Centredale
3-7
206724

Battelle
The Business *of* Innovation
Duxbury Operations
397 Washington Street
Duxbury, Massachusetts 02332
Telephone 781-934-0571
Fax: 781-934-2124

SDMS DocID 206724

July 26, 2004

Ms. Beverly Lawrence
U.S. Army Corps of Engineers, New England District
696 Virginia Road
Concord, MA 01742-2751

CONTRACT NO. DACW33-01-D-0004
DELIVERY ORDER: 01
SUBMITTAL OF DELIVERABLES – Final Technical Memorandum, Approach for Developing a Long-term Remedy for Source Area Soils, Centredale Manor Restoration Project Superfund Site

Dear Ms. Lawrence:

Enclosed please find four (4) copies of the subject Final Technical Memorandum for the Centredale Manor Restoration Project Superfund Site. This document has been finalized in response to USEPA review comments. If you have any questions regarding this document, please contact Deirdre Dahlen at (781) 952-5253 or Ms. Patty White at (781) 952-5279.

Sincerely,

Deirdre T. Dahlen

Deirdre Dahlen
Project Manager

Lisa Lefkovitz
Program Manager

encl.

cc: A. Krasko, USEPA (3 copies)
C. Rosiu, USEPA
C. Vu, USEPA
A. Beliveau, USEPA
P. Cook, USEPA/EERL Duluth
L. Maccarone, RIDEM

Superfund Records Center
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US ARMY CORPS
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New England District

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July 2004

Final Technical Memorandum

Approach for Developing a Long-term Remedy for Source Area Soils

Centredale Manor Restoration Project Superfund Site

North Providence, Rhode Island

FINAL TECHNICAL MEMORANDUM

Approach for Developing a Long-term Remedy for Source Area Soils

Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island

CONTRACT NO. DACW33-01-D-0004
DELIVERY ORDER NO. 01

Submitted to:

Department of the Army
U.S. Army Corps of Engineers
New England District

July 2004

Prepared by:

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

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ABBREVIATIONS AND ACRONYMS

BERA	Baseline ecological risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
FS	Feasibility Study
NAPL	Non-aqueous phase liquid
NPL	National Priorities List
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene (perchloroethene)
PRG	Preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
SARA	Superfund Amendments and Reauthorization Act of 1986
SPLP	Synthetic Precipitation Leaching Procedure
SVOC	Semi-volatile organic compound
TCDD	Tetrachlorodibenzo-p-dioxin
TCE	Tetrachloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-critical removal action
TEQ	Toxic Equivalency Quotient
TPH	Total Petroleum Hydrocarbon
TSCA	Toxic Substance Control Act
UCL	Upper Concentration Limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
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 Superfund Site (hereafter referred to as the site) located in North Providence, Rhode Island. This technical memorandum presents the recommended approach for developing a long-term remedy for contaminated soils located in the main part of the site (i.e., the source area). The source area is located at 2072 and 2074 Smith Street (Route 44) in North Providence, Rhode Island (Figure 1) and encompasses approximately 9 acres.

1.1 Background

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. 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).

Contamination at the source area is being addressed in two stages: immediate (removal) actions, and long term (remedial) actions. A time-critical removal action (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 (Cap Area #1) in a formerly wooded area immediately south of the Centredale Manor parking lot (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 Area #2) between the Woonasquatucket River and the Centredale Manor building (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 along the western edge of the cap to reduce erosion.
- Placement of rip rap along the eastern bank of the Woonasquatucket River from the Brook Village apartments to the south end of Cap Area #1 to isolate contaminated soils and reduce erosion.

Another TCRA was performed in 2003-2004 to minimize the potential for the erosion of contaminated soils and sediments in the tailrace on the east side of the source area. The TCRA activities included soil grading within the tailrace, construction of a permeable protective cap over contaminated soils and

sediments, installation of a precast modular storm water control structure at the terminus of a storm drain at the north end of the tailrace, and construction of a drainage swale along the length of the capped area.

The purpose of the interim caps is to minimize human exposure to contaminated soils and prevent soil erosion and transport. 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.

1.2 Objectives

The objectives of this technical memorandum are to 1) compare soil and groundwater sample data from the source area to applicable regulatory criteria; 2) identify the most important contaminant transport and human health and ecological exposure pathways, and 3) recommend an approach for developing a long-term in situ remedy that will address the most important transport and exposure pathways. Although excavation and off-site disposal of residual waste and contaminated soils also will be evaluated in the FS, it is expected that this approach would pose an unacceptable potential human health risk to residents from exposure to contaminants during excavation activities.

1.3 Overview of Rhode Island Remediation Regulations

In this memorandum, the relevant Rhode Island Department of Environmental Management (RIDEM) Remediation Regulations (RIDEM, 1993) are reviewed, and site data are compared with applicable standards. Section 8.02 of the RIDEM Remediation Regulations states that soil contaminated as a result of a release of hazardous materials must be remediated in a manner that meets the direct exposure and leachability criterion for each hazardous substance present, as established in the regulations. Because the Centredale Manor site is used for residential purposes, the residential direct exposure criteria are applicable. Method 1 residential direct exposure criteria are listed in Table 1. These criteria must be applied to soils throughout the vadose zone in accordance with Rule 8.02.A.

Leachability criteria also apply to vadose zone soils. The leachability criteria are intended to ensure protection of the designated groundwater classification. The groundwater underlying and downgradient of the Centredale Manor site is classified as GB; therefore, the GB leachability criteria apply to site soils as long as application of these criteria does not contribute to actual or potential adverse impacts to surface water and/or sediment. GB leachability criteria are established for VOCs and PCBs only, and are provided in Table 1. Leachability criteria for inorganics, as established through the Toxicity Characteristic Leaching Procedure (TCLP) or Synthetic Precipitation Leaching Procedure (SPLP), only apply to GA groundwater areas.

Rule 8.03 states that groundwater contaminated as a result of a release of hazardous materials located in a GB area shall be remediated to a concentration that meets the GB groundwater objectives. GB groundwater objectives are established for VOCs only and are provided in Table 2. Upper concentration limits (UCLs) (Rule 8.07) are concentrations of hazardous substances which, if exceeded, may demarcate a transition between contaminated environmental media and waste in the environment. Conditions exceeding UCLs are as follows: 1) the presence of non-aqueous phase liquids (NAPL) in any environmental medium; 2) >30,000 parts per million (ppm) total petroleum hydrocarbons (TPH) in soil; 3) >10,000 ppm of any hazardous substance in soil; and 4) concentrations exceeding UCLs in GB groundwater that protect against potential explosive conditions due to the volatilization of hazardous substances in groundwater to structures where human exposures cannot be reasonably expected to occur (Table 2).

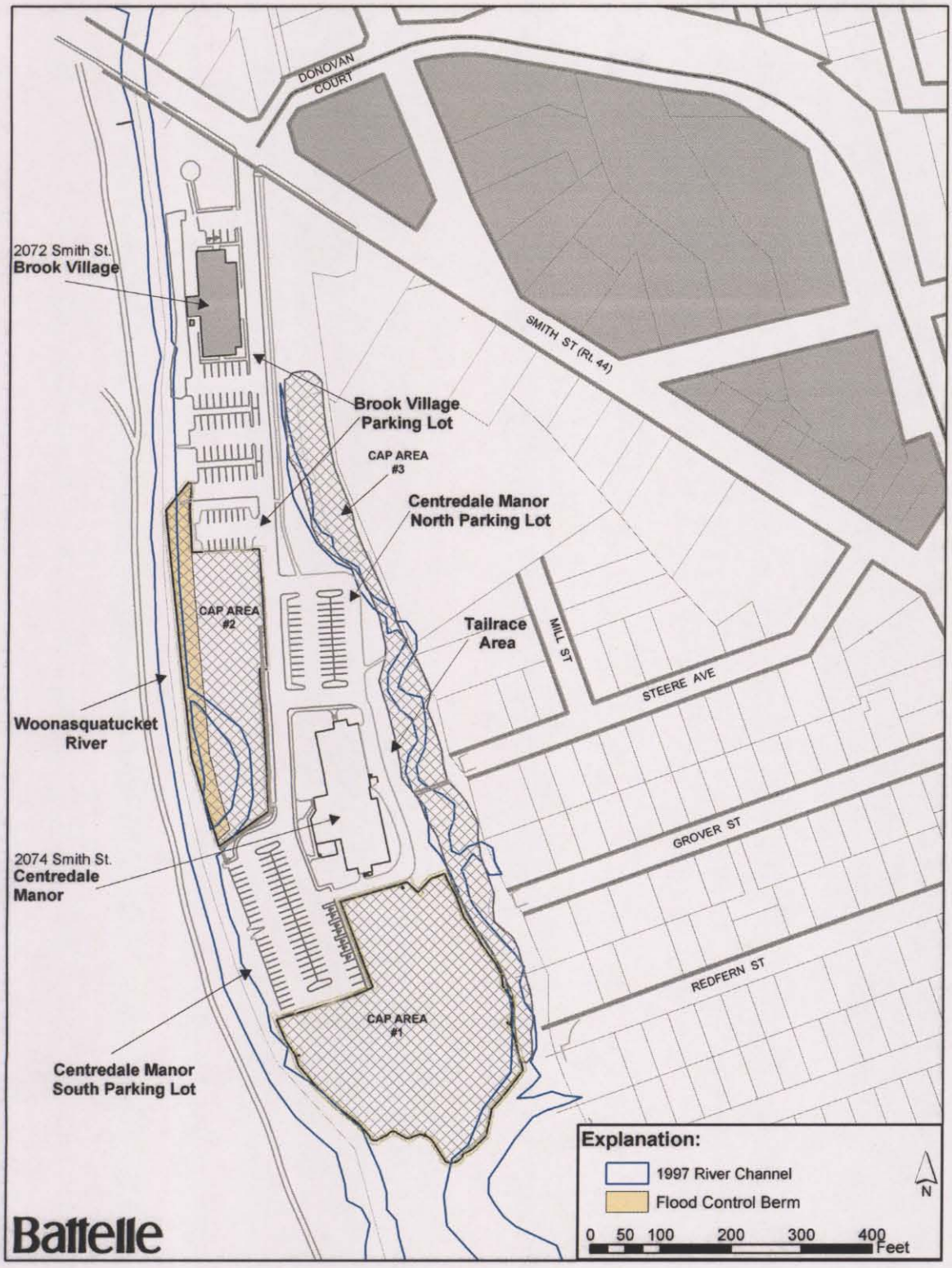

Figure 1. Source Area Features

Table 1. Rhode Island Residential Direct Exposure Criteria and GB Leachability Criteria.

Substance	Residential Direct Exposure Criteria (mg/kg)	GB Leachability Criteria (mg/kg)
Volatile Organic Compounds		
Acetone	7,800	-
Benzene	2.5	4.3
Bromodichloromethane	10	-
Bromoform	81	-
Bromomethane	0.8	-
Carbon tetrachloride	1.5	5.0
Chlorobenzene	210	100
Chloroform	1.2	-
Dibromochloromethane	7.6	-
Dibromochloropropane (DBCP)	0.5	-
Dichloroethane (1,1-)	920	-
Dichloroethane (1,2-)	0.9	2.3
Dichloroethene (1,1-)	0.2	0.7
Dichloroethene (cis-1,2-)	630	60
Dichloroethene (trans-1,2-)	1,100	92
Dichloropropane (1,2)	1.9	70
Ethyl benzene	71	62
Ethylene dibromode (EDB)	0.01	-
Isopropyl benzene	27	-
Methyl ethyl ketone	10,000	-
Methyl isobutyl ketone	1200	-
Methyl-tert-butyl-ether (MTBE)	390	100
Methylene chloride	45	-
Styrene	13	64
Tetrachloroethane,1,1,1,2	2.2	-
Tetrachloroethane,1,1,2,2	1.3	-
Tetrachloroethene (PCE)	12	4.2
Toluene	190	54
Trichloroethane, 1,1,1-	540	160
Trichloroethane, 1,1,2-	3.6	-
Trichloroethene (TCE)	13	20
Vinyl chloride	0.02	-
Xylenes (Total)	110	-

Table 1. Continued

Substance	Residential Direct Exposure Criteria (mg/kg)	GB Leachability Criteria (mg/kg)
Semivolatile Organic Compounds		
Acenaphthene	43	-
Acenaphthylene	23	-
Anthracene	35	-
Benzo(a)anthracene	0.9	-
Benzo(a)pyrene[a]	0.4	-
Benzo(b)fluoranthene	0.9	-
Benzo(g,h,i)perylene	0.8	-
Benzo(k)fluoranthene	0.9	-
Biphenyl, 1,1-	0.8	-
Bis(2-ethylhexyl)phthalate	46	-
Bis(2-chloroethyl)ether	0.6	-
Bis(2-chloroisipropyl)ether	9.1	-
Chloroaniline, 4- (p-)	310	-
Chlorophenol, 2-	50	-
Chrysene	0.4	-
Dibenzo(a,h)anthracene[a]	0.4	-
Dichlorobenzene, 1,2- (o-DCB)	510	-
Dichlorobenzene, 1,3- (m-DCB)	430	-
Dichlorobenzene, 1,4- (p-DCB)	27	-
Dichlorobenzidine, 3,3-	1.4	-
Dichlorophenol, 2,4-	30	-
Diethyl phthalate	340	-
Dimethyl phenol, 2,4-	1,400	-
Dimethyl phthalate	1,900	-
Dinitrophenol, 2,4-	160	-
Dinitrotoluene, 2,4-	0.9	-
Fluoranthene	20	-
Fluorene	28	-
Hexachlorobenzene	0.4	-
Hexachlorobutadiene	8.2	-
Hexachloroethane	46	-
Indeno(1,2,3-cd)pyrene	0.9	-
Methyl naphthalene, 2-	123	-
Naphthalene	54	-
Pentachlorophenol	5.3	-
Phenanthrene	40	-

Table 1. Continued

Substance	Residential Direct Exposure Criteria (mg/kg)	GB Leachability Criteria (mg/kg)
Phenol	6,000	-
Pyrene	13	-
Trichlorobenzene, 1,2,4-	96	-
Trichlorophenol, 2,4,5-	330	-
Trichlorophenol, 2,4,6-	58	-
Pesticides/PCBs		
Chlordane	0.5	-
Dieldrin	0.04	-
Polychlorinated biphenyls (PCBs)[b]	10	10
Inorganics		
Antimony	10	-
Arsenic[c]	1.7	-
Barium	5,500	-
Beryllium[c]	0.4	-
Cadmium	39	-
Chromium III (Trivalent)	1,400	-
Chromium VI (Hexavalent)	390	-
Copper	3,100	-
Cyanide	200	-
Lead[d]	150	-
Manganese	390	-
Mercury	23	-
Nickel	1,000	-
Selenium	390	-
Silver	200	-
Thallium	5.5	-
Vanadium	550	-
Zinc	6,000	-

[a] Estimated quantitation limit
[b] Direct exposure criteria for PCBs consistent with the Toxic Substance Control Act (TSCA)
[c] *Background Levels of Priority Pollutant Metals In Rhode Island Soils,* T. O'Connor, RIDEM
[d] Direct exposure criteria for Lead consistent with the Rhode Island Department of Health *Rules and Regulations for Lead Poisoning Prevention* [R23-24.6-PB], as amended.

Table 2. GB Groundwater Criteria and Upper Concentration Levels.

Substance	GB Groundwater Objective (mg/L)	GB Groundwater UCL (mg/L)
Benzene	0.14	18
Carbon tetrachloride	0.07	-
Chlorobenzene	3.2	56
Dibromomchloropropane (DBCP)	0.0002	-
Dichloroethane (1,2-)	0.11	670
Dichloroethylene (1,1-)	0.007	23
Dichloroethylene (cis-1,2-)	2.4	69
Dichloroethylene (trans-1,2-)	2.8	79
Dichloropropane (1,2-)	3.0	140
Ethylbenzene	1.6	16
Styrene	2.2	50
Methyl Tertiary Butyl Ether (MTBE)	5.0	-
Tetrachloroethene (PCE)	0.15	-
Toluene	1.7	21
Trichloroethane (1,1,1-)	3.1	68
Trichloroethene (TCE)	0.54	87

2.0 RESIDENTIAL DIRECT EXPOSURE CRITERIA

Analytical results for soil samples collected from the Centredale Manor source area were extracted from the project database and compared to Method 1 residential direct exposure criteria. Non-detected results with detection limits that were higher than the direct exposure criteria were excluded from the analysis. Results for samples collected from the 0-5 ft depth interval, which is approximately the average thickness of the vadose zone, were included in the analysis.

Dioxin is the primary contaminant of concern at the site. Direct exposure and leachability criteria for dioxin have not been established by RIDEM. Therefore, site data were compared to 1 part per billion (ppb) dioxin as a toxic equivalency quotient (TEQ), which is generally used as a preliminary remediation goal (PRG) for residential surface soil (USEPA, 1998).

Table 3 summarizes the chemicals detected in vadose zone soil samples at concentrations exceeding the residential direct exposure criteria. Results for each contaminant type are presented below.

Table 3. Comparison of Results for Source Area Vadose Zone Soil Samples to RI Residential Direct Exposure Criteria.

Substance	Residential Direct Exposure Criteria (mg/kg)	No. Source Area Sample Results (0-5 ft interval)[a]	No. Detected Results > Criterion[b]	Average Concentration > Criterion (mg/kg)[c]
Volatile Organic Compounds				
Benzene	2.5	93	7	155
Chlorobenzene	210	90	4	470
Dichloroethane (1,2-)	0.9	87	1	1.7
Ethyl benzene	71	90	1	81
Tetrachloroethene (PCE)	12	91	6	491
Toluene	190	90	1	430
Trichloroethene (TCE)	13	90	4	773
Vinyl chloride	0.02	89	6	0.61
Xylenes (Total)	110	85	3	263
Semivolatile Organic Compounds				
Benzo(a)anthracene	0.9	122	40	2.3
Benzo(a)pyrene	0.4	118	63	1.6
Benzo(b)fluoranthene	0.9	122	46	2.7
Benzo(g,h,i)perylene	0.8	122	23	1.8
Benzo(k)fluoranthene	0.9	122	25	2.6
Chrysene	0.4	124	75	1.9
Dibenzo(a,h)anthracene	0.4	121	12	1.1
Dichlorobenzene, 1,2- (o-DCB)	510	165	2	2150
Dichlorobenzene, 1,4- (p-DCB)	27	165	3	34
Fluoranthene	20	124	1	24
Indeno(1,2,3-cd)pyrene	0.9	122	23	1.9
Naphthalene	54	176	1	84
Pentachlorophenol	5.3	123	1	18
Pyrene	13	124	4	18
Trichlorobenzene, 1,2,4-	96	164	2	305
Pesticides/PCBs/Dioxin				
Dieldrin	0.04	122	4	3.7
PCBs (Total Aroclor)	10	313	56	132
Dioxin TEQ[d]	0.001	690	155	0.011
Inorganics				
Antimony	10	108	5	21
Arsenic	1.7	116	86	6.3
Beryllium	0.4	114	62	0.8
Cadmium	39	115	1	180
Lead	150	116	40	569
Manganese	390	115	19	711
Thallium	5.5	114	6	9.6

(a) Some boring locations have more than one sample in the 0-5 ft interval.
(b) Some boring locations have more than one detected result exceeding the RIDEM residential direct exposure criteria in the 0-5 ft interval.
(c) This value represents the average of all samples with detected results that exceeded the RIDEM Residential Direct Exposure Criteria.
(d) No residential direct exposure criteria for dioxin is available; criterion is preliminary remediation goal (PRG) for residential surface soil (USEPA, 1998).

2.1 Volatile Organic Compounds

Six VOCs exceeded the residential direct exposure criteria in more than one sample: benzene, chlorobenzene, tetrachloroethene (also known as perchloroethene [PCE]), trichloroethene (TCE), vinyl chloride, and xylenes. These VOCs are either solvents or fuel-related compounds. The majority of the exceedances occurred in samples from boring locations CMS-417, CMS-419, and MW-05S. These boring locations are in areas that are currently capped or paved. Figure 2 shows the distribution of PCE in vadose zone samples from the source area. PCE was chosen as a representative VOC because it is one of the most frequently detected compounds, and is the only VOC in groundwater (except for TCE in one well) that exceeds the GB groundwater objective (see Section 4.0).

2.2 Semivolatile Organic Compounds

Polynuclear aromatic hydrocarbons (PAHs) slightly exceeded the direct exposure criteria in numerous vadose zone samples across the site. Several SVOCs (i.e., chlorinated benzenes) also exceeded the criteria in several samples.

2.3 Pesticides/PCBs/Dioxin

Dieldrin exceeded the direct exposure criteria in four samples. PCBs exceeded the residential direct exposure criteria of 10 mg/kg in the vadose zone at numerous locations, as shown in Figure 3. The highest PCB concentrations are found under Cap Area #1 and under the Centredale Manor north parking lot. Two of the locations (CMS-428 and CMS-433) are in areas that are not currently capped or paved. The sample from CMS-428 was collected from the 0-1 ft interval and had a total PCB concentration of 14 mg/kg, and the sample from CMS-433 was collected from the 2-3 ft interval and had a PCB concentration of 16 mg/kg.

Table 3 indicates that 155 vadose zone samples from the source area had dioxin TEQ concentrations exceeding 1 ppb. Figure 4 shows the distribution of dioxin in surface soils (0-0.25 ft) across the source area (these data are shown as isoconcentrations because of the higher density of sample points compared with other chemicals). The highest dioxin concentrations in surface soils are found under the two interim soil caps. Dioxin TEQ concentrations exceeded 1 ppb in several locations outside the edge of Cap Area #1 (CMS-159, CMS-167, and CMS-177). Dioxin TEQ concentrations in samples from these borings ranged from 2.1 to 3.4 ppb, with the exception of a 0-1 ft sample from CMS-177, which had a TEQ concentration of 22.6 ppb. One sample location (CMS-098) is in an unpaved area between the Centredale Manor apartment building and the tailrace east of the building. A surface soil sample (0-0.25 ft) from this location had a dioxin TEQ concentration of 28 ppb. All other sample locations with dioxin TEQ concentrations exceeding 1 ppb appear to be in areas that are currently paved or capped.

2.4 Inorganics

Arsenic and beryllium exceeded the direct exposure criteria in numerous samples. It should be noted that the criteria for these metals represent background concentrations for Rhode Island soils. Lead exceeded the residential direct exposure criteria in 40 vadose zone samples south of the Brook Village parking lot, some of which are in areas that are not currently capped or paved. The distribution of lead is shown in Figure 5. Other metals, including antimony, cadmium, manganese and thallium also exceeded the direct exposure criteria, but at a lower frequency compared to lead (Table 3).

3.0 GB LEACHABILITY CRITERIA

Sample data for vadose zone soils were compared with GB leachability criteria for VOCs and PCBs. Non-detected results with detection limits above the leachability criteria were excluded from the analysis. Results for each contaminant type are presented below.

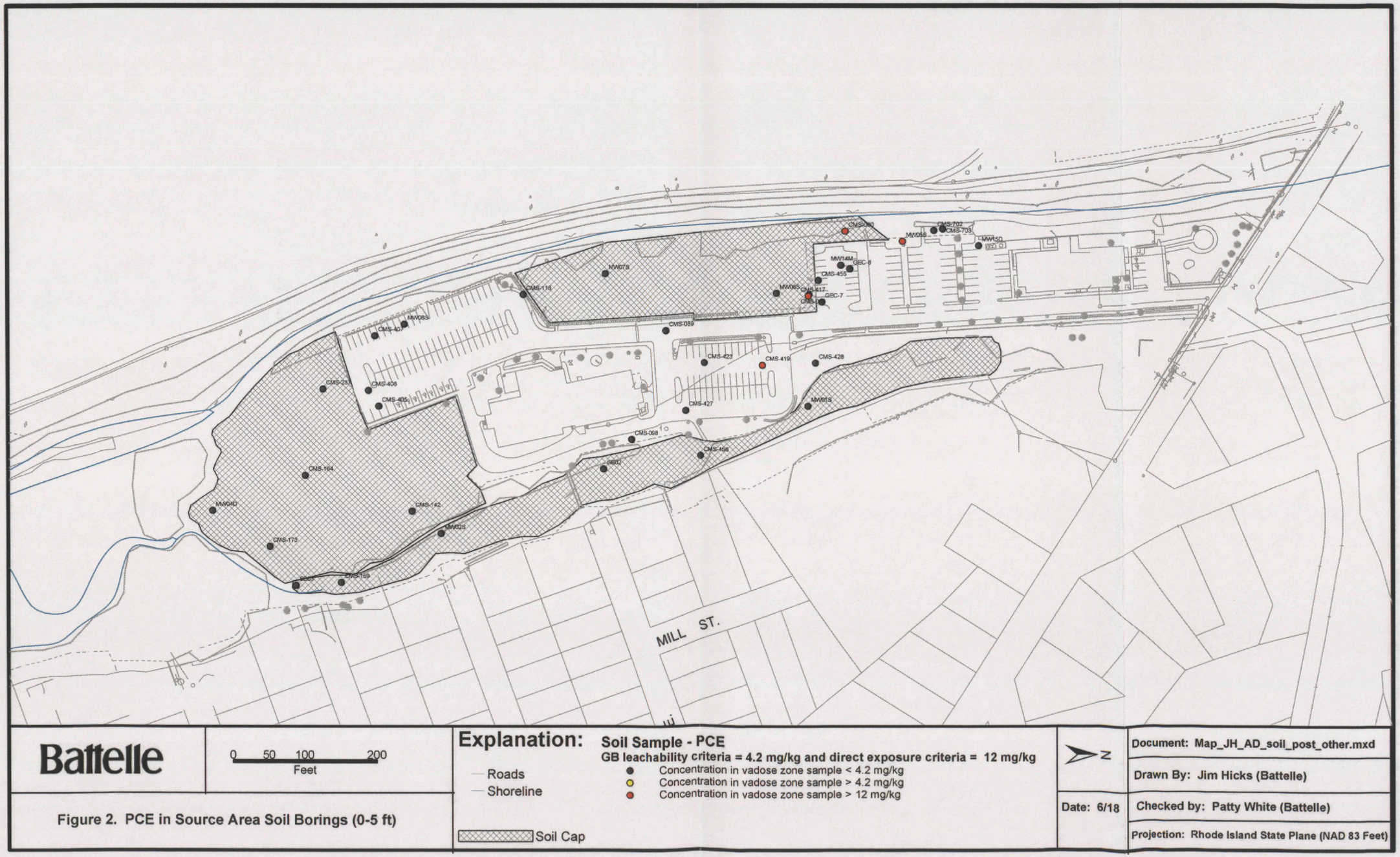

Figure 2. PCE in Source Area Soil Borings (0-5 ft)

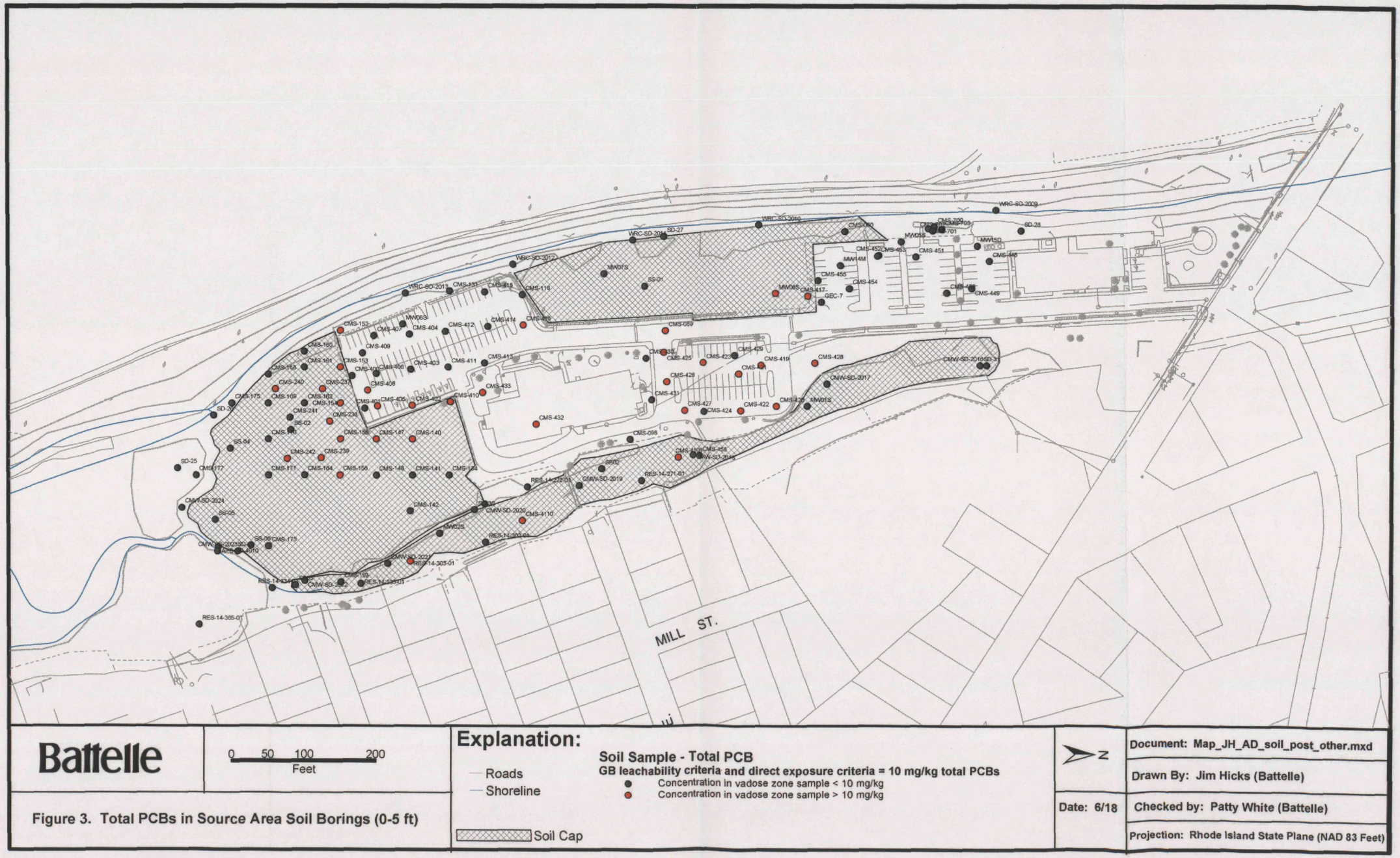

Figure 3. Total PCBs in Source Area Soil Borings (0-5 ft)

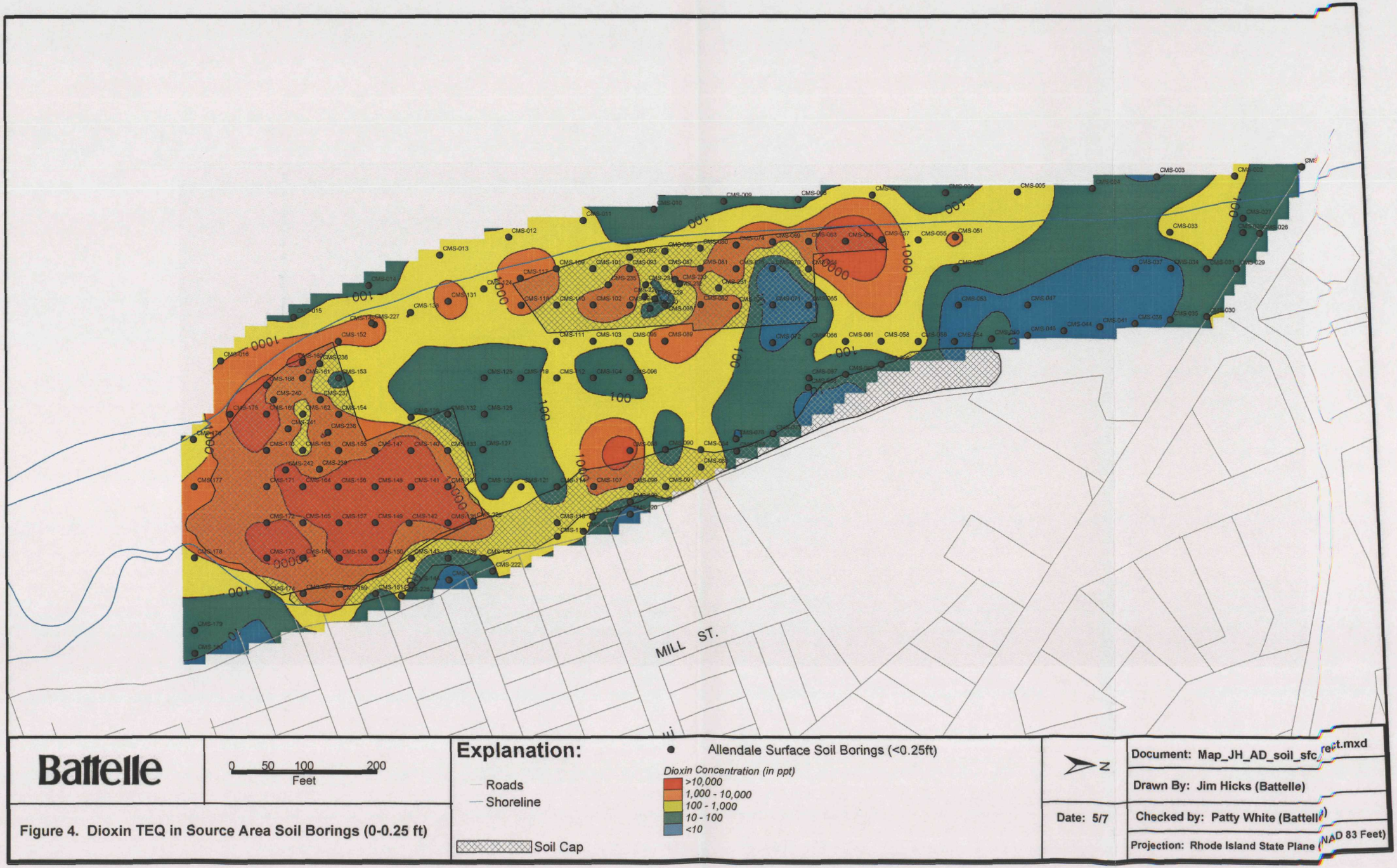

Figure 4. Dioxin TEQ in Source Area Soil Borings (0-0.25 ft)

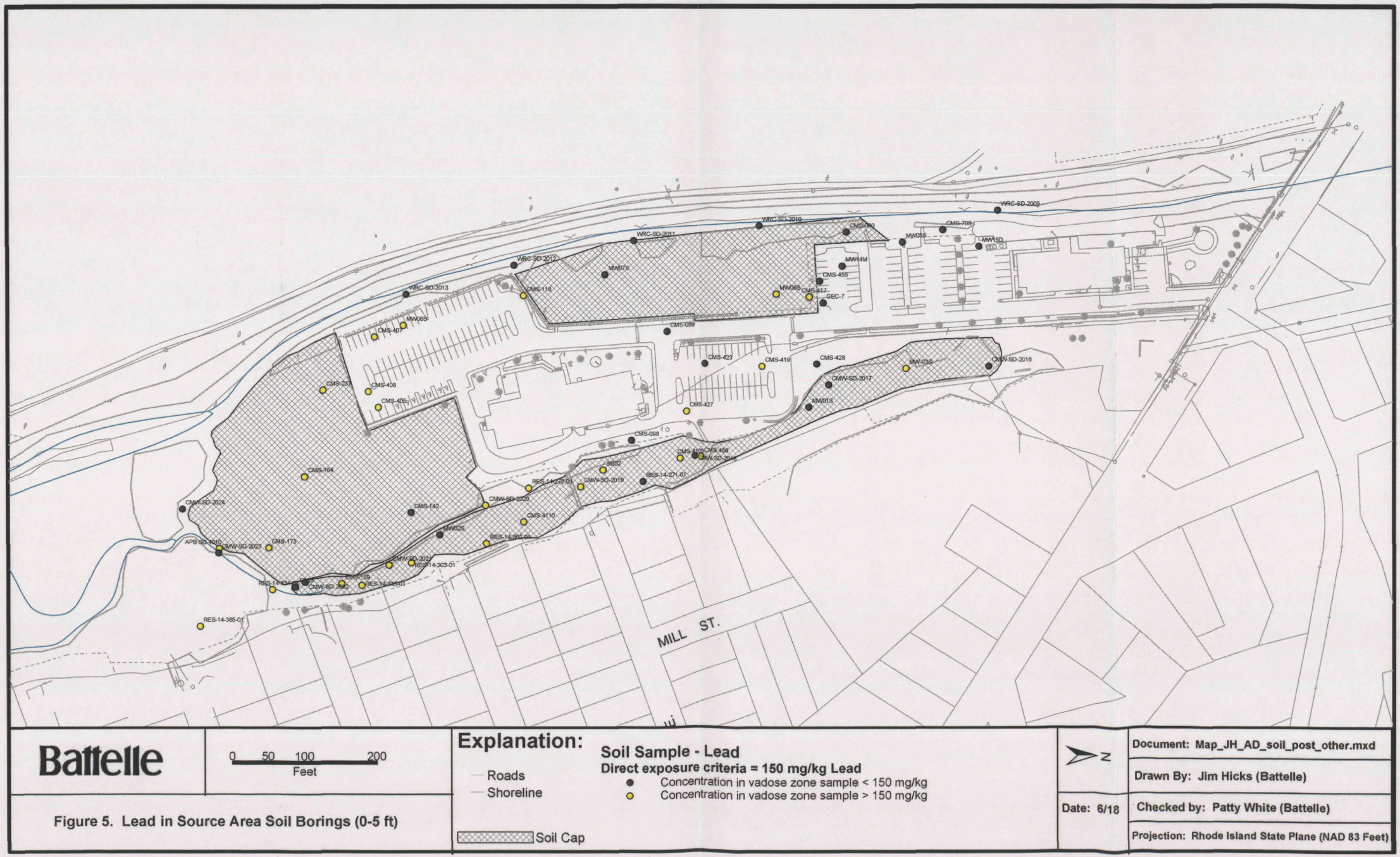

Figure 5. Lead in Source Area Soil Borings (0-5 ft)

3.1 VOCs

Table 4 summarizes the VOCs that exceed GB leachability criteria in vadose zone samples, and the boring locations where they occur. Boring locations are shown in Figure 6. GB leachability criteria for VOCs are exceeded beneath the Brook Village parking lot, and the Centredale Manor north and south parking lots.

Table 4. Boring Locations Where VOC Concentrations in Vadose Zone Samples Exceed GB Leachability Criteria.

Boring ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Sample ID	Parameter	Result (mg/kg)		GB Leachability Criteria (mg/kg)
CMS-060	0	1	GP09-FD	Tetrachloroethene	63	J	4.2
CMS-060	1	2	CMS-060-B	Tetrachloroethene	25	J	4.2
CMS-405	1	2	CMS-405-B	Benzene	140	J	4.3
CMS-405	1	2	GP04-FD	Benzene	83	J	4.3
CMS-405	2	3	CMS-405-C	Benzene	27	J	4.3
CMS-405	3	4	CMS-405-D	Benzene	130	J	4.3
CMS-405	4	5	CMS-405-E	Benzene	66	J	4.3
CMS-408	1	2	CMS-408-B	Benzene	160		4.3
CMS-408	2	3	CMS-408-C	Benzene	480		4.3
CMS-417	0	1	CMS-417-A	Chlorobenzene	360		100
CMS-417	0	1	CMS-417-A	Cis-1,2-dichloroethene	180		60
CMS-417	0	1	CMS-417-A	Tetrachloroethene	820		4.2
CMS-417	0	1	CMS-417-A	Toluene	140		54
CMS-417	0	1	CMS-417-A	Trichloroethene	630		20
CMS-417	1	2	CMS-417-B	Chlorobenzene	1000		100
CMS-417	1	2	CMS-417-B	Cis-1,2-dichloroethene	500		60
CMS-417	1	2	CMS-417-B	Ethylbenzene	81	J	62
CMS-417	1	2	CMS-417-B	Tetrachloroethene	1700		4.2
CMS-417	1	2	CMS-417-B	Toluene	430		54
CMS-417	1	2	CMS-417-B	Trichloroethene	2400		20
CMS-417	2	3	CMS-417-C	Chlorobenzene	220		100
CMS-417	2	3	CMS-417-C	Cis-1,2-dichloroethene	490		60
CMS-417	2	3	CMS-417-C	Tetrachloroethene	9.4	J	4.2
CMS-417	2	3	CMS-417-C	Toluene	110		54
CMS-417	2	3	CMS-417-C	Trichloroethene	34		20
CMS-419	1	2	CMS-419-B	Chlorobenzene	300		100
CMS-419	1	2	CMS-419-B	Cis-1,2-dichloroethene	73		60
CMS-419	1	2	CMS-419-B	Ethylbenzene	68		62
CMS-419	1	2	CMS-419-B	Tetrachloroethene	40		4.2
CMS-419	1	2	CMS-419-B	Toluene	75		54

Table 4. Continued

Boring ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Sample ID	Parameter	Result (mg/kg)		GB Leachability Criteria (mg/kg)
MW05S	4	6	CM-SO-MW05-0406	Tetrachloroethene	300	*J	4.2
MW05S	4	6	CM-SO-MW05-0406	Trichloroethene	26	*J	20

ft bgs feet below ground surface
J Estimated value
* From dilution analysis

3.2 PCBs

The GB leachability criterion for PCBs is the same as the residential direct exposure criterion (10 mg/kg). Figure 3 shows the locations where the leachability criterion is exceeded; primarily beneath Cap Area #1 and the Centredale Manor north parking lot.

4.0 GB GROUNDWATER OBJECTIVES

Table 5 compares VOC concentrations measured in groundwater samples collected in 2002 to levels measured in 2001 and to GB groundwater objectives. Monitoring well locations are shown in Figure 7. These data indicate that contaminant concentrations generally have decreased or remained consistent from 2001 to 2002. All VOC concentrations detected in 2002 were below the GB groundwater objectives except for PCE and TCE in the sample from Well MW-05S, and PCE in the samples from Wells MW-13D and MW-14M. The PCE concentrations in Wells MW-05S and MS-13D have decreased since 2001. However, the PCE concentration in Well MW-14M increased from below detection in 2001 to 1900 µg/L in 2002. This well is in the Brook Village parking lot, south-southeast (downgradient) of Well MW-05S, which has the highest PCE concentration on site. These results suggest that the PCE plume has migrated downgradient from the vicinity of Well MW-05S to Well MW-14M. The lateral extent of this PCE plume is well-defined in shallow groundwater, but is not defined at depth.

A vapor diffusion sampler survey performed by the U.S. Geological Survey in 2000 indicated that VOC-contaminated groundwater is discharging to the Woonasquatucket River in the vicinity of Well MW-05S (USGS, 2000). Lower concentrations of VOCs are discharging to the river at the south end of the site. The draft Baseline Ecological Risk Assessment (BERA; MACTEC, 2003) indicated that VOCs are not having an adverse impact on surface water and sediment quality in the river. However, it is possible that VOC contamination in the vicinity of Well MW-05S has increased dissolved concentrations of dioxin in groundwater, which is subsequently discharging to river. The dioxin (2,3,7,8-TCDD) concentrations measured in groundwater samples from Well MW-05S were 4180 pg/L in 2001, and 1030 pg/L (1460 pg/L in a field duplicate sample) in 2002 (Battelle, 2003).

Dioxin was detected in groundwater samples from eleven other monitoring wells in 2001 at concentrations that were two to three orders of magnitude lower than the concentration measured in the sample from Well MW-05S (TTNUS, 2002). A qualitative assessment of the data indicates no apparent correlation between dissolved dioxin and elevated VOC concentrations in groundwater except at Well MW-05S.

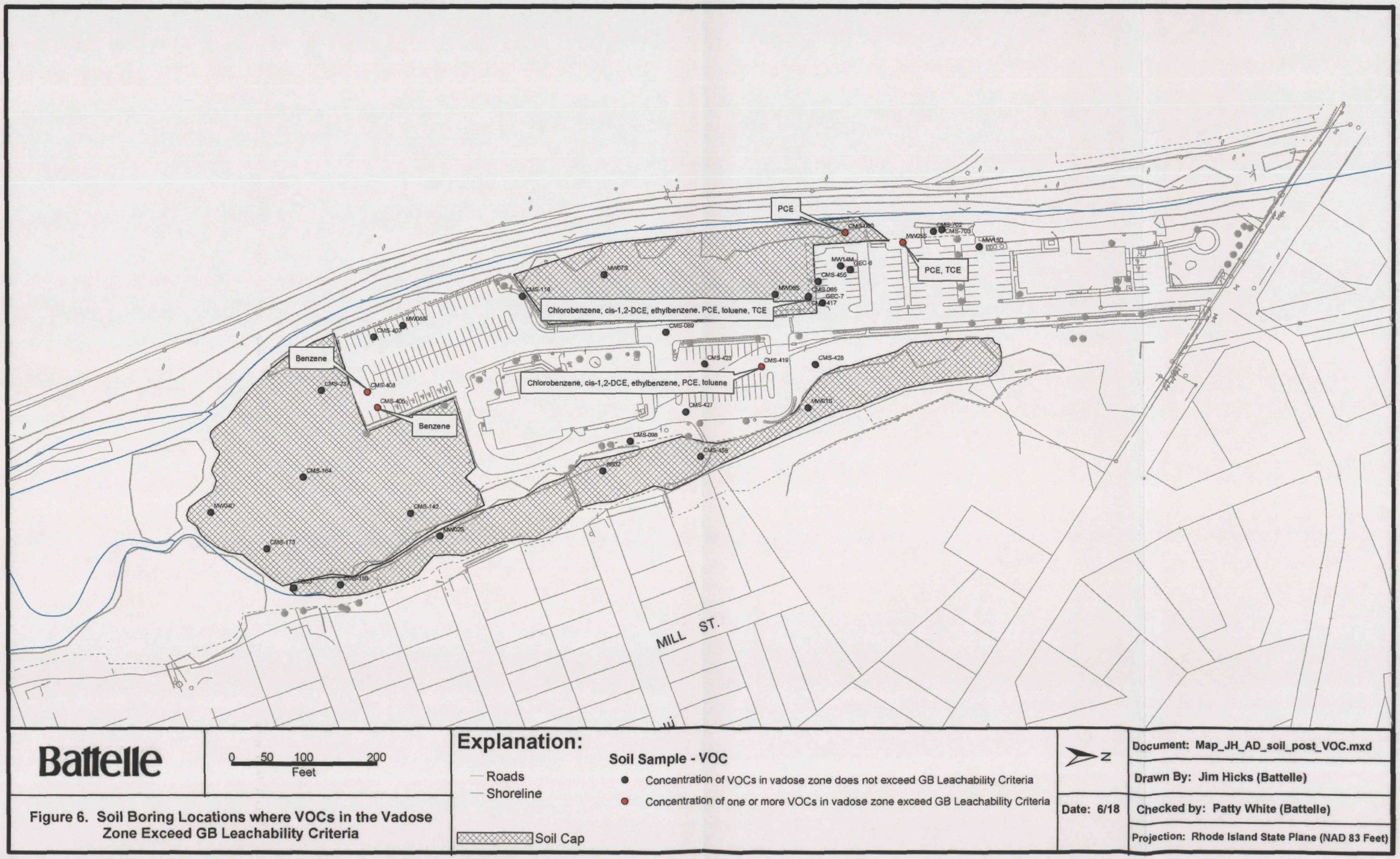

Figure 6. Soil Borings where VOC GB Leachability Criteria are Exceeded in Vadose Zone Samples (0-5 ft)

Table 5. Comparison of Groundwater VOC Concentrations to GB Objectives.

Well ID	Parameter	Spring 2001 (µg/L)	Summer 2001 (µg/L)	Fall 2002 (µg/L)	Fall 2002 Field Duplicate Sample (µg/L)	GB Groundwater Objective [a] (µg/L)	Exceeds GB Groundwater Objective [b]
GEC-4	cis-1,2-Dichloroethene	1 U		2.8		2400	
GEC-5	cis-1,2-Dichloroethene	38 U		21		2400	
GEC-5	Tetrachloroethene (PCE)	2.2		0.86 J		150	
GEC-5	Trichloroethene (TCE)	1.3		0.62 J		540	
GEC-6	Chlorobenzene		10 U	1.5		3200	
GEC-6	cis-1,2-Dichloroethene	10 U	18	5.6		2400	
GEC-6	Tetrachloroethene (PCE)	150	200 *	11		150	
GEC-6	Trichloroethene (TCE)	1 U	10 U	0.74 J		540	
GEC-7	Benzene	1.3		1 U		140	
GEC-7	cis-1,2-Dichloroethene	5.6 U		0.48 J		2400	
GEC-7	Tetrachloroethene (PCE)	11		0.21 J		150	
GEC-7	Trichloroethene (TCE)	2		1 U		540	
MW02D	cis-1,2-Dichloroethene		2 J	12		2400	
MW02D	Tetrachloroethene (PCE)		700 *	73		150	
MW02D	Toluene		10 U	1.8 J		1700	
MW02D	Trichloroethene (TCE)		27	4.2		540	
MW02M	Tetrachloroethene (PCE)		110	110		150	
MW02M	Trichloroethene (TCE)		2 J	1.1 J		540	
MW02S	Benzene	10 U	1 J	1 U		140	
MW02S	Chlorobenzene	10 U	1 J	2.1		3200	
MW04B	Tetrachloroethene (PCE)		63	17		150	
MW04B	Trichloroethene (TCE)		0.9 J	0.39 J		540	
MW04D	Tetrachloroethene (PCE)		64	27		150	
MW04D	Trichloroethene (TCE)		1 J	0.46 J		540	
MW04S	Benzene		2 J	1 U		140	
MW04S	Chlorobenzene		5 J	2.1		3200	
MW04S	cis-1,2-Dichloroethene		7 J	5.9		2400	
MW04S	Tetrachloroethene (PCE)		17 U	4.4		150	
MW04S	Trichloroethene (TCE)		0.8 J	3.2		540	
MW05S	cis-1,2-Dichloroethene		1200 J	1600 J	520 J	2400	
MW05S	Tetrachloroethene (PCE)		61000 *	28000	37000	150	Yes
MW05S	Trichloroethene (TCE)		2500	1800	2200	540	Yes
MW06S	Benzene	5 J	6 J	6.8 J	11	140	
MW06S	Chlorobenzene	100	58	160	190	3200	
MW06S	cis-1,2-Dichloroethene	4 J	4 J	2.8 J	10 U	2400	
MW06S	Ethylbenzene	7 J	10 U	1.2 J	2.7 J	1600	
MW06S	Toluene	5 J	10 U	3.3 J	10 U	1700	
MW06S	Trichloroethene (TCE)	10 U	0.9 J	6 U	10 U	540	

Table 5. Continued.

Well ID	Parameter	Spring 2001 (µg/L)	Summer 2001 (µg/L)	Fall 2002 (µg/L)	Fall 2002 Field Duplicate Sample (µg/L)	GB Groundwater Objective [a] (µg/L)	Exceeds GB Groundwater Objective [b]
MW07D	Tetrachloroethene (PCE)		10 U	10		150	
MW07D	Trichloroethene (TCE)		10 U	0.31 J		540	
MW07S	1,2-Dibromo-3-chloropropane	10 U	7 J	1 U		2	
MW08S	Benzene	6 J	4 J	12 J		140	
MW08S	Chlorobenzene	10	40	25		3200	
MW08S	cis-1,2-Dichloroethene	10 U	10 U	9.3		2400	
MW08S	Ethylbenzene	1 J	10 U	2.7 J		1600	
MW08S	Toluene	1 J	10 U	0.98 J		1700	
MW08S	trans-1,2-Dichloroethene	10 U	10 UJ	3 U		2800	
MW08S	Trichloroethene (TCE)	10 U	10 U	2.8 J		540	
MW09S	Benzene	1 J	21	9.7		140	
MW09S	Chlorobenzene	1 J	10 U	3.4		3200	
MW09S	cis-1,2-Dichloroethene	2 J	12	14		2400	
MW09S	Tetrachloroethene (PCE)	2 J	21 U	3.3		150	
MW09S	Trichloroethene (TCE)	10 U	1 J	0.72 J		540	
MW10B	Tetrachloroethene (PCE)		10 U	0.25 J		150	
MW10D	Tetrachloroethene (PCE)		10 U	0.39 J		150	
MW12B	Tetrachloroethene (PCE)		10 U	0.89 J		150	
MW12D	Tetrachloroethene (PCE)		18	0.64 J		150	
MW13B	Tetrachloroethene (PCE)		220 *	96		150	
MW13B	Trichloroethene (TCE)		7 J	5		540	
MW13D	Tetrachloroethene (PCE)		340 *	220		150	Yes
MW13D	Trichloroethene (TCE)		6 J	5.2 J		540	
MW13S	Tetrachloroethene (PCE)		10 U	7.7		150	
MW14M	Tetrachloroethene (PCE)		10 U	1900		150	Yes

J Estimated value.
U Not detected at the given detection limit.
[a] State of Rhode Island Remediation Regulations (DEM-DSR-01-93).
[b] Evaluation against GB Groundwater Objectives conducted using fall 2002 data only.
* From dilution analysis.

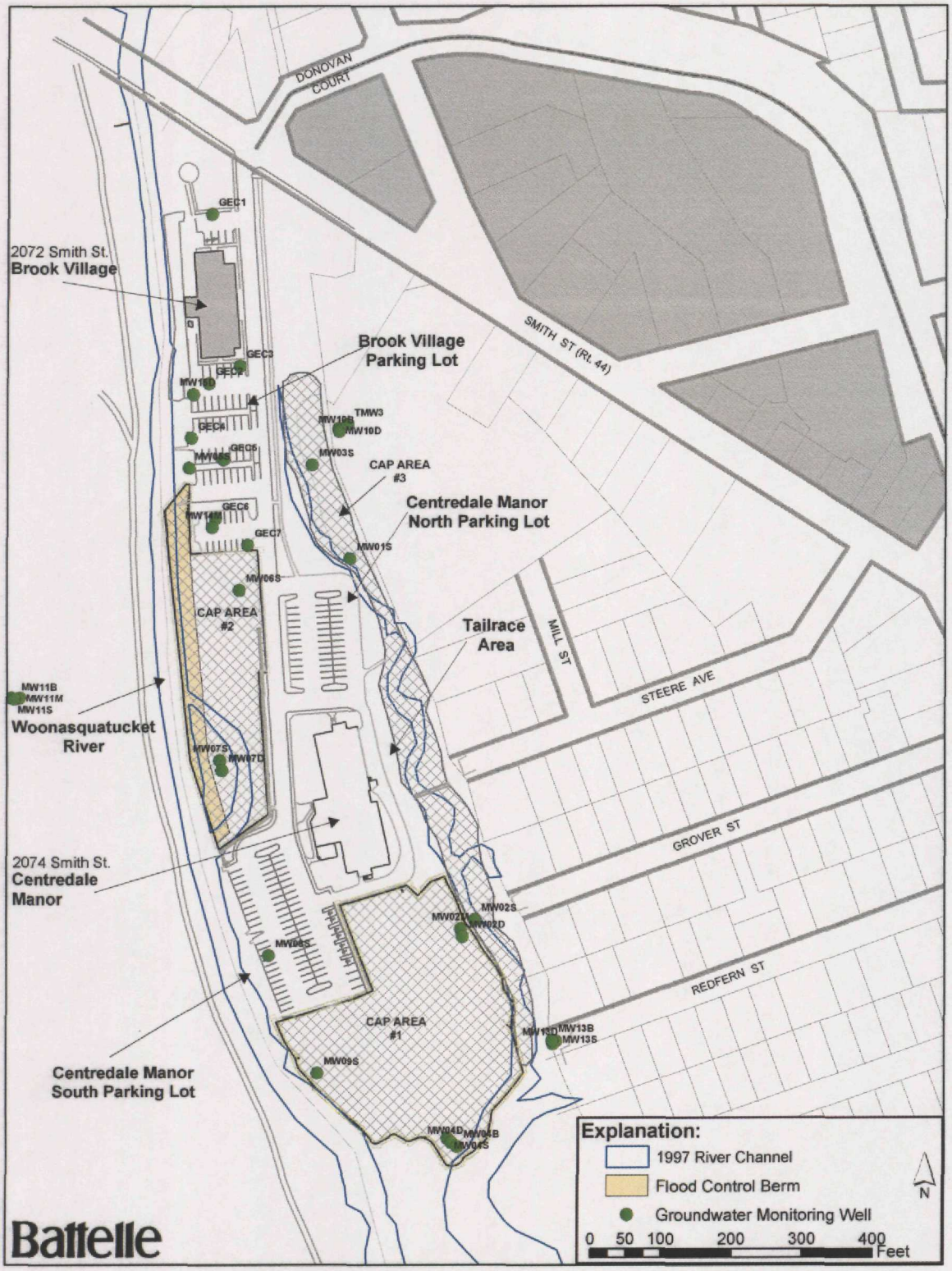

Figure 7. Monitoring Well Locations

5.0 UPPER CONCENTRATION LIMITS

UCLs have not been exceeded in soil or groundwater on the site; therefore, none of the contaminated media represent hazardous waste.

6.0 SUMMARY AND CONCLUSIONS

RIDEM residential direct exposure criteria and the USEPA-recommended dioxin PRG of 1 ppb as a TEQ are exceeded in vadose zone soils throughout the Centredale Manor source area. VOCs are found primarily beneath the Brook Village and Centredale Manor north parking lots. PCBs are highest under Cap Area #1 and the Centredale Manor north parking lot. The highest dioxin concentrations are found under the two interim soil caps. Lead is found at concentrations above the residential direct exposure criteria across the site south of the Brook Village parking lot. Slightly elevated levels of PAHs are found throughout the source area. The majority of locations where direct exposure criteria are exceeded are in areas that are currently capped or paved, with several exceptions (see Sections 2.3 and 2.4).

GB leachability criteria for VOCs are exceeded primarily in soils beneath the Brook Village parking lot, and beneath the Centredale Manor north and south parking lots. PCBs exceed leachability criteria primarily under Cap Area #1 and the Centredale Manor north parking lot. However, GB groundwater objectives are exceeded only in two wells in the Brook Village parking lot (MW-05S and MW-14M) and one deep well on the southeast side of the site (MW-13D). These data indicate that leaching and subsequent groundwater contamination do not appear to be widespread at the site except in the vicinity of Well MW-05S in the Brook Village parking lot. VOC (PCE and TCE) contamination in the vicinity of Well MW-05S has increased the solubility of dioxin, and as a consequence dioxin-contaminated groundwater may be actively discharging to the Woonasquatucket River. Outside of this area, leaching of contaminants from soil to groundwater does not appear to be a concern.

The primary human health and ecological risk associated with contaminated source area soils is from direct contact. The majority of the contaminated soils in the source area are currently in paved or capped areas, preventing direct contact as long as the surfaces remain intact. Institutional controls are not currently in place to manage excavations on site (e.g. to install or repair utilities).

Erosion and transport of contaminated soils appears to be the primary contaminant transport pathway in the source area, except in the vicinity of Well MW-05S in the Brook Village parking lot where discharge of contaminated groundwater to the river occurs. The caps and parking lots in the source area are currently preventing soil erosion, and also appear to be effective in limiting the leaching of contaminants into groundwater.

7.0 RECOMMENDATIONS

Recommendations for developing a long-term remedy for contaminated source area soils at the Centredale Manor site are as follows:

- The long-term remedial approach for the source area soils should focus on preventing direct exposure to and erosion of contaminated soils. The adequacy of the existing caps and paved surfaces in terms of providing long-term protection will be evaluated in the FS, and design modifications will be developed as required. Because there is little evidence that leaching of contaminants from soil to groundwater is occurring, additional measures to prevent leaching should not be necessary, provided that the paved and capped surfaces are maintained.

- Institutional controls should be instituted to prevent or manage any excavation activities on the site. In particular, the locations of all underground utilities will be documented, and alternatives for minimizing risk to utility workers will be evaluated (e.g. relocating utilities to uncontaminated areas as appropriate; encasing utilities in clean soil or a walled conduit).
- Long-term monitoring should be performed to verify that contamination left in place remains relatively immobile, and that no future releases occur.
- Soils in several small areas that are not paved or capped with contaminant concentrations that exceed direct exposure criteria or a dioxin TEQ of 1 ppb should be addressed. These areas are not believed to pose a significant health risk because they are limited in areal extent.
- The mass of dioxin being discharged to the Woonasquatucket River in the vicinity of Well MW-05S will be estimated in the RI. If this contaminant transport pathway is found to be significant, then remedial alternatives for controlling this pathway will be evaluated in the FS or a removal action will be implemented.

According to Section 9.0 of the RIDEM Remediation Regulations (Remedial Action Work Plan), Rule 9.03, for onsite treatment and/or containment of contaminated media, the best management practices must be used to: 1) prevent the infiltration/migration of hazardous substances at levels harmful to human health or the environment; 2) prevent direct contact with hazardous substances at levels harmful to human health and the environment; 3) eliminate volatilization and entrainment of hazardous substances; and 4) minimize and manage surface runoff from the area including during remedial action. These factors will be incorporated into the evaluation of remedial alternatives for source area soils in the FS for the site.

8.0 REFERENCES

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