SD-2011	Aquatic Sediment	0.0-0.5	0.21	0.003	400	89
WRC-SD-2012-01	WRC-SD-2012	Aquatic Sediment	0.0-0.5	0.407 $	0.003	196	89
WRC-SD-2013-000.5-01	WRC-SD-2013	Aquatic Sediment	0.0-0.5	0.059	0.003	-	89
WRC-SD-2014-01	WRC-SD-2014	Aquatic Sediment	0.0-0.5	8.3 J$	0.003	-	89
WRC-SD-2015-01	WRC-SD-2015	Aquatic Sediment	0.0-0.5	7.3 J$	0.003	2410	89
WRL-SD-2039-01	WRL-SD-2039	Aquatic Sediment	0.0-0.5	2.84 J$	0.003	-	89
WRL-SD-2040-01-MAX	WRL-SD-2040	Aquatic Sediment	0.0-0.5	0.081 .	0.003	-	89
WRL-SD-2041-01	WRL-SD-2041	Aquatic Sediment	0.0-0.5	3.15 $	0.003	210	89
WRL-SD-2042-01	WRL-SD-2042	Aquatic Sediment	0.0-0.5	2.01 J$	0.003	361	89
WRL-SD-2043-01	WRL-SD-2043	Aquatic Sediment	0.0-0.5	3.23 J$	0.003	307	89
WRL-SD-2044-000.5-01	WRL-SD-2044	Aquatic Sediment	0.0-0.5	3.35 J$	0.003	95	89
WRM-SD-2054-01	WRM-SD-2054	Aquatic Sediment	0.0-0.5	2.62 J$	0.003	390	89

ft. bgs - feet below ground surface
MAX - Duplicate sample station where highest duplicate sample results are reported
J - Estimate value as a result of data validation
$ - value reported from 1:100 dilution
- indicates that no value was observed above average aquatic and deep sediment background level
TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin

aquatic sediments (0-0.5 feet bgs). PCBs were not detected above background at any of the deeper aquatic sediment stations.

4.3.4.3 Floodplain Sediment Dioxin Distribution

2,3,7,8-TCDD was detected in 5 of the 16-floodplain sediment samples collected in the study area south of the Route 44 crossing. Elevated TCDD values ranged from 0.186 to 16.38 ug/Kg (Table 4-5 and Figures 4-1 and 4-2). The average floodplain sediment background level for dioxin was 0.0301 ug/Kg. All floodplain dioxin sediment results are from the surface interval with the exception of sample CMW-SD-2022-0.502 (0.186 ug/Kg), taken from 0.5 to 2.0 feet below ground surface. This subsurface sample was collected from the 0.5 to 2-foot depth interval. The surface interval collected at this location was below background.

High levels of dioxin (greater than 1.0 ug/Kg) were detected in 4 of the 16 floodplain samples collected. It appears (based on field observations) that most of the floodplain sample stations had been submerged prior to the Allendale Dam breach, but are now exposed (not flooded) during most of the growing season.

4.3.4.4 Floodplain Sediment PCB Distribution

PCBs were detected at elevated levels above background in 6 of the 16 river sediment samples collected adjacent to or downstream of the Site. Elevated PCB contamination values ranged from 250 to 2070 µg/Kg (Table 4-5 and Figures 4-1 and 4-2). The only PCB detected in the floodplain sediments was Aroclor 1254. The average floodplain sediment background level for PCBs was 210 µg/Kg. These results are from the floodplain sediment surface interval with the exception of a high level of Aroclor 1254 detected at CMW-SD-2022 (1500 µg/Kg) from the 0.5 to 2-foot subsurface interval. This same subsurface interval also had dioxin results (0.186 µg/Kg) above background (see Section 4.3.4.3). The PCB results for the surface interval for this station was below background.

4.3.5 Surface Water Contaminant Distribution

Dioxin and total Aroclor results are from unfiltered surface water samples collected in conjunction with sediment sampling. Surface water samples were collected prior to sediment

TABLE 4-5
FLOODPLAIN SEDIMENT DATA SUMMARY
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Boring Station	Sample Matrix	Dept Interval (ft. bgs)	2,3,7,8-TCDD Results > Background ug/Kg	Average 2,3,7,8-TCDD Background ug/Kg	Aroclor (Total) Results > Background ug/Kg	Average Aroclors Background ug/Kg
APB-FP-2028-000.5-01	APB-FP-2028	Floodplain Sediment	0.0-0.5	-	0.03	250	210
APB-FP-2032-01	APB-FP-2032	Floodplain Sediment	0.0-0.5	-	0.03	480	210
APB-FP-2033-000.5-01	APB-FP-2033	Floodplain Sediment	0.0-0.5	4.06 $J	0.03	-	210
CMW-FP-2026-000.5-01-MAX	CMW-FP-2026	Floodplain Sediment	0.0-0.5	16.38	0.03	270	210
CMW-FP-2027-01	CMW-FP-2027	Floodplain Sediment	0.0-0.5	4.96 $J	0.03	400	210
CMW-SD-2021-01	CMW-SD-2021	Floodplain Sediment	0.0-0.5	2.0 $	0.03	870	210
CMW-SD-2022-0.502-01	CMW-SD-2022	Floodplain Sediment	0.5-2.0	0.186	0.03	2070	210

TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin
ft. bgs - feet below ground surface
MAX - Duplicate sample station where highest duplicate sample results are reported
J - Estimate value as a result of data validation
$ - value reported from 1:100 dilution
- indicates that no value was observed above average floodplain sediment background level

sampling and disturbance. Generally, surface water samples were collected approximately 1-foot above the bottom of the stream or pond. During the surface water sampling event, extreme care was taken to minimize sediment disturbance in shallow areas, with less than 1-foot total water depth. Dioxins are measured in water in picograms of contaminant per liter of water (pg/l), which are roughly equivalent to parts per quadrillion. PCBs are measured in water in micrograms per liter of water (ug/l), roughly equivalent to parts per billion.

Positive dioxin results for surface water samples (positive values reported above method quantitation limit) were found in 17 of 39 samples collected (not including QC) during this sampling event (Figures 4-1 and 4-2). Positive dioxin results ranged from 2.9 to 12,740J pg/L (Table 4-6). High results for dioxin (greater than 1,000 pg/L) were found at locations CMW-SW-2019 (12,740J pg/L) and APB-SW-2029 (4,000 pg/L). Station CMW-SW-2019 is located in a shallow and stagnant portion of the old raceway stream east of the Centredale Manor high-rise building. Surface water location APB-SW-2029 is located in a shallow, backwater area of Allendale Pond.

One Aroclor (1254) was detected in 1 of 39 surface water samples collected (Figures 4-1 and 4-2) as part of this investigation. This result was noted at location CMW-SW-2019 which also corresponds to the highest surface water dioxin result as discussed above (Table 4-6).

4.3.6 Data Summary

2,3,7,8-TCDD and PCB concentrations have been selected for evaluation of this data set because previous sampling events have indicated elevated concentrations of these compounds exist in the sediment near the subject property. The abbreviated evaluations performed in the preceding sections indicate that both 2,3,7,8-TCDD and PCBs (characterized by Aroclor 1254) are elevated in Allendale Pond and the associated wetlands in comparison to the reference stations sampled. Such a distribution of these compounds indicates a source of these contaminants is present in or around the Centredale Manor and Brook Village properties.

Both compounds were detected at reference stations sampled, although they were found at very low concentrations. These findings are indicative of possible atmospheric deposition from prior burning of waste materials or as process emissions during plant operations.

TABLE 4-6
SURFACE WATER RESULTS
FINAL TECHNICAL MEMORANDUM
CENTREDALE MANOR RESTORATION PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

Sample Identification	Matrix	Corresponding Sediment Boring	2,3,7,8-TCDD pg/L	Total Aroclors µg/L
APB-SW-2029-01	Surface Water	APB-SD-2029	4000J	-
APB-SW-2034-01	Surface Water	APB-SD-2034	4.9	-
CMW-SW-2019-01	Surface Water	CMW-SD-2019	12740J	4.6
CMW-SW-2020-01	Surface Water	CMW-SD-2020	28.5	-
CMW-SW-2024-01	Surface Water	CMW-SD-2024	760	-
LPX-SW-2046-01	Surface Water	LPX-SD-2046	137	-
LPX-SW-2049-01	Surface Water	LPX-SD-2049	38	-
LPX-SW-2050-01	Surface Water	LPX-SD-2050	2.9	-
WRC-SW-2010-01	Surface Water	WRC-SD-2010	10.3J	-
WRC-SW-2015-01	Surface Water	WRC-SD-2015	44.4J	-
WRL-SW-2041-01	Surface Water	WRL-SD-2041	53J	-
WRL-SW-2042-01	Surface Water	WRL-SD-2042	853	-
WRL-SW-2043-01	Surface Water	WRL-SD-2043	157	-
APC-SW-2036-01-MAX	Surface Water	APC-SD-2036	5	-
CMW-SW-2023-01-MAX	Surface Water	CMW-SD-2023	22.9	-
LPX-SW-2051-01-MAX	Surface Water	LPX-SD-2051	4.1	-
WRL-SW-2040-01-MAX	Surface Water	WRL-SD-2040	5	-

pg/l - parts per quadrillion: 1 pg/l is approximately equivalent to 0.000001 ug/l (ppb)
MAX - Duplicate sample station where highest duplicate sample results are reported
J - Estimate value as a result of data validation
- not detected

TARGET SHEET

THE MATERIAL DESCRIBED BELOW
WAS NOT SCANNED BECAUSE:

(X) OVERSIZED

() NON-PAPER MEDIA

() OTHER:

DESCRIPTION: DOC# 6771, FIGURE 4-1, DIOXIN/PCB DISTRIBUTION.

THE OMITTED MATERIAL IS AVAILABLE FOR REVIEW,
BY APPOINTMENT,
AT THE US EPA NEW ENGLAND SUPERFUND RECORDS CENTER,
BOSTON, MA

TARGET SHEET

THE MATERIAL DESCRIBED BELOW
WAS NOT SCANNED BECAUSE:

(X) OVERSIZED

() NON-PAPER MEDIA

() OTHER:

DESCRIPTION: DOC# 6771, FIGURE 4-2, DIOXIN/PCB DISTRIBUTION, LYMANSVILLE.

THE OMITTED MATERIAL IS AVAILABLE FOR REVIEW,
BY APPOINTMENT,
AT THE US EPA NEW ENGLAND SUPERFUND RECORDS CENTER,
BOSTON, MA

TARGET SHEET

THE MATERIAL DESCRIBED BELOW
WAS NOT SCANNED BECAUSE:

(X) OVERSIZED

() NON-PAPER MEDIA

() OTHER:

DESCRIPTION: DOC# 6771, FIGURE 4-3, DIOXIN/PCB DISTRIBUTION, LYMANSVILLE POND DETAIL.

THE OMITTED MATERIAL IS AVAILABLE FOR REVIEW,
BY APPOINTMENT,
AT THE US EPA NEW ENGLAND SUPERFUND RECORDS CENTER,
BOSTON, MA

5.0 SUMMARY

Samples of soil, sediment and surface water were collected from the Woonasquatucket River for chemical contaminants and physical parameters. The study was performed to augment existing data collected, and to attempt to isolate the possible source of dioxins that have been previously identified in the river system. The data was collected such that the analytical results could be used to support a full human health and ecological risk assessment if these are deveoped in the future.

Samples collected identified dioxin, characterized by the presence of 2,3,7,8-TCDD, in the surface sediments of Allendale Pond, Lymansville Pond, the banks of the river and on residential use property that is adjacent to these ponds. Concentrations of 2,3,7,8-TCDD were found to be highest in depositional wetland areas of Allendale Pond. Concentrations appeared to decrease with distance downstream of the present location of the Centredale Manor apartment complex.

Other contaminants were also found in the river sediments and water during this investigation. Contaminants included polyaromatic hydrocarbons (PAHs), other semivolatile organic compounds, pesticides and metals (Appendices A-D). A full discussion of contaminants found during this study in conjunction with data collected during the previous studies is currently under preparation, and will be published as a part of the Engineering Evaluation/Cost Analysis for the study area.

Additional data needs include the evaluation of groundwater data to determine flow direction and possible contaminant contribution to the river, and downstream extent of contamination at concentrations considered a concern for human health and the environment. In addition, a full analysis of nature and extent of contamination and a quantified risk assessment may be warranted.

The single sediment sample collected downstream of the Lymansville Dam as a part of this investigation indicates 2,3,7,8-TCDD is present at this location at 2.4 ug/kg. Sampling should be continued downstream of this point, possibly to a point immediately downstream of the Manton dam to determine if these concentrations continue to decrease with distance from the Centredale Manor and Brook Village properties.

Finally, groundwater may be collecting or liberating contaminants from underground sources at the Centredale Manor and Brook Village properties, and carrying these contaminants into the river. A full assessment of the flow patterns and quality of groundwater at and near the Centredale Manor site needs to be performed to assure remediated areas are not going to be recontaminated from groundwater recharge of the river and ponds. This assessment should be performed prior to the selection of a final remedy for the site.