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# *FINAL WORK PLAN*

# Interim Data Collection Remedial Investigation And Feasibility Study Centredale Manor Restoration Project Site North Providence, Rhode Island

# WORK PLAN

## Interim Data Collection
## Remedial Investigation And Feasibility Study
## Centredale Manor Restoration Project Site
## North Providence, Rhode Island

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**DELIVERY ORDER NO. 01**

***Submitted to:***

**Department of the Army**
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***Prepared by:***

**BATTELLE**
**397 Washington Street**
**Duxbury, MA 02332**
**(781) 934-0571**

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| BERA | Baseline ecological risk assessment |
| COPC | Chemical of potential concern |
| CSM | Conceptual site mode |
| DMP | Data Management Plan |
| DQO | Data quality objective |
| EE/CA | Engineering Evaluation/Cost Analysis |
| ERA | Ecological risk assessment |
| FS | Feasibility Study |
| FSP | Field Sampling Plan |
| HCX | Hexachloroxanthene |
| LEA | Loureiro Engineering Associates |
| NAPL | Non-aqueous phase liquid |
| NPL | National Priority 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 |
| PRG | preliminary remediation goal |
| QAPP | Quality Assurance Project Plan |
| RI | Remedial Investigation |
| RIDEM | Rhode Island Department of Environmental Management |
| SMP | Site Management Plan |
| TCDD | Tetrachlorodibenzodioxin |
| TCRA | Time-critical removal action |
| TEQ | Toxic Equivalency Quotient |
| USACE | United States Army Corps of Engineers |
| USEPA | United States Environmental Protection Agency |
| VOC | Volatile organic compound |

# 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 located in North Providence, Rhode Island. This Interim Data Collection Work Plan addresses data gaps that were identified in the *Summary of Data Needs for the Centredale Manor Restoration Project Site RI/FS* (Battelle, 2002) and revised during a Technical Project Planning Meeting on April 24, 2002. This Work Plan is consistent with the requirements set forth in the May 21, 2002 Statement of Work provided by USACE.

## 1.1 Objective And Scope

The purpose of the Centredale Manor Restoration Project Site RI is 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. The RI will evaluate areas of the Centredale Manor Restoration Project Site that have not already been addressed by time-critical removal actions (TCRA) completed in 2000 and a non-time critical removal action (NTCRA) that is currently in progress (see Section 2.3). This Work Plan describes additional data collection required to complete the RI/FS for the terrestrial part of the site. Additional data collection is planned in 2002 and 2003 to complete the characterization of contaminated sediments adjacent to and downstream of the site. The overall approach for addressing environmental contamination at the site will be described in the RI/FS Work Plan (in preparation).

## 1.2 Work Plan Organization

This Draft Work Plan is divided into four sections as follows:

Section 1.0: Introduction.

Section 2.0: Site description, background information and conceptual site model (CSM).

Section 3.0: Data summary and description of proposed data collection and analysis.

Section 4.0. References.

Supporting information is contained in the appendices. Companion documents to this Interim Data Collection Work Plan are as follows:

Field Sampling Plan (FSP);

Quality Assurance Project Plan (QAPP) Addendum;

Data Management Plan (DMP) Update;

Site Management Plan (SMP) Update; and

Health and Safety Plan (HASP).

# 2.0 GENERAL SITE INFORMATION

This section provides background information regarding the Centredale Manor Restoration Project Site and presents the CSM.

## 2.1 Site Description and History

The main part of the Centredale Manor Restoration Project Site is located at 2072 and 2074 Smith Street in North Providence, Rhode Island, immediately south of Route 44 and on the east bank of the Woonasquatucket River. Features of the main part of the site (i.e., the source area) are shown in Figure 1. The main part of the site is occupied by the Brook Village and Centredale Manor apartment complexes and is bounded on the north by Route 44; on the east by a former mill tailrace (drainage swale); on the south by Allendale Pond, an impoundment of the Woonasquatucket River behind the Allendale Dam; and on the west by the Woonasquatucket River. The site also includes the reach of the Woonasquatucket River affected by contamination from the site, including Allendale Pond, Lyman Mill Pond, and possibly areas downstream of the Lyman Mill Dam.

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 north end of site, north of the existing Centredale Manor building and north parking lot. It is believed that Metro Atlantic manufactured hexachlorophene (of which hexachloroxanthene [HCX] is a by-product) and trichlorophenols. Operations at Metro Atlantic Chemical Corporation ceased during the 1960s or early 1970s. Between 1952 and 1969, 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 burned prior to drum reconditioning. In 1972, fire destroyed most property structures. Brook Village was constructed in 1977 and Centredale Manor was constructed in 1982. The site was listed on the National Priority List (NPL) in March 2000.

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, polychlorinated biphenyls (PCBs), and inks. Evidence suggests that contaminants of potential concern (COPCs) were buried, released directly to the ground, and released directly to the Woonasquatucket River. Subsequent erosion and downstream transport resulted in the contamination of sediments in the Woonasquatucket River, Allendale Pond, Lyman Mill Pond, and potentially downstream of the Lyman Mill Dam. COPCs have also been found in floodplain areas associated with these water bodies. An analysis of 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 Allendale Dam was partially breached in 1991, resulting in the downstream transport of contaminated sediments and allowing the water in Allendale Pond to recede. The dam breached completely in 2001. As a result, most of the pond bottom adjacent to residential properties along the eastern bank of Allendale Pond was exposed 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 NTCRA for the site (see Section 2.3.2).

## 2.2 Previous Investigations

Previous investigations at the Centredale Manor Restoration Project Site are summarized in Table 1. Elevated levels of dioxin were discovered in 1996 in the Woonasquatucket River during a study conducted by USEPA Narragansett Laboratories and the Providence Urban Initiative Program. Subsequently, elevated concentrations of dioxin and PCBs were identified in sediment in the Woonasquatucket River and downstream impoundments in 1998 during a study conducted by USEPA. Additional site investigations were performed between 1998 and 2001 to characterize the source area and delineate the concentrations of dioxin and other site-related contaminants in soil, sediment and groundwater. Contaminants detected onsite include dioxin, PCBs, chlorinated and aromatic volatile organic carbons (VOCs), polycyclic aromatic hydrocarbons (PAHs), and various metals.

A recent Source Area Investigation (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 in the Brook Village parking lot (see Figure 1). 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 COPCs (e.g., phenols and dioxin) were also detected in some samples.

## 2.3 Previous Site Actions

As previously noted, a TCRA and NTCRA have been implemented at the site. These actions are described further below. The RI/FS will evaluate any site-related contamination that is not permanently remedied by the TCRA or NTCRA.

### 2.3.1 Time-critical Removal Action

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.
- 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 (Cap #1) in a formerly wooded area immediately south of the Centredale Manor parking lot (see Figure 1). 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 (Cap #2) between the Woonasquatucket River and the Centredale Manor building (see Figure 1). 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.

Details regarding the TCRA are contained in USEPA Action Memoranda dated May 4, 1999; September 13, 1999; and June 1, 2000. The primary purpose of the interims caps is to minimize human exposure to contaminated soils. The interim protective caps are expected to be retained as part of the permanent remedy for the site, and their adequacy for this purpose will be evaluated in the RI (see Section 3.2.6).

### 2.3.2 Non-time Critical Removal Action

An Engineering Evaluation/Cost Analysis (EE/CA) was performed in 2000 as the basis for a NTCRA (TtNUS, 2000). 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 from residential properties along the east side of Allendale and Lyman Mill Ponds and recreational access areas along the eastern banks of the ponds to minimize exposure to site-related contaminants.

Details regarding the NTCRA are contained in an Action Memorandum dated January 18, 2001. Delineation of residential soils for the NTCRA is being performed by the Centredale Manor Performing Parties Group and is in progress. Soil samples were collected from 12 action areas in 2001 and analyzed for dioxin using immunoassay screening analyses to better define the limits of the excavation areas. Additional sampling was conducted in 2002 to complete the delineation process. Based on these results, the NTCRA is proceeding as follows:

- The extent of contamination in eight of the action areas was delineated and excavation in these areas will proceed in late 2002.

- Additional samples will be collected in three of the action areas to complete the delineation process prior to excavation.

- Contamination in one of the action areas in the tailrace on the east side of the Centredale Manor site extends beyond the EPA-defined boundaries of the NTCRA; therefore, this area will be addressed in the RI/FS rather than the NTCRA.

### 2.4 Current and Reasonably Foreseeable Uses of the Site

As previously noted, the RI/FS will address the main part of the site and the adjacent Woonasquatucket River. The northern part of the Centredale Manor Restoration Project Site is occupied by the Brook Village and Centredale Manor apartment complexes. 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 "not suitable for public or private drinking water use" (State of Rhode Island Department of Environmental Management [RIDEM] Rules and Regulations for Groundwater Quality, Regulation 12-100-006, August 1996).

The remaining portions of the site consist of the Woonasquatucket River and its impoundments. The river is 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 a fishable condition.

## 2.5 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. Potential human health and ecological risks and the status of the baseline risk assessments for the Centredale Manor Site are described in Sections 2.5.1 and 2.5.2.

Potential historical sources of contamination at the Centredale Manor site include improper storage and disposal of chemicals in drums, stockpiles and surface impoundments. Chemicals were apparently released directly to the ground, buried, and discharged directly to the Woonasquatucket River. 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 of 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 and the Brook Village and Centredale Manor south parking lots. Localized groundwater contamination has also occurred. The erosion and transport of contaminated soils by surface runoff and periodic flooding of the river resulted in sediment contamination in the adjacent river and ponds and tailrace on the east side of the site. Direct discharge of chemicals to the river during site operations may also have contributed to sediment contamination. As noted in Section 2.1, 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. Additionally, sediments may have been remobilized by high river flows and deposited on the river banks and in the adjacent floodplain during storm events. The nature and extent of sediment contamination will be addressed more fully in a sediment coring effort scheduled for 2003.

The CSM for the tailrace east of the source area is described in more detail below because it is the primary focus of this interim data collection effort. Examination of historical aerial photos and maps indicated that prior to about 1940, the Woonasquatucket River flowed along the east side of the site (in the current location of the tailrace) (LEA, 2002). The original stream channel probably exhibited typical stream morphology, which is characterized by riffle and pool zones with faster flow in the riffles and slower flow or stagnant areas in the pools. The pools would tend to be depositional areas. After about

1940, the majority of the river flow was diverted to the west side of the site, although some flow remained through the tailrace. Between 1939 and 1951, the north end of tailrace was filled and no longer flowed continuously, although surface water was present throughout the tailrace. During 1960s-70s, the tailrace was vegetated and appeared to receive some surface drainage from the site. The west side of the tailrace was modified during redevelopment and landscaping of the site (during the construction of Centredale Manor), although the east side remained vegetated and relatively unchanged.

Analysis of aerial photos by LEA (2002) and TTNUS (2002) did not yield any specific information or details about the history or location of potential filling in the tailrace. Artificial fill was noted in subsurface material from three of five borings in the tailrace; however, no artificial fill was noted in the other two (TTNUS, 2002). Therefore, fill history and location in the tailrace are uncertain. The presence of moderate to heavy vegetation and ponded water in the tailrace throughout the period when the Metro Atlantic Chemical Corporation operated suggests that it was not actively or frequently disturbed by site operations or used as a waste disposal area, although it appears likely that the tailrace received drainage from site impoundments and/or surface water at various times in the past as described below.

Aerial photos from the 1950s show a waste disposal area south of the drum recycling building (in the current location of the Centredale Manor north parking lot), with drainage from the waste piles east into the tailrace. A 1970 photo shows an impoundment that extended southwest to northeast in the current location of the Centredale Manor building and southeast corner of the north parking lot. It appears that a drainage feature from this impoundment entered the tailrace near the location of boring CMS-078 (Figure 2). A 1979 photo shows surface flow paths from west to east towards the tailrace near the former drum recycling facility and impoundment.

Contaminants in surface runoff could have accumulated in low-lying areas in the tailrace (i.e., pools), 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. Additionally, artificial fill could have included contaminated material from the site, although as previously noted, it appears that extensive disturbance and filling in the tailrace did not take place. The western edge of the tailrace was apparently modified during construction of the Centredale Manor apartment complex and parking lot; however, the nature of these modifications and materials used are unknown. The historical information for the tailrace was used to develop the data collection program described in Section 3.2.1.

### 2.5.1 Human Health Risk Assessment

Figure 3 presents the human health CSM for the Centredale Manor Restoration Project Site. Potentially significant human health exposure pathways include direct contact with and incidental ingestion of contaminated soil, surface water and sediment at site. Ingestion of contaminated fish or other aquatic life also poses a potentially significant human health risk.

Table 2 summarizes the status of the human health risk assessment activities for the site and the scope of the baseline human health risk assessment. Health risks to residents near the site and recreational users of the Allendale and Lyman Mill Pond banks are being addressed through the NTCRA and will not be included in the RI/FS. The following exposure scenarios will be evaluated in the RI/FS:

- Incremental and cumulative risk from ingestion of fish and/or other biota from the Woonasquatucket River, direct contact with surface water and sediment during recreational use of the river, and direct contact with bank sediment during recreational use (i.e., fishing).

- Potential health risks to commercial site workers in areas where a complete exposure pathway exists. Direct contact (incidental ingestion and dermal contact) with surface soil will be evaluated.

Details regarding the biota consumption risk assessment are provided in the *Human Health and Ecological Risk Assessment Work Plan* (Harding ESE, 2001). Methods to be used for the evaluation of cumulative risk and commercial exposure will be described in the RI/FS Work Plan for the site (in preparation).

### 2.5.2 Ecological Risk Assessment

An ecological CSM for the Centredale Manor Restoration Project Site is provided in Figure 4. In general, aquatic receptors (including invertebrates and both demersal and pelagic fish species) are exposed to COPCs in sediment and surface water via direct contact, direct ingestion, or by consuming prey items that have bioaccumulated COPCs. 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 COPCs in floodplain soil directly or by ingesting contaminated prey.

The baseline ecological risk assessment (BERA) is in progress (Harding ESE, 2001). Although the primary focus of the BERA is on the effects of bioaccumulating compounds (particularly dioxins, HCX, furans, and PCBs) on the ecological health of the Woonasquatucket River, several other classes of chemicals were also identified in the streamlined ecological risk assessment performed for the EE/CA (TtNUS, 2000) and are also being evaluated. Of particular note, potential impacts to the macroinvertebrate community associated with the discharge of contaminated groundwater to the Woonasquatucket River in the vicinity of the site are a specific focus of the BERA.

# 3.0 DATA SUMMARY

This section summarizes data collected in previous investigations that will be used in the RI/FS for the Centredale Manor Restoration Project Site, discusses the RI/FS data gaps identified in the April 24, 2002 Technical Planning Meeting and describes the data that will be collected to address these data gaps.

## 3.1 Existing Data

Table 1 summarizes previous investigations and data collection efforts that have been conducted at the Centredale Manor Restoration Project Site. All project data are stored in a centralized database that will be the basis for RI/FS data evaluation. The *Summary of Data Needs for the Centredale Manor Restoration Project Site RI/FS* (Battelle, 2002) evaluated the sufficiency of the existing data for completing the RI/FS. A summary of the data gap evaluation and approach for resolution is provided in Table 3 and described further below.

## 3.2 Planned Data Collection and Evaluation

RI/FS data gaps were identified in several areas, and additional data collection is described in this Work Plan as follows:

- Collection and analysis of source area residential use 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.

In addition, sediment sample collection and analysis will be required to fully define the extent of contamination in the Woonasquatucket River and its ponds. The scope of this effort will be determined after the results of the BERA are available and a geomorphic analysis and geophysical survey of the Woonasquatucket River system has been completed. The BERA and the geomorphic analysis are being conducted by USACE and the geophysical survey is being conducted by USEPA Environmental Response Team Center. An engineering analysis of the existing interim protective caps has also been performed by USACE to evaluate their adequacy as a permanent remedy.

The RI/FS and interim data collection effort are based on the following assumptions:

- The interim protective caps and parking lots will become part of the permanent remedy for the site.
- Contaminated soils in the vicinity of Well MW-05S will be actively remediated.
- Land use controls will be included in the permanent remedy for the site to prevent future excavation and exposure of subsurface soils.
- Contaminated subsurface soils will not contaminate groundwater to levels that are higher than already observed.
- Dioxin is the primary risk driver for the site and a permanent remedy based on dioxin contamination will also reduce the risk from exposure to other COPCs.
- Long-term monitoring will be conducted at the site to verify that COPCs have been effectively isolated from the environment.

Interim data collection activities are described in detail below. Data quality objectives (DQOs) for each of the sampling activities were developed following USEPA's seven-step DQO process (USEPA, 2000). Details regarding the collection and analysis of samples for the interim data collection effort can be found in the FSP, QAPP addendum and DMP update.

### 3.2.1 Source Area Residential Use Soils

DQOs for the source area residential use soil sampling are provided in Table 4. Most of the contaminated source area soils are currently beneath interim protective caps, parking lots and paved areas. However, dioxin concentrations in some samples collected in the tailrace east of the Centredale Manor apartment complex exceed USEPA's preliminary remediation goal (PRG) of 1 ppb for residential soils (USEPA, 1998).

Previous soil and sediment sample locations in the tailrace are shown in Figure 2, and dioxin results for samples collected from these locations are summarized in Table 5 (only laboratory data are reported in this table; immunoassay screening data that were collected for the NTCRA are not included). Dioxin data are reported as TEQs. Samples from thirteen locations within the tailrace had dioxin TEQ concentrations exceeding 1 ppb (shown as red sample stations in Figure 4).

Insufficient data are available to characterize the vertical distribution of dioxin in the tailrace. Dioxin TEQs of > 1 ppb have been found at depths of 1-2 ft bgs (CMS-456; 2.1 ppb), 2-4 ft bgs (MW-01S; 1.1 ppb), and 2-3 ft bgs (01-DEL-05; 128 ppb). The origin of the subsurface contamination is not clear; some possible explanations are 1) liquid waste entered the tailrace, ponded and migrated down into the relatively permeable sands and gravels of the former river bed, 2) the subsurface material includes contaminated artificial fill, or 3) contaminated soils in the tailrace were buried by deposition of more recent material.

The horizontal extent of surface contamination appears to be well-bounded on the north, with no surface TEQs > 1 ppb north of borings CMS-084 and CMS-456 (it should be noted that one subsurface sample with a TEQ of 1.1 ppb was collected from the 2-3 ft sample from MW-01S). The north end of the site was formerly occupied by buildings; therefore, high levels of contamination would not necessarily be expected. Evidence of improper waste storage and disposal has been found primarily south of the former building locations. However, historical aerial photos show drainage pathways on the north side of the former drum recycling building into the tailrace east of the building, and the presence or absence of contamination in this area should be verified.

Surface contamination is reasonably well bounded on the east except in the vicinity of borings CMS-456, 01-DEL-05 and 01-DEL-21. The east side of the tailrace is bounded by an embankment that rises to an elevation of approximately 104 ft at the northern end and 98 ft at the southern end. If the majority of the contamination originated from direct discharge of waste to the tailrace and erosion and runoff of contaminated soils from the site, accumulation in the low-lying areas of the tailrace and subsequent reworking by episodic surface water flow, then lower levels of contamination would be expected higher on the embankments. Additionally, subsurface contamination on the embankment slopes would not be expected.

Surface contamination is not well bounded on the west side of the tailrace adjacent to the Centredale Manor building. A TEQ of 28.1 ppb was measured in the 0-0.25 ft sample from CMS-098 on the west side of the tailrace at an elevation of about 97 ft. The distribution of dioxin along this boundary is not predictable because it was apparently modified during the construction of the Centredale Manor apartment complex using material of an unknown origin.

Dioxin concentrations appear to be highest in the lowest-lying parts of the tailrace, at elevations of less than about 94 ft. Concentrations are particularly high within the tailrace adjacent to the south end of the Centredale Manor north parking lot, where a TEQ of 40 ppb was measured in surface sample 01-DEL-100 (0-2 ft composite), and a maximum TEQ of 128 ppb was measured in subsurface soil sample 01-DEL-05 (2-3 ft). Elevated dioxin concentrations also appear to exist near sample locations CMS-107 and CMW-SD-2019, and at the south end of the tailrace near sample locations CMS-SD-2020-and SD-30. All three of these areas appear to be in slightly lower lying areas (i.e., pools). However, the tailrace between these apparent pools has not been well characterized. If these areas represent former riffle zones, then lower concentrations of dioxin would be expected.

The southern extent of contamination appears to be reasonably well bounded. Elevated dioxin concentrations appear to exist in the vicinity of SD-2020 and SD-30; however, the majority of surface samples south of this location had TEQs < 1 ppb. Subsurface samples from borings MW-02S and SB-03 at the south end of the tailrace had TEQs < 1 ppb.

Given the uncertainty regarding the filling history/location in the tailrace and reworking of contaminated soils by surface water flow, the horizontal and vertical distribution of dioxin cannot be confidently predicted. However, if the CSM is accurate and the amount of contaminated fill is minimal, then the highest levels of contamination would be expected to occur in the lowest lying areas in the tailrace, which are assumed to be depositional. The slightly higher areas between these pools should contain lower levels of contamination.

Additional sampling is proposed to better define the horizontal and vertical distribution of soil with dioxin concentrations exceeding 1 ppb. The broad sampling objective is to characterize the horizontal and vertical distribution of dioxin with sufficient resolution to evaluate capping and excavation alternatives in a FS. Data should be sufficient for 1) defining the lateral limits of areas that may require capping, and 2) calculating volumes of sediment with dioxin concentrations exceeding the PRG. It should be noted that the high cost of laboratory dioxin analyses will limit the number of samples that can be collected and consequently affect the level of certainty associated with the volume estimates. Specific sampling objectives are as follows:

- Verify the presence or absence of dioxin contamination in surface and subsurface soils in the vicinity of the former drum recycling facility where surface runoff apparently entered the north end of the tailrace.
- Better define the limits of the elevated dioxin concentrations in the tailrace adjacent to the south end of the Centredale Manor north parking lot, where the highest dioxin levels have been found.
- Characterize surface and subsurface dioxin levels in the center of the tailrace between the three apparent low-lying pool areas.
- Characterize dioxin levels in surface and subsurface soils along the western edge of the tailrace, which was modified and possibly filled when Centredale Manor was constructed.
- Measure concentrations of other COPCs in areas where contaminant concentrations are expected to be highest (i.e., in the low-lying pools).

A targeted, judgmental sampling strategy was designed to address these specific sampling objectives. Table 6 summarizes the proposed surface and subsurface sample locations, rationale for each sample location and required analyses. Proposed sample locations are shown in Figures 5, 6 and 7.

Composite samples will be collected from the following intervals assuming that the soil type is uniform: 0-1 ft, 1-3 ft, 3-5 ft, 5-7 ft and 7-9 ft. If the soils are stratified, then sample intervals will be adjusted so that different soil types are not mixed in the same sample. However, no composite sample will exceed 2 ft in thickness. The 5-7 and 7-9 ft intervals will be archived pending analysis of first round to ensure that the vertical extent of contamination has been defined.

### 3.2.2 Commercial Use Soils

As noted in the RI/FS data needs evaluation (Table 3), potential human health risks to commercial site workers in the Lyman Mill Pond area have not been evaluated. Where accessible, these properties were examined during a site visit on July 9, 2002. The western shore of Lyman Mill Pond was steep and bushy and did not appear to be accessible to commercial site workers. The accessible parts of the commercial properties appeared to be above the flood level of the pond. The commercial properties on the east side of Lyman Mill Pond were paved; therefore, potential exposure of site workers to site-related contaminants is likely to be minimal. However, a fenced yard underlain with grass and exposed soil was observed in the rear of the John E. Fogarty Center, which houses an adult basic education program for developmentally disabled adults. This yard abuts the shoreline of Lyman Mill Pond immediately north of one of the NTCRA recreational use action areas (i.e., Action Area 12). Three surface soil samples will be collected from this yard and analyzed for dioxin/furans, HCX, pesticides, PCBs, semivolatile organic compounds, metals, grain size and total organic carbon. Subsurface soil contamination is unlikely at this location given the presumed transport mechanism (i.e., deposition by floodwaters from the Lyman Mill Pond).

Data will be used to determine whether the property is affected by site-related contamination, and if so, potential human health risks will be assessed. DQOs for commercial use soil sampling are presented in Table 7, and sample locations are shown in Figure 8. A soil sample summary is presented in Table 6.

### 3.2.3 Groundwater Monitoring

DQOs for groundwater monitoring are presented in Table 8. Groundwater data will be compared with previous results to confirm the nature and extent of contamination and monitor the migration of COPCs. The groundwater sampling program is summarized in Table 9 and monitoring well locations are shown in Figure 9. Groundwater samples will be collected from all existing wells and analyzed for VOCs. The sample from Well MW-05S will also be analyzed for dioxins/furans.

### 3.2.4 Landfill Cap Evaluation

As previously discussed, it is assumed that the interim protective caps will be retained as a component of the permanent remedy for the site. The primary purposes of the interim soil caps are to 1) minimize potential human health impacts by preventing direct contact with site soils, and 2) prevent erosion and off-site transport of contaminated soils.

The results of the Source Area Investigation (TtNUS, 2002) indicated that with the exception of the area around Well MW-05S, COPC concentrations in groundwater are moderate to low. Even though evidence exists that some waste material is still present beneath the surface at the Centredale Manor Restoration Project site, offsite migration of site-related COPCs via groundwater is not currently a concern and it is unlikely that groundwater contamination poses an unacceptable human health or ecological risk. Therefore, it is assumed that it will not be necessary for the soil caps to prevent the infiltration of surface water and offsite migration of groundwater. However, this assumption must be verified when the results of the BERA are final.

An engineering review of the interim protective soil caps was performed as part of Work Plan development. The caps were examined during a site visit on July 9, 2002. The engineering review has been provided in a separate technical memorandum.

# 4.0 REFERENCES

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LEA, Inc. 2002. *Review of Historic Topographic Maps and Aerial Photographs Summary Report, Centredale Manor Restoration Project, North Providence, Rhode Island.* Prepared for the Centrdale Manor Performing Parties Group. January 23.

TTNUS, Inc.. 2002. *Draft Technical Memorandum, Source Area Investigation, Centredale Manor Restoration Project Site, North Providence, Rhode Island.* Prepared for the U.S. Environmental Protection Agency. January.

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U.S. Environmental Protection Agency. 1998. *Approaches for Addressing Dioxins in Soil at CERCLA and RCRA Sites.* USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-26. April 13.

# 5.0 TABLES

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

| Date | Media/Collected By | Analytes/Reference | Original Use of Data |
|---|---|---|---|
| 1) 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. |
| 2) 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. |
| 3) 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. |
| 4) 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. |
| 4) January,1999 (cont'd) | 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 |
|---|---|---|---|
| 5) 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. |
| 6) 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. |
| 7) 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. |
| 8) 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. |
| 9) 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. |
| 10) 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. |
| 11) 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. |
| 12) 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 |
|---|---|---|---|
| 13) 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. |
| 14) 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 |
|---|---|---|---|
| 15) 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. |
| 16) 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. |
| 17) 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. |
| 18) 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 |
| 19) 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 |
| 20) 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 |
| 21) July 2000 | N/A | USEPA Aerial Photographic Analysis | Identified historical site features and potential sources of contamination. |

Modified from TTNUS, 2000.

**Table 2. Human Health Risk Assessment Approach.**

| Timeframe | Receptor | Exposure Point | Activity | Exposure Medium | Exposure Route* | Previous Evaluations | RI/FS Approach |
|---|---|---|---|---|---|---|---|
| Current/Future | Resident | Centredale Manor and Brook Village Apartments | Living onsite | Surface soil | Direct contact | Qualitatively evaluated by ATSDR (Draft Health Consultation, March 19, 1999); report was basis for TCRA | Evaluation of soils beneath interim caps and parking lots not necessary because a risk management decision has been made to include the caps and parking lots as components of the permanent remedy. |
| | | | | Surface soil | Inhalation of particulates and vapors | Not evaluated | Not included because most highly contaminated soils are beneath interim caps; interim caps will be a component of the permanent remedy. |
| | | | | Groundwater | Inhalation of VOCs | Air samples collected from Centredale Manor and Brook Village in 1999 by OEME, no significant migration of VOCs into buildings was found. | Not included; indoor air survey indicated insignificant migration of VOCs into buildings. |
| | | Allendale Pond, Lyman Mill Pond, Manton Reach, Dyerville Reach | Angling, fish consumption | Aquatic biota tissue | Ingestion | Human Health Biota Consumption Risk Assessment in progress | Included in RI/FS. Data will be included in assessment of cumulative risk to anglers. |
| | | | Swimming/wading | Surface water/aquatic sediment | Direct contact | EPA screening in 1998 using 1996 data (2/24/98 memo from Ann-Marie Burke to Woonasquatucket Team) | Include in RI/FS and use existing data to verify USEPA 1998 screening evaluation. Data will also be included in assessment of cumulative risk to anglers. |
| | | Recreational areas along east bank of Allendale and Lyman Mill Pond | Walking/exploring edges of pond | Bank surface soil | Direct contact | Streamlined HHRA in EE/CA (TtNUS, 2000); report was basis for NTCRA | Removal of soil as part of NTCRA expected to be final action; this scenario will not be included in the RI/FS per USEPA directive. Existing bank data will be included in assessment of cumulative risk to anglers. |
| | | 28 residential exposure points (homes) | Living onsite | Surface/subsurface soil | Direct contact | Streamlined HHRA in EE/CA (TtNUS, 2000); report was basis for NTCRA | Removal of soil as part of NTCRA expected to be final action; this scenario will not be included in the RI/FS per USEPA directive. |
| | | | | Surface soil | Inhalation of particulates | Not evaluated | Removal of soil as part of NTCRA expected to be final action; this scenario will not be included in the RI/FS per USEPA directive. |
| | | | | Groundwater | Inhalation of VOCs | Not evaluated. VOCs are not likely to be present in groundwater outside of the source area. | Removal of soil as part of NTCRA expected to be final action; this scenario will not be included in the RI/FS per USEPA directive. |
| | Commercial/ Industrial Worker | Commercial property @ NE corner of Lyman Mill Pond; commercial properties on west bank of Lyman Mill Pond. | Working or taking breaks outdoors | Surface soil | Direct contact | Not evaluated | Will not be evaluated in RI/FS because accessible parts of commerical properties appear to be above the flood level of Lyman Mill Pond. |
| | | | Working indoors | Groundwater | Inhalation of volatiles that migrate from the subsurface to indoor air of current buildings. | Not evaluated | Not included; site-related VOCs not likely to be found in groundwater in Lyman Mill Pond area. |
| | | John E. Fogarty Center | Working or taking breaks outdoors | Surface soil | Direct contact | Not evaluated | Included in RI/FS |
| | | | Working indoors | Groundwater | Inhalation of volatiles that migrate from the subsurface to indoor air of current buildings. | Not evaluated | Not included; site-related VOCs not likely to be found in groundwater in Lyman Mill Pond area. |
| Future Only | Excavation Worker | Areas of excavation at Centredale Manor and Brook Village (not currently planned). | Soil excavation | Surface/subsurface soil, groundwater | Direct contact, inhalation of VOCs, inhalation of particulates. | Not evaluated | Not included because institutional controls that prohibit excavation and exposure of subsurface soils will be a component of the permanent remedy. |

**Notes:**

* "Direct contact" includes dermal contact with and/or incidental ingestion of the particular medium.

VOCs = volatile organic compounds

**Table 3. Summary of RI/FS Data Needs Based on Technical Project Planning Meeting.**

| 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 in follow-up project team discussions. | Geomorphic analysis and geophysical survey to be 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 to be 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 to be collected 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 potential 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 will be collected 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 to be analyzed for VOCs (all samples) and dioxin (Well MW-05S only). |

**Table 3. Summary of RI/FS Data Needs Based on Technical Project Planning Meeting (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.<br><br>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 |

**Table 4. Data Quality Objectives for Source Area Residential Use Soils.**

| |
|---|
| **STEP 1: State the Problem** |
| The horizontal and vertical extent of soil with dioxin TEQ concentrations of >1 ppb in the tailrace area east of Centredale Manor is not defined. Additionally, the potential presence of other COPCs has not been verified. |
| **STEP 2: Identify the Decision** |
| Are dioxin TEQ concentrations in soil samples greater than 1 ppb?<br>Are other COPCs present at concentrations above risk-based screening criteria? |
| **STEP 3: Identify Inputs to the Decision** |
| • Dioxin/furan/HCX concentration data in surface and subsurface soil samples<br>• Sample data for other COPCs (PCBs, pesticides, SVOCs, and metals) from a subset of surface samples<br>• Station location and sample depth |
| **STEP 4: Define the Study Boundaries** |
| Samples will be collected in an area bounded on the east by the Centredale Manor property boundary, on the west by Centredale Manor and the paved road to the Centredale Manor parking lot, on the south by Interim Cap #1, and on the north by the limit of the tailrace.<br><br>Samples will be collected from the following intervals assuming a uniform soil type: 0-1 ft, 1-3 ft, 3-5 ft, 5-7 ft, 7-9 ft. The 5-7 ft and 7-9 ft intervals will be archived pending analysis of the shallower samples. In heterogeneous soils, sample intervals may be adjusted to ensure that different soil types are not mixed in the same sample. However, no composite sample will exceed 2 ft in thickness. |
| **STEP 5: Develop a Decision Rule** |
| If the sample dioxin TEQ concentration is >1 ppb, then it exceeds the preliminary remediation goal. The horizontal and vertical extent of soil with dioxin TEQ concentrations >1 ppb will be recommended for inclusion in the Feasibility Study.<br><br>Sample concentrations for other COPCs will be compared with risk-based screening criteria. Sample locations with COPCs that exceed the criteria will be evaluated further as appropriate. |
| **STEP 6: Evaluate Decision Errors** |
| Inadequate coverage of any portion of the study area could result in missing an area with dioxin TEQ concentrations exceeding 1 ppb (false negative). The judgmental sampling strategy is intended to reduce the likelihood of this error by verifying the CSM for the tailrace.<br>The sampling depth may not be sufficient to define the vertical extent of contamination. An archive of deeper soil sample intervals will be retained if additional depth data are needed. |
| **STEP 7: Optimize the Design for Obtaining Data**<br>• A judgmental sampling strategy was developed to verify the CSM and expected dioxin distribution as summarized in Table 6.<br>• Samples will be analyzed for dioxins/furans/HCX except in locations where previous data exist. Two surface samples will also be analyzed for PCBs, pesticides, SVOCs, and metals.<br>• An archive of the 5-7 ft and 7-9 ft intervals from each subsurface soil boring will be retained for future laboratory analysis if required. |

**Table 5. Dioxin TEQ Concentrations in Tailrace Soil Samples.**

| Boring ID | Depth Top (ft) | Depth Bottom (ft) | Sample ID | Field QC Type | Sampling Date | Data Source | Dioxin TEQ Concentration (ug/kg) | |
|---|---|---|---|---|---|---|---|---|
| 01-DEL-05 | 2.0 | 3.0 | 200_4320-01-DEL-05D | None | | LEA | 128 | (1) |
| 01-DEL-21 | 0.5 | 1.0 | 200_4539-01-DEL-21B | None | | LEA | 2.15 | (1) |
| CMS-061 | 0.0 | 0.25 | 3428-CMS-061D | Field Dup. | 2/16/1999 | IT | 0.222 | |
| CMS-061 | 0.0 | 0.25 | 3428-CMS-061 | Field Dup. | 2/16/1999 | IT | 0.195 | |
| CMS-062 | 0.0 | 0.25 | 3428-CMS-062 | None | 2/16/1999 | IT | 0.012 | |
| CMS-067 | 0.0 | 0.25 | 3428-CMS-067 | None | 2/16/1999 | IT | 0.118 | |
| CMS-068 | 0.0 | 0.25 | 3428-CMS-068 | Field Dup. | 2/16/1999 | IT | 0.0085 | |
| CMS-068 | 0.0 | 0.25 | 3428-CMS-068D | Field Dup. | 2/16/1999 | IT | 0.0084 | |
| CMS-072 | 0.0 | 0.25 | 3428-CMS-072 | None | 2/16/1999 | IT | 0.0040 | |
| CMS-073 | 0.0 | 0.25 | 3428-CMS-073 | None | 2/16/1999 | IT | 0.028 | |
| CMS-078 | 0.0 | 0.25 | 3428-CMS-078D | Field Dup. | 2/16/1999 | IT | 0.0092 | |
| CMS-078 | 0.0 | 0.25 | 3428-CMS-078 | Field Dup. | 2/16/1999 | IT | 0.0061 | |
| CMS-079 | 0.0 | 0.25 | 3428-CMS-079 | None | 2/16/1999 | IT | 0.036 | |
| CMS-084 | 0.0 | 0.25 | 3428-CMS-084 | Field Dup. | 2/16/1999 | IT | 0.746 | |
| CMS-084 | 0.0 | 0.25 | 3428-CMS-084D | Field Dup. | 2/16/1999 | IT | 0.156 | |
| CMS-085 | 0.0 | 0.25 | 3428-CMS-085 | None | 2/17/1999 | IT | 0.329 | |
| CMS-090 | 0.0 | 0.25 | 3428-CMS-090 | None | 2/17/1999 | IT | 0.013 | |
| CMS-091 | 0.0 | 0.25 | 3428-CMS-091 | None | 2/17/1999 | IT | 0.225 | |
| CMS-098 | 0.0 | 0.25 | 3428-CMS-098 | None | 2/17/1999 | IT | 28.1 | |
| CMS-098 | 0.0 | 1.0 | CMS-098-A | None | 6/28/1999 | IT | 2.50 | |
| CMS-099 | 0.0 | 0.25 | 3428-CMS-099 | None | 2/17/1999 | IT | 0.767 | |
| CMS-100 | 0.0 | 0.25 | 3428-CMS-100 | None | 2/17/1999 | IT | 0.012 | |
| CMS-107 | 0.0 | 0.25 | 3428-CMS-107 | None | 2/17/1999 | IT | 1.81 | |
| CMS-108 | 0.0 | 0.25 | 3428-CMS-108 | None | 2/17/1999 | IT | 0.095 | |
| CMS-114 | 0.0 | 0.25 | 3428-CMS-114 | Field Dup. | 2/17/1999 | IT | 0.024 | |
| CMS-114 | 0.0 | 0.25 | 3428-CMS-114D | Field Dup. | 2/17/1999 | IT | 0.023 | |
| CMS-115 | 0.0 | 0.25 | 3428-CMS-115 | None | 2/17/1999 | IT | 0.463 | |
| CMS-116 | 0.0 | 0.25 | 3428-CMS-116 | None | 2/17/1999 | IT | 0.132 | |
| CMS-121 | 0.0 | 0.25 | 3428-CMS-121 | None | 2/17/1999 | IT | 0.280 | |
| CMS-123 | 0.0 | 0.25 | 3428-CMS-123 | None | 2/17/1999 | IT | 2.10 | |
| CMS-123 | 0.0 | 1.0 | CMS-123-A | None | 7/13/1999 | IT | 0.400 | |
| CMS-127 | 0.0 | 0.25 | 3428-CMS-127 | None | 2/16/1999 | IT | 0.039 | |
| CMS-128 | 0.0 | 0.25 | 3428-CMS-128 | None | 2/16/1999 | IT | 0.018 | |
| CMS-130 | 0.0 | 0.25 | 3428-CMS-130 | None | 2/17/1999 | IT | 0.072 | |
| CMS-220 | 0.0 | 0.25 | 3428-CMS-220 | None | 2/16/1999 | IT | 0.0029 | |
| CMS-222 | 0.0 | 0.25 | 3428-CMS-222 | None | 2/16/1999 | IT | 0.099 | |
| CMS-223 | 0.0 | 0.25 | 3428-CMS-223 | None | 2/16/1999 | IT | 0.120 | |
| CMS-419 | 0.0 | 1.0 | CMS-419-A | None | 7/7/1999 | IT | 0.095 | |
| CMS-419 | 1.0 | 2.0 | CMS-419-B-QC | Field Dup. | 7/7/1999 | IT | 0.077 | |
| CMS-419 | 1.0 | 2.0 | CMS-419-B | Field Dup. | 7/7/1999 | IT | 0.060 | |
| CMS-419 | 2.0 | 3.0 | CMS-419-C | None | 7/7/1999 | IT | 0.080 | |
| CMS-419 | 3.0 | 4.0 | CMS-419-D | None | 7/7/1999 | IT | 0.015 | |
| CMS-419 | 4.0 | 5.0 | CMS-419-E | None | 7/7/1999 | IT | 0.0065 | |
| CMS-419 | 5.0 | 6.0 | CMS-419-F | None | 7/7/1999 | IT | 0.0023 | |

**Table 5. Dioxin TEQ Concentrations in Tailrace Soil Samples (continued).**

| Boring ID | Depth Top (ft) | Depth Bottom (ft) | Sample ID | Field QC Type | Sampling Date | Data Source | Dioxin TEQ Concentration (ug/kg) | |
|---|---|---|---|---|---|---|---|---|
| CMS-419 | 6.0 | 7.0 | CMS-419-G | None | 7/7/1999 | IT | 0.048 | |
| CMS-419 | 7.0 | 8.0 | CMS-419-H | None | 7/7/1999 | IT | 0.0060 | |
| CMS-420 | 0.0 | 1.0 | CMS-420-A | None | 7/2/1999 | IT | 0.016 | |
| CMS-420 | 1.0 | 2.0 | CMS-420-B | Field Dup. | 7/2/1999 | IT | 0.0095 | |
| CMS-420 | 1.0 | 2.0 | GP11-FD | Field Dup. | 7/2/1999 | IT | 0.0043 | |
| CMS-420 | 2.0 | 3.0 | CMS-420-C | Field Dup. | 7/2/1999 | IT | 1.45 | |
| CMS-420 | 2.0 | 3.0 | CMS-420-C-QC | Field Dup. | 7/2/1999 | IT | 0.321 | |
| CMS-420 | 3.0 | 4.0 | CMS-420-D | None | 7/2/1999 | IT | 3.40 | |
| CMS-421 | 0.0 | 1.0 | CMS-421-A | None | 7/8/1999 | IT | 0.0024 | |
| CMS-421 | 1.0 | 2.0 | CMS-421-B | Field Dup. | 7/8/1999 | IT | 0.105 | |
| CMS-421 | 1.0 | 2.0 | GP15-FD | Field Dup. | 7/8/1999 | IT | 0.079 | |
| CMS-421 | 2.0 | 3.0 | CMS-421-C | Field Dup. | 7/8/1999 | IT | 0.160 | |
| CMS-421 | 2.0 | 3.0 | CMS-421-C-QC | Field Dup. | 7/8/1999 | IT | 0.025 | |
| CMS-421 | 3.0 | 4.0 | CMS-421-D | None | 7/8/1999 | IT | 0.0044 | |
| CMS-421 | 4.0 | 5.0 | CMS-421-E | None | 7/8/1999 | IT | 0.0017 | |
| CMS-421 | 5.0 | 6.0 | CMS-421-F | None | 7/8/1999 | IT | 0.0027 | |
| CMS-421 | 6.0 | 7.0 | CMS-421-G | None | 7/8/1999 | IT | 0.0090 | |
| CMS-421 | 7.0 | 8.0 | CMS-421-H | None | 7/8/1999 | IT | 0.013 | |
| CMS-422 | 0.0 | 1.0 | CMS-422-A | None | 7/2/1999 | IT | 0.031 | |
| CMS-422 | 1.0 | 2.0 | CMS-422-B | None | 7/2/1999 | IT | 0.410 | |
| CMS-422 | 2.0 | 3.0 | CMS-422-C | None | 7/2/1999 | IT | 0.0034 | |
| CMS-422 | 3.0 | 4.0 | CMS-422-D | None | 7/2/1999 | IT | 0.017 | |
| CMS-423 | 0.0 | 1.0 | CMS-423-A | None | 7/7/1999 | IT | 0.0060 | |
| CMS-423 | 1.0 | 2.0 | CMS-423-B | None | 7/7/1999 | IT | 0.039 | |
| CMS-423 | 2.0 | 3.0 | CMS-423-C | None | 7/7/1999 | IT | 0.0026 | |
| CMS-423 | 3.0 | 4.0 | CMS-423-D | Field Dup. | 7/7/1999 | IT | 0.120 | |
| CMS-423 | 3.0 | 4.0 | GP13-FD | Field Dup. | 7/7/1999 | IT | 0.011 | |
| CMS-423 | 4.0 | 5.0 | CMS-423-E | None | 7/7/1999 | IT | 0.0038 | |
| CMS-423 | 5.0 | 6.0 | CMS-423-F | None | 7/7/1999 | IT | 0.0049 | |
| CMS-423 | 6.0 | 7.0 | CMS-423-G | None | 7/7/1999 | IT | 0.0055 | |
| CMS-423 | 7.0 | 8.0 | CMS-423-H | None | 7/7/1999 | IT | 0.0024 | |
| CMS-424 | 0.0 | 1.0 | CMS-424-A | None | 7/2/1999 | IT | 0.0041 | |
| CMS-424 | 1.0 | 2.0 | CMS-424-B | None | 7/2/1999 | IT | 0.012 | |
| CMS-424 | 2.0 | 3.0 | CMS-424-C | None | 7/2/1999 | IT | 0.010 | |
| CMS-424 | 3.0 | 4.0 | CMS-424-D | None | 7/2/1999 | IT | 0.0034 | |
| CMS-424 | 4.0 | 5.0 | CMS-424-E | None | 7/2/1999 | IT | 0.0040 | |
| CMS-424 | 5.0 | 6.0 | CMS-424-F | None | 7/2/1999 | IT | 0.0043 | |
| CMS-424 | 6.0 | 7.0 | CMS-424-G | None | 7/2/1999 | IT | 0.0070 | |
| CMS-424 | 7.0 | 8.0 | CMS-424-H | None | 7/2/1999 | IT | 0.0043 | |
| CMS-425 | 0.0 | 1.0 | CMS-425-A | None | 7/8/1999 | IT | 0.370 | |
| CMS-425 | 1.0 | 2.0 | CMS-425-B | None | 7/8/1999 | IT | 0.860 | |
| CMS-425 | 2.0 | 3.0 | CMS-425-C | None | 7/8/1999 | IT | 0.065 | |
| CMS-425 | 3.0 | 4.0 | CMS-425-D | None | 7/8/1999 | IT | 0.028 | |
| CMS-425 | 4.0 | 5.0 | CMS-425-E-QC | Field Dup. | 7/21/1999 | IT | 16.3 | |

**Table 5. Dioxin TEQ Concentrations in Tailrace Soil Samples (continued).**

| Boring ID | Depth Top (ft) | Depth Bottom (ft) | Sample ID | Field QC Type | Sampling Date | Data Source | Dioxin TEQ Concentration (ug/kg) | |
|---|---|---|---|---|---|---|---|---|
| CMS-425 | 4.0 | 5.0 | CMS-425-E-QC | Field Dup. | 7/21/1999 | IT | 16.3 | |
| CMS-425 | 4.0 | 5.0 | CMS-425-E | Field Dup. | 7/8/1999 | IT | 0.022 | |
| CMS-425 | 6.0 | 7.0 | CMS-425-G | None | 7/8/1999 | IT | 0.0095 | |
| CMS-425 | 7.0 | 8.0 | CMS-425-H | None | 7/8/1999 | IT | 0.025 | |
| CMS-426 | 0.0 | 1.0 | CMS-426-A | None | 7/7/1999 | IT | 0.094 | |
| CMS-426 | 1.0 | 2.0 | GP14-FD | Field Dup. | 7/7/1999 | IT | 8.40 | |
| CMS-426 | 1.0 | 2.0 | CMS-426-B | Field Dup. | 7/7/1999 | IT | 3.30 | |
| CMS-426 | 2.0 | 3.0 | CMS-426-C | Field Dup. | 7/7/1999 | IT | 8.20 | |
| CMS-426 | 2.0 | 3.0 | CMS-426-C-QC | Field Dup. | 7/7/1999 | IT | 4.31 | |
| CMS-426 | 3.0 | 4.0 | CMS-426-D | None | 7/7/1999 | IT | 0.190 | |
| CMS-426 | 4.0 | 5.0 | CMS-426-E | None | 7/7/1999 | IT | 0.037 | |
| CMS-426 | 5.0 | 6.0 | CMS-426-F | None | 7/7/1999 | IT | 0.038 | |
| CMS-426 | 6.0 | 7.0 | CMS-426-G | None | 7/7/1999 | IT | 0.210 | |
| CMS-426 | 7.0 | 8.0 | CMS-426-H | None | 7/7/1999 | IT | 0.076 | |
| CMS-427 | 0.0 | 1.0 | CMS-427-A | None | 7/6/1999 | IT | 0.380 | |
| CMS-427 | 1.0 | 2.0 | CMS-427-B | None | 7/6/1999 | IT | 0.600 | |
| CMS-427 | 2.0 | 3.0 | CMS-427-C | None | 7/6/1999 | IT | 0.0024 | |
| CMS-427 | 3.0 | 4.0 | CMS-427-D | None | 7/6/1999 | IT | 0.470 | |
| CMS-427 | 4.0 | 5.0 | CMS-427-E | None | 7/6/1999 | IT | 0.215 | |
| CMS-427 | 5.0 | 6.0 | CMS-427-F | None | 7/6/1999 | IT | 0.063 | |
| CMS-427 | 6.0 | 7.0 | CMS-427-G | None | 7/6/1999 | IT | 0.0060 | |
| CMS-427 | 7.0 | 8.0 | CMS-427-H | None | 7/6/1999 | IT | 0.0085 | |
| CMS-428 | 0.0 | 1.0 | CMS-428-A | None | 7/20/1999 | IT | 0.049 | |
| CMS-428 | 1.0 | 2.0 | CMS-428-B | None | 7/20/1999 | IT | 0.0090 | |
| CMS-428 | 2.0 | 3.0 | CMS-428-C | Field Dup. | 7/20/1999 | IT | 0.019 | |
| CMS-428 | 2.0 | 3.0 | GP18-FD | Field Dup. | 7/20/1999 | IT | 0.012 | |
| CMS-428 | 3.0 | 4.0 | CMS-428-D | None | 7/20/1999 | IT | 0.023 | |
| CMS-428 | 4.0 | 5.0 | CMS-428-E | Field Dup. | 7/20/1999 | IT | 0.014 | |
| CMS-428 | 4.0 | 5.0 | CMS-428-E-QC | Field Dup. | 7/20/1999 | IT | 0.0083 | |
| CMS-428 | 5.0 | 6.0 | CMS-428-F | None | 7/20/1999 | IT | 0.021 | |
| CMS-429 | 0.0 | 1.0 | CMS-429-A | None | 7/8/1999 | IT | 0.0020 | |
| CMS-429 | 1.0 | 2.0 | CMS-429-B | None | 7/8/1999 | IT | 0.0090 | |
| CMS-429 | 2.0 | 3.0 | CMS-429-C | None | 7/8/1999 | IT | 0.0060 | |
| CMS-429 | 3.0 | 4.0 | CMS-429-D | None | 7/8/1999 | IT | 0.0075 | |
| CMS-429 | 4.0 | 5.0 | CMS-429-E | None | 7/8/1999 | IT | 0.0048 | |
| CMS-429 | 5.0 | 6.0 | CMS-429-F | None | 7/7/1999 | IT | 0.031 | |
| CMS-429 | 6.0 | 7.0 | CMS-429-G | None | 7/7/1999 | IT | 0.016 | |
| CMS-429 | 7.0 | 8.0 | CMS-429-H | None | 7/8/1999 | IT | 0.017 | |
| CMS-430 | 0.0 | 1.0 | CMS-430-A | None | 7/9/1999 | IT | 0.170 | |
| CMS-430 | 1.0 | 2.0 | CMS-430-B | None | 7/9/1999 | IT | 0.265 | J |
| CMS-430 | 2.0 | 3.0 | CMS-430-C | None | 7/9/1999 | IT | 0.016 | |
| CMS-431 | 0.0 | 1.0 | CMS-431-A | None | 7/9/1999 | IT | 0.350 | |
| CMS-431 | 1.0 | 2.0 | CMS-431-B | None | 7/9/1999 | IT | 0.230 | |
| CMS-431 | 2.0 | 3.0 | CMS-431-C | None | 7/9/1999 | IT | 0.090 | |

**Table 5. Dioxin TEQ Concentrations in Tailrace Soil Samples (continued).**

| Boring ID | Depth Top (ft) | Depth Bottom (ft) | Sample ID | Field QC Type | Sampling Date | Data Source | Dioxin TEQ Concentration (ug/kg) | |
|---|---|---|---|---|---|---|---|---|
| CMS-432 | 0.0 | 1.0 | CMS-432-A | None | 7/9/1999 | IT | 0.720 | |
| CMS-432 | 1.0 | 2.0 | GP16-FD | Field Dup. | 7/9/1999 | IT | 0.087 | |
| CMS-432 | 1.0 | 2.0 | CMS-432-B | Field Dup. | 7/9/1999 | IT | 0.044 | |
| CMS-432 | 2.0 | 3.0 | CMS-432-C-QC | Field Dup. | 7/9/1999 | IT | 0.028 | |
| CMS-432 | 2.0 | 3.0 | CMS-432-C | Field Dup. | 7/9/1999 | IT | 0.018 | |
| CMS-432 | 3.0 | 4.0 | CMS-432-D | None | 7/9/1999 | IT | 0.400 | |
| CMS-432 | 4.0 | 5.0 | CMS-432-E | None | 7/9/1999 | IT | 0.0070 | |
| CMS-442 | 0.0 | 1.0 | CMS-442-A | None | 7/13/1999 | IT | 0.011 | |
| CMS-443 | 0.0 | 1.0 | CMS-443-A | None | 7/14/1999 | IT | 0.083 | |
| CMS-444 | 0.0 | 1.0 | CMS-444-A | None | 7/14/1999 | IT | 0.044 | J |
| CMS-445 | 0.0 | 1.0 | CMS-445-A | None | 7/14/1999 | IT | 0.096 | |
| CMS-456 | 0.0 | 1.0 | CMS-456-A | None | 7/20/1999 | IT | 0.480 | |
| CMS-456 | 1.0 | 2.0 | CMS-456-B | None | 7/20/1999 | IT | 2.10 | J |
| CMS-500 | 0.0 | 1.0 | HA16-FD | Field Dup. | 8/12/1999 | IT | 0.038 | |
| CMS-500 | 0.0 | 1.0 | CMS-500-A | Field Dup. | 8/12/1999 | IT | 0.026 | |
| CMS-501 | 0.0 | 1.0 | CMS-501-A | None | 8/12/1999 | IT | 0.024 | |
| CMS-502 | 0.0 | 1.0 | CMS-502-A | None | 8/12/1999 | IT | 0.070 | |
| CMS-503 | 0.0 | 1.0 | CMS-503-A | None | 8/12/1999 | IT | 0.027 | |
| CMS-504 | 0.0 | 1.0 | CMS-504-A-QC | Field Dup. | 8/13/1999 | IT | 0.036 | |
| CMS-504 | 0.0 | 1.0 | CMS-504-A | Field Dup. | 8/12/1999 | IT | 0.034 | |
| CMS-505 | 0.0 | 1.0 | CMS-505-A | None | 8/12/1999 | IT | 0.013 | |
| CMS-506 | 0.0 | 1.0 | CMS-506-A | None | 8/12/1999 | IT | 0.026 | |
| CMS-507 | 0.0 | 1.0 | CMS-507-A | None | 8/12/1999 | IT | 0.048 | |
| CMS-508 | 0.0 | 1.0 | CMS-508-A | None | 8/12/1999 | IT | 0.019 | |
| CMW-SD-2017 | 0.0 | 0.5 | CMW-SD-2017-01 | Field Dup. | 10/27/1999 | TTNUS | 0.024 | |
| CMW-SD-2018 | 0.0 | 0.5 | CMW-SD-2018-01 | None | 10/26/1999 | TTNUS | 0.029 | |
| CMW-SD-2019 | 0.0 | 0.5 | CMW-SD-2019-01 | None | 10/26/1999 | TTNUS | 8.41 | |
| CMW-SD-2020 | 0.0 | 0.5 | CMW-SD-2020-01 | None | 10/26/1999 | TTNUS | 4.74 | |
| MW01 | 1.0 | 2.0 | CM-SO-MW01-0102 | None | 12/28/2000 | TTNUS | 0.0089 | |
| MW01 | 2.0 | 4.0 | CM-SO-MW01-0204 | None | 12/28/2000 | TTNUS | 1.10 | |
| MW01 | 4.0 | 6.0 | CM-SO-MW01-0406 | None | 12/28/2000 | TTNUS | 0.0058 | |
| MW01 | 6.0 | 8.0 | CM-SO-MW01-0608 | None | 12/28/2000 | TTNUS | 0.0049 | |
| RES-14-271-01A | 0.0 | 1.0 | RES-SS-14-271-01A | None | 12/2/1999 | TTNUS | 0.237 | |
| SB02 | 2.0 | 4.0 | CM-SO-SB02-0204 | None | 1/3/2001 | TTNUS | 0.958 | J |
| SB02 | 4.0 | 6.0 | CM-SO-SB02-0406 | None | 1/3/2001 | TTNUS | 0.986 | J |
| SB02 | 6.0 | 8.0 | CM-SO-SB02-0608 | None | 1/3/2001 | TTNUS | 0.986 | J |
| SD-30 | 0.0 | 0.5 | SD-30 | None | 9/9/1998 | SPINA | 15.9 | |

(1) Results reported as 2,3,7,8-TCDD

**Table 6. Soil Sample Summary.**

| Sample Location | Description | Purpose | Depth Interval (ft) | Dioxins/ Furans | Pesticides, PCBs, SVOCs, metals, HCX, grain size, TOC | Archive |
|---|---|---|---|---|---|---|
| *Source Area Residential Use Soils (Tailrace)* | | | | | | |
| CMS-4101 | Center of tailrace, north end near CMS-442 | Verify level of contamination near former drainage feature from drum recycling facility | 0 – 1(1) | | | X |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |
| CMS-4102 | Center of tailrace south of CMS-079, elevation approx. 94.5 ft | Define the northern limit of elevated dioxin levels; this location is immediately north of the apparent pool that received runoff from the former impoundment and waste piles | 0 - 1 | X | | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |
| CMS-4103 | Composite surface samples along the residential property line at an elevation of approximately 94.5 ft | Measure dioxin concentrations at site boundary | 0 – 1 | X | | |
| CMS-4104 | Composite surface sample immediately north of 01-DEL-100 at an elevation of 95 ft | Define northern edge of elevated dioxin levels | 0 – 1 | X | | |
| CMS-4105 | Center of tailrace near 01-DEL-21 at elevation of approximately 93.5 ft | Define vertical extent of contamination; this location is in the lowest part of the tailrace | 0 – 1(2) | | X | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |
| CMS-4106 | Center of tailrace between two apparent low-lying pools. | Better define horizontal limits of elevated dioxin levels | 0 - 1 | X | | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |

**Table 6. Soil Sample Summary (continued).**

| Sample Location | Description | Purpose | Depth Interval (ft) | Dioxins/ Furans | Pesticides, PCBs, SVOCs, metals, HCX, grain size, TOC | Archive |
|---|---|---|---|---|---|---|
| CMS-4107 | West side of tailrace at north end of Centredale Manor building; adjacent to CMS-098 where 28 ppb dioxin was found in 0-0.25 ft sample. | Characterize potentially filled or reworked area; define western limit of contamination | 0 – 1(3) | | | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |
| CMS-4108 | West side of tailrace at middle of Centredale Manor building | Characterize potentially filled or reworked area; define western limit of contamination | 0 - 1 | X | | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |
| CMS-4109 | Center of tailrace between two apparent low-lying pools. | Better define horizontal limits of elevated dioxin levels | 0 - 1 | X | | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |
| CMS-4110 | Center of tailrace in apparent low-lying pool | Determine whether elevated dioxin levels occur in this low-lying area | 0 - 1 | X | X | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |
| CMS-4111 | West side of tailrace at south end of Centredale Manor building | Characterize potentially filled or reworked area; define western limit of contamination | 0 - 1 | X | | |
| | | | 1 – 3 | X | | |
| | | | 3 – 5 | X | | |
| | | | 5 – 7 | | | X |
| | | | 7 - 9 | | | X |

**Table 6. Soil Sample Summary (continued).**

| Sample Location | Description | Purpose | Depth Interval (ft) | Dioxins/ Furans | Pesticides, PCBs, SVOCs, metals, HCX, grain size, TOC | Archive |
|---|---|---|---|---|---|---|
| *Commercial Use Soils (John E. Fogarty Center)* | | | | | | |
| LPX-4112 | John E. Fogarty Center | Assess potential human health risk | 0.0 - 0.5 | X | X | |
| LMX-4113 | John E. Fogarty Center | Assess potential human health risk | 0.0 - 0.5 | X | X | |
| LMX-4114 | John E. Fogarty Center | Assess potential human health risk | 0.0 - 0.5 | X | X | |

(1) Surface sample dioxin data from CMS-442 will be used to represent surface dioxin concentrations in this area.

(2) Surface sample will be analyzed for PCBs, pesticides, semivolatile organic compounds, metals, grain size and TOC. Near-surface sample dioxin data from 01-DEL-21 will be used to represent surface dioxin concentrations in this area.

(3) Surface sample dioxin data from CMS-098 will be used to represent surface conditions in this area.

**Table 7. Data Quality Objectives for Commercial Soil Sampling.**

| |
|---|
| **STEP 1: State the Problem**<br>The potential health risk to workers and visitors at the John E. Fogarty Center has not been assessed. |
| **STEP 2: Identify the Decision** |
| Does potential exposure to contamination originating from the Centredale Manor Site pose an unacceptable health risk to workers and visitors at the John E. Fogarty Center? |
| **STEP 3: Identify Inputs to the Decision** |
| COPC concentration data for surface soil samples (0-0.5 ft) collected from the fenced yard in the rear of the John E. Fogarty Center on the eastern shore of Lyman Mill Pond. COPCs include dioxins/furans, HCX, pesticides, PCBs, metals, and semivolatile organic compounds.<br>Station location and sample depth.<br>Risk-based screening criteria for soil.<br>Human health risk assessment input parameters if required. |
| **STEP 4: Define the Study Boundaries** |
| Fenced, unpaved yard at the rear of the John E. Fogarty Center. Surface soil samples (0-0.5 ft) will be collected from all stations. |
| **STEP 5: Develop a Decision Rule** |
| If COPC concentrations in soil exceed the human health risk-based screening criteria, then potential human health risks will be assessed. If the risk assessment finds an unacceptable risk to site users, then the affected property will be recommended for inclusion in the Feasibility Study.<br>Groundwater elevation data will be compared with historical data regarding previously-calculated horizontal and vertical gradients. |
| **STEP 6: Evaluate Decision Errors** |
| Inadequate coverage of the property could result in missing an area with elevated COPC concentrations. However, hot spots are not likely given the distance from the source area and associated transport mechanism (erosion, transport and deposition of contaminated soil/sediment). |
| **STEP 7: Optimize the Design for Obtaining Data**<br>Three soil samples will be collected at equally-spaced intervals along the edge of the fenced yard closest to Lyman Mill Pond. |

**Table 8. Data Quality Objectives for Groundwater Monitoring.**

| |
|---|
| **STEP 1: State the Problem** |
| Groundwater monitoring wells at the Centredale Manor Site were installed and sampled in 2001. Additional groundwater sample data are needed to confirm previous results and monitor the migration of contamination, and groundwater elevation data are needed to confirm conclusions regarding groundwater flow. |
| **STEP 2: Identify the Decision** |
| Are concentrations of volatile organic compounds (VOCs) in groundwater samples consistent with levels that were measured in 2001?<br>Is the dioxin concentration in groundwater near Well MW-05S consistent with the concentration measured in 2001?<br>What is the elevation of the groundwater table at the site? |
| **STEP 3: Identify Inputs to the Decision** |
| VOC concentrations in groundwater samples from all wells.<br>Dioxin concentration in a groundwater sample from Well MW-05S.<br>Groundwater elevation in each monitoring well. |
| **STEP 4: Define the Study Boundaries** |
| Samples will be collected from all existing monitoring wells located at the Centredale Manor site (see Table 9). |
| **STEP 5: Develop a Decision Rule** |
| Concentrations of VOCs in all samples and the dioxin concentration in the sample from MW-05S will be compared with previous sample results from 2001 to evaluate any changes or apparent trends. |
| **STEP 6: Evaluate Decision Errors** |
| Concentrations of other site-related chemicals were below levels of concern in 2001; therefore, these chemicals will not be analyzed. Although it is possible that concentrations of these chemicals have increased, it is unlikely due to the installation of soil caps in the most contaminated parts of the Source Area in 1999 and 2000. |
| **STEP 7: Optimize the Design for Obtaining Data**<br>Samples will be collected from all existing monitoring wells. |

**Table 9. Groundwater Sample Summary.**

| Monitoring Well ID | Total Depth (ft bgs) | Volatile Organic Compounds | Dioxins/ Furans |
|---|---|---|---|
| GEC1 | 14.5 | X | |
| GEC2 | 15.0 | X | |
| GEC3 | 15.0 | X | |
| GEC4 | 15.0 | X | |
| GEC5 | 15.0 | X | |
| GEC6 | 11.0 | X | |
| GEC7 | 12.0 | X | |
| MW01S | 8.1 | X | |
| MW02S | 8.0 | X | |
| MW02M | 30.0 | X | |
| MW02D | 69.8 | X | |
| MW03S | 8.9 | X | |
| MW04S | 14.0 | X | |
| MW04D | 45.5 | X | |
| MW04B | 77.0 | X | |
| MW05S | 8.0 | X | X |
| MW06S | 9.0 | X | |
| MW07S | 7.8 | X | |
| MW07D | 58.0 | X | |
| MW08S | 8.5 | X | |
| MW09S | 10.0 | X | |
| MW10D | 45.0 | X | |
| MW10B | 85.0 | X | |
| MW11S | 25.0 | X | |
| MW11M | 42.0 | X | |
| MW11B | 89.5 | X | |
| MW12D | 44.0 | X | |
| MW12B | 102.5 | X | |
| MW13S | 14.0 | X | |
| MW13D | 45.5 | X | |
| MW13B | 80.0 | X | |
| MW14M | 34.0 | X | |
| MW15D | 53.1 | X | |

# 6.0 FIGURES

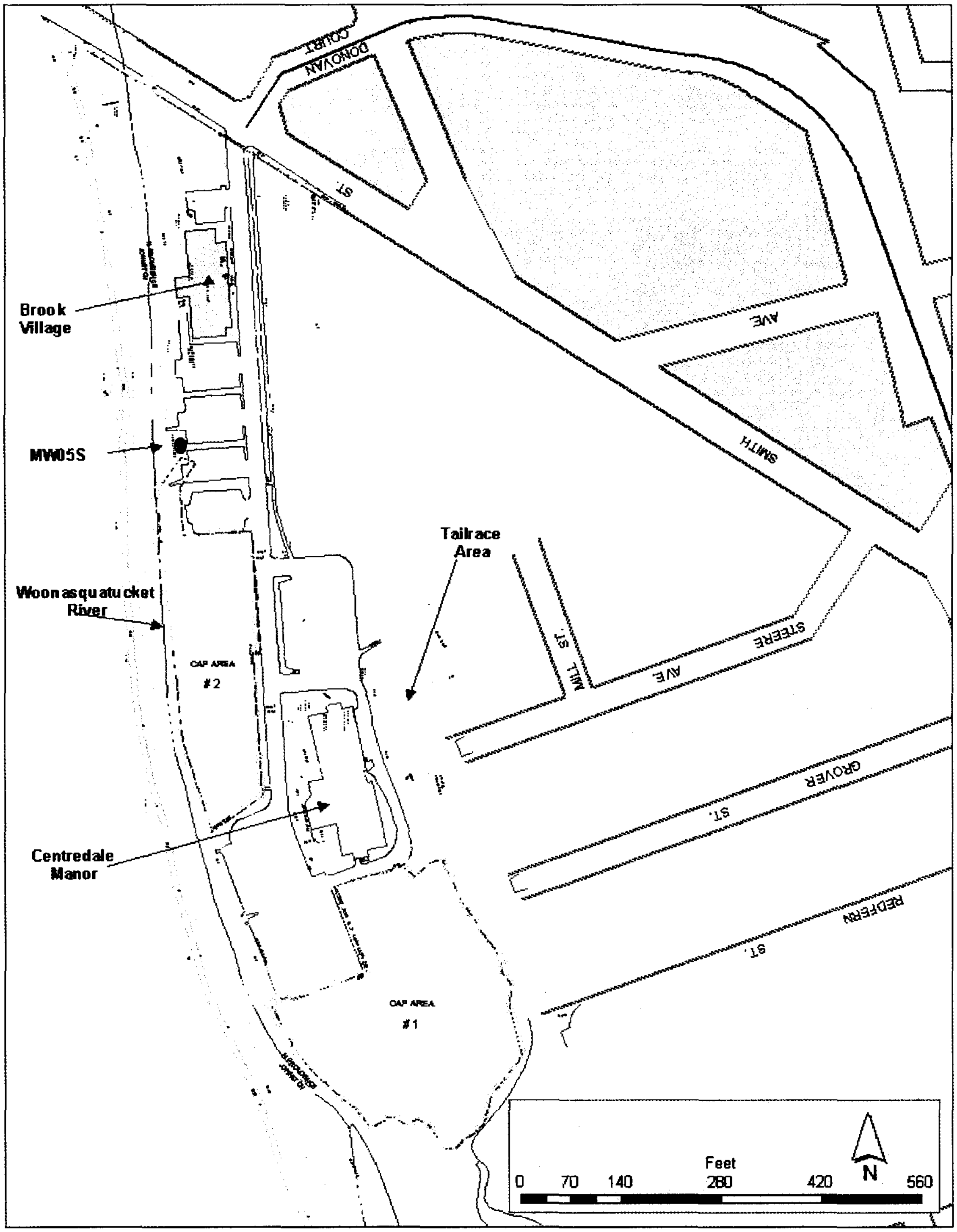


**Figure 1. Source Area Features.**

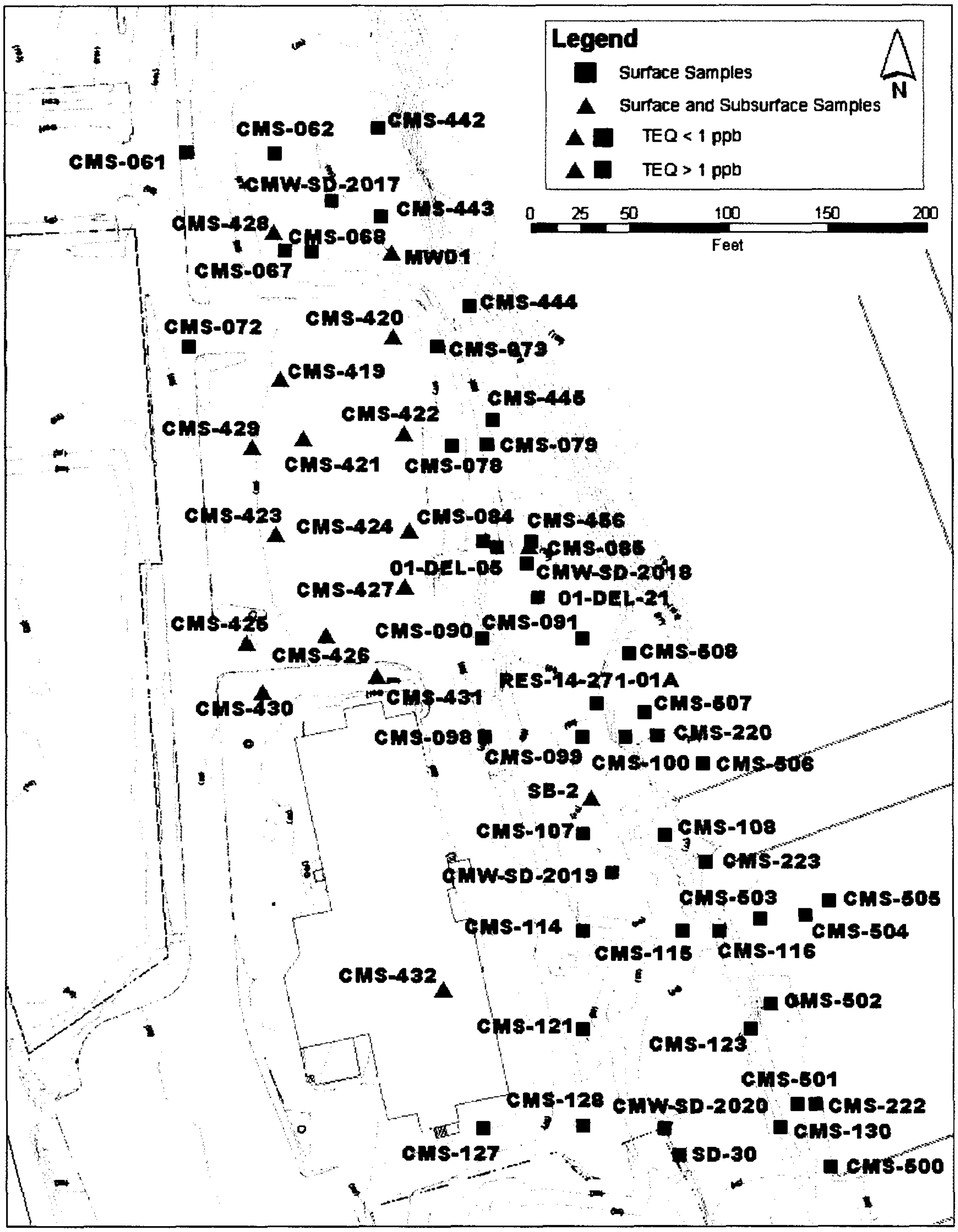


Figure 2. Previous Tailrace Boring Locations.

Original includes color coding.

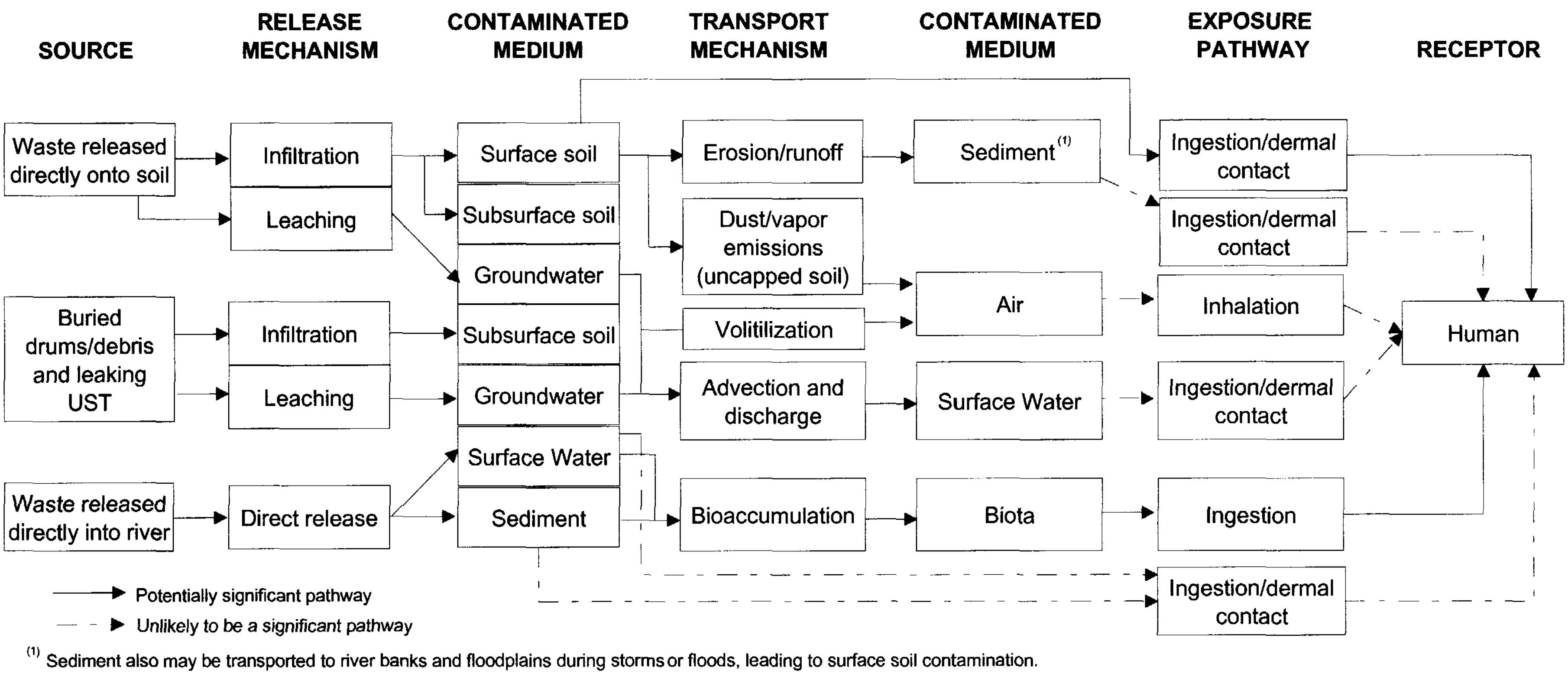


**Figure 3. Human Health Conceptual Site Model for the Centredale Manor Restoration Project Site.**

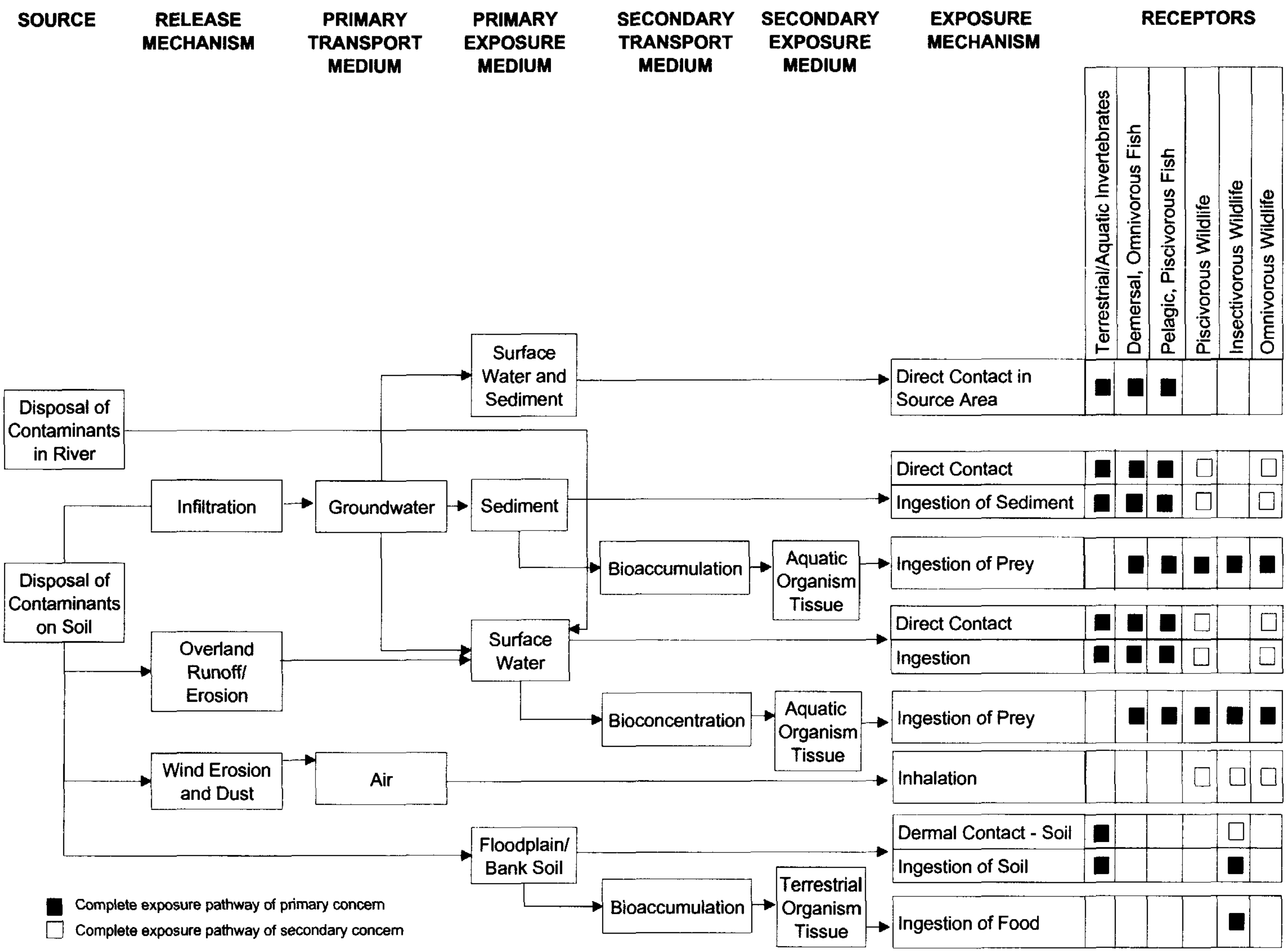


Figure 4. Ecological Conceptual Site Model for the Centredale Manor Restoration Project Site (from Harding ESE, 2001).

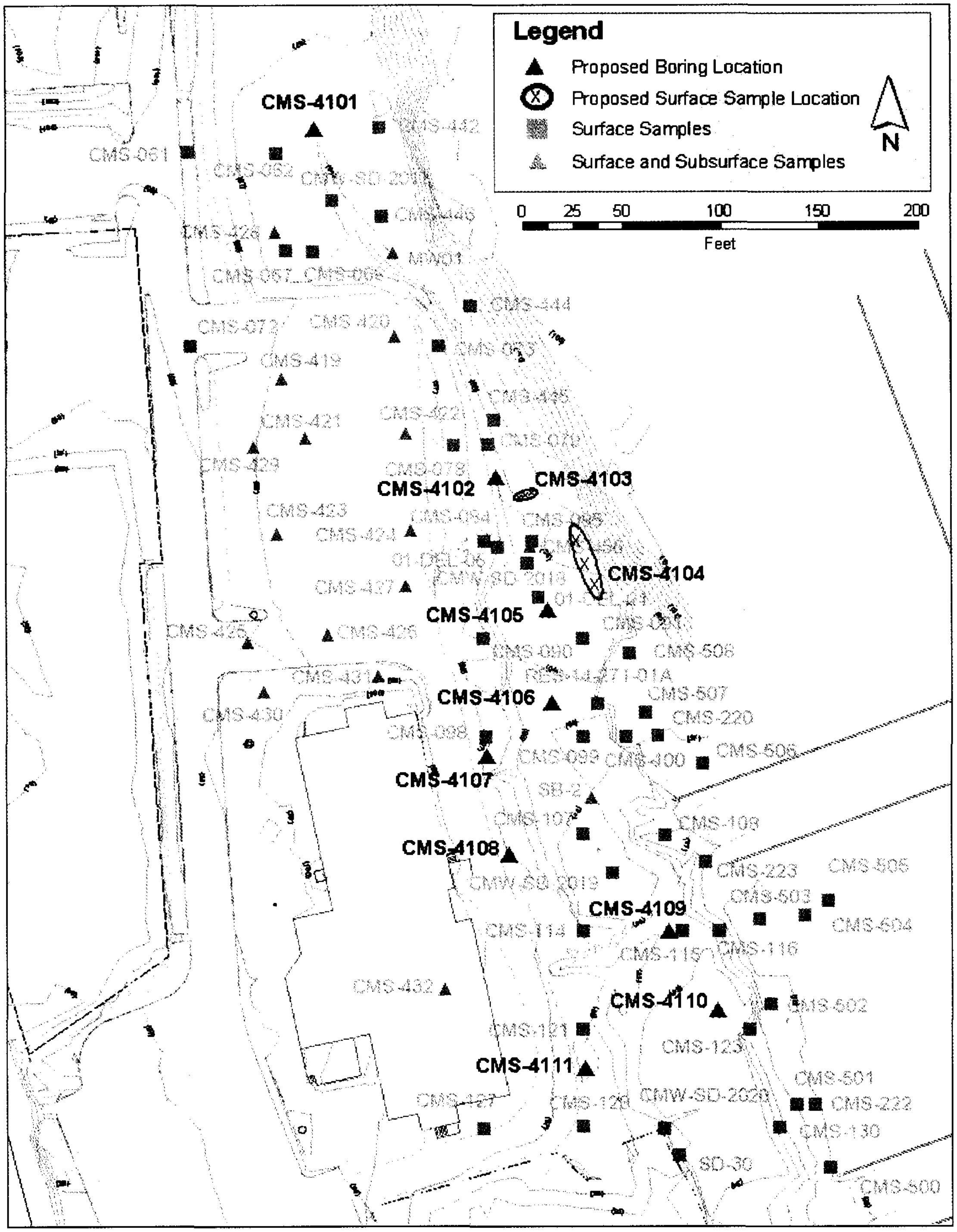


**Figure 5. Boring Locations in Tailrace.**

Original includes color coding.

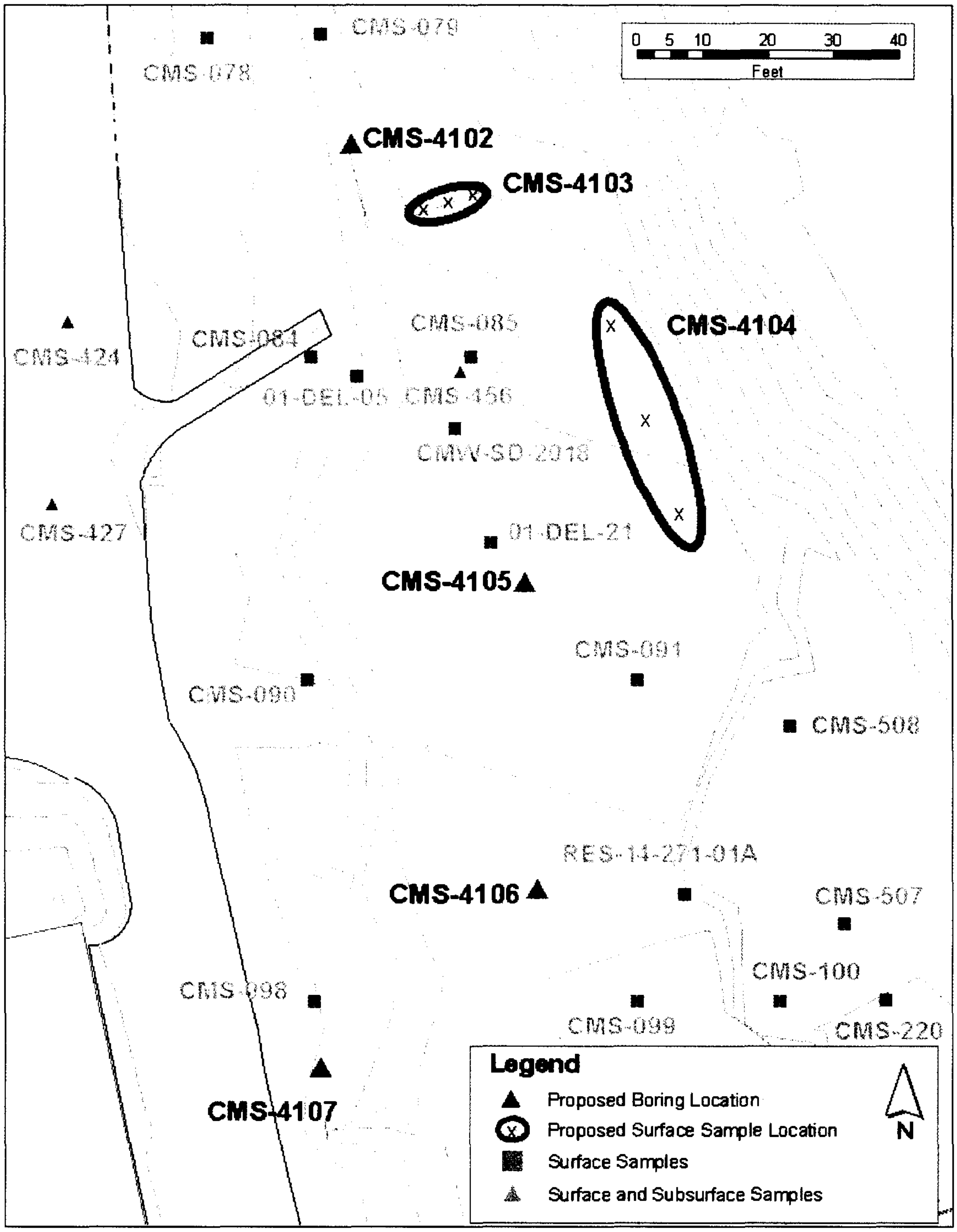


**Figure 6. Detailed Map of Soil Sample Locations CMS-4102 through CMS-4107.**

Original includes color coding.

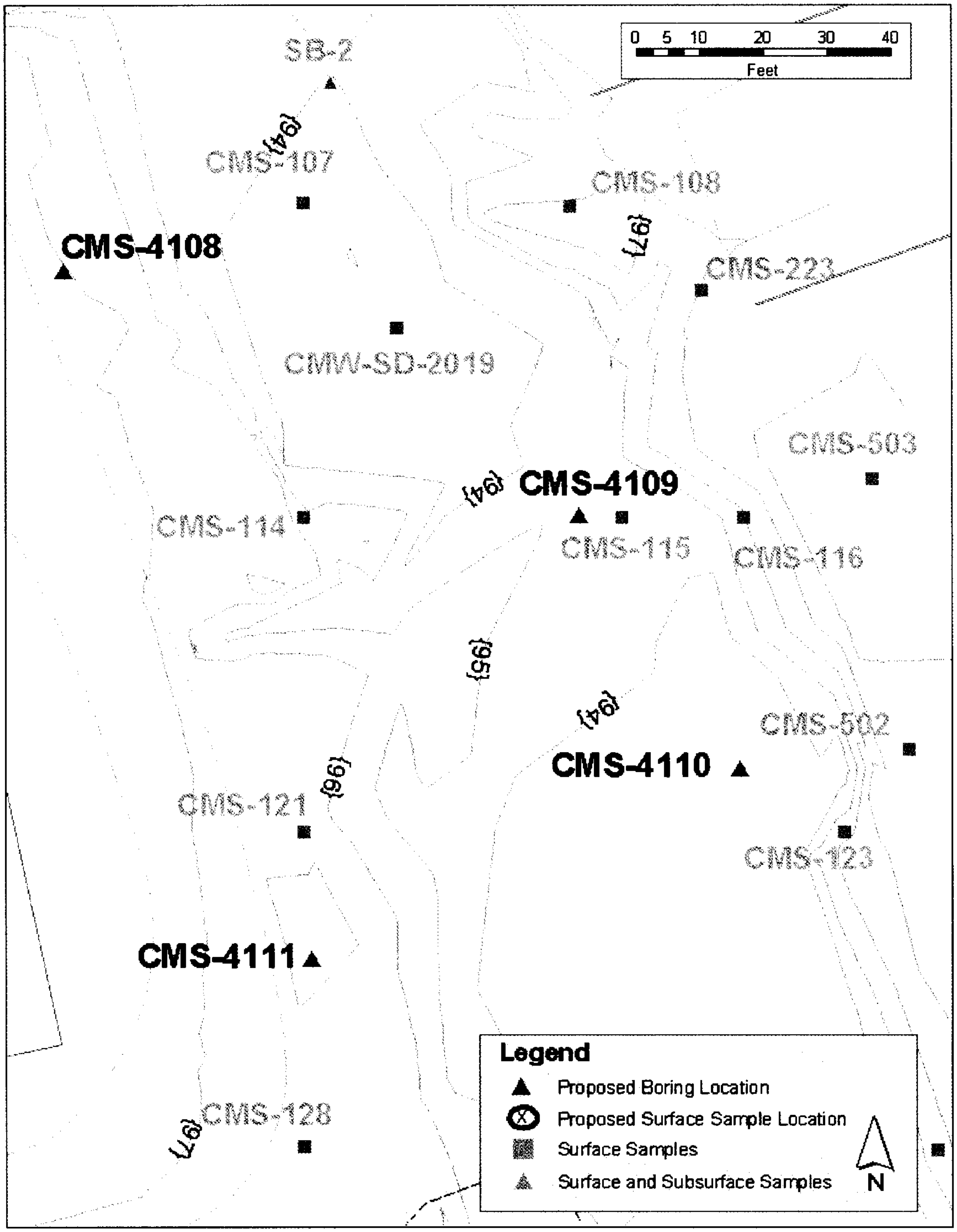


**Figure 7. Detailed Map of Soil Sample Locations CMS-4108 through CMS-4111.**

Original includes color coding.

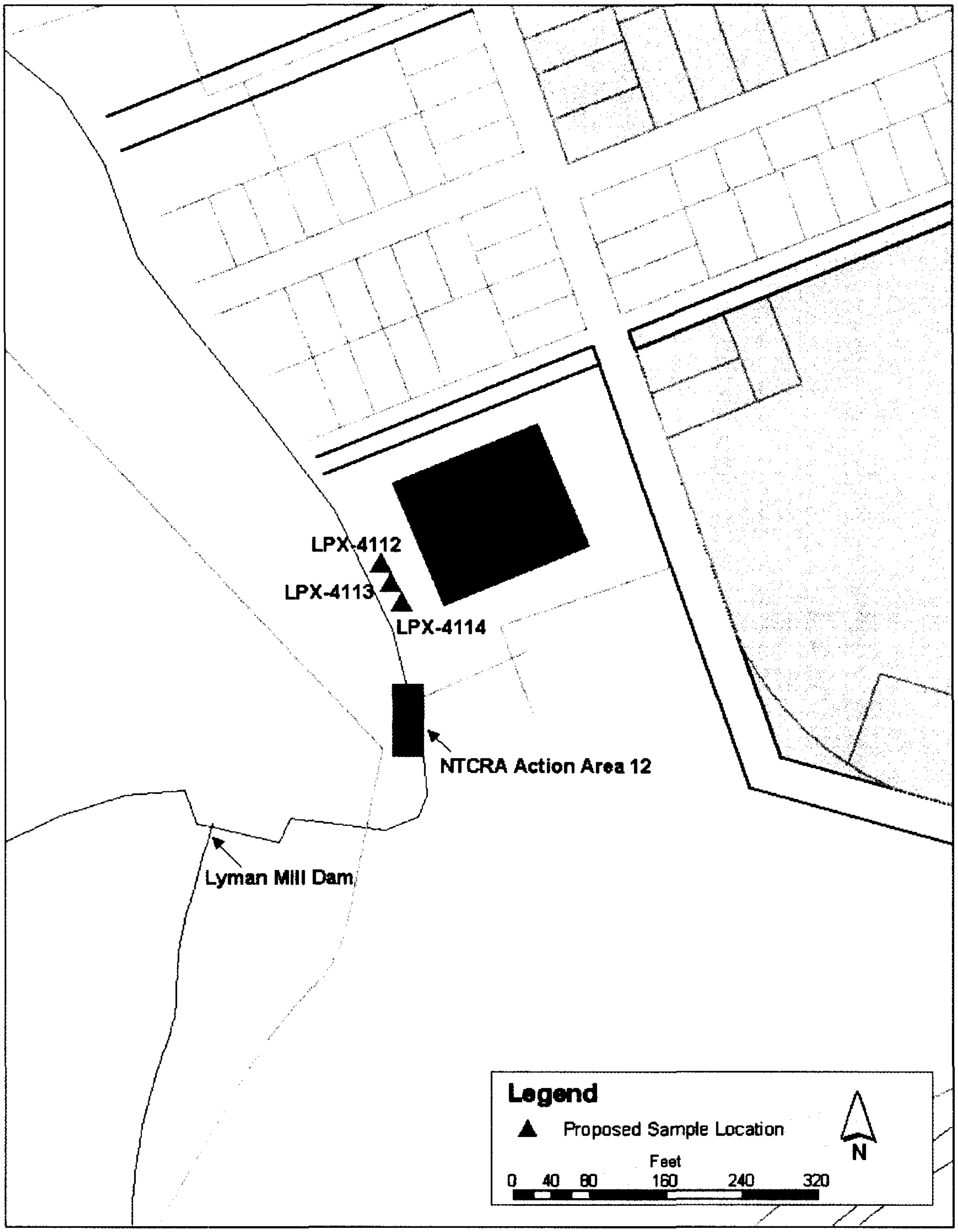


**Figure 8. Soil Sample Locations at the John E. Fogarty Center**

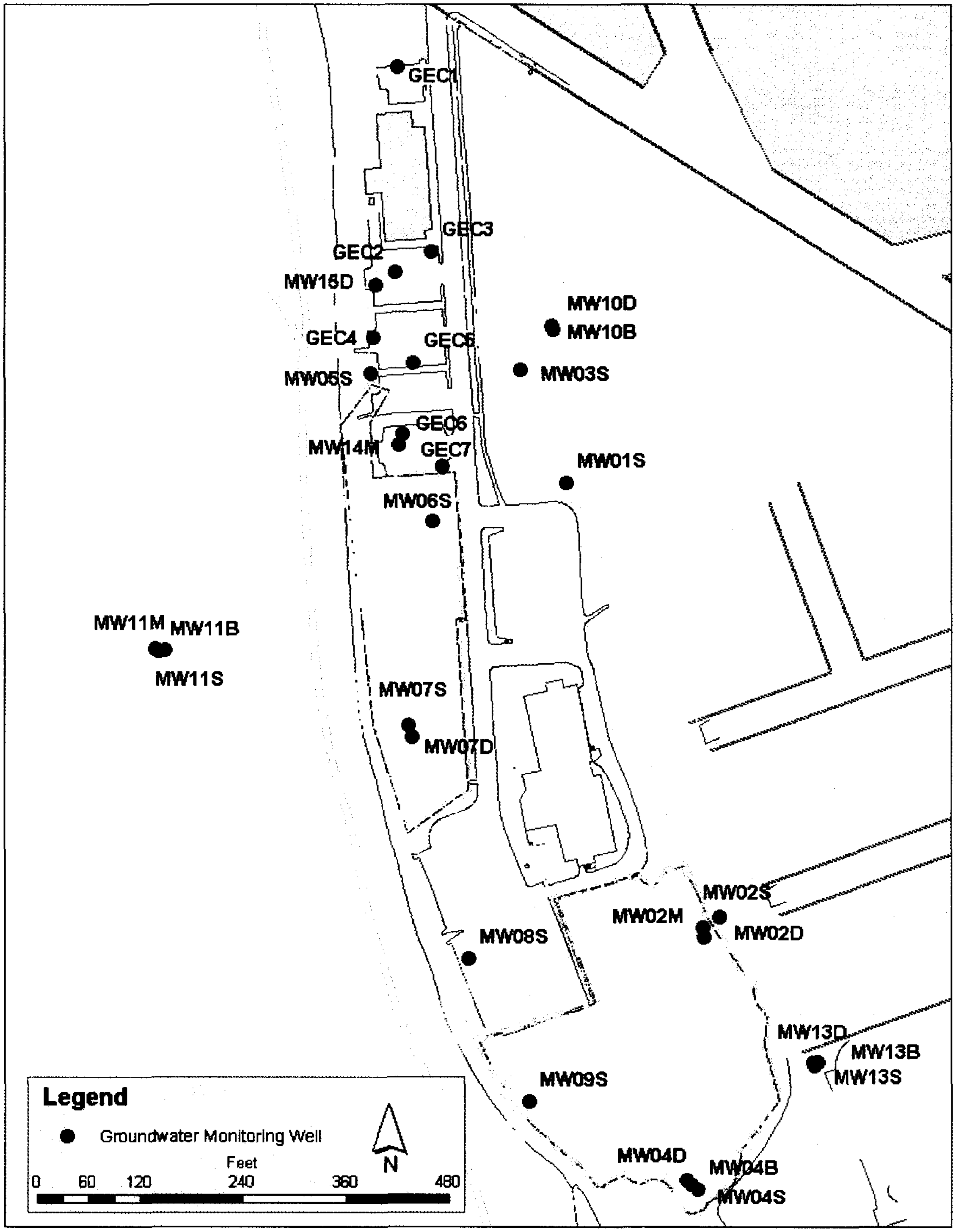


**Figure 9. Monitoring Well Locations.**