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Final Work Plan

Remedial Investigation and Feasibility Study

Centredale Manor Restoration Project Site
North Providence, Rhode Island

FINAL WORK PLAN

Remedial Investigation and Feasibility Study
Centredale Manor Restoration Project Site
North Providence, Rhode Island

CONTRACT NO. DACW33-01-D-004
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ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or relevant and appropriate requirement
ATSDR	(U.S. Department of Heath and Human Services) Agency for Toxic Substances and Disease Registry
BERA	Baseline ecological risk assessment
BHHRA	Baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	Conceptual site model
EE/CA	Engineering Evaluation/Cost Analysis
ERA	Ecological risk assessment
ERDC	Environmental Research and Development Center
ERTC	Environmental Response Team Center
FS	Feasibility Study
GIS	Geographic information system
GPR	Ground penetrating radar
HCX	Hexachloroxanthene
NAPL	Non-aqueous phase liquid
NCDC	National Climatic Data Center
NOAA	National Oceanographic and Atmospheric Administration
NPL	National Priorities List
NTCRA	Non-time critical removal action
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene (polychloroethene)
ppb	Parts per billion
ppm	Parts per million
PRG	Preliminary remediation goal
RAO	Remedial action objective
ROD	Record of Decision
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RIDOH	Rhode Island Department of Health
SARA	Superfund Amendments and Reauthorization Act of 1986
SVOC	Semi-volatile organic compound
TCDD	Tetrachlorodibenzo-p-dioxin
TCRA	Time-critical removal action
TEQ	Toxic Equivalency Quotient
TTNUS	TetraTech NUS Inc.
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile organic compound

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) Region I and U.S. Army Corps of Engineers (USACE) New England District are conducting a Remedial Investigation and Feasibility Study (RI/FS) for the Centredale Manor Restoration Project Site (hereafter referred to as the site) located in North Providence, Rhode Island. This Work Plan presents the approach for completing the RI/FS at the site.

The main part of the site, generally referred to as the source area, is located at 2072 and 2074 Smith Street in North Providence, Rhode Island (Figure 1). The source area encompasses approximately 9 acres. The remaining portions of the site consist of reaches, man-made ponds, and wetlands associated with the Woonasquatucket River.

Prior to 1936, the Centredale Manor Restoration Project Site properties were occupied by Centredale Worsted Mills, a woolens mill. The Atlantic Chemical Company began operating on the properties in approximately 1943. Atlantic Chemical Company changed its name to Metro-Atlantic, Inc. in 1953 and continued to operate until the early 1970s. The New England Container Company, Inc. operated an incinerator-based drum reconditioning facility on a portion of the site from 1952 until 1971. A major fire in 1972 destroyed most of the structures at the site. The Brook Village apartments were opened in 1977 and the Centredale Manor apartments were opened in 1983 on the site of these former facilities.

Dioxin was first identified in the area in 1996 in fish collected from the Woonasquatucket River. Since that time, USEPA has documented elevated levels of contaminants including dioxin, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals in various media including soil, sediment, and groundwater at the site. A fish consumption advisory is currently in effect for the Woonasquatucket River in the vicinity of the site. The site was added to the National Priorities List (NPL) in February 2000 and is being investigated and remediated in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

1.1 Objective and Scope

Contamination at the Centredale Manor Restoration Project Site is being addressed in two stages: immediate (removal) actions, and long term (remedial) actions. The scope and objectives of the removal actions, which are in various stages of completion, are described in Section 2.3. This Work Plan presents the approach for completing the RI and identifying the long-term risk management strategies and remedial actions for evaluation in the FS.

The overall objectives of the RI are to determine the sources, nature, and extent of contamination at the site; characterize the fate and transport of contaminants; and evaluate potential human health and ecological risks resulting from exposure to site-related contaminants. Specific objectives are as follows:

- Ensure the protection of residents and visitors on and near the site from exposure to site-related contaminants.
- Evaluate the risk to human health associated with the consumption of fish present in the portion of the Woonasquatucket River that constitutes the site, and with potential ingestion of and dermal contact with bank soil, surface water, and sediment in the portion of the Woonasquatucket River that constitutes the site. USEPA's goal is to restore the river to an unrestricted fishable condition.

- Evaluate the risk to aquatic, semi-aquatic, and terrestrial receptor populations at the site. The overall objective is to determine if exposure to contaminants detected in site media is likely to cause a decline in receptor populations or to adversely affect the integrity of aquatic or floodplain soil communities.

The RI will focus on areas of the site that have not already been addressed by short-term removal actions (Section 2.3). The FS will evaluate risk management strategies and alternatives for remediating contamination that is found to pose an unacceptable risk to human health or the environment. The FS will also evaluate the long-term effectiveness of the short-term removal actions and determine whether additional action is required to effect a permanent remedy.

The results of the RI/FS will be used to formulate a Proposed Plan for the site, which will recommend remedial actions that will result in overall protection of human health and the environment, fulfill the requirements of CERCLA, be acceptable to all stakeholders, and satisfy the guidelines in USEPA's *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002b).

1.2 Work Plan Organization

This Work Plan is divided into four sections as follows:

Section 1.0: Introduction.

Section 2.0: Site setting and history; including site description, history, and summary of previous responses and investigations.

Section 3.0: Initial evaluation of the site; including conceptual site model (CSM), initial assessment of the nature and extent of contamination, preliminary assessment of potential human health and ecological risks, preliminary identification of general response actions, and preliminary identification of applicable or relevant and appropriate requirements (ARARs).

Section 4.0. Description of RI/FS tasks. This section summarizes the activities associated with the RI/FS for the site, including investigations that are currently in progress.

Section 5.0. References.

Section 6.0. Tables.

Section 7.0. Figures.

2.0 SITE SETTING AND HISTORY

This section provides a summary of the site setting, history, previous responses and previous investigations at the Centredale Manor Restoration Project Site.

2.1 Site Setting

The main part of the site (i.e., the source area) is located at 2072 and 2074 Smith Street in North Providence, Rhode Island. The site is currently occupied by the Brook Village and Centredale Manor apartment complexes, and is privately owned. The main part of the site comprises parking lots, roadways, lawn areas, and two residential buildings, Centredale Manor and Brook Village (Figure 2). Brook Village is on the northern part of the property and Centredale Manor is located to the south. The site also consists of reaches of the Woonasquatucket River associated with Allendale and Lyman Mill Ponds. The site consists of all contaminated areas within this area as well as any other location to which contamination from that area has come to be located, or from which that contamination came. Two interim protective soil caps (Interim Cap #1 and Interim Cap #2) are located to the south and west of Centredale Manor, respectively.

2.1.1 Topography

The main part of the site is relatively flat. It is situated on the 100-year floodplain of the Woonasquatucket River, which flows from north to south and is known to flood periodically. The Centredale Manor and Brook Village properties are located along the east bank of the river. Approximately 2,000 feet downstream of the site, the Woonasquatucket River widens to form Allendale Pond, an impoundment of the river behind Allendale Dam. Below the Allendale Dam, the Woonasquatucket River flows south and widens again to form Lyman Mill Pond, an impoundment behind the Lyman Mill Dam.

2.1.2 Geology and Hydrogeology

An investigation of the subsurface geology at the Centredale Manor site was carried out by TetraTech NUS Inc. (TTNUS) in 2001. According to TTNUS (2002), the subsurface soils at the site largely comprise silty sands and gravels ranging from 40 feet to over 70 feet in thickness. These unconsolidated materials are underlain by bedrock. Geophysical data indicate that the site is situated above a north-south trending bedrock valley. The following stratigraphic units were identified at the site:

Fill – The majority of the site is covered with a loose to very dense fill composed of unsorted silt, sand, and gravel with trace amounts of anthropogenic debris. Fill thickness appears to vary significantly across the site, with a maximum thickness of approximately 9 feet measured at a location within the tailrace.

Silt/Organic Silt/Wetland Deposits – Fine-grained deposits consisting primarily of silt and fine sand-size particles with variable amounts of organic matter are found underlying the fill at selected locations at the site. These relatively thin layers of fine grained sediments appear to have been deposited in former wetland areas that were subsequently filled in with fill material (above). The thickness of this sediment type ranges from 0.2 feet to 2.7 feet.

Sand and Gravel – The most common soil type present at the site consists of relatively coarse-grained materials, ranging from fine to coarse gravel and cobbles to poorly-graded, silty, fine to medium sands. This soil type underlies both the fill and the finer-grained wetland deposits and overlies the majority of the glacially–carved bedrock valley throughout the site. Thickness of this unit ranges from 12.5 feet to 43 feet, and appears to extend well beyond the site.

Fine Sand and Silt – A dense, fine-grained unit varying from fine sand, some silt to silt with trace fine sand and trace clay is present either within or beneath the coarse-grained sand and gravel unit. This unit has a rhythmic bedding pattern, indicative of a relatively short-term presence of a glacial lake or pond, where seasonal depositional variations formed varve-like patterns in the sediment.

Possible Till – At most locations within the site, a dense to very dense, unsorted mixture of grain sizes, possibly representing a basal till, is present beneath the coarse-grained sand and gravel unit. The thickness of the possible till unit ranges from approximately 3 feet to 40 feet.

TTNUS (2002) characterized groundwater flow at the site based on overburden and bedrock borings, geophysical surveys, hydraulic conductivity tests, and water level measurements taken during the spring and fall of 2001. Groundwater flow is from north to south with an easterly trend during high river stage events. This was particularly evident during significant rain events in the spring of 2001. Groundwater consistently discharges to the tailrace on the east side of the site, and seems to have an exchange with the river, gaining water during high stage events, and losing water to the river during more dry periods.

Groundwater flow through the deep overburden and bedrock beneath the northern and central portions of the site is generally to the southeast, with the easterly component to flow diminishing as groundwater reaches Interim Cap #1.

The average groundwater velocity in the shallow overburden is estimated at 0.21 ft/d (TTNUS, 2002). The average velocities in the deeper overburden and bedrock are estimated to be 0.55 ft/d and 27 ft/d, respectively. The difference in average groundwater velocity between the shallow and deep overburden is primarily due to the difference in mean hydraulic conductivity. The much higher velocity in the bedrock, despite its relative low hydraulic conductivity, is due to its lower effective porosity.

2.1.3 Meteorology

The National Oceanic and Atmospheric Administration (NOAA) provides national weather service data on the World Wide Web (http://www.nws.noaa.gov/). According to NOAA's National Climatic Data Center (NCDC), the weather in the vicinity of Providence (including Centredale) is influenced by its proximity to Narragansett Bay and the Atlantic Ocean. Winter temperatures are modified considerably, and major snowstorms often change to rain before reaching the area. Hot summer days are often cooled by sea breezes. In early fall, severe coastal storms of tropical origin occasionally bring destructive winds to the area. Coastal storms usually produce the severest weather.

Temperatures are generally moderate and average around 50°F on an annual basis. The average temperature between late May to late September is approximately 70°F. During this period, it is not unusual for several days to reach 90°F, however it is rare that the temperature exceeds 100°F. Freezing temperatures occur on the average about 125 days per year, and are very common between late November and March. However, sub-zero weather in winter seldom occurs. Measurable precipitation occurs on about one day out of every three, and is fairly evenly distributed throughout the year. There is usually no definite dry season, but occasionally droughts do occur.

Thunderstorms are responsible for much of the rainfall from May through August, and usually produce heavy rainfall. Over the last five years, four floods and two flash floods have been documented in Warwick and Coventry counties of Rhode Island. The most recent documented flooding of the Woonasquatucket River occurred on June 14, 1998. According to the NCDC, the river was in flood for almost 24 hours after a very slow moving storm system produced rainfall of 6 to 8 inches over much of Rhode Island.

2.1.4 Hydrology

The USGS has monitored streamflow for the Woonasquatucket River at Centredale since the early 1940s and has a wide range of streamflow statistical data available on the World Wide Web, including daily, monthly, annual and peak streamflows (www.waterdata.usgs.gov/nwis/sw/). Annual mean streamflow has ranged from 50 ft^3/s to 100 ft^3/s in most years (Figure 3). The lowest annual mean streamflow was observed in 1966, at 35.3 ft^3/s. The highest annual mean streamflows were observed in 1972 and 1983, at 122 ft^3/s and 126 ft^3/s, respectively.

Peak streamflow data for the Woonasquatucket River is presented in Figure 4. Over the last 60 years, peak streamflow ranged between 250 ft^3/s and 750 ft^3/s 64% of the time. Between 1942 and 1966, peak streamflow was fairly consistent and fell within this specified range, except in September 1954 and October 1955 when peak streamflow exceeded 950 ft^3/s. In the last 35 years, peak streamflow has been somewhat more variable, with values ranging from 190 ft^3/s to 1,520 ft^3/s.

2.1.5 Land Use

The Brook Village and Centredale Manor apartment complexes occupy the northern part of the site. This area is currently occupied and covered by buildings, pavement, landscaping, and interim protective caps and is expected to remain a multi-family residential use area. The groundwater beneath the site is classified by the State of Rhode Island as Class GB, which is defined as "may not be suitable for drinking water use without treatment due to known or presumed degradation" (State of Rhode Island Department of Environmental Management [RIDEM] Rules and Regulations for Groundwater Quality, Regulation 12-100-006, August 1996).

The Woonasquatucket River and its impoundments are not used as a source of drinking water. According to the RIDEM Water Quality Regulations EVM 112-88.97-1 (June 23, 2000), the Woonasquatucket River (from Esmond Mill Drive in Smithfield to the CSO Outfall at Glenbridge Avenue in Providence) is classified as a Class B1 water body. Class B1 water bodies are:

> "designated for primary and secondary contact recreational activities and fish and wildlife habitat. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges."

Ultimately, the USEPA plans to restore the Woonasquatucket River and associated reaches and ponds to an unrestricted fishable condition.

2.2 Site History

This section summarizes the chronology of activities at the Centredale Manor Restoration Project site and briefly discusses the type and volume of waste materials at the site.

2.2.1 Chronology

Former building locations on the Centredale Manor site are shown in Figure 5. Prior to 1936, Centredale Worsted Mills, a woolens manufacturing plant, occupied the main part of the site. In approximately 1940, Metro Atlantic Chemical Corporation began manufacturing chemicals on the site. The mill complex buildings were located at the north end of the site, north of the existing Centredale Manor building and north parking lot. Trichlorophenols were shipped to the site, where it is believed that Metro Atlantic manufactured hexachlorophene (of which hexachloroxanthene [HCX] and dioxin are byproducts). Operations at Metro Atlantic Chemical Corporation ceased during the late 1960s or early

1970s. Between 1952 and 1971, New England Container Company operated a drum reconditioning facility at the south end of the mill complex (immediately north of the Centredale Manor north parking lot). Chemical residues were dumped or burned prior to drum reconditioning. Residues associated with drum reconditioning operations may also be a source of dioxin to the site. In 1972, fire destroyed most property structures. Brook Village was constructed in 1977 and Centredale Manor was constructed in 1982.

Historical aerial photographs of the site were studied extensively by EPA Office of Research and Development (USEPA, 2000). This analysis revealed various types evidence of waste disposal at the site, including presence of drums, stained soils, grading scars, evidence of solid and liquid waste materials, mixtures of solid waste and drums, and surface impoundments. According to this analysis, "the most significant amount of waste-related activity and the greatest areal extent of waste-related features on the subarea were observed from 1962 through 1970." These waste-related features were concentrated in the central and southern portions of the site. The historical aerial photographs show evidence of drainage leading away from waste disposal areas to the west into the Woonasquatucket River, and to the east towards the tailrace. A photograph from 1979 shows cessation of waste-related activity, and sparse vegetation across the previously disturbed areas in the central and southern parts of the site.

The Allendale Dam was partially breached in 1991, reducing the surface water level in Allendale Pond. The dam breached completely in 2001, exposing most of the pond bottom adjacent to residential properties along the eastern bank of Allendale Pond from 1991-2002. Allendale Dam was reconstructed and the Allendale Pond was restored to its pre-1991 elevation in early 2002 as part of a non-time critical removal action (NTCRA) at the site (see Section 2.3.2).

2.2.2 Waste Type and Estimated Volume

Evidence of improper historical waste disposal was discovered during construction of the apartment complexes, and approximately 400 drums and 6,000 cubic yards of contaminated soil were removed from the Centredale Manor site. Chemicals that were potentially used onsite were identified based on drum labels and included caustics, halogenated solvents, PCBs, and inks. An analysis of the historical aerial photographs and geophysical data suggests that some waste material (e.g., metallic fill and debris) may still be present in the source area (TTNUS, 2002). The locations of geophysical anomalies that may be associated with waste material are shown in Figure 5. Evidence from historical photographs, state report files and geophysical testing strongly suggest that buried drums may be present in several areas of the site (USEPA, 1999). However, the exact nature and volume and any waste material remaining on the site cannot be reliably determined without the use of invasive methods. Invasive methods would likely increase the risk of exposure of site residents and workers to contaminants and transport of contaminants away from the source area.

2.3 Summary of Previous Responses

Time critical removal actions (TCRA) and a NTCRA have been implemented at the site. These actions are described further below. The RI will evaluate any site-related contamination that was not remedied by the TCRA or NTCRA, and the FS will evaluate the adequacy of these actions as permanent remedies.

2.3.1 Time-Critical Removal Actions

A TCRA was conducted at the site in 1999 and 2000 to reduce the immediate human health threat to residents on and near the site. The TCRA included the following:

- Removal of approximately 6 acres of undergrowth from the main part of the site.

- Construction of fencing in the main part of the site and in residential areas adjoining Allendale Pond to restrict access to potentially contaminated areas.
- Construction of an interim protective cap (Interim Cap #1) in a formerly wooded area immediately south of the Centredale Manor parking lot (Figure 2). This area is prone to flooding and had the highest concentrations of dioxin and PCBs in surface soil at the site.
- Construction of a second interim cap (Interim Cap #2) between the Woonasquatucket River and the Centredale Manor building (Figure 2). This area is also prone to flooding and contained elevated concentrations of dioxin in surface soils (i.e., greater than 1 part per billion [ppb]). A flood control berm was also constructed to prevent erosion of the cap.
- Placement of rip rap along the shore of the river to isolate contaminated soils and prevent erosion.

These contaminated soil areas and need for the caps were evaluated as part of the USEPA Region I Action Memorandum, dated May 4, 1999, as amended September 13, 1999 and June 1, 2000, and were addressed under the TCRA in 2000. The primary purpose of the interims caps is to minimize human exposure to contaminated soils. Evaluation of protectiveness from exposure to those contaminated soils and integrity of the interim caps, rip rap and existing pavement at the site will be included in the FS as part of selection of the components of the permanent remedy. Another TCRA is under consideration in 2003 to reduce the immediate human health risk from exposure to dioxin in tailrace soils on the east side of the source area.

2.3.2 Non-Time Critical Removal Actions

An Engineering Evaluation/Cost Analysis (EE/CA) was performed in 2000 as the basis for a NTCRA (TTNUS, 2000a). The EE/CA included a streamlined human health risk assessment and screening ecological risk assessment (ERA). The streamlined human health risk assessment identified potential human health risks to residents and recreational users of the pond banks from exposure to site-related chemicals. Dioxin was identified as the primary risk driver, and an action level of 1 ppb dioxin as a toxic equivalency quotient (TEQ) was selected as the action level for the NTCRA based on the USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-26 (*Approaches for Addressing Dioxins in Soil at CERCLA and RCRA Sites*, April 13, 1998). This action level represents the recommended starting point for soil cleanups based on a residential exposure scenario.

The objectives of the NTCRA are to 1) mitigate an unacceptable human health risk by removing contaminated soil from residential and recreational use properties on the Woonasquatucket River floodplain between Route 44 and Lyman Mill Dam, and 2) minimize further downstream migration of contaminated river sediment. The EE/CA did not address contaminated soils within the main part of the site (i.e., at the Centredale Manor and Brook Village apartment complexes). The NTCRA includes the following elements:

- Reconstruction of the Allendale Dam and restoration of Allendale Pond to prevent further downstream migration of site contaminants. This action was completed in early 2002.
- Delineation and excavation of contaminated soils in eleven action areas on residential properties along Allendale and Lyman Mill Ponds and recreational access areas along the banks of the ponds to minimize exposure to site-related contaminants. Excavation of the affected soils was completed in 2002 and restoration of the remediated areas is in progress.

Details regarding the NTCRA are contained in an Action Memorandum dated January 18, 2001. The NTCRA is being performed by several of the Centredale Manor potentially responsible parties.

2.4 Summary of Previous Investigations

Previous investigations at the Centredale Manor Restoration Project Site are summarized in Table 1. USEPA has conducted a number of investigations at the site, including a preliminary assessment in 1986, screening site inspection in 1990, site inspection prioritization in 1997, and an expanded site inspection in 1998. Additional site investigations were performed between 1998 and 2002 to better characterize the site and delineate the concentrations of dioxin and other site-related contaminants in soil, sediment, surface water and groundwater. Contaminants detected onsite include dioxin, PCBs, chlorinated and aromatic VOCs, polycyclic aromatic hydrocarbons (PAHs), and various metals. An initial evaluation of the nature and extent of contamination based on these data is provided in Section 3.2.

Table 1 details the types of samples collected at the site and the original use of the data. All relevant data will be used to support the RI/FS. All existing data for the site (with the exception of data for soils removed under the NTCRA) are compiled in a comprehensive database and geographic information system (GIS) maintained by USEPA. Table 2 lists the number of samples currently in the database for each class of contaminants for various media in the source area/Allendale Pond area, Lyman Mill area, and area downstream of the Lyman Mill Dam. Additional data collected at the site (Section 4.3) will be added to the database and used in the RI/FS.

3.0 INITIAL EVALUATION

This section presents the initial evaluation of the Centredale Manor Restoration Project Site, including the CSM, description of the nature and extent of contamination, preliminary assessment of potential human health and ecological risks, identification of preliminary remedial alternatives, and preliminary identification of ARARs.

3.1 Preliminary Conceptual Site Model

The CSM identifies potential sources of contamination, release mechanisms, contaminated media and contaminant transport mechanisms, exposure pathways, and potential receptors. The CSM provides a framework for characterizing the movement of contaminants at the site and evaluating potential human health and ecological risks from exposure to contamination. The preliminary CSM for the site is described below. The CSM will be refined throughout the RI/FS process based on additional data collection (Section 4.3) and development of a better understanding of the site.

As described in Section 2.2, potential historical sources of contamination at the site include improper storage and disposal of chemicals in drums, stockpiles and surface impoundments. These activities appear to have been concentrated in the central and southern parts of the source area. Chemicals were apparently released directly to the ground, buried, and discharged directly to the Woonasquatucket River and possibly the tailrace. Other materials related to site operations were also apparently buried on the site (e.g. metal and construction debris such as bricks and asphalt).

Direct infiltration of chemicals and leaching through the ground surface led to the contamination of surface and subsurface soils, primarily in the areas that are currently beneath Interim Caps #1 and #2. Localized groundwater contamination has also occurred, particularly on the west side of the Brook Village parking lot in the vicinity of Well MW-05S (TTNUS, 2002) (Figure 2). Discharge of chemicals directly into the river, potential overland flow of chemicals and erosion and transport of contaminated source area soils by surface runoff resulted in sediment contamination in the adjacent river and ponds and tailrace on the east side of the site. Discharge of contaminated groundwater may also contribute to surface water and sediment contamination, particularly in the vicinity of Well MW-05S. The breach of the Allendale Dam in 1991 and again in 2001 apparently resulted in the downstream transport of contaminated sediment from Allendale Pond to Lyman Mill Pond and possibly downstream of the Lyman Mill dam, and left the pond bottom sediments exposed as floodplain soils. Allendale Pond was restored to its original level in early 2002.

It is presumed that contaminated sediments have accumulated in depositional areas of the Woonasquatucket River. It is not known whether contaminated sediments presently are being naturally buried by cleaner sediments, or whether the sediment bed in depositional areas of the river is stable and resistant to erosion. Sediments may be eroded and redistributed by high river flows, and deposited on the river banks and in the adjacent floodplain during flood events. Contaminants in surface runoff also could have accumulated in low-lying areas in the tailrace on the east side of the source area, with post-depositional reworking by flood waters and episodic flow. It is possible that some anthropogenic reworking may have occurred, although historical aerial photographs indicate that little activity apparently took place in the tailrace.

Figure 6 presents the human health CSM for the site. Potentially significant human health exposure pathways include ingestion of contaminated fish or other aquatic life, and potential inadvertent ingestion of and dermal contact with contaminated bank soil, surface water and sediment at site. The scope of the baseline human health risk assessment (BHHRA) for the site is discussed in Section 4.3.1.

An ecological CSM for the site is provided in Figure 7. In general, aquatic receptors (including invertebrates and both demersal and pelagic fish species) are exposed to contaminants in sediment and surface water via direct contact, direct ingestion, or by consuming prey items that have bioaccumulated contaminants. Semi-aquatic receptors (including mammals, birds, reptiles, and amphibians) may be exposed as a result of incidental ingestion of sediment, consumption of water, or ingestion of contaminated prey. Terrestrial invertebrates and wildlife that prey on these species may be exposed to contaminants in floodplain soil directly or by ingesting contaminated prey. The scope of the baseline ecological risk assessment (BERA) for the site is discussed in Section 4.3.2.

3.2 Nature and Extent of Contamination

The following is an initial evaluation of the nature and extent of contamination based on data collected at the site from 1997 through 2001. A detailed analysis that includes all data collected for the RI will be provided in the RI report.

3.2.1 Soil

Soil sampling efforts in the source area have focused on characterizing the distribution of dioxin, which was identified as the primary contaminant of concern in the Health Consultation for the site (U.S. Department of Heath and Human Services Agency for Toxic Substances and Disease Registry [ATSDR], 1999). A subset of soil samples was also analyzed for other site-related chemicals. Elevated levels of dioxin, PCBs, VOCs, SVOCs, and selected metals have been identified in site soils. Dioxin contamination is widespread, with levels up to 140 ppb in surface soil. Concentrations in subsurface soils are generally lower (IT Group, 2000). Total PCBs, total VOCs and total SVOCs have been measured at concentrations up to 1,300 parts per million (ppm), 10,000 ppm, and 1,800 ppm, respectively (USEPA, 1999).

Dioxin concentration data are typically reported on an individual congener basis and converted to a 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) TEQ concentrations. As noted in Section 2.3.1, a preliminary cleanup level of 1 ppb dioxin as a TEQ should be used for residential properties (USEPA, 1998). This cleanup level was recommended as the basis for the TCRA in the source area (ATSDR, 1999). Figures 8 and 9 show the locations where the dioxin TEQ exceeds 1 ppb in the Allendale and Lyman Mill areas, respectively. In the source area, most of the soils with dioxin TEQs exceeding 1 ppb are found beneath the interim caps (sediment data are summarized in Section 3.2.3).

The distribution of dioxin in the tailrace is shown in more detail in Figure 10 and is described in detail in the Interim Data Collection Work Plan (Battelle, 2002a). Briefly, the distribution of dioxin greater than 1 ppb TEQ in the tailrace is patchy and discontinuous. Additional data collected as part of the Interim Data Collection effort (Section 4.3.4) will better define the horizontal and vertical distribution of dioxin in the tailrace. These data will be reported in the RI.

Figure 11 shows source area soil sample locations in areas located under existing paved surfaces (i.e., not located under the interim soil caps or in the tailrace). Sample locations shown in red correspond with samples taken under existing paved surfaces from 0-2 ft with contaminant concentrations that either exceed the State of Rhode Island direct exposure criteria for residential soils at contaminated sites (Rhode Island Remediation Regulations Rule 8.02.B), or the preliminary cleanup level of 1 ppb TEQ for dioxin (USEPA, 1998). Sample locations with shallow soils exceeding the Rhode Island direct exposure criteria are concentrated in the Centredale Manor north and south parking lots, although shallow soils in several locations at the Brook Village parking lot also exceed direct exposure criteria.

3.2.2 Groundwater

Groundwater monitoring well locations at the site are shown in Figure 12. A source area Investigation conducted in 2001 (TTNUS, 2002) indicated that significant groundwater contamination at the site is limited to the vicinity of Well MW-05S on the eastern bank of the Woonasquatucket River adjacent to the Brook Village parking lot. High levels of chlorinated solvents and dioxin were detected in samples from this well, and non-aqueous phase liquid (NAPL) was found in subsurface soil samples. Tetrachloroethene (PCE) was detected in some of the deeper monitoring wells elsewhere on the site at concentrations in the hundreds of parts per billion, and lower concentrations of VOCs were detected in samples from some of the shallow monitoring wells. Trace levels of several other contaminants (e.g., phenols and dioxin) were also detected in some samples.

The extent of shallow groundwater contamination as defined above was confirmed by a USGS study using vapor diffusion samplers deployed in the Woonasquatucket River, tailrace and Allendale Pond (USGS, 2000). This survey identified the seepage of VOC-contaminated groundwater along a 500-ft stretch of the Woonasquatucket River immediately downstream of Well MW-05S (Figure 5).

An additional round of groundwater samples from all monitoring wells was collected in October and November 2002 as part of the Interim Data Collection Effort (Section 4.3.3). All samples were analyzed for VOCs, and the sample from MW-05S also was analyzed for dioxin. These data will be presented in the RI report.

3.2.3 Sediment

Sediment sample locations for dioxin analysis in the Allendale and Lyman Mill areas are shown in Figures 8 and 9. Dioxin TEQs exceed 1 ppb in much of the Allendale Pond sediment (it should be noted that the preliminary cleanup goal of 1 ppb for residential soils will not apply to river and pond sediments; cleanup goals for sediment will be developed based on the results of the BERA and BHHRA). Subsurface data indicate that dioxin concentrations are highest in surface sediment. Dioxin concentrations are lower in the Lyman Mill pond than in Allendale Pond.

According to a study conducted by TTNUS (2000b), concentrations of dioxin (i.e., 2,3,7,8-TCDD) were found to be highest in depositional wetland areas of Allendale Pond, and decreased with distance downstream of the source area. Further, the elevated dioxin concentrations appeared to be limited to the upper two feet of sediment, based on limited deep samples collected. Dioxin concentrations found in the aquatic sediments of Lyman Mill and Allendale Ponds ranged up to 7.7 ppb and 110 ppb, respectively. Sediment samples collected further downstream at the Manton and Dyerville areas generally contained lower concentrations of dioxin, with only 2 out of 16 samples collected exceeding 1 ppb (TTNUS, 2001). Other contaminants were also found in the river sediments, including PAHs, other SVOCs, pesticides, PCBs, and metals. According to TTNUS (2000b), PCBs, reported as Aroclor 1254, were detected above background levels in approximately 50% of the aquatic sediment samples collected in the study area, and ranged up to 2,410 ppb. Recent measurements of PCB (as Aroclor) showed comparable results, with PCB concentrations ranging up to 3,250 ppb and 2,210 ppb at Allendale and Lyman Mill Ponds, respectively (MACTEC, 2003a). Aroclor 1254 was the dominant PCB present in the aquatic sediments; however, lower levels of Aroclor 1268 were also detected, and represented approximately 15% on average of the total PCB (MACTEC, 2003a). Additional characterization of sediment in the ponds will be conducted as part of the RI (Section 4.3.5).

3.2.4 Surface Water

Studies conducted by TTNUS (2000a, b) showed that surface water samples collected from the Woonasquatucket River and its tributaries contained dioxins and traces of metals, PCBs, pesticides and

selected SVOCs (i.e., bis [2-ethylhexyl]phthalate and phenol). Approximately half of the samples contained 2,3,7,8-TCDD, while only one surface water samples contained PCBs. Dioxin concentrations ranged up to 12,740 pg/L. The highest dioxin concentration was found in a sample from a shallow and stagnant portion of the tailrace east of Centredale Manor (estimated as 12,740 pg/L). The next highest dioxin concentration was measured in a sample from a shallow, backwater area of Allendale Pond (estimated as 4,000 pg/L). Dioxin was detected in surface water samples from both the Allendale Pond and Lyman Mill Pond areas, although the higher concentrations were found to be associated with the shallower water and wetland areas of Allendale Pond.

The one surface water sample that contained PCBs was collected from the tailrace location with the highest dioxin concentration. Pesticides were found at various locations throughout the site, and were not limited to depositional areas. This suggests that the presence of pesticides may be a result of lawn treatments nearby. Results from the metals analyses suggested that the source of metals to the surface waters was natural (TTNUS, 2000b).

A USGS study using vapor diffusion samplers deployed in the Woonasquatucket River, tailrace and Allendale Pond provided a qualitative indicator of surface water contamination by VOCs (USGS, 2000). Vapor diffusion sampling results identified the discharge of VOC-contaminated groundwater along a 500-ft stretch of the Woonasquatucket River on the west side of the site, and another zone of lower VOC levels south of Interim Cap #1.

3.2.5 Biota

Prior to the 2001 BERA investigation, limited data were available to assess the nature and extent of contamination in biota from the source area and downstream locations. In 1996, USEPA collected fish tissue data from two areas of the Woonasquatucket River: Valley Street and Smith Street. Sunfish muscle and offal tissues (three samples of each) were analyzed in the Valley Street sample and eel muscle and offal tissues (one sample of each) were analyzed in the Smith Street sample. At both sites, pesticides, PCBs, and various metals were detected in fish tissue. In 1999, Rhode Island Department of Health (RIDOH) conducted a fish tissue study in the vicinity of Centredale Manor. Tissues for four individual fish (two eel, one pumpkinseed, and one bluegill) were analyzed. Tissues were found to contain dioxins, furans, and PCBs. Further discussion of the nature and extent of contamination found in biota will be provided in the BERA (Section 4.3.2).

3.3 Preliminary Identification of Remedial Alternatives

Based on the preliminary assessment of the nature and extent of contamination and potential human health and ecological risks, it is expected that action will be required to address site-related contamination in source area soils and in sediments located in the Woonasquatucket River, including Allendale Pond and possibly Lyman Mill Pond. Specific assumptions regarding the risk management strategy for the site include the following:

- The areas addressed in time critical removal actions (i.e., the soils beneath the interim protective caps and a planned action in the tailrace on the east side of the source area) were sources of contaminant release and migration posing unacceptable human health risk, and permanent cleanup alternatives will be evaluated in the FS.
- Contaminant concentrations in shallow soils (i.e., less than 2 ft deep) beneath the Centredale Manor north and south parking lots, and in a few locations in the Brook Village parking lot, exceed Rhode Island direct exposure criteria, and alternatives for preventing direct exposure to these soils will be evaluated in the FS.

- Contaminated subsurface soils in the vicinity of Well MW-05S will be actively remediated if the RI determines that they are acting as a continuing source of contamination to the Woonasquatucket River via contaminated groundwater discharge.
- Because the primary sources of contamination at the site have been controlled, subsurface soils will not contaminate groundwater to levels that are higher than already observed.
- Dioxin appears to be the primary risk driver for the site and a permanent remedy based on dioxin contamination will also reduce the risk from exposure to other contaminants, unless it is found that exposure to contamination is driven by leaching or volatilization, in which case these issues will be addressed as well.

General response actions for source area soils are as follows:

- Excavation of all contaminated soils and buried waste material from the source area, including the tailrace, followed by off-site disposal;
- In situ treatment of contaminated soils;
- In situ capping of contaminated soils and buried waste material (i.e., conversion of interim protective caps to permanent features and installation of cap in the tailrace);
- In conjunction with capping, institutional controls to prevent direct exposure to soils and beneath the Centredale Manor north and south parking lots and restrict the future development of capped areas.

General response actions for contaminated sediment in the Woonasquatucket River and its impoundments are as follows:

- Monitored natural recovery;
- In situ capping;
- Excavation (i.e., dredging) and on-site containment (i.e., contained aquatic disposal);
- Excavation and offsite disposal;
- Institutional controls as required to minimize exposure to contaminants in the ponds or restrict future use and development.

Potential remedial alternatives for soil, sediment and any other media found to pose an unacceptable risk will be screened in the FS, and detailed alternatives will be developed and analyzed.

3.4 Preliminary Identification of ARARs

Based on the initial evaluation of site conditions and potential remedial alternatives, a preliminary list of potential ARARs was identified. ARAR identification will continue throughout the RI/FS process, and a more complete list will be presented in the FS report.

ARARs are divided into three categories: chemical-, location-, and action-specific. Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical cleanup values. These values specify the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. If more than one ARAR applies to a chemical, the most stringent requirement will be identified as an ARAR for any remedial action.

Location-specific ARARs are restrictions on the concentration of hazardous substances or the conduct of activities due to the characteristics of the site or immediate environment. For example, either a site location

or proposed remedial action in a floodplain, wetland, historic place, or sensitive ecosystem may trigger location-specific ARARs.

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken. These requirements are triggered by the particular remedial activities selected. Action-specific ARARs do not in themselves determine the remedial alternative; rather, they indicate how an alternative must be conducted. Action-specific ARARs are identified for remedies involving actions such as dredging, confinement, treatment, or disposal.

Table 3 provides a preliminary list of potential ARARs for the site. These potential ARARs will be evaluated in more detail and refined as part of the development of remedial alternatives.

4.0 RI/FS WORK PLAN TASKS

This section presents the tasks associated with performing the RI/FS for the Centredale Manor Restoration Project Site. RI/FS activities were initiated in 1999, and some of the tasks described below are in progress. Data collection to characterize contamination in the terrestrial part of the site (i.e., to define the nature and extent of soil and groundwater contamination) has been completed, and sample data are in the process of finalization. Data evaluation for the BHHRA and BERA is in progress. USEPA has also defined specific tasks that are required to address *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002b). These tasks are in the planning stages and are discussed further in Section 4.3.5. All RI/FS tasks are described below.

4.1 Project Planning

A report was prepared in February 2002 that evaluated existing data for the site and identified data gaps that needed to be addressed to complete the RI/FS (Battelle, 2002b). An Interim Data Collection Work Plan was prepared to address these data gaps (Battelle, 2002a). A summary of the data needs that were identified is provided in Table 4. The data collection efforts to address these data gaps are described in Section 4.3.

4.2 Community Relations

USEPA has conducted community relations activities at the site since the initiation of site activities. USEPA will continue to prepare fact sheets; organize public hearings and meetings; and communicate with local residents, organizations and other parties as required. Updated site information is made available to the public on the USEPA Superfund web site (http://www.epa.gov/region01/superfund/sites/centredale).

4.3 Data Collection

Data from the previous investigations (Table 1) will be used to support the RI/FS as appropriate. The results of the data collection efforts described below will be used in conjunction with existing data (with the exception of data for soils removed under the NTCRA) to complete the RI/FS for the site. The timeline for all data collection activities is provided in Table 5.

4.3.1 Baseline Human Health Risk Assessment

The overall goal of the BHHRA is to evaluate the risk to human health associated with the consumption of fish present in the portion of the Woonasquatucket River that constitutes the site, and with potential ingestion of and dermal contact with bank soil, surface water, and sediment in the portion of the Woonasquatucket River that constitutes the site. Risk will also be evaluated at the two reference locations, i.e., Greystone Mill Pond and Assapumpset Brook. Risk to neighborhood residents and visitors will be evaluated. The objective of the BHHRA is to analyze potential adverse human health effects for both current and future conditions caused by hazardous substance releases from the site in the absence of any actions to control or mitigate these releases (i.e., assuming no action or the absence of the RIDOH health advisories on fish consumption for this particular site). Currently, the fish consumption advisory issued by the State of Rhode Island is not believed to be a sufficient barrier to precluding exposure to biota from the Woonasquatucket River in the short-term. Current and potential future exposure to fish and other biota (including high lipid content biota such as eels) may occur at the river. USEPA's goal is to restore the river to an unrestricted "fishable" river.

Acceptable risks associated with biota consumption and contact with bank soil, surface water and sediment will be achieved and/or maintained through risk management procedures that may include development of preliminary remediation goals (PRGs) for sediment and other media as appropriate.

Detailed descriptions of the scope and methods to be used for the BHHRA are provided in the *Human Health and Ecological Risk Assessment Work Plan* (Harding ESE, 2001) and *Work Plan, Expanded Human Health Risk Assessment* (MACTEC, 2003b). Data to support the BHHRA was collected in 2001 (Harding ESE, 2001). These data will be used in conjunction with data from previous investigations (Table 1) as appropriate to perform the BHHRA. The adequacy of the data to complete the BHHRA is discussed in the *Final Data Evaluation Report* (MACTEC, 2003a). The results of the BHHRA will be presented in a BHHRA report.

4.3.2 Baseline Ecological Risk Assessment

The following summary of the BERA was provided in the *Final Data Evaluation Report* (MACTEC, 2003a). In general, the objectives for the BERA are the protection and maintenance of aquatic, semi-aquatic, and terrestrial receptor populations at the site. The overall objective is to determine if exposure to contaminants detected in site media is likely to cause a decline in receptor populations or to adversely affect the integrity of aquatic or floodplain soil communities. The general types of effects of concern include the following:

- Mortality, growth, or reproductive effects resulting from direct exposure to contaminants that affect a significant proportion of the receptor population;
- Mortality, growth, or reproductive effects resulting from exposure to contaminants that have bioaccumulated in the food chain that affect a significant proportion of a higher trophic level receptor population, and
- Indirect effects associated with a substantial reduction in abundance of prey populations.

Field population and community studies were implemented to evaluate potential population level effects (e.g. survival, growth, or reproduction) or community-level effects (e.g. species richness and abundance) associated with exposure to site media. The six assessment endpoint receptor groups selected for the BERA are as follows:

- Aquatic and floodplain invertebrates (crayfish, earthworms);
- Demersal and omnivorous fish;
- Pelagic, piscivorous, or semi-piscivorous fish;
- Piscivorous mammals and birds;
- Insectivorous mammals and birds; and
- Omnivorous mammals and birds.

The BERA will evaluate the protection and maintenance of communities and/or populations of the receptors identified above. There are multiple measures of effects for each of the BERA assessment endpoints. The BERA will also incorporate results from tree swallow studies conducted by the USGS in 2000 and 2001, and early life stage testing of fish conducted by USACE in 2001.

The detailed scope and methods for the BERA are provided in the *Human Health and Ecological Risk Assessment Work Plan* (Harding ESE, 2001). The adequacy of the data to complete the BERA is discussed in the *Final Data Evaluation Report* (MACTEC, 2003a). The results of the BERA will be presented in a BERA report.

4.3.3 Development of Preliminary Remediation Goals

As required, the results of the BHHRA and BERA will be used to develop PRGs for the site. These goals will be directly related to the contaminants, media and exposure pathways that are found to pose an unacceptable ecological and/or human health risk. The results of this task will be provided in a PRG report.

4.3.4 Interim Data Collection Effort

An Interim Data Collection effort was conducted in October and November of 2002 to address data needs that had been identified in the Data Gaps report (Battelle, 2002a). The scope of the Interim Data Collection effort was as follows:

- Collection and analysis of surface and subsurface soil samples from the tailrace on the east side of the source area to better define the distribution and extent of dioxin contamination and screen for the presence of other site-related contaminants;
- Collection and analysis of soil samples from the John E. Fogarty Center property on the southeast shore of Lyman Mill Pond to evaluate potential human health risks to site users; and
- Collection and analysis of groundwater samples from all existing monitoring wells.

Details of this sampling effort are provided in the Interim Data Collection Work Plan (Battelle, 2002a). Data will be presented in a Data Summary Report and will be evaluated fully in the RI report (Section 4.4).

4.3.5 Sediment-Related Studies

In July 2002, USEPA prepared a description of tasks required to address *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002b). This guidance document presents eleven risk management principles that should be considered when investigating and managing contaminated sediment sites. The data and information collected under the USEPA scope of work will be used to estimate volumes of contaminated sediment, estimate rates of sediment accumulation or erosion, characterize sediment stability, and evaluate the comparative risk of implementing active remediation in the short term (e.g. excavation, capping) with remedy effectiveness of less invasive action (e.g., monitored natural recovery) in the long term. Ecological and human health risk assessment data will be incorporated into the sediment-related studies as appropriate. Work planned to complete each of these tasks is described further below.

Geophysical and Geomorphology Investigations

The USEPA Environmental Response Team Center (ERTC) performed a geophysical investigation of the Allendale and Lyman Mill ponds in the fall of 2002 in accordance with *Work Plan, Centredale Manor Site* (September 17, 2002). Waterborne geophysical surveys were performed from a low-draft, pontoon-type boat. Two geophysical methods were attempted: ground penetrating radar (GPR) imaging and acoustic sub-bottom profiling. The sub-bottom profiling was unsuccessful due to heavy vegetation and gas bubbles on the pond bottoms, and was abandoned. GPR was used to map soft sediment thickness in both of the ponds. Bathymetric data were also collected. Maps of bathymetry and sediment thickness, and cross-sections of the ponds will be prepared and incorporated into the GIS for the site. Results will be presented in a Geophysical Report in the spring of 2003. Data will be used in conjunction with the results of the geomorphology investigation to design a sediment characterization study.

The USACE Environmental Research and Development Center (ERDC) is conducting a geomorphology investigation in accordance with *Proposal for a Geomorphic Evaluation of the Woonasquatucket River, North Providence, RI* (July 29, 2002). The geomorphic evaluation will support the sediment characterization study and also provide information for the FS. The investigation includes identification of geomorphic landforms (e.g. floodplains, terraces, abandoned channels) and associated active and passive geomorphic processes. The identification of landforms and processes will enable efficient planning of future sampling operations by delineating those areas most likely to enhance contaminant concentration and migration. The study includes a literature review and collection and analysis of data

for the Woonasquatucket River and surrounding area, including information from web sites and other key information sources (universities, state and federal agencies). Aerial photographs and maps from different time periods will be examined for identification and comparison of geomorphic features and processes over time.

Sediment Characterization Study

This task will be performed jointly by USEPA/ERTC and USACE/ERDC and is scheduled for spring of 2003. The objectives of this task are as follows:

- If possible, identify the sediment depth associated with the onset of waste-related activities at the site through visual inspection of sediment cores and radiometric age dating.
- Identify any relationships between sediment depth, age, and dioxin (2,3,7,8-TCDD) concentration.
- Estimate the rate of sediment accumulation in depositional areas and assess the degree to which natural recovery (i.e., burial) appears to be occurring.
- Evaluate the degree of sediment disturbance through the analysis of radioisotope profiles.
- Determine the horizontal and vertical extent of sediment with dioxin concentrations exceeding PRGs based on the results of the BERA and BHHRA.
- Collect additional data as required to support the evaluation of contaminant fate and transport, sediment stability, and evaluation of remedial alternatives.

The sediment characterization study is currently in the planning stages. The complete results of the sediment characterization study will be loaded into the GIS and database and evaluated in the RI report (Section 4.4).

Evaluate Volume of Contaminated Sediment

The results of the sediment characterization study will be used to calculate the volume of sediment exceeding PRGs using kriging or other appropriate methods. Sediment volumes will be presented in the FS report (Section 4.5) and will be used in the development and evaluation of remedial alternatives.

Sediment Stability Evaluation

USEPA's sediment management principles (USEPA, 2002b) emphasize that sediment stability should be considered in the CSM. The scope of the sediment stability evaluation and decision about whether to utilize a qualitative or quantitative (i.e., numerical modeling) approach will be made after evaluation of the geophysical, geomorphic, and sediment core data. The sediment stability evaluation will predict sediment deposition or erosion under various hydraulic regimes, and predict the effects of large-magnitude disruptive forces in current and future scenarios. The results of the sediment stability evaluation will be presented in the RI report and will be used to refine the CSM and support development of remedial alternatives for sediment in the FS.

Comparative Analysis of Short-Term and Long-Term Risks

USEPA's sediment management principles (USEPA, 2002b) stipulate that remedies at sediment sites should be designed to minimize short-term risks while achieving long term protection. A comparative analysis of short-term risks associated with implementing a sediment remedial action versus the long-term protectiveness afforded by the remedy will be conducted during the FS and presented in the FS report (Section 4.5). This analysis will include an evaluation of the potential for breaching of the Allendale Dam abutments due to large flood events.

4.4 Remedial Investigation Report

After the sediment-related studies are completed and all data are finalized, the RI report will be prepared. The RI report will address the terrestrial and aquatic portions of the site. The RI report will include the following:

- A synthesis of information pertaining to the site background, history and chronology of events;
- A detailed description of site physical characteristics;
- Discussion of the sources of contamination and status of source control;
- Presentation of a refined CSM that considers sediment stability and temporal/spatial variations in site conditions;
- Definition of the nature and extent of contamination in all media (i.e., soil, groundwater, sediment, surface water and biota);
- Detailed discussion of contaminant fate and transport, including a summary of the sediment stability evaluation;
- Summary of the findings of the BHHRA and BERA reports, which will be completed before the RI report.

The RI will identify the location and extent of contaminated media that pose an unacceptable risk to human health and the environment. The RI report will be prepared in accordance with CERCLA guidance for RI/FS investigations (USEPA, 1988) (Table 5). Assumptions and uncertainties associated with site characterization data and models also will be evaluated in the RI report in accordance with *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002b).

4.5 Feasibility Study

The FS will consist of two phases: identification and screening of remedial alternatives, and the detailed analysis of alternatives. Activities associated with each phase are described below. The timeline for FS activities is provided in Table 5.

4.5.1 Remedial Alternatives Screening

In this task, risk management options and remedial alternatives for contaminated media that pose an unacceptable human health or environmental risk as identified in the RI will be identified and screened. USEPA (2002b) encourages the use of an iterative approach in developing effective risk management strategies for contaminated sediment sites. The remedial alternative screening process for sediment should consider the use of a phased approach which allows for a course correction to increase the effectiveness of the remedy. The following activities will be completed under this task:

- Establish the risk management options and remedial action objectives (RAOs) for the site. The RAOs will be based on the PRGs developed from the BERA and BHHRA (Section 4.3.3) and will specify the contaminant(s) and media of concern, exposure route(s) and receptor(s), and acceptable contaminant level of range of levels for each exposure route. Sediment cleanup goals must be clearly tied to risk management goals (USEPA, 2002b).
- Establish the general response actions for each medium requiring remediation. Various actions to satisfy the RAOs will be identified, and will encompass all potentially applicable approaches to risk management at the site (e.g. monitored natural recovery, institutional controls, excavation, containment, treatment, disposal). No presumptive remedies exist for contaminated sediment sites, and all remedies that may potentially meet risk management goals and RAOs should be considered (USEPA, 2002b).

- Identify and screen remedial technologies. Remedial technologies associated with each general response action will be identified and screened. The USEPA's contaminated sediment remediation guidance (USEPA, 2002a) will be used to support the identification and evaluation of remedial technologies for sediment. Technologies will be evaluated in terms of effectiveness, implementability and cost according to CERCLA guidance (USEPA, 1988). The relative effectiveness and limitations of institutional controls with respect to sediment sites will be taken into consideration (USEPA, 2002b).
- Any treatability testing requirements will be identified for technologies that are likely to be carried forward for detailed analysis, or for promising innovative technologies.
- Develop remedial alternatives based on combinations of representative technologies that are found to be potentially effective and feasible for application at the site. These alternatives will be analyzed in detail in the FS (Section 4.6).

Results of the remedial alternatives screening will be reported in a technical memorandum. This memorandum will be the basis for the FS report (Section 4.5.2).

4.5.2 Feasibility Study Report

The detailed analysis of remedial alternatives will be completed in the FS. The FS will include the following:

- Detailed description of each alternative;
- Identification of ARARs associated with each alternative;
- Individual analysis of each alternative relative to the two threshold and five balancing FS evaluation criteria (i.e., overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost; USEPA, 1988). The final two modifying evaluation criteria, state and community acceptance, will be evaluated in the Record of Decision (ROD).
- Comparative analysis of the alternatives in terms of the FS evaluation criteria.

The integrity of the existing interim caps, rip rap, and pavement at the site will be addressed in the FS. For the sediment portion of the site, a comparative analysis of the short-term risks associated with remedy implementation with the long-term risk associated with residual contamination should be taken into account (USEPA, 2002b). Results of the FS will be presented in a FS report.

4.6 Post RI/FS Support

This task includes all activities required to support implementation of the recommended remedial alternative or risk management strategy, including preparation of the Proposed Plan, responsiveness summary, and ROD. This task includes preparation of documentation to demonstrate compliance with *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002b). It also includes definition of the performance standards for the remedy, site monitoring strategy, and exit criteria.

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6.0 TABLES

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Table 1. Summary of Existing Data for the Centredale Manor Restoration Project Site.

Date	Media/Collected By	Analytes/Reference	Original Use of Data
May, 1996	Fish collected by USEPA at two locations: 15 sunfish collected at Valley St. site, Providence, RI. 3 American eel collected at Smith St. site (near Centredale), N. Providence, RI. Fillet and offal samples for each.	Selected metals, PCB congeners: #8, 18, 28, 52, 44, 66, 101, 118, 153, 105, 138, 187, 128, 180, 170, 195, 206, 209,. Pesticides – HCB, DDE, DDD, DDT, Lindane, alpha-chlordane, nonachlor. Dioxins and dioxin-like PCBs (#77, 126, 169).	Fish analyzed to provide an indicator of the quality of the river system.
October, 1997	Water and sediment collected behind 7 dams on Woonasquatucket River – Esmond, Allendale, Lymansville, Manton, Dyerville, Olneyville, Lonigan. Samples identified as DAM-01 – DAM-07, North to South.	Water analyzed for DO, Temp, conductivity, pH. Sediment analyzed for total metals, PAHs, PCBs, pesticides, AVS, SEM, dioxin and TOC. (*Sediment Water Quality Analysis, Prepared by EPA Region 1 OEME, 7/31/98*)	First sediment evaluation to locate possible source of dioxin.
September, 1998	Soil and sediment samples collected from 42 locations. 5 soil samples at Centredale Manor property, 1 soil sample at Brook Village property, 35 sediment samples on Woonasquatucket River and 4 sediment samples in Centredale Raceway. Samples identified as SD-##.	Samples analyzed for dioxin and HCX, SVOCs, pest/PCBs. (*Final Summary Report for Expanded Site Inspection for Centredale Manor, Prepared by Roy F. Weston, 3/9/99*)	Sediment investigation to confirm high concentrations of chemicals in sediment near the Centredale Manor property.
January, 1999	Soil samples collected from 17 locations at Centredale Manor, No. Providence Boys and Girls Club, Early Years Learning Center, Lee Romano Baseball Field. Samples identified as SS-99-00 thru SS-99-16.	Samples analyzed for dioxin only. (*Final Summary Report for Expanded Site Inspection for Centredale Manor, Prepared by Roy F. Weston, 3/9/99*)	Determine possible risks to persons using these areas for recreational purposes. Ballfield and Boys/Girls club properties were found to not pose a risk to humans.
	Three drinking water samples collected also – 2 at Yacht Club Bottling Works Co. and 1 at the Pied Piper School.	Samples analyzed for dioxin only. (*Final Summary Report for Expanded Site Inspection for Centredale Manor, Prepared by Roy F. Weston, 3/9/99*)	Determine possible risks to persons drinking water at these locations.

Table 1. Summary of Existing Data for the Centredale Manor Restoration Project Site (continued).

Date	Media/Collected By	Analytes/Reference	Original Use of Data
January, 1999	Five soil samples collected by USEPA Emergency Response Group from Lee Romano Baseball Field. These samples are SS-21 through SS-25.	Samples analyzed for dioxin only. (*Final Summary Report for Expanded Site Inspection for Centredale Manor, Prepared by Roy F. Weston, 3/9/99*)	Determine possible risks to persons using these areas for recreational purposes. These areas were found to not pose a risk to humans.
February, 1999	222 soil samples collected by USEPA Emergency Response Group from Centredale Manor and Brook Village properties and several residential properties located adjacent to Centredale Raceway.	Samples taken from Centredale Manor and Brook Village properties, analyzed for 2,3,7,8-TCDD only. Samples from other residential properties sampled for all dioxins. (*Final Site Inspection Report, Prepared by the IT Group, 1/00*)	Determine extent of surface contamination, and develop approach for short term actions under emergency response.
June - July, 1999	A total of 524 soil samples collected by USEPA Emergency Response Group from Centredale Manor and Brook Village properties.	All soil samples analyzed for dioxins and PCBs. 20% of samples analyzed for SVOCs, metals, Pest/PCBs, dioxins. (*Final Site Inspection Report, Prepared by the IT Group, 1/00*)	Determine extent of contamination and provide support for the selected approach for short term actions.
July, 1999	28 soil samples by USEPA Emergency Response Group collected at residential properties adjacent to Centredale raceway and wetlands by hand auger	All samples analyzed for dioxins and PCBs. (*Final Site Inspection Report, Prepared by the IT Group, 1/00*)	Identify presence of contaminants on residential property, and determine appropriate location of fence to control access to contaminated areas.
July - August, 1999	68 soil samples collected by USEPA Emergency Response Group at residential properties adjacent to Allendale Pond by hand auger.	All samples analyzed for dioxins and PCBs. (*Final Site Inspection Report, Prepared by the IT Group, 1/00*)	Identify presence of contaminants on residential property, and determine appropriate location of fence to control access to contaminated areas.
September – October, 1999	43 sediment samples collected by USEPA Emergency Response Group from Allendale Pond.	All samples analyzed for dioxins and PCBs. (*Final Site Inspection Report, Prepared by the IT Group, 1/00*)	Begin to evaluate downstream extent of contamination.
November, 1999	11 soil samples collected from the river bank near Brook Village by USEPA Emergency Response Group. Soil now covered with rip-rap.	Full suite of chemical analyses. *Final Site Inspection Report, Prepared by the IT Group, 1/00)*	Determine need to cap bank sediments at Brook Village property.
August, 1999	5 indoor air samples collected in Centredale Manor and Brook Village by OEME and START.	Samples analyzed for volatile organic compounds. (*Final Report, Centredale Manor Indoor Air Survey, Prepared by OEME, 8/99*).	Performed to identify possible hazards to residents from air quality inside building. No significant VOCs were found to be migrating into buildings.

Table 1. Summary of Existing Data for the Centredale Manor Restoration Project Site (continued).

Date	Media/Collected By	Analytes/Reference	Original Use of Data
September, 1999	165 vapor diffusion samples installed by USGS to sample for soil gas in wetland areas and in sections of the river.	Samples analyzed for select VOCs. (*Distribution of Selected Volatile Organic Compounds Determined with Water-to-Vapor Diffusion Samplers at the Interface Between Groundwater and Surface Water, Centredale Manor Site, USGS Open File Report 00-276, 2000)*	Located discharge locations of VOCs from source area into the river.
October – November, 1999	50 sediment samples collected by USEPA Remediation Group from aquatic flood plain sediments in river and Allendale and Lymansville ponds	All samples analyzed for dioxins and HCX, SVOCs, metals, pesticides and PCBs, grain size, TOC, and SEM/AVS. (*Final Technical Memorandum, Woonasquatucket River Sediment Investigation, Prepared by Tetra Tech NUS, 6/00*).	Performed to determine nature and extent of contaminants in sediment of river and ponds downstream of source area and support future risk assessments
	35 water samples collected by USEPA Remediation Group from river and Allendale and Lymansville ponds	All samples analyzed for dioxins and HCX, SVOCs, metals, pesticides and PCBs. (*Final Technical Memorandum, Woonasquatucket River Sediment Investigation, Prepared by Tetra Tech NUS, 6/00*).	Performed to determine nature and extent of contaminants in river and ponds downstream of source area and support future risk assessments
	24 samples of sediment collected USEPA Remediation Group from banks of river.	All samples analyzed for dioxins and HCX, SVOCs, metals, pesticides and PCBs. (*Final Technical Memorandum, Woonasquatucket River Sediment Investigation, Prepared by Tetra Tech NUS, 6/00*).	Performed to determine nature and extent of contaminants in river and ponds downstream of source area and support future risk assessments
	126 soil samples collected by USEPA Remediation Group from residential use soils along Centredale raceway, Allendale Pond, and Lymansville Pond.	All samples analyzed for dioxins and HCX, approximately half also analyzed for SVOCs, metals, pesticides and PCBs, dioxin. Sampled from just upstream of Rte 44 Bridge to the Lyman Mill Pond area. (*Final Technical Memorandum, Woonasquatucket River Sediment Investigation, Prepared by Tetra Tech NUS, 6/00*).	Performed to determine nature and extent of contaminants on residential use property adjacent and downstream of source area and support future risk assessments

Table 1. Summary of Existing Data for the Centredale Manor Restoration Project Site (continued).

Date	Media/Collected By	Analytes/Reference	Original Use of Data
July 2000	N/A	USEPA Aerial Photographic Analysis	Identified historical site features and potential sources of contamination.
Summer 2000	Tree swallow samples collected by USGS at two locations: 5 nestling, 1 diet, and 7 unhatched eggs collected at Greystone Mill Pond, upstream of the Centredale site. 5 nestling, 2 diet and 13 unhatched eggs collected at Allendale Pond, downstream of the site.	Dioxins/furans, PCB congeners (100+), and lipid content (*Task 15 Revised Letter Data Report;* prepared under contract to USACE, Contract No. DACW33-96-D-0005; DO#59 Battelle 2000).	Swallows analyzed to provide an indicator of the quality of the river system.
September, 2000	Sediment samples collected by USEPA Remediation Group from 11 stations downstream of Lyman Mill Dam.	All samples analyzed for dioxins and HCX, SVOCs, metals, pesticides and PCBs, grain size, TOC, and SEM/AVS. (*Draft Technical Memorandum, Manton and Dyerville Reaches Sediment Sampling, Prepared by Tetra Tech NUS, 1/01*).	Performed to determine the extent of contamination in the Woonasquatucket River downstream of Lyman Mill Dam.
September, 2000 – August, 2001	Soil borings advanced and monitoring wells installed in the source area; collection of surface and subsurface soil samples and groundwater samples; geophysical survey; water level monitoring; and hydraulic conductivity tests.	All samples analyzed for dioxins and HCX, SVOCs, metals, pesticides and PCBs. (*Draft Technical Memorandum, Source Area Investigation, Prepared by Tetra Tech NUS, 1/02*).	Performed to determine nature of soil contamination in the source area, characterize hydrogeological setting and groundwater flow, and determine nature and extent of groundwater contamination.
April-July, 2001	Tissue, sediment, surface water and soil samples collected by USEPA Remediation Group from Allendale Reach, Lyman Mill Reach, Manton Reach and Dyerville Reach and two reference areas.	Samples analyzed for dioxins/furans, HCX, pesticides, PCBs, grain size and total organic carbon. A subset of samples were also analyzed for SVOCs and metals, including methylmercury. (*Work Plan, Human Health and Ecological Risk Assessment, Prepared by Harding ESE and Battelle, 3/16/01*)	Performed to support baseline ecological risk assessment and human health biota consumption risk assessment.
2001	Approximately 1000 soil samples collected by Loureiro Engineering Associates (LEA) for the Centredale Manor Performing Parties Group	Samples analyzed for dioxin using an immunoassay screening method	Delineate excavation limits of action areas for NTCRA

Table 1. Summary of Existing Data for the Centredale Manor Restoration Project Site (continued).

Date	Media/Collected By	Analytes/Reference	Original Use of Data
April-May 2001	U.S. Fish and Wildlife Service assessed differences between species and numbers of anuran amphibians (*i.e.*, frogs) at the site and reference areas.	*Anuran Call Survey of the Woonasquatucket River in the Vicinity of the Centredale Manor Superfund Site, North Providence, RI.* Prepared by U.S. Fish and Wildlife Service New England Field Office, September 2002.	Performed to support baseline ecological risk assessment.
May-July, 2001	Tree swallow samples collected by USGS at three locations: 5 nestling, 1 diet, 5 nestling liver, and 9 unhatched eggs collected at Greystone Mill Pond, upstream of the Centredale site. 5 nestling, 1 diet, 5 nestling liver and 16 unhatched eggs collected at Allendale Pond, downstream of the site. 5 nestling, 1 diet, 5 nestling liver and 11 unhatched eggs collected at Lyman Mill Pond, downstream of Allendale Dam and the Centredale site.	All samples (except nestling liver and 8 out of the 36 nestlings) were analyzed for dioxins/furans, HCX and TCX. Ten percent of all samples (except nestling liver) were also analyzed for approximately 130+ PCB congeners. A subset of samples (except nestling liver) were also analyzed for PCB Aroclor, chlorinated pesticides and lipid content. Nestling liver samples were analyzed for metals and methyl mercury. (*Post Third Party Validation, Task 22A Tree Swallow Chemistry Data Report*; prepared under contract to USACE, Contract No. DACW33-01-D-0004; DO#1, Battelle 2002)	Swallows analyzed to provide an indicator of the quality of the river system.
Summer 2001	At the completion of the ELS test, 39 ELS egg and 14 catfish fry samples were collected by USEPA for chemical analysis.	Dioxins/furans, PCBs 77 and 126, and lipid content (*Post Third Party Validation, ELS Egg and Catfish Fry Chemistry Data Report*; prepared under contract to USACE, Contract No. DACW33-01-D-0004; DO#1, Battelle 2002).	ELS egg and catfish fry samples were analyzed in support of an ELS study designed to assess risk to demersal, omnivorous fish from contaminants associated with submerged sediments from Allendale and Lyman Mill Ponds and the Woonasquatucket River at the Centredale Manor study area. Results from the ELS study will be used in support of the BERA.

Table 1. Summary of Existing Data for the Centredale Manor Restoration Project Site (continued).

Date	Media/Collected By	Analytes/Reference	Original Use of Data
Summer, 2002	Tree swallow samples collected by USGS at four locations: 4 unhatched eggs and 1 diet collected at Greystone Mill Pond, upstream of the Centredale site. 7 unhatched eggs collected at the Woonasquatucket Reservoir (also known as Stump Pond or Firestation site), in Smithfield, RI. 5 unhatched eggs collected at Allendale Pond, downstream of the site. 3 unhatched eggs collected at Lyman Mill Pond, downstream of Allendale Dam and the Centredale site.	Samples currently undergoing chemical analysis for dioxins and furans.	Swallows analyzed to provide an indicator of the quality of the river system.
April 2002	40 soil samples collected by LEA for the Centredale Manor Performing Parties Group	Samples analyzed for dioxin using laboratory method	Define dioxin concentrations between NTCRA action areas
July 2002	51 soil samples collected by LEA for the Centredale Manor Performing Parties Group	Samples analyzed for dioxin using immunoassay screening method and laboratory method	Further delineate excavation limits of action areas for NTCRA
October-November, 2002	Surface and subsurface soil samples collected from the tailrace on the east side of the source area, groundwater samples collected from all monitoring wells, surface soil samples collected from the John E. Fogarty Center near Lyman Mill Dam. All samples collected by USEPA Remediation Group.	Tailrace soil samples analyzed for dioxin (two samples also analyzed for dioxin, metals, PAHs, pesticides and PCBs); groundwater samples analyzed for VOCs (Well MW-05S also sampled for dioxin); John E. Fogarty Center soil samples analyzed for dioxin, metals, PAHs, pesticides and PCBs. (*Work Plan, Interim Data Collection for the RI/FS, Prepared by Battelle, 10/02*).	Performed to support RI; John E. Fogarty Center data collected to support human health risk assessment.

Modified from TTNUS, 2000.

Table 2. Summary of Analytical Chemistry Samples from Previous Studies.

Matrix	Dioxins/Furans	VOCs	SVOCs	Pesticides/PCBs	Metals
Source Area and Allendale Reach					
Soil					
Surface[3]	224	21	58	157	57
Subsurface[4]	368	100	96	311	93
Groundwater	33	40	39	36	68
Sediment[5]					
Surface[3]	36	0	36	37	36
Subsurface[4]	16	0	16	16	16
Surface Water	25	0	22	22	42
Biota	46	0	0	19	5
Lyman Mill Reach					
Soil < 1 ft bgs					
Surface[3]	111	0	38	38	38
Subsurface[4]	0	0	0	0	0
Sediment[5]					
Surface[3]	40	0	38	36	38
Subsurface[4]	7	0	7	7	7
Surface Water	19	0	16	16	32
Biota	64	0	0	31	5
Downstream of Lyman Mill Dam					
Sediment	14	0	14	14	14
Biota	9	0	0	0	0
Greystone Mill Pond (Reference Area)					
Soil	4	0	4	4	4
Sediment	22	0	19	23	15
Surface Water	3	2	5	5	5
Biota	79	0	40	66	53
Assapumpsett Brook (Reference Area)					
Soil	0	0	0	0	0
Sediment	4	0	4	5	5
Surface Water	0	1	1	1	1
Biota	18	0	17	18	18

[1] Other analyses not tabulated include herbicides, TPH, AVS/SEM, TOC, grain size.
[2] Sample results without coordinates in the database are not included on this table.
[3] Classified as surface sample if top of sample = 0 ft.
[4] Classified as subsurface sample if top of sample > 0 ft.
[5] Some sediment samples are classified as soil in database.

Table 3. Preliminary Identification of Potential ARARs for the Centredale Manor Restoration Project Site.

Requirement	Status	Synopsis	Potential Application to RI/FS
Chemical-Specific ARARs			
Federal Requirements			
OSWER Directive 92-4-26	To be considered	One ppb dioxin as TEQ is to be generally used as a starting point for setting cleanup levels for CERCLA removal sites and as a PRG for remedial sites for dioxin in surface soil involving residential exposure scenarios. A cleanup range of 5 to 20 ppb of dioxin (as TEQ) has been established for commercial and industrial exposure scenarios.	Some soils at the site contain dioxin at levels above the PRG.
EPA Region IX Risk-Based Concentrations (Oct 1997)	To be considered	Risk Based Concentrations (RBCs) are human health based allowable exposure guidance levels developed for carcinogenic and non-carcinogenic compounds, using reference doses and carcinogenic potency slopes obtained from EPA's Integrated Risk Information System (IRIS) database, EPA's Health Effects Assessment Summary Tables (HEAST), and standard exposure scenarios. RBCs are chemical concentrations corresponding to a fixed level of risk in various media.	RBCs will be used in the BHHRA to identify and select potential contaminants of concern.
Safe Drinking Water Act Maximum Contaminant Levels (MCLs), 40 CFR 141.11-141.16	Not applicable	MCLs have been set for toxic compounds as enforceable standards for public drinking water systems	Groundwater and surface water at and near the site are not a source of drinking water.
Safe Drinking Water Act Maximum Contaminant Levels Goals (MCLGs), 40 CFR 141.50-141.51	Not applicable	MCLGs are unenforceable goals under the SDWA.	Groundwater and surface water at and near the site are not a source of drinking water.
Clean Water Act Federal Water Quality Criteria, 51 FR 43665	Applicable	Ambient Water Quality Criteria (AWQC) are provided for toxic chemicals.	Discharges from the site may cause degradation of Woonasquatucket River surface water quality in excess of AWQC.
State Requirements			
RIDEM Rules and Regulations for Hazardous Waste Management	Applicable	Sets forth requirements for hazardous waste determination according to federal (40 CFR 262.11) and RI state (Rule 3.67) definitions.	Media at the site will undergo hazardous waste determination.

Table 3. Preliminary Identification of Potential ARARs for the Centredale Manor Restoration Project Site (continued).

Requirement	Status	Synopsis	Potential Application to RI/FS
RIDEM Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (i.e., Remediation Regulations)	Applicable	Unless otherwise specified, soil contaminated as a result of a release of hazardous materials shall be remediated in a manner which meets the direct exposure and leachability criteria for each hazardous substance established in Rule 8.02.B (Method 1 Soil Objectives)	Some soils at the site contain contaminants subject to the Rule 8.02B soil objectives.
RIDEM Water Quality Regulations	Applicable	Provides water classification for surface waters in Rhode Island and sets ambient water quality criteria for toxic substances.	Discharges from the site may cause degradation of Woonasquatucket River surface water quality in excess of State AWQC.
RIDEM Rules and Regulations for Groundwater Quality	Applicable	Establishes MCLs, limits, and requirements for current and future public water supply systems.	Groundwater and surface water at and near the site are not currently a source of drinking water.
Location-Specific ARARs			
Fish and Wildlife Coordination Act 16 U.S.C. 661, Fish and Wildlife Protection (40 CFR Section 6.302(g))	Applicable	Requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and other related state agencies. The federal agency must also take action to prevent, mitigate, or compensate for project-related losses of fish and wildlife resources.	On-site remediation activities may include modifications to the Woonasquatucket River adjacent to the site.
Clean Water Act, Section 404(b)(1) Guidelines for specification of disposal sites for dredged or fill material (40 CFR Part 230)	Applicable	Outlines requirements for the discharge of dredged or fill materials into surface waters, including wetlands.	On-site remediation activities may include discharge of dredged or fill material into the Woonasquatucket River. On-site activities do not require permitting, but substantive requirements must be met.
Rivers and Harbors Act (33 U.S.C. Section 403; Section 10)	Applicable	Sets forth criteria for placing dams/structures in navigable waters of the U.S.	Remediation activities may involve placing structures in the Woonasquatucket River.
Protection of Wetlands (Executive Order 11990), 40CFR6.302(a) and statement of procedures on Floodplain Management and Wetlands Protection (40CFR 6, App. A)	Applicable	Federal agencies are required to avoid undertaking or providing assistance for new construction located in wetlands unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use.	Some wetlands are located within the site boundaries.

Table 3. Preliminary Identification of Potential ARARs for the Centredale Manor Restoration Project Site (continued).

Requirement	Status	Synopsis	Potential Application to RI/FS
Floodplain Management (Executive Order 11988 – 40 CFR 6.302(b) and statement of procedures on Floodplain Management and Wetlands Protection (40 CFR 6, App. A) Floodplain Management Policy	Applicable	Federal agencies are required to avoid impacts associated with the occupancy and modification of a floodplain and avoid support of floodplain development wherever there is a practicable alternative.	The site is located in a 100-year floodplain.
RCRA Location Requirements 40 CFR 264.18(c)[1]	Applicable	Sets forth minimum requirements for design, construction, and operation of a facility where treatment, storage, or disposal of hazardous waste will be located within a 100-year floodplain.	Treatment, disposal, and storage of hazardous materials may take place during remediation of the site, which is located within the 100-year floodplain.
State Requirements			
RIDEM Rules and Regulations for Hazardous Waste Management	Applicable	Sets forth minimum requirements for design, construction, and operation of a facility where treatment, storage, or disposal of hazardous waste will be located within a 100-year floodplain.	Treatment, disposal, and storage of hazardous materials may take place during remediation of the site, which is located within the 100-year floodplain.
RIDEM Rules and Regulations Governing the Enforcement of the Freshwater Wetlands Act	Applicable	Any activity which alters a wetland must avoid all probable impact to freshwater wetlands to the maximum extent possible. If impacts cannot be avoided, they must be reduced to the maximum extent possible.	Some wetlands are located within the site boundaries.
RIDEM Rules and Regulations for Groundwater Quality	Applicable	Sets forth policy to protect future and present sources of drinking water by protection of the groundwater, aquifers, recharge areas, and watersheds.	Some wetlands are located within the site boundaries. Groundwater and surface water at and near the site are not currently a source of drinking water.
Action-Specific ARARs			
Federal Requirements			
Clean Water Act Section 402: National Pollutant Discharge Elimination System (NPDES) (40 CFR Parts 122, 125, 131)	Applicable	Contains discharge limitations, monitoring requirements, and best management practices. Substantive requirements under NPDES are written such that state and federal ambient water quality criteria are met. Permits are required for offsite discharges.	Remediation activities may require discharge of water to the Woonasquatucket River.

Table 3. Preliminary Identification of Potential ARARs for the Centredale Manor Restoration Project Site (continued).

Requirement	Status	Synopsis	Potential Application to RI/FS
Occupational Safety and Health Administration (OSHA) Standards, 29 CFR 1910.120 for Hazardous Waste Operations and Emergency Responses, Part 1926 for General Safety and Health Standards, and Reporting Requirements	Applicable	Sets limits on exposure to workers on hazardous site or emergency responses, sets forth minimum health and safety requirements such as personal protection and training, and reporting requirements.	All activities taking place on the site including remediation, construction, and monitoring are subject to OSHA Health and Safety regulations.
Department of Transportation (DOT) rules for the transport of hazardous substances; 49 CFR	Applicable	Regulates the labeling, packaging, placarding, and transportation of solid and hazardous wastes off-site.	Remedial actions may include the off-site transport and disposal of solid and hazardous wastes.
State Requirements			
RIDEM Rules and Regulations for Hazardous Waste Management	Applicable	Establishes minimum requirements for the generation, transportation, storage, treatment, and disposal of hazardous wastes.	R.I. has the authority to administer the state rules and regulations for hazardous waste generation, transportation, treatment, storage, and disposal. Remediation at the site will include some of these activities.
RIDEM Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (i.e., Remediation Regulations)	Applicable	Establishes an integrated program requiring reporting, investigation and remediation of contaminated sites to eliminate and/or control threats to human health and the environment in a timely and cost-effective manner. To aid this process and ensure consistency, clean up objectives for soil and groundwater have been developed to manage the risks to human health and the environment, and are to be applied in a manner consistent with the current and reasonably expected future use of the contaminated property.	The RI/FS will evaluate potential remediation alternatives for the site.
RIDEM Water Quality Regulations	Applicable	Sets ambient water quality criteria for toxic substances and governs water quality impacts associated with site activities; establishes the requirements for the approval of a RIPDES water discharge permit..	Remediation activities that affect the Woonasquatucket River should not violate water quality standards; remediation may include a surface water discharge.
RIDEM Rules and Regulations for Groundwater Quality	Applicable	Establishes construction standards for permanent monitoring wells and abandonment procedures	The site contains approximately 33 monitoring wells.

Table 3. Preliminary Identification of Potential ARARs for the Centredale Manor Restoration Project Site (continued).

Requirement	Status	Synopsis	Potential Application to RI/FS
RI Air Pollution Control Regulation #5: Fugitive Dust	Applicable	Materials, including but not limited to sand, gravel, soil, aggregate and any other organic or inorganic solid mater capable of releasing dust, to be handled, transported, mined, quarried, stored or otherwise utilized in any way so as to cause airborne particulate matter to travel beyond the property line of the emission source without taking adequate precautions to prevent particulate matter from becoming airborne.	Remediation of the site may include earth moving activities, vehicles transporting materials, and construction of protective caps
RI Air Pollution Control Regulation #17: Odors	Applicable	Sets prohibitions against emission into the atmosphere of any air contaminant or combination of air contaminants that create an objectionable odor beyond the property line of said person	Remediation of the site should not result in a release of air contaminants resulting in objectionable odors

Table 4. Summary of RI/FS Data Needs (from Battelle, 2002b).

Item/Matrix	Data Gap	Data Collection	Sample Design
Source Identification	None identified.	N/A	N/A
Contaminant Fate and Transport	Evaluation of site hydrodynamics and sediment stability.	To be determined.	Geomorphic analysis and geophysical survey conducted by USEPA and USACE.
Source Area Residential Use Soils	Engineering analysis of interim caps and parking lots.	Scope of engineering analysis to be detailed in RI/FS Work Plan.	Engineering analysis provided in technical memorandum.
	Potentially insufficient soil data to define extent of dioxin contamination east of the Centredale Manor apartment complex	If necessary, collect additional surface and subsurface soil samples in the area east of the Centredale Manor building and west of the centerline of the tailrace.	Surface and subsurface samples were collected in fall 2002 from borings in the tailrace and analyzed for dioxin.
	Definition of the extent of NAPL in soil near Well MW-05S would help support remedial design (note: optimal data need, but not required for completion of RI/FS)	N/A	N/A
Residential Use Soils (NTCRA)	None	N/A	N/A
Recreational Use Soils (NTCRA)	None	N/A	N/A
Commercial Use Soils	Soil samples have not been collected on commercial properties at northeast corner of Lyman Mill Pond or in the undeveloped area along the west bank of Lyman Mill Pond, and risk to site workers has not been assessed.	Collection of soil samples from commercial properties where a complete exposure pathway may exist	Three surface soil samples were collected in fall 2002 from the John E. Fogerty Center and analyzed for a full range of contaminants (dioxins/furans, SVOCs, pesticides, PCBs and metals).
Groundwater	None	Collection of groundwater samples to verify contaminant concentrations and characterize temporal variations	33 groundwater samples were collected in fall 2002 and analyzed for VOCs (all samples) and dioxin (Well MW-05S only).

Table 4. Summary of RI/FS Data Needs (from Battelle, 2002b) (continued).

Item/Matrix	Data Gap	Proposed Data Collection	Proposed Sample Design
Sediment	Data may be insufficient to fully define extent of contamination, particularly in Lyman Mill Pond and downstream	Additional targeted sediment sample collection and analysis for chemicals of concern to fully define extent of contamination above site-specific PRGs.	The scope of the sampling effort will be determined after chemicals of concern are confirmed and PRGs are developed. EPA will undertake sediment core sampling in 2003 to investigate vertical extent of contamination and degree of natural recovery.
Surface water	None	N/A	N/A

N/A, Not applicable.

Table 5. RI/FS Activities and Preliminary Schedule.

Task	2003				2004				2005	
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr
Biota Consumption Risk Assessment										
Baseline Ecological Risk Assessment										
Development of PRGs										
Interim Data Collection										
Geophysical Investigation										
Geomorphic Analysis										
Sediment Characterization										
Remedial Investigation Report										
Remedial Alternatives Development and Screening										
Feasibility Study										

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7.0 FIGURES

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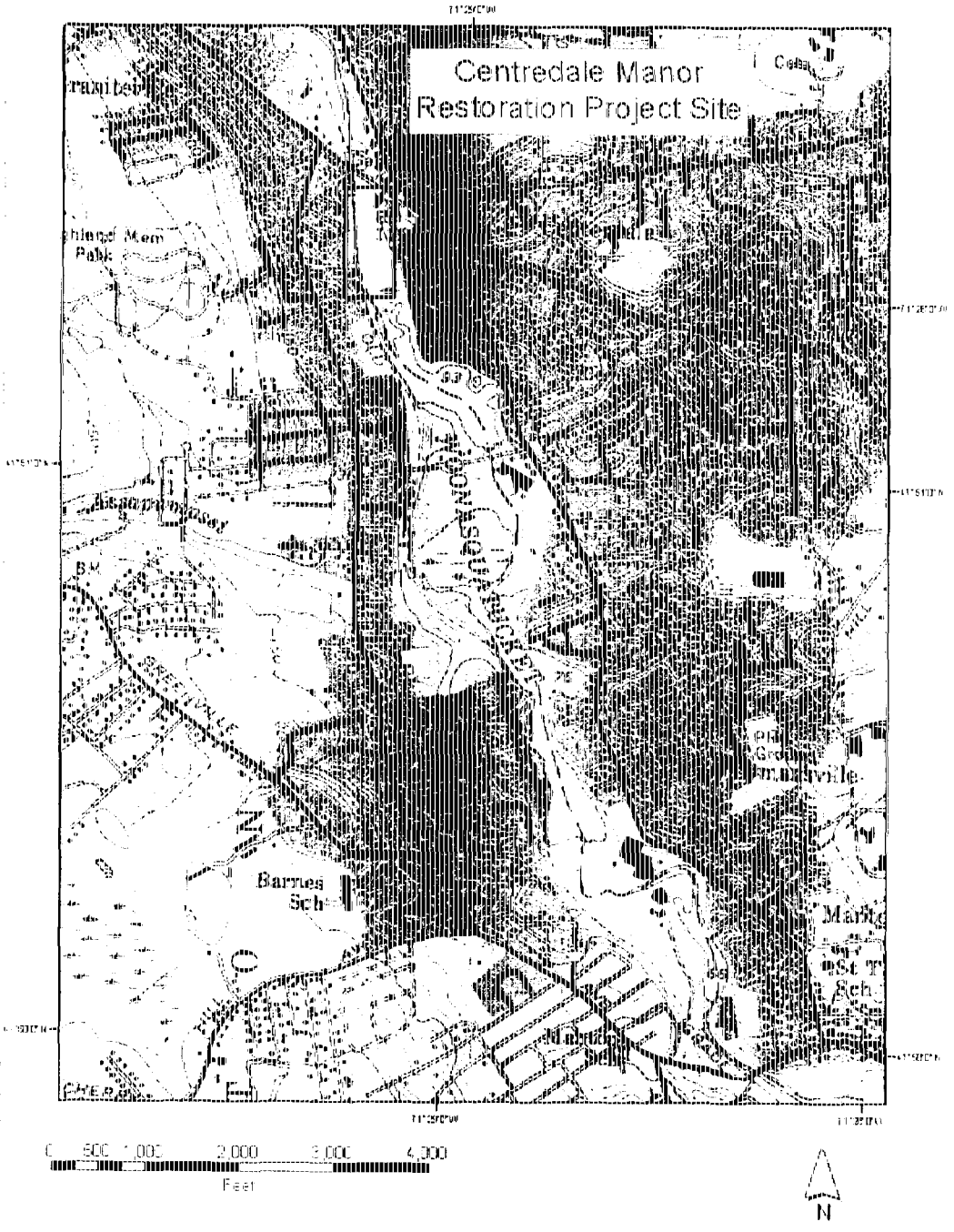
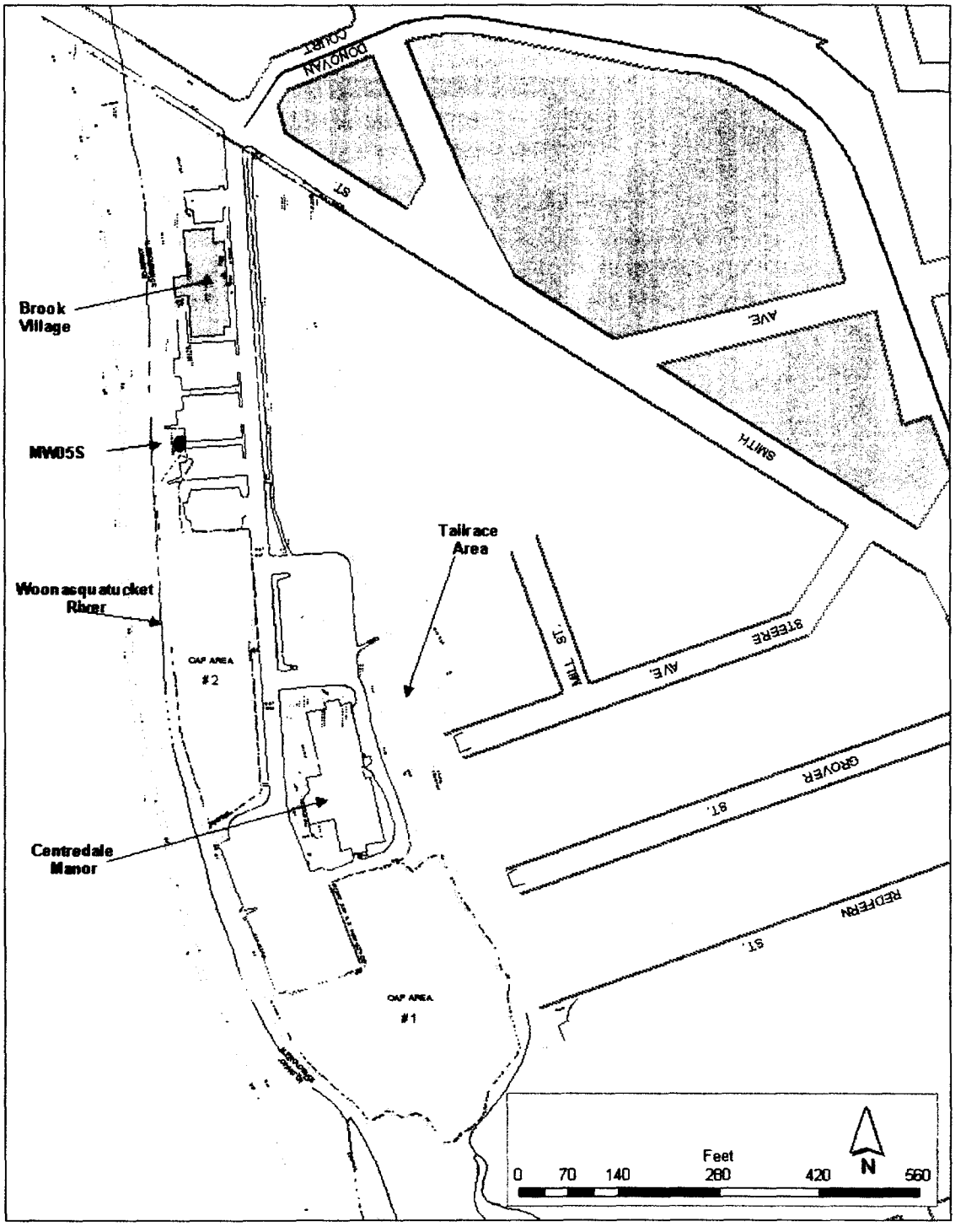


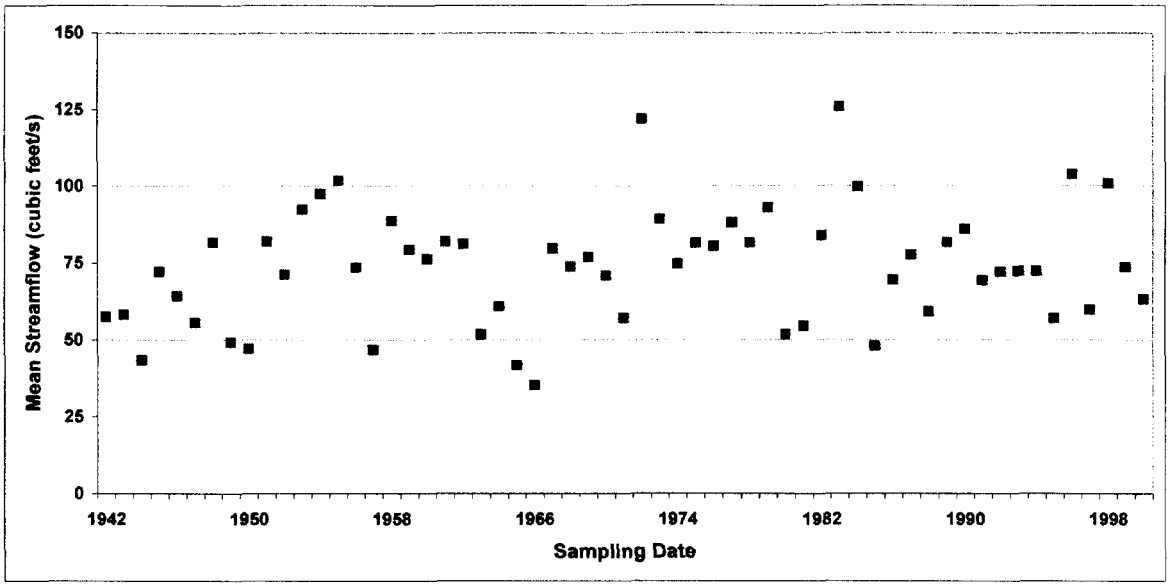
Figure 1. Site Location Map.

Originals in color.



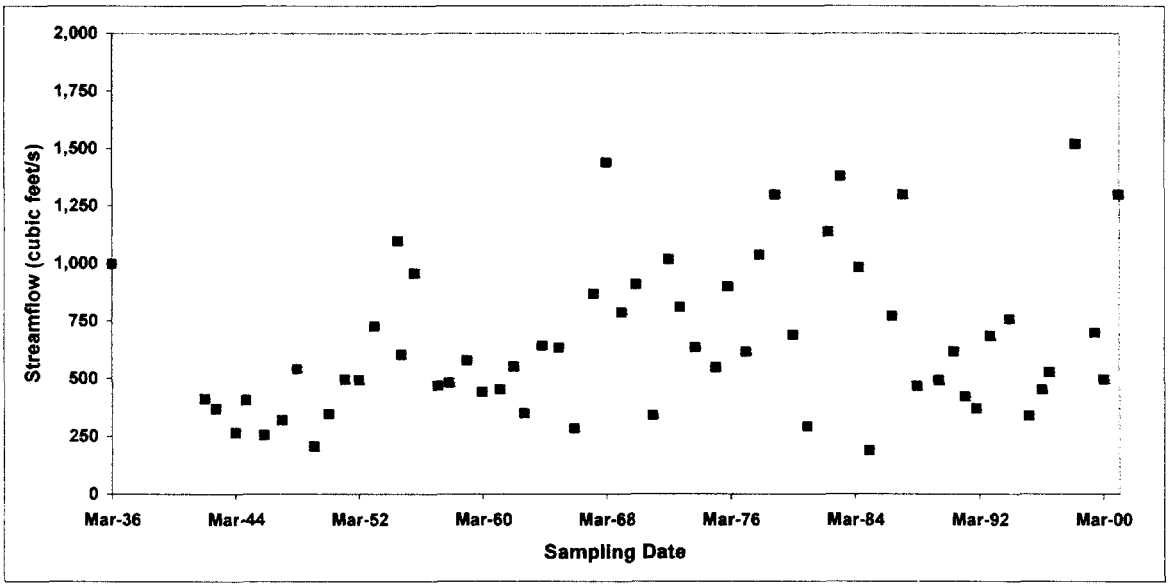
Originals in color.

Figure 2. Source Area Features.



Source: USGS (www.waterdata.usgs.gov/nwis/sw/).

Figure 3. Annual Mean Streamflow (cfs) at the Woonasquatucket River from 1942 to 2001.



Source: USGS (www.waterdata.usgs.gov/nwis/sw/).

Figure 4. Peak Streamflow (cfs) at the Woonasquatucket River between 1936 and 2000.

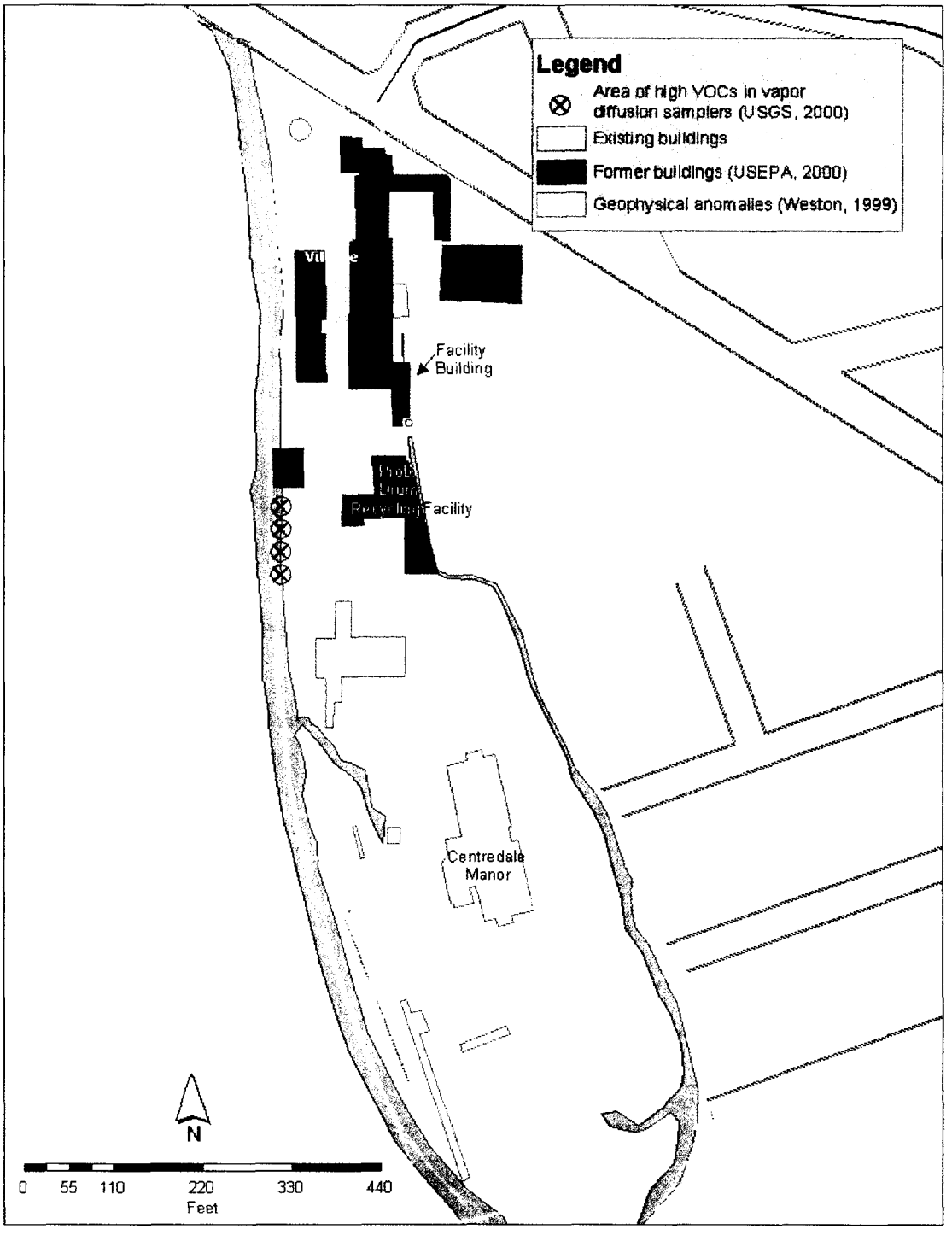


Figure 5. Historical Building Locations and Geophysical Anomalies (modified from TTNUS, 2002).

Originals in color.

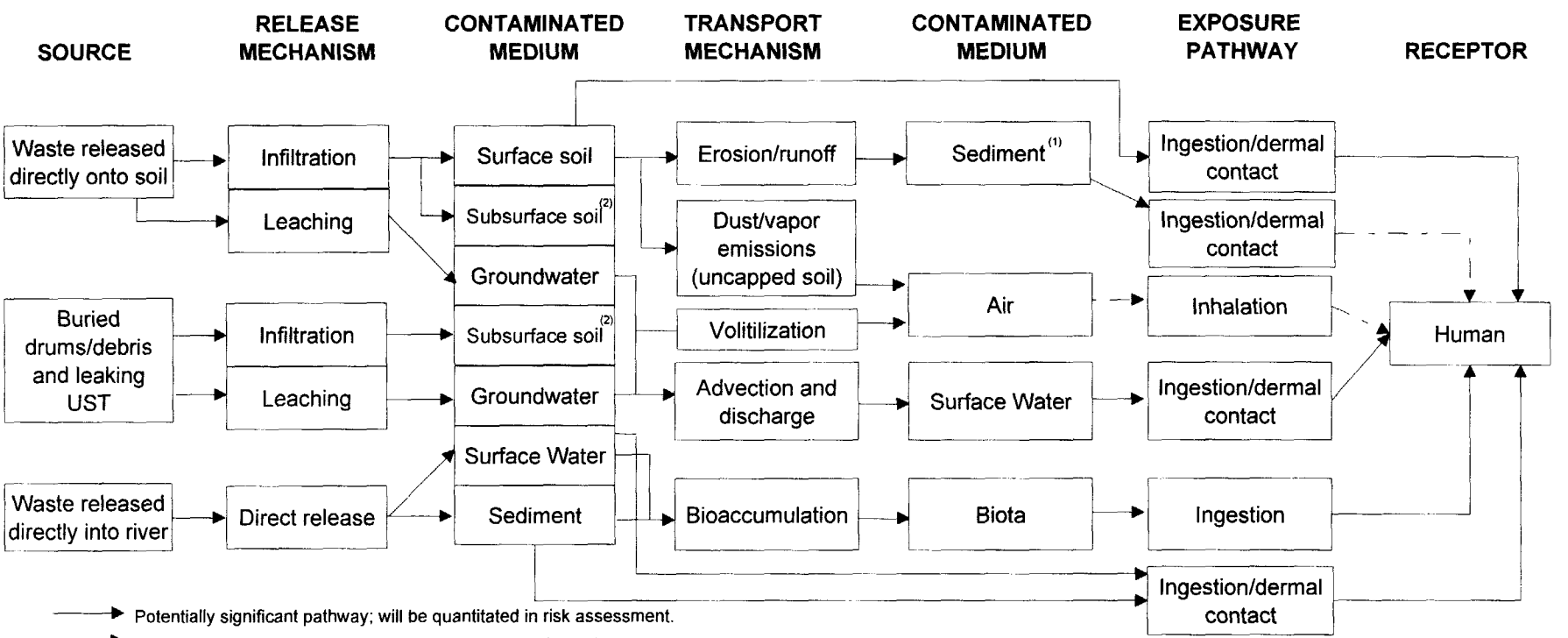


Figure 6. Human Health Conceptual Site Model for the Centredale Manor Restoration Project Site.

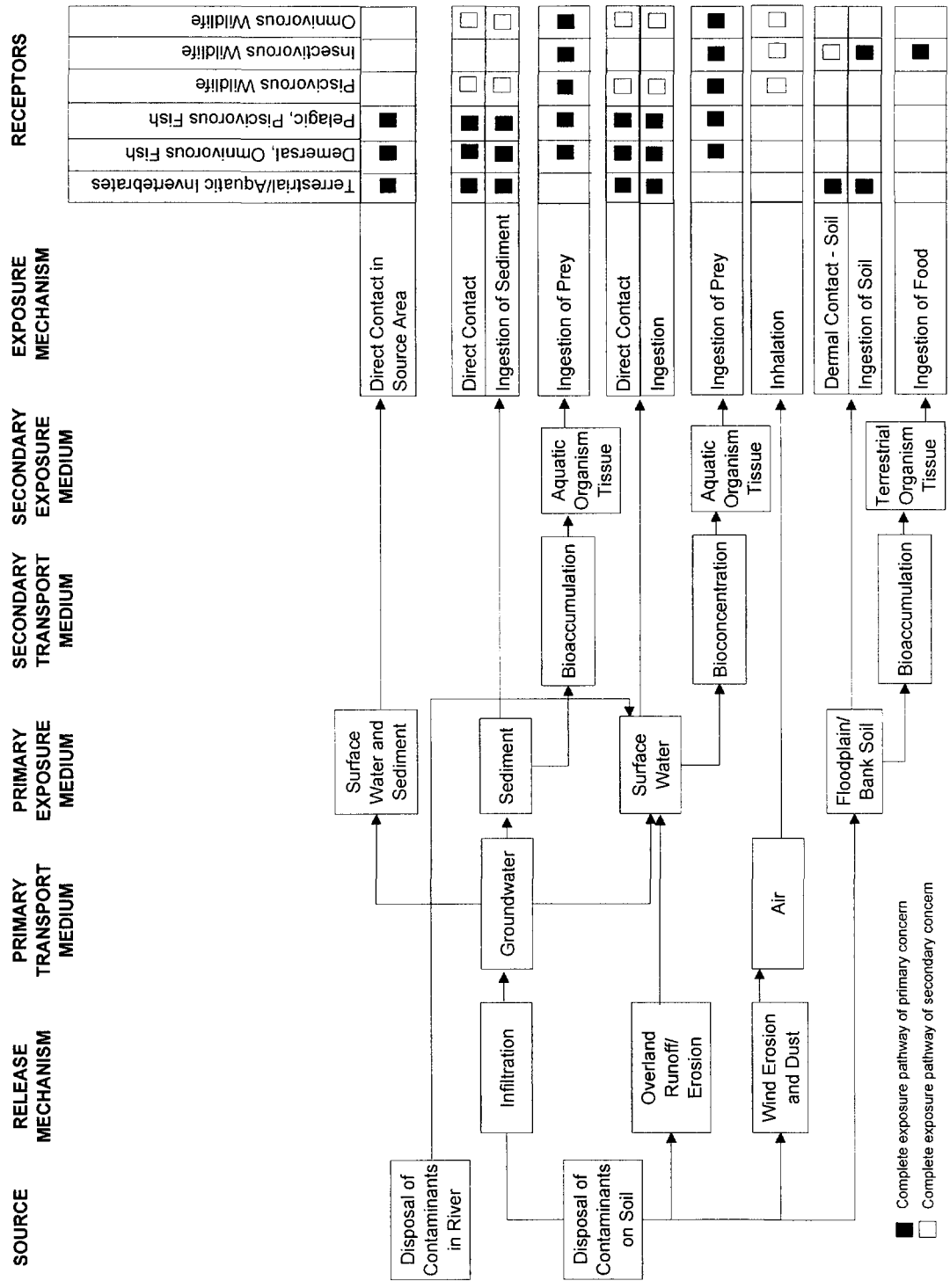


Figure 7. Ecological Conceptual Site Model for the Centredale Manor Restoration Project Site (from Harding ESE, 2001).

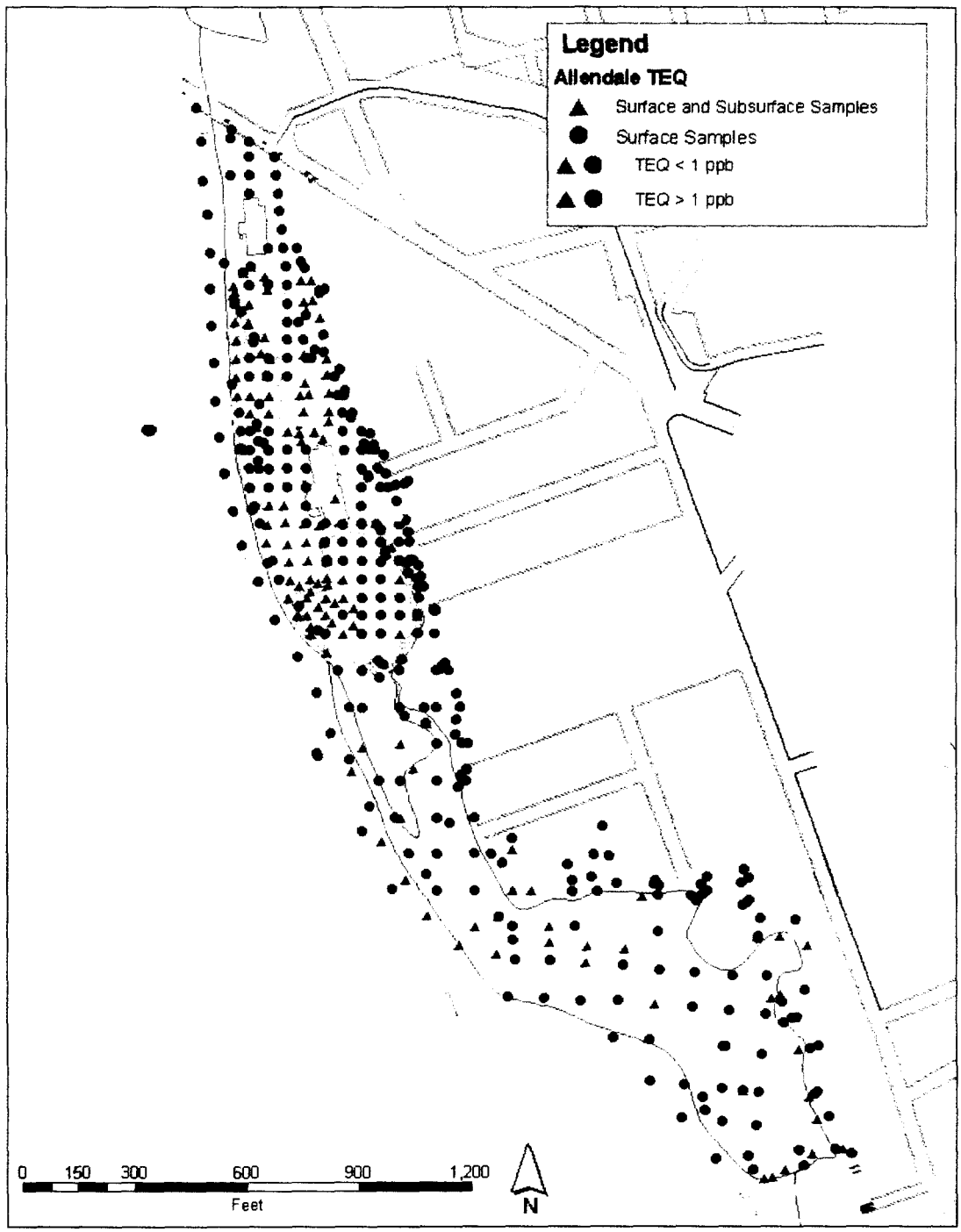


Figure 8. Summary of Dioxin TEQ Concentrations in Soil and Sediment Samples from the Source Area and Allendale Pond.

Original includes color coding.

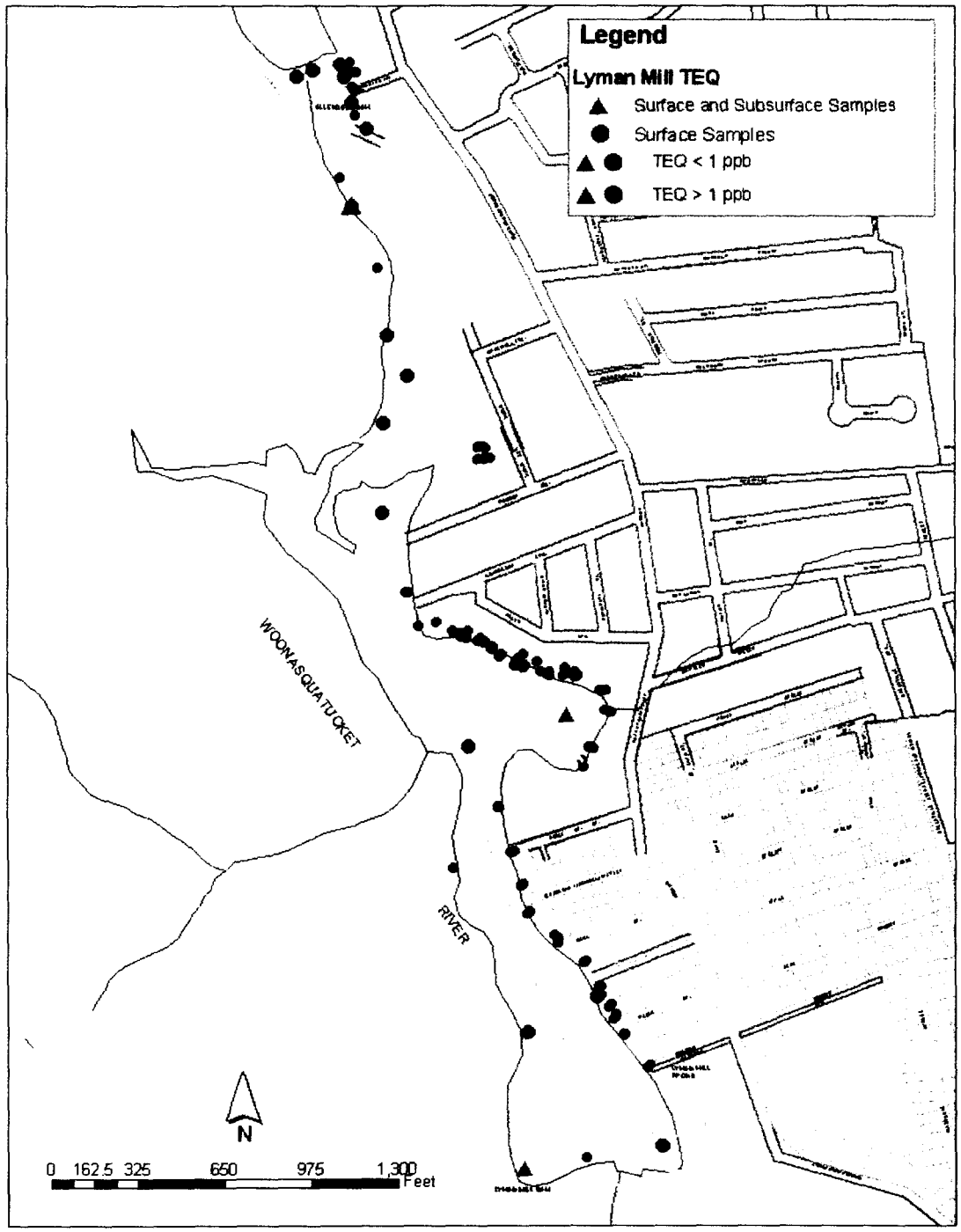
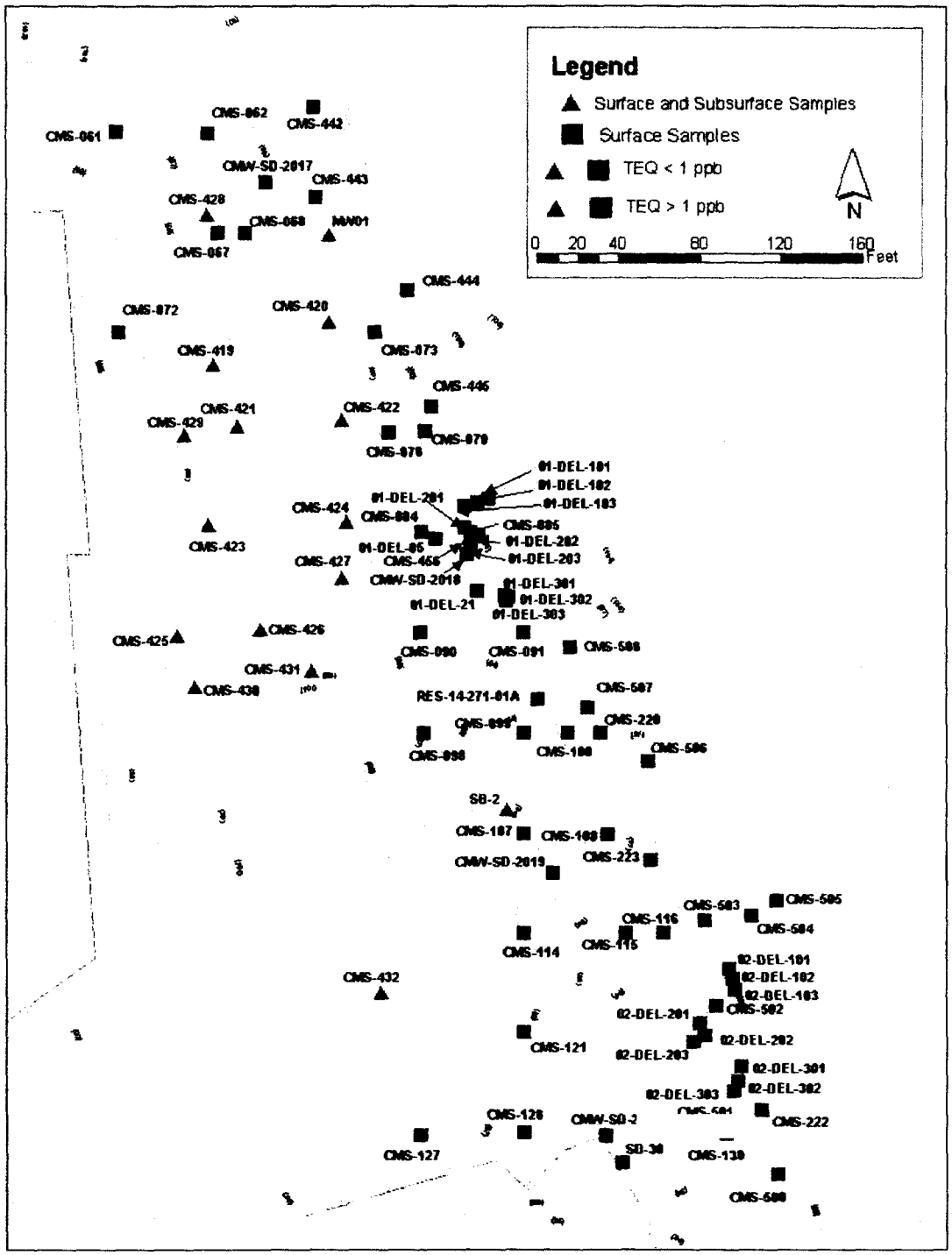


Figure 9. Summary of Dioxin TEQ Concentrations in Soil and Sediment Samples from the Lyman Mill Pond Area.

Original includes color coding.



Note: fall 2002 data not included.

Figure 10. Summary of Dioxin TEQ Concentrations in Soil Samples from the Tailrace.

Original includes color coding.

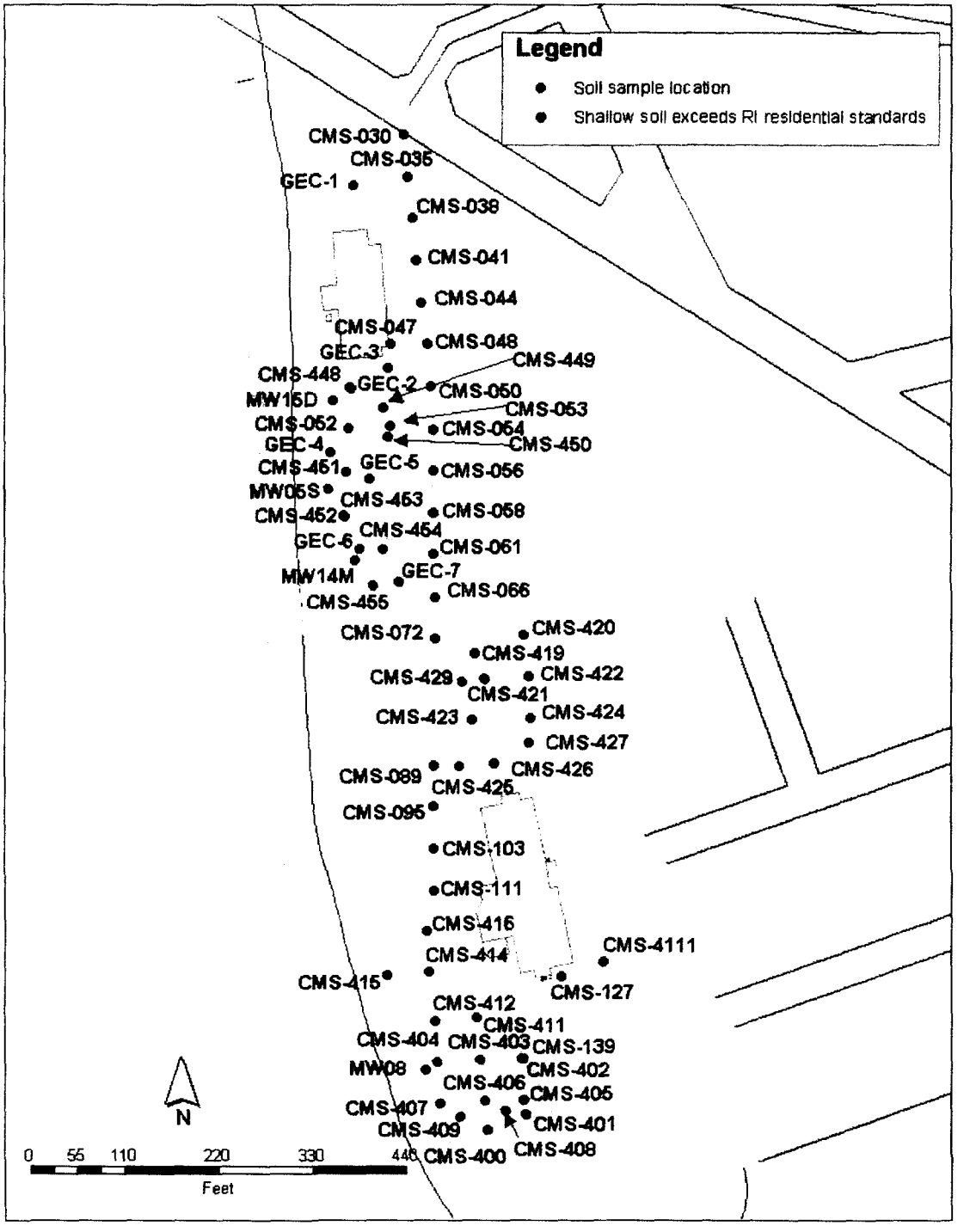


Figure 11. Soil Sample Locations Beneath Paved Surfaces in the Source Area.

Original includes color coding.

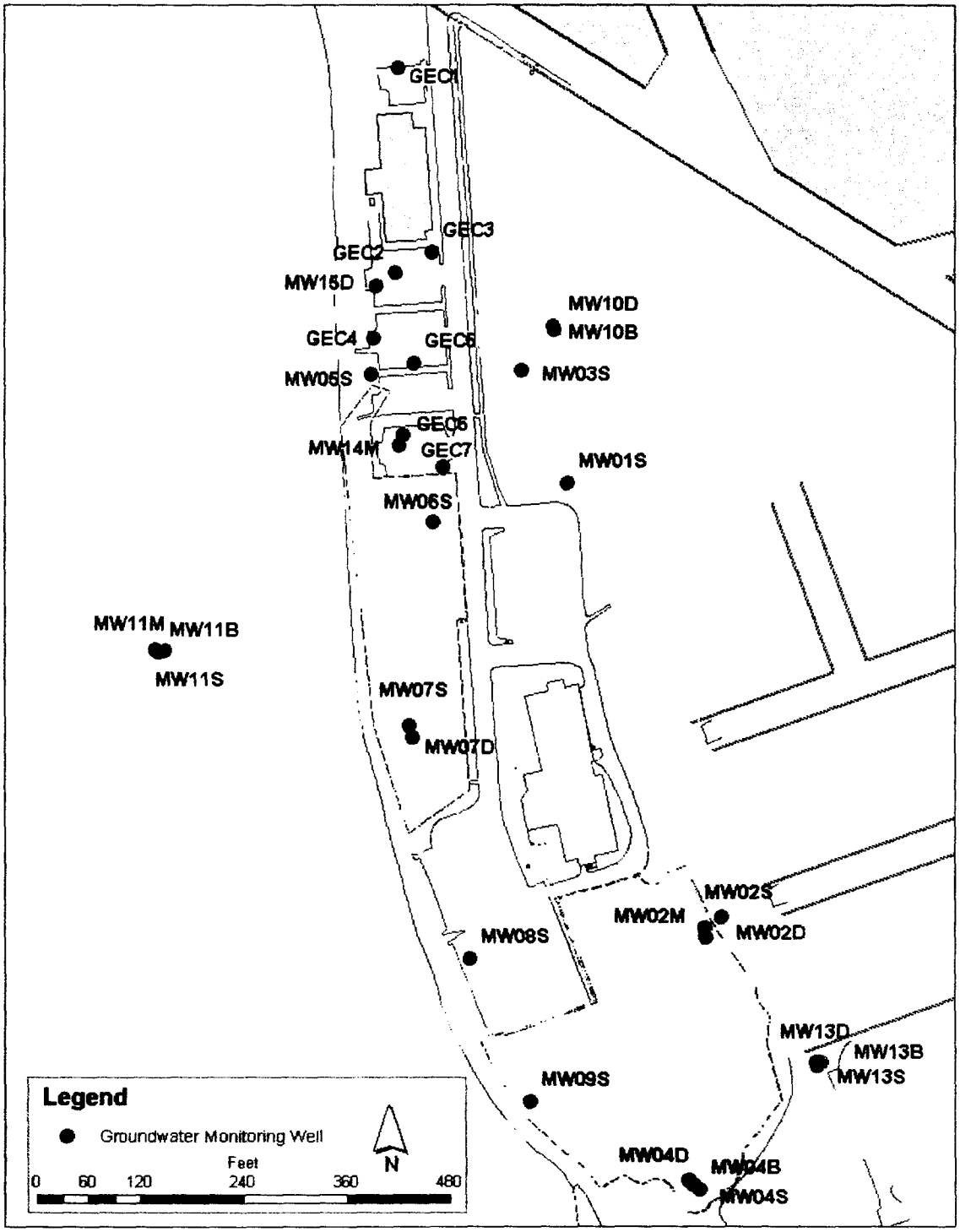


Figure 12. Monitoring Well Locations.

Originals in color.