NPL-U30-2-1-R1

FINAL HAZARD RANKING SYSTEM PACKAGE

CENTREDALE MANOR
RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND
CERCLIS ID NO.: RID981203755

Prepared For:
U.S. Environmental Protection Agency
Region I
Office of Site Remediation and Restoration
1 Congress Street, Suite 1100
Boston, MA 02114-2023

CONTRACT NO. 68-W5-0009

TDD NO. 99-05-0104

PCS No. 7045

DC Number A-4328

Prepared by:

Roy F. Weston, Inc. (WESTON®)
Superfund Technical Assessment and Response Team (START)
217 Middlesex Turnpike
Burlington, MA 01803

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Attachments

SITE DESCRIPTION

The Centredale Manor Restoration Project site ("the site") consists of an area of contaminated fill on parts of both the Centredale Manor and Brook Village apartment complex properties in North Providence, Rhode Island (Providence County) (See Figures 1 and 2 in Attachment A of this document). The Centredale Manor property comprises 4.7 acres and is designated by the Town of North Providence Tax Assessor's Office as Plat 14, Lot 250 [11; 12]. The Brook Village property comprises 4.3 acres and is designated as Plat 14, Lot 200 [12]. The site is bordered by Route 44 (Smith Street) to the north, a small wooded area and an unpaved perennial drainage channel (alternately referred to as the drainage channel or former tail race in references) to the east, a wooded wetland area to the south, and the Woonasquatucket River to the west [3, Volume I, p. 19, Volume II, p. 25].

The site comprises an area of contaminated fill where the dioxin congener 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and other hazardous substances have been disposed of or have come to be located on land now occupied by the Brook Village and Centredale Manor apartment complexes in North Providence, Rhode Island (see Figure 3 in Attachment A of this document) [12]. From at least 1921 to 1940, the site was used for textile manufacturing by the Centredale Worsted Mill and then the Olneyville Wool Combing Company [6, p. 0002; 45, p. 002]. It is currently unknown what type of activities occurred at the site between 1940 and 1943. Between 1943 and 1971, the site was used by two companies, the Atlantic Chemical Company/Metro-Atlantic, Inc. for chemical manufacturing and New England Container Company, Inc. for drum recycling [6, p. 0003]. Aerial photographs taken during the 1960s and 1970s show areas of uncovered, outdoor drum storage in the central area of the site, along with disturbed areas in the southern portion of the site [46 - 51]. On-site observations of the disturbed areas indicate that they comprise areas of fill containing glass, concrete, paint, and other wastes [3, Volume II, pp. 27 - 29]. Sanborn Fire Insurance Rate maps compiled in 1956 and 1965 depict areas of drum (barrel) storage and drum (barrel) cleaning bordering the former tail race (now the drainage channel) in the southern portion of the site [45, pp. 004, 005]. There is no additional information regarding the activities conducted by these firms on the site, including information regarding waste disposal practices.

During the early 1970s, the mill buildings which housed the former textile and chemical companies on the site were demolished [36, p. 2]. The fate of the demolition debris is unknown. The Brook Village apartment building was constructed sometime between 1976 and 1979 on Lot 200 at the northern end of the site, and the Centredale Manor apartment building was constructed in 1982 on Lot 250 at the southern end of the site [11; 12; 36, p. 2; 50; 51].

In 1977, representatives of the State of Rhode Island Department of Health, Division of Air Pollution Control responded to complaints of fumes at the site which resulted in the discovery of a number of abandoned drums (greater than 50) [58; 59]. In the early 1980s, additional abandoned drums were identified at the site by Rhode Island Department of Environmental Management (RI DEM) Division of Air and Hazardous Waste Management personnel [52, p. 0001; 55, p. 0001]. One drum apparently contained polychlorinated biphenyls (PCBs), while some drums may have contained an acid or caustic material (based on the presence of polyliners), solvents, and ink wastes [52, p. 0001; 55, pp. 0002 - 0005]. Subsequently, a Notice of Violation was issued to the property owners for violations of the State Hazardous Waste Management Act [60]. In February 1982, approximately 300 drums were removed under the supervision of RI DEM [55, p. 0001; 73, pp. 1 of 2, 2 of 2].

The Woonasquatucket River borders the site to the west, and a drainage channel borders the site to the east [3, Volume II, pp. 25, 26]. The drainage channel was formerly a channel (consisting of a head and tail race), which extended north of Route 44, that diverted water for use at the Centredale Worsted Mill [38, pp. 26, 27; 45, pp. 004, 005]. The drainage channel is now blocked off to the north of Route 44 [38, p. 26]. The drainage channel currently receives storm water runoff via a head wall at its northern end, via overland flow from the eastern half of the site, and via a drainage pipe from the roof of the Centredale Manor building [3, pp. 27, 36]. The storm water discharged to the drainage channel at the head wall is collected from catch basins located along Route 44 north and east of the site [3, Volume II, pp. 23, 35, 36]. The western half of the site generally slopes towards the Woonasquatucket River, while the eastern half slopes towards the drainage channel [3, Volume II, pp. 25, 26]. The site includes portions of the Woonasquatucket River 10-year floodplain [34]. A low-lying area located in the western-central portion of the site has been documented to flood during periods of high water from the Woonasquatucket River [3, Volume II, pp. 23, 25]. Surface water runoff from the site enters the Woonasquatucket River and drainage channel at numerous points along the western and eastern edges of Lot 200 and Lot 250 [3, Volume II, pp. 25, 26, 32, 33; 12].

Contaminated Fill

The Contaminated Fill source (Source 1) at the site is located on a peninsula bounded by 11 shallow soil samples with Route 44 to the north, the Woonasquatucket River to the west, the drainage channel to the east, and extending approximately 135 feet south of the southernmost parking area to the south [7, pp. 1 of 4, 3 of 4; 18]. The Contaminated Fill source comprises an area of contaminated fill (an estimated 219,869 square feet) where TCDD has been disposed of or has come to be located on parts of Plat 14, Lot 200 and Lot 250 (see Figure 3 in Attachment A of this document) [7, pp. 1 of 4, 3 of 4; 12]. Historical information indicates that former mill and drum recycling activities took place in portions of the area of contaminated fill. The source of the hazardous substances present in the Contaminated Fill source is unknown, but is likely due to the largely unregulated use, storage, and disposal of hazardous substances on the site from at least 1921 until 1977.

On 16 and 17 February 1999, Response Engineering and Analytical Contractor (REAC) personnel collected shallow soil samples from the Contaminated Fill source from Lot 200 and Lot 250 [61, pp. 1, 2, 4, Sections 3.2, 3.2.4]. The shallow soil samples were submitted to a private laboratory for dioxin/furan analysis by EPA Method 8290 (including the congener TCDD) [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. The data were validated according to EPA Region I Tier III requirements [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. In the Contaminated Fill source, TCDD was detected at concentrations up to 115.82 parts per billion (ppb) [85, p. 15]. Additional analytical results from previous sampling events indicated the presence of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) including hexachloroxanthene (HCX), pesticides, PCBs, and inorganic elements in sediment and source samples collected on or around Lot 200 and Lot 250 [40, pp. 9-12]. However, for the purposes of this package, only TCDD analytical results will be used and evaluated.

HRS DOCUMENTATION RECORD--REVIEW COVER SHEET

Name of Site: Centredale Manor Restoration Project

Contact Persons

Site Investigation:

Roy F. Weston, Inc. (WESTON®)/ Superfund Technical Assessment and Response Team (START) (Mr. Sean P. Kennedy and Mr. Joseph Schmidl, P.G.)	(781) 229-6430

Documentation Record:

EPA Region I (Ms. Nancy Smith)	(617) 918-1436

Pathways, Components, or Threats Not Evaluated

The ground water pathway has not been evaluated due to lack of actual contamination targets or nearby potential targets which results in a relatively low pathway score. Although releases to ground water may have occurred as a result of poor containment of the source area, the nearest private drinking water well is located approximately 0.12 mile from the site and the nearest public drinking water well is located approximately 0.8 mile from the site [40, p. 12]. Both of the above-mentioned wells were sampled by START on 15 January 1999 and were analyzed for TCDD by EPA Method 1613B [3, Volume II, p. 11; 64, p. 001]. Results did not indicate the presence of TCDD [64, p. 008]. The resulting ground water pathway score would not contribute significantly to the overall site score; therefore, the ground water pathway has not been scored in the documentation record.

The air pathway has not been evaluated due to the lack of sufficient data to document an observed release to air from the source on the site. There is historical evidence which documents the release of "smoke" from a leaking drum containing a 70% sulfuric acid solution [54]. However, the drum was removed from the site in 1982; therefore, the source was not evaluated [54 -57; 60, pp. 0023, 0024]. There are no analytical data available which document that an observed release to the air pathway has occurred from the source. The resulting air pathway score would not contribute significantly to the overall site score; therefore, the air pathway has not been scored in the documentation record.

A number of hazardous substances, in addition to TCDD, have been detected in the Contaminated Fill source and the Woonasquatucket River and drainage channel sediments. These substances include VOCs, SVOCs, pesticides, PCBs, and inorganic elements [62, pp. 8 - 11, 15, 22]. However, only TCDD is evaluated in this package in order to simplify the Hazard Ranking System (HRS) evaluation [2, p. B-18].

HRS DOCUMENTATION RECORD

Name of Site: Centredale Manor Restoration Project

EPA Region: I (New England) Date Prepared: 13 October 1999

Street Address of Site: 2072 and 2074 Smith Street (Route 44)

County and State: Providence County, Rhode Island

General Location in the State: North-central portion of the State

Topographic Map: Providence, RI - Mass. U.S. Geological Survey. 1957.

Latitude*: N 41E 51' 27.6" Longitude*: W 71E 29' 14.1"

* Latitude and Longitude values measured from the center of the site.

[5]

Scores

Air Pathway	NE
Ground Water Pathway	NE
Soil Exposure Pathway	100.00
Surface Water Pathway	100.00
HRS SITE SCORE	70.71

NE = Not evaluated

WORKSHEET FOR COMPUTING HRS SITE SCORE

		S	S^2
1.	Ground Water Migration Pathway Score (S_{gw})	NE	NE
2a.	Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	100.00	10,000.00
2b.	Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	NE	NE
2c.	Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	100.00	10,000.00
3.	Soil Exposure Pathway Score (S_s) (from Table 5-1, line 22)	100.00	10,000.00
4.	Air Migration Pathway Score (S_a)	NE	NE
5.	Total of $S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$	20,000.00	
6.	**HRS Site Score** Divide the value on line 5 by 4 and take the square root	70.71	

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET

Factor Categories and Factors			Maximum Value	Value Assigned	
DRINKING WATER THREAT					
	Likelihood of Release				
1.	Observed Release		550	550	
2.	Potential to Release by Overland Flow				
	2a.	Containment (Overland Flow)	10	NE	
	2b.	Runoff	25	NE	
	2c.	Distance to Surface Water	25	NE	
	2d.	Potential to Release by Overland Flow [lines 2a × (2b + 2c)]	500	NE	
3.	Potential to Release by Flood				
	3a.	Containment (Flood)	10	NE	
	3b.	Flood Frequency	50	NE	
	3c.	Potential to Release by Flood (lines 3a × 3b)	500	NE	
4.	Potential to Release (lines 2d + 3c, subject to a maximum value of 500)		500	NE	
5.	Likelihood of Release (greater of lines 1 and 4)		550		550
	Waste Characteristics				
6.	Toxicity/Persistence		a	10,000	
7.	Hazardous Waste Quantity		a	100	
8.	Waste Characteristics Factor Category Value		100		32
	Targets				
9.	Nearest Intake		50	0	
10.	Population				
	10a.	Level I Concentrations	b	0	
	10b.	Level II Concentrations	b	0	
	10c.	Potential Contamination	b	0	
	10d.	Population (lines 10a + 10b + 10c)	b	0	
11.	Resources		5	5	
12.	Targets (lines 9 + 10d + 11)		b		5
	Drinking Water Threat Score				
13.	Drinking Water Threat Score [(lines 5 × 8 × 12) ÷ 82,500] [(550 × 32 × 5) ÷ 82,500]		100		1.07

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET (Continued)

	Factor Categories and Factors	Maximum Value	Value Assigned	
	HUMAN FOOD CHAIN THREAT			
	Likelihood of Release			
14.	Likelihood of Release (same value as line 5)	550		550
	Waste Characteristics			
15.	Toxicity/Persistence/Bioaccumulation	a	5×10^{7}	
16.	Hazardous Waste Quantity	a	100	
17.	Waste Characteristics Factor Category Value	1,000		180
	Targets			
18.	Food Chain Individual	50	45	
19.	Population			
	19a. Level I Concentrations	b	NE	
	19b. Level II Concentrations	b	0.03	
	19c. Potential Human Food Chain Contamination	b	0.0003006	
	19d. Population (lines 19a + 19b + 19c)	b	0.0303006	
20.	Targets (lines 18 + 19d)	b		45.0303006
	Human Food Chain Threat Score			
21.	Human Food Chain Threat Score [(lines 14 × 17 × 20) ÷ 82,500] [(550 × 180 × 45.0303006) ÷ 82,500]	100		54.04

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET (Concluded)

Factor Categories and Factors		Maximum Value	Value Assigned	
ENVIRONMENTAL THREAT				
	Likelihood of Release			
22.	Likelihood of Release (same value as line 5)	550		550
	Waste Characteristics			
23.	Ecosystem Toxicity/Persistence/Bioaccumulation	a	5×10^{7}	
24.	Hazardous Waste Quantity	a	100	
25.	Waste Characteristics Factor Category Value	1,000		180
	Targets			
26.	Sensitive Environments			
	26a. Level I Concentrations	b	0	
	26b. Level II Concentrations	b	55	
	26c. Potential Contamination	b	0.251	
	26d. Sensitive Environments (lines 26a + 26b + 26c)	b	55.251	
27.	Targets (value from line 26d)	b		55.251
	Environmental Threat Score			
28.	Environmental Threat Score [(lines 22 × 25 × 27) ÷ 82,500] [(550 × 180 × 55.251) ÷ 82,500]	60		60
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE FOR A WATERSHED				
29.	Watershed Score[c] (lines 13 + 21 + 28)	100		100
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE				
30.	Component Score (S_{of})[c] (highest score from line 29 for all watersheds evaluated, subject to a maximum value of 100)	100		100

[a]Maximum value applies to Waste Characteristics Category.
[b]Maximum value not applicable.
[c]Do not round to the nearest integer.
NE = Not evaluated.

TABLE 5-1
SOIL EXPOSURE COMPONENT SCORESHEET

	Factor Categories and Factors	Maximum Value	Value Assigned	
RESIDENT POPULATION THREAT				
	Likelihood of Exposure			
1.	Likelihood of Exposure	550		550
	Waste Characteristics			
2.	Toxicity	a	10,000	
3.	Hazardous Waste Quantity	a	10	
4.	Waste Characteristics Factor Category Value	100		18
	Targets			
5.	Resident Individual	50	50	
6.	Resident Population			
	6a. Level I Concentrations	b	2,580	
	6b. Level II Concentrations	b	NE	
	6c. Resident Population (lines 6a + 6b)	b	2,580	
7.	Workers	15	5	
8.	Resources	5	0	
9.	Terrestrial Sensitive Environments	c	0	
10.	Targets (lines 5 + 6c + 7 + 8 + 9)	b		2,635
	Residential Population Threat Score			
11.	Residential Population Threat (lines 1 × 4 × 10)	b		2.609×10^7

TABLE 5-1
SOIL EXPOSURE COMPONENT SCORESHEET (Concluded)

Factor Categories and Factors		Maximum Value	Value Assigned	
NEARBY POPULATION THREAT				
	Likelihood of Exposure			
12.	Attractiveness/Accessibility	100	75	
13.	Area of Contamination	100	20	
14.	Likelihood of Exposure	550		50
	Waste Characteristics			
15.	Toxicity	a	10,000	
16.	Hazardous Waste Quantity	a	10	
17.	Waste Characteristics Factor Category Value	100		18
	Targets			
18.	Nearby Individual	1	0	
19.	Population Within 1 Mile	b	NE	
20.	Targets (lines 18 + 19)	b		0
	Nearby Population Threat Score			
21.	Nearby Population Threat (lines 14 × 17 × 20)	b		0
SOIL EXPOSURE COMPONENT SCORE				
22.	Soil Exposure Pathway Score[d] (S_s) [(lines 11 + 21) ÷ 82,500] [$(2.609\times10^7 + 0) \div 82{,}500$]	100		100

[a]Maximum value applies to Waste Characteristics Category.
[b]Maximum value not applicable.
[c]No specific maximum value applies to factor. However, pathway score based solely on terrestrial sensitive environments is limited to a maximum of 60.
[d]Do not round to the nearest integer.
NE = Not evaluated.

NOTES TO THE READER

All reference citations used to document the HRS score will follow the following conventions:

Reference 42	= Reference No. 42 (all references cited by number)
Attachment A	= Attachment A
Appendix A	= Appendix A
Figure 1	= Figure 1
Table 1	= Table 1
Plate 1	= Plate 1
p.	= single page
pp.	= multiple pages (pp. 2-5, 9 or pp. A-1 to A-10)
";"	= next reference

For example:

"Source No. 1 is located in the southern portion of the site at a topographic high (Reference 4, Plate 3; 5, pp. 15-21, 23)," means that the information presented is documented in Reference No. 4 on Plate 3 and Reference No. 5 on pages 15 through 21 and page 23.

Referenced text has been either quoted or paraphrased for clarity.

REFERENCES

(see attached volumes)

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SOURCE DESCRIPTION

2.2 Source Characterization

Number of the source: 1

Name and description of the source: Contaminated Fill (Contaminated Soil)

The Contaminated Fill source is located on portions of the properties identified as Plat 14, Lot 200 and Lot 250 [7; 12]. Source 1 comprises an area of contaminated soil where TCDD has been disposed of or has come to be located (see Figure 3 in Attachment A of this document).

On 16 and 17 February 1999, REAC personnel collected 222 shallow soil samples [not including quality assurance/quality control (QA/QC) samples] from the site and from the floodplain downstream of the site [61, pp. 1, 2, 4, Sections 3.2, 3.2.4]. Sampling activities were conducted in accordance with the EPA Region I, EPA Environmental Response Team (ERT), RI DEM, and the Centredale Manor Management Action Committee approved Task Work Plan, dated 5 February 1999 and approved 10 February 1999 [61, pp. 1, 2, Section 3.2; 91, pp. 1, 2]. The shallow soil samples were submitted to a private laboratory for dioxin/furan analysis by EPA Method 8290 [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. The data were validated according to EPA Region I Tier III requirements [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01].

For the purposes of this evaluation, 11 shallow soil samples were selected which define the extent of the Contaminated Fill source. Among the 11 selected shallow soil samples, TCDD was detected at a maximum concentration of 115.82 ppb in the contaminated fill, in shallow soil sample CMS-060 [85, p. 15]. Concentrations of TCDD were greater than or equal to the background shallow soil sample's sample quantitation limit (SQL) value in all 11 of the aforementioned shallow soil samples collected from Source 1 at the site [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. Using Geographic Information System (GIS) and ArcView software, the area within the boundaries delineated by the 11 shallow soil sample locations is an estimated 219,869 square feet [7, p. 1 of 4]. Based on additional GIS data, approximately 50% of the area of Source 1 lies under maintained asphalt paving and building footprints [7, p. 1 of 4].

Location of the source, with reference to a map of the site:

Source 1 at the site occupies most of the parcels designated by the North Providence Tax Assessor's Office as Plat Number 14, Lots 200 and 250 (see Figure 3 in Attachment A of this document) [7, pp. 1 of 4, 3 of 4; 12]. Source 1 is bounded by 11 shallow soil sample locations, and extends approximately 135 feet south of the southernmost parking area to the south, within 10 feet of the western side of the drainage swale to the east, to shallow soil sample location CMS-030 to the north, and parallel to the Woonasquatucket River to the west [7, pp. 1 of 4, 3 of 4; 18].

Containment

Release via overland migration and/or flood:

Based on visual interpretation and GIS data, approximately 50% of Source 1 is covered with maintained asphalt paving and building footprints and approximately 40% of the source is covered with maintained lawns [3, Volume II, pp. 25, 26, 32, 33; 7, p. 1 of 4]. The southern end of the contaminated soil source, approximately 10% of its total area, has no apparent cover and waste is visible at the surface [3, Volume II, pp. 25, 27].

The maintained asphalt pavement, which covers over approximately 50% of the source, comprises a maintained engineered cover [3, Volume II, pp. 25, 32, 33]. Precipitation which falls on the paved parking areas flows off the paved parking areas via notches in the asphalt berms along the edges of the parking areas and access road [3, Volume II, pp. 25, 26, 32]. However, the runoff from these areas is not directed to a runoff management system, but discharges to the Woonasquatucket River and drainage channel without treatment [3, Volume II, pp. 32, 33]. The remainder of the source has no maintained engineered cover or run-on control/runoff management system [3, Volume II, pp. 23, 32, 33]. Subsurface investigations of the Contaminated Fill source have not encountered any containment structures which would be representative of a liner [61, Appendix B, p. 004, Appendix C, pp. 30, 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. Based on the lack of complete run-on control and runoff management systems, a Containment Factor Value of 10 has been assigned for release via overland/flood migration to surface water for Source 1 [1, p. 51609, Table 4-2].

2.4.1 Hazardous Substances

On 16 and 17 February 1999, REAC personnel collected shallow soil samples from the Contaminated Fill source from Plat 14, Lot 200 and Lot 250 [12; 61, pp. 1, 2, 4, Sections 3.2, 3.2.4]. The shallow soil samples were collected at depths of 0 to 3 inches below ground surface [61, p. 4, Section 3.2.4]. The shallow soil samples were submitted to a private laboratory for dioxin/furan analysis by EPA Method 8290 [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. The data were validated according to EPA Region I Tier III requirements [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. The analytical results for these samples are used to associate hazardous substances with the source [1, p. 51588, Section 2.2.2].

Hazardous Substance	Evidence	Reference
TCDD	Analytical results	84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19

Background Samples

REAC collected shallow soil samples from the site on 16 and 17 February 1999 [61, pp. 1, 2, Section 3.2]. The shallow soil samples were submitted to a private laboratory for dioxin/furan analysis by EPA Method 8290 [61, p. 4, Section 3.2.5; 84, p. 1; 85, p. 1; 86, p. 1; 87, p. 1]. One of the samples, CMS-026, was selected as the reference shallow soil sample due to its location outside of the contaminated fill area at the site and its non-detection of TCDD [86, p. 16].

Shallow soil sample CMS-026 was described as loam [61, Appendix C, p. 30]. The matrix of the reference shallow soil sample is the same as the 11 shallow soil samples used to establish observed contamination [61, Appendix C, pp. 30, 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. Additionally, the reference shallow soil sample and the 11 shallow soil samples used to establish observed contamination were all collected from a depth of 0 to 3 inches [61, p. 4, Section 3.2.4].

Because TCDD is not naturally-occurring, it is sufficient to document its presence in this source by the chemical analysis of contaminated source samples; a background sample is not needed. However, background concentrations have been provided to further support association of TCDD to Source 1, and to demonstrate TCDD is not ubiquitous in the area.

Sample ID	Depth	Date	Reference
CMS-026	0 to 3 inches	16 February 1999	61, pp. 1, 2, Section 3.2, 4, Section 3.2.4, Appendix C, p. 30

For the purposes of this package, shallow soil sample concentrations greater than or equal to the background shallow soil sample concentration for CMS-026 can be used to associate hazardous substances with the source [1, pp. 51588, Section 2.2.3, 51589, Table 2-3].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
CMS-026	TCDD	0.0047 UJ ppb	0.0047 ppb	86, p. 16; 89

UJ = Indicates non-detect result.
ppb = parts per billion

Note = The SQL for non-detect results is the same as the detection limit for that sample.
ppb = micrograms per kilogram (Fg/kg)

Contaminated Samples

On 16 and 17 February 1999, REAC personnel collected shallow soil samples from the site [61, pp. 1, 2, 4, Sections 3.2, 3.2.4]. Sampling activities were conducted in accordance with the EPA Region I, EPA ERT, RI DEM, and the Centredale Manor Management Action Committee approved Task Work Plan, dated 5 February 1999 and approved 10 February 1999 [61, pp. 1, 2, Section 3.2; 91, pp. 1, 2]. The samples were submitted to a private laboratory for dioxin/furan analysis by EPA Method 8290 [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. The data were validated according to EPA Region I Tier III requirements [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. For the purposes of this evaluation, 11 shallow soil samples were selected which define the extent of the Contaminated Fill source. The following 11 shallow soil samples were collected from depths of 0 to 3 inches from locations in contaminated fill on the Centredale Manor Restoration Project site: CMS-030, CMS-031, CMS-050, CMS-060, CMS-061, CMS-067, CMS-098, CMS-131, CMS-134, CMS-152, and CMS-242 [61, p. 4, Section 3.2.4, Appendix C, pp. 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249].

Sample ID	Depth	Date	Reference
CMS-030	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 34
CMS-031	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 35
CMS-050	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 53
CMS-060	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 63
CMS-061 (Duplicate)	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 64
CMS-067	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 70
CMS-098	0 to 3 inches	17 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 101
CMS-131	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 135
CMS-134	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 138
CMS-152	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 156
CMS-242	0 to 3 inches	17 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 249

Among the 11 selected shallow soil samples, TCDD was detected at a maximum concentration of 115.82 ppb in the contaminated fill, in shallow soil sample CMS-060 [85, p. 15]. Concentrations of TCDD were greater than or equal to the background shallow soil sample's SQL value in all 11 of the aforementioned shallow soil samples collected from Source 1 at the site [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. The background shallow soil concentration of TCDD has been established using analytical results for shallow soil sample CMS-026, in which TCDD was not detected.

Shallow soil sample CMS-026 was described as loam, as were the 11 shallow soil samples which are used to document observed contamination [61, Appendix C, pp. 30, 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. Therefore, for the purpose of this package, shallow soil sample concentrations which are greater than or equal to the reference sample's SQL value have been used to associate hazardous substances with the source [1, p. 51588, Section 2.2.2, p. 51589, Table 2-3].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Background Sample Concentration	Reference
CMS-030	TCDD	0.0943 J ppb	0.000989 ppb	0.0047 UJ ppb	86, p. 16; 89; 90
CMS-031	TCDD	0.103 J ppb	0.000986 ppb	0.0047 UJ ppb	86, p. 16; 89; 90
CMS-050	TCDD	0.053 J ppb	0.000995 ppb	0.0047 UJ ppb	85, p. 14; 86, p. 16; 89; 90
CMS-060	TCDD	115.82 $J ppb	0.09998 ppb	0.0047 UJ ppb	85, p. 15; 86, p. 16; 89; 90
CMS-061	TCDD	0.161 J ppb	0.000988 ppb	0.0047 UJ ppb	85, p. 15; 86, p. 16; 89; 90
CMS-067	TCDD	0.115 J ppb	0.09877 ppb	0.0047 UJ ppb	85, p. 16; 86, p. 16; 89; 90
CMS-098	TCDD	28.04 $J ppb	0.09954 ppb	0.0047 UJ ppb	86, p. 16; 87, p. 15; 89; 90
CMS-131	TCDD	3.3 $J ppb	0.09690 ppb	0.0047 UJ ppb	84, p. 14; 86, p. 16; 89; 90
CMS-134	TCDD	15.52 $J ppb	0.09972 ppb	0.0047 UJ ppb	84, p. 15; 86, p. 16; 89; 90
CMS-152	TCDD	1.3 $ ppb	0.09933 ppb	0.0047 UJ ppb	84, p. 15; 86, p. 16; 89; 90
CMS-242	TCDD	20.27 $J ppb	0.09963 ppb	0.0047 UJ ppb	86, p. 16; 87, p. 19; 89; 90

TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
ppb = parts per billion
J = Indicates estimated result.
UJ = Indicates non-detect result.
$ = TCDD reported from a 1:100 dilution analysis.

Note: ppb = Fg/kg

2.4.2. Hazardous Waste Quantity

The Hazardous Waste Quantity for Source 1 was calculated based on the Area Factor Value of contaminated soil [1, p. 51591, Table 2-5, Section 2.4.2.1.4]. The Hazardous Constituent Quantity and Hazardous Wastestream Quantity Values were not evaluated for Source 1 because insufficient information was available [1, p. 51591, Table 2-5, Sections 2.4.2.1.1 and 2.4.2.1.2]. The Volume Factor Value was not calculated for Source 1 because insufficient data are available to document the volume of the source [1, p. 51591, Table 2-5, Section 2.4.2.1.3].

2.4.2.1.1. Hazardous Constituent Quantity

There is insufficient information to evaluate the source for Hazardous Constituent Quantity.

Hazardous Substance	Constituent Quantity (pounds) (Mass - s)	Reference
NE (Insufficient information)		

sum: (pounds)

Hazardous Constituent Quantity Value (S): NE

2.4.2.1.2. Hazardous Wastestream Quantity

There is insufficient information to evaluate the source for Hazardous Wastestream Quantity.

Hazardous Wastestream	Quantity (pounds)	Reference
NE (Insufficient information)		

sum: (pounds)

Hazardous Wastestream Quantity Value (W): NE

2.4.2.1.3. Volume

The volume of Source 1 could not be determined; therefore, a value of 0 is assigned [1, p. 51591, Section 2.4.2.1.3].

Dimension of source [cubic yards (yd^3) or gallons]: unknown

References(s):

Volume Assigned Value: 0

2.4.2.1.4. Area

The area of Source 1 was determined by considering the sampling locations where TCDD was detected at concentrations greater than or equal to the background concentration and the area lying between such locations, including the parts of Source 1 which are covered with maintained asphalt paving and building footprints [1, p. 51591, Section 2.4.2.1.4, p. 51609, Table 4-2; 7, pp. 1 of 4, 3 of 4].

The area of Source 1 was calculated as follows. Sample locations which document observed contamination with TCDD (CMS-030, CMS-031, CMS-050, CMS-060, CMS-061, CMS-067, CMS-098, CMS-131, CMS-134, CMS-152, and CMS-242) were located using global positioning system hardware and plotted on a scale drawing of the site via GIS and ArcView software. The boundary of Source 1 is the line connecting these sample location points. In order to calculate the area of Source 1, ArcView calculated the area of the polygon which was drawn connecting the above-mentioned sample locations [7, pp. 1 of 4, 3 of 4]. Source 1 is an estimated 219,869 square feet (ft^2)[7, p. 1 of 4].

Area of source (ft^2): 219,869

References: 7, p. 1 of 4; 18

The area of a "contaminated soil" source is divided by 34,000 to assign a Hazardous Waste Quantity to the source [1, p. 51647]. 219,869 square feet ÷ 34,000 = 6.47

Area Assigned Value: 6.47

2.4.2.1.5. Source Hazardous Waste Quantity Value

The Hazardous Waste Quantity Value for Source 1 was calculated based on the Area Factor Value (6.47) [1, p. 51591]. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Factor Values were not evaluated for Source 1 because insufficient information was available [1, p. 51591].

Source Hazardous Waste Quantity Value: 6.47

SITE SUMMARY OF SOURCE DESCRIPTIONS

Source No.	Source Hazardous Waste Quantity Value	Containment			
		Ground Water	Surface Water	Gas	Air Particulate
1	6.47	NE	10	NE	NE

Total Source Hazardous Waste Quantity Value: 6.47

The following potential sources have been identified during previous investigations but have not been used for purposes of scoring:

Drums

From 1977 to 1983, RI DEM personnel noted approximately 300 drums disposed of at the site [52; 53; 55; 58; 59; 72; 73]. Drums were found to be deposited both above the ground surface and beneath the ground surface during excavation activities along the former tail race area and along the western boundaries of Lots 200 and 250 near the bank of the Woonasquatucket River where fill material had also been deposited [52, p. 0001; 53, p. 0001; 56, p. 0001]. The majority of drums inventoried were reported to be crushed and/or empty [53, p. 0001]. RI DEM personnel reported chemical deposits and vegetation "kill areas" throughout the drum disposal area, apparently the result of spillage or leakage from the drums [52, p. 0001]. Of the drums inventoried in 1982, 30 drums were found to contain chemical residues (liquids and solids) which were subsequently sampled by RI DEM personnel and Goldberg, Zoino & Associates (GZA) personnel [55, p. 0001]. An estimated 300 drums were removed from the site in February 1982 [55, p. 0001; 73]. On 1 April 1982, it was determined by RI DEM and GZA personnel that of the 30 drums previously sampled, eight contained hazardous waste materials and were required to be sent to a secured hazardous waste landfill, one contained material which was required to be neutralized with a caustic soda prior to disposal at a licensed landfill, and the remaining 21 drums sampled were permitted to be disposed of in a licensed landfill [55, p. 0001; 60, pp. 0023, 0024]. Drums that were verified to be empty and non-hazardous in nature were crushed and sent to a solid waste facility for proper disposal [55, p. 0001]. While manifests were generated during the drum removal in 1982, it could not be considered a qualifying removal under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) due to the lack of description of drum contents and the exact number of drums removed [60].

Based on subsequent site observations by START in 1998 and 1999, approximately 10 deteriorated 55-gallon drums remain scattered across portions of Lot 200 and Lot 250 [3, Volume II, p. 37]. No information regarding the former contents of the drums, nor the likelihood that the drums have released hazardous substances to the environment, is available [3, Volume II, p. 37]. Available information is not sufficient to document buried drums at the site as a potential source of hazardous substances. The omission of this potential source does not affect the HRS site score.

1,000-Gallon Diesel Fuel Underground Storage Tank (UST)

A 1,000-gallon diesel fuel UST is located approximately 20 feet from the northwest corner of the Centredale Manor building [3, Volume II, p. 31]. The diesel fuel in the tank is used by an emergency generator when the supplied power fails at the Centredale Manor apartment building [3, Volume II, p. 31]. The UST was leak-tested on 11 November 1996 and 2 June 1999, and test results indicated that the UST passed [67, pp. 5, 7]. Due to the exclusion of petroleum products from the CERCLA definition of "hazardous substances", the UST is not considered a source for the purposes of the HRS site score for the Centredale Manor Restoration Project site [81, p. 2 of 9].

10,000-Gallon Fuel Oil UST

An old 10,000-gallon fuel oil UST was removed from Lot 200 at the beginning of September 1998 and a new one was installed in its place by the end of September 1998 [43; 44, p. 1]. The UST location is along the western border of the parking lot south of the Brook Village apartment building [45, p. 017]. The fuel oil is used by a furnace to supply heat and hot water for the Brook Village apartment building [43]. Soil samples were collected along the walls of the excavated area of the UST grave, and analytical results indicated low concentrations of inorganic elements, phthalates, and several polyaromatic hydrocarbons (PAHs) [44, p. 2]. The PAHs were detected at concentrations significantly exceeding method detection limits [44, p. 2]. In response to the soil analytical results, seven flush-mounted overburden monitoring wells were installed in the vicinity of the UST grave location (current location of the new UST) to monitor possible contaminated ground water migration [45, pp. 001, 017]. Due to the exclusion of petroleum products from the CERCLA definition of "hazardous substances", the UST has not been considered as a source for the purposes of the HRS site score for the Centredale Manor Restoration Project site [81, p. 2 of 9].

Potential Buried Objects

In February1999, a geophysical survey was performed by REAC for EPA ERT at Lot 200 and Lot 250 [61, Appendix B, p. 001]. The purpose of the geophysical survey was to locate possible additional buried waste containers (e.g., 55-gallon drums) or a buried waste container reclamation area [61, Appendix B, p. 001]. A total of 44 anomalies were interpreted from the geophysical data collected, with the northern and southern areas of Lot 250 and the central area of Lot 200 identified as possible disposal areas [61, Appendix B, p. 004]. Numerous other small anomalies were interpreted to represent debris, pipes, and buried power lines throughout Lot 200 and Lot 250 based on the collected geophysical data [61, Appendix B, p. 004]. A more detailed geophysical survey was conducted by REAC and EPA ERT personnel on 6 and 7 April 1999 to further define the extent of the 44 anomalies and to complete geophysical surveying of portions of the site not covered during the initial investigation [76, pp. 74, 75; 88, p. 1]. As a result of the April 1999 geophysical survey, a total of 13 anomalies were identified within four surveyed areas. Based on data collected, it was determined the anomalies may be anthropogenic (i.e., mixed metallic fill or construction debris) [88, p. 9]. Anomalies present along the southern parking lot on Lot 250 were deemed to have the highest potential for containing buried bulk metallic materials [88, p. 9]. Currently, EPA is conducting soil sampling at depth to physically characterize the anomalies detected in February and April 1999. Since deep soil sampling results are incomplete at this time, the potential buried objects have not been considered as a source for the purposes of the HRS site score for the Centredale Manor Restoration Project site.

Contaminated Floodplain Soils

The Contaminated Floodplain Soils source is differentiated from the Contaminated Fill source based on the means by which the contaminated soils have been deposited. The Contaminated Fill source was deposited by activities performed by the industries formerly located at the site; the Contaminated Floodplain Soils source was deposited by redistribution of contaminated soil by runoff from the site and floodwaters of the Woonasquatucket River. In February 1999, REAC and ERT personnel collected shallow soil samples along the 10- and 100-year floodplains of the Woonasquatucket River in the vicinity of the site [12; 18; 61, pp. 2, 3, Section 3.2.1]. Soil samples were collected between 0 and 3 inches below ground surface and were analyzed by a private laboratory for dioxin/furan congeners [61, p. 4, Sections 3.2.4, 3.2.5]. Results from shallow soil samples (collected along the floodplain) revealed TCDD at concentrations comparable to concentrations of TCDD detected in shallow soil samples collected from the Contaminated Fill source [12; 18; 84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. However, since investigations of the floodplain are incomplete, the Contaminated Floodplain Soils have not been considered as a source for the purposes of the HRS site score for the Centredale Manor Restoration Project site.

3.0 GROUND WATER MIGRATION PATHWAY - Not Evaluated

3.0.1 GENERAL CONSIDERATIONS

Rationale for not evaluating the Ground Water Pathway is provided in the HRS Review Cover Sheet.

4.0 SURFACE WATER PATHWAY

4.1 OVERLAND/FLOOD MIGRATION COMPONENT

4.1.1.1 DEFINITION OF HAZARDOUS SUBSTANCE MIGRATION PATH FOR OVERLAND/FLOOD COMPONENT

The Contaminated Fill source (Source 1) at the site is located on a peninsula bounded on the west by the Woonasquatucket River and on the east by a drainage channel which regularly contains water along its southern end [3, Volume II, pp. 25, 26; 17]. The drainage channel was formerly a channel (consisting of a head and tail race), which extended north of Route 44, that diverted water for use at Centredale Worsted Mill [38, p. 26; 45, pp. 004, 005]. The drainage channel is now blocked off to the north of Route 44 [38, p. 26]. The drainage channel currently receives storm water discharge via a drainage pipe located at a head wall at its northern end, via overland flow from the eastern half of the site, and via a drainage pipe from the roof of the Centredale Manor building [3, pp. 27, 36]. The storm water discharged to the drainage channel at the head wall is collected from catch basins located along Route 44 north and east of the site [3, Volume II, pp. 23, 35, 36]. The source at the site lies within the 10-year floodplain of the Woonasquatucket River [34].

Based on visual observations and GIS data, approximately 50% of the Contaminated Fill source is covered with maintained asphalt paving and building footprints, approximately 40% of the source is covered with maintained lawns, and approximately 10% of the source (located at its southern end) has no apparent cover and waste materials are visible at the surface [3, Volume II, pp. 25 - 27, 32, 33; 7, pp. 1 of 4, 2 of 4].

Runoff from the paved parking areas flows via notches in the asphalt berms along the edges of the parking areas and access road, either westerly to the Woonasquatucket River or easterly to the drainage channel [3, Volume II, pp. 25, 26, 32, 33]. A runoff divide extends north to south across the site (see Figure 4 of this document). The runoff divide begins at a point located approximately 5 feet west of the paved access road north of the Brook Village apartments [3, Volume II, pp. 25, 26]. The divide follows a line approximately due south to a seasonally flooded area, to a point south of the southernmost parking lot on Lot 200. The divide extends eastward approximately 10 feet to the access road at a point northwest of the northern parking lot on Lot 250. The divide continues south to a point where the access road merges with the southern parking lot on Lot 250. Continuing in a southeasterly direction along the eastern edge of the southern parking lot, the divide proceeds beyond the parking lot into the woods, where the contaminated soil source ends in an uneven scarp face (slope) about 1 to 2 feet high (see Figure 4 in Attachment A of this document) [3, Volume II, pp. 25 - 27]. Precipitation falling on the west side of the divide drains to the Woonasquatucket River, while runoff from the east side of the divide flows to the drainage channel [3, Volume II, pp. 25, 26]. Runoff from the southern portion of the source (south of the southernmost parking lot) generally drains southerly into a distributary stream of the Woonasquatucket River [3, Volume II, pp. 25, 26].

The most upstream probable point of entry (PPE) to surface water in the drainage channel is located due east of the center of the parking lot north of the Centredale Manor apartment building, where the drainage channel first becomes a perennial surface water body [3, Volume II, pp. 25, 26]. The most upstream PPE to surface water in the Woonasquatucket River is located immediately southwest of the gazebo, located north of the Brook Village apartment building. The most downstream PPE is located at the distributary stream south of the southern tip of the Contaminated Fill source, south of shallow soil sample CMS-242 (see Figure 4 in Attachment A of this document) [7, p. 4 of 4].

The drainage basin, upstream of the drainage channel where it discharges to the Woonasquatucket River, includes the storm water collection system along the eastern half of the site, the slope east of the drainage channel, and a catch basin system located along Route 44 north and east of the site [3, Volume II, pp. 25, 35, 36, 37; 17; 20]. The area of the drainage basin, upstream of the mouth of the drainage channel, is approximately 0.062 square miles (mi^2) [17; 20]. Using the United States Geological Survey (USGS) New England mean annual flow rate estimating factor of 1.8 cubic

4.1.1.1 DEFINITION OF HAZARDOUS SUBSTANCE MIGRATION PATH FOR OVERLAND/FLOOD COMPONENT (Concluded)

feet per second (cfs)/mi^2, the estimated mean annual flow rate of the drainage channel is 0.1 cfs [20; 66]. The drainage channel discharges to a distributary stream of the Woonasquatucket River approximately 0.3 miles downstream of the most upstream PPE to the drainage channel [23; 27]. Based on the above drainage basin measurements, the entire reach of the drainage channel is estimated to have a mean annual flow rate of #10 cfs. Based on the lack of evidence of use, the drainage channel is not considered a recreational fishery [92].

The USGS maintains gaging station Number 01114500 on the Woonasquatucket River approximately 0.1 miles upstream of the most upstream PPE to the Woonasquatucket River [21, p. 144]. The drainage basin of the Woonasquatucket River upstream of USGS gaging station No. 01114500 is 38.3 mi^2 [21, p. 144]. The mean annual flow rate of the Woonasquatucket River measured at USGS gaging station No. 01114500 is 73.3 cfs, based on records from 1941 to 1997 [21, p. 144]. Based on the drainage basin area and mean annual flow rate of the Woonasquatucket River, a mean annual flow rate estimating factor specific to the Woonasquatucket River can be calculated as 73.3 cfs ÷ 38.3 mi^2, which equals 1.91cfs/mi^2. The river flows 6.4 miles downstream from the most upstream PPE to the Woonasquatucket River, to its mouth at the Providence River, where its drainage basin area is 50.72 mi^2 [22; 23; 27]. Using the mean annual flow rate estimating factor specific to the Woonasquatucket River of 1.91 cfs/mi^2, the estimated mean annual flow rate at the mouth of the Woonasquatucket River is 50.72 mi^2 × 1.91 cfs/mi^2, which equals 96.88 cfs. Therefore, the entire reach of the Woonasquatucket River downstream of the site has a mean annual flow rate between 10 and 100 cfs.

The Providence River, at its confluence with the Woonasquatucket River, is a saline tidal river which meets the definition of an estuary [15, pp. A-3, A-11; 77; 83]. The mean annual flow rate of the estuary is not applicable, as an estuary is evaluated as coastal tidal waters [1, pp. 51605, Section 4.0.2, 51613, Table 4-13]. Approximately 8.0 miles downstream of its confluence with the Woonasquatucket River, the Providence River discharges into Narragansett Bay [17, 24, 25, 26]. The mean annual flow rate of the bay is not applicable, as a bay is evaluated as coastal tidal waters [1, pp. 51605, Section 4.0.2, 51613, Table 4-13]. The remainder of the 15-mile downstream surface water pathway comprises 0.6 miles of Narragansett Bay downstream of the discharge of the Providence River [23; 31; 32]. The terminus of the 15-mile downstream surface water pathway is an arc that extends across Narragansett Bay from Conimicut Point in Warwick, Rhode Island to south of Nayatt Point in Barrington, Rhode Island (See Figure 4 of this document) [23; 31].

4.1.2.1 LIKELIHOOD OF RELEASE

4.1.2.1.1 Observed Release

Chemical Analysis

Background Samples (Sediment)

Sediment samples SD-33 and SD-34 were collected on 9 September 1998 by START from the Woonasquatucket River at locations upstream from Source 1 (see Figure 6 in Attachment A of this document) [16, Figure 3A]. Sediment samples SD-31 and SD-32 (duplicate of SD-31) were collected on 9 September 1998 by START from the drainage channel at a location upstream from Source 1 (see Figure 4 in Attachment A of this document) [16, Figure 3A]. The sediment samples were analyzed by EPA Region VII according to EPA Method 1613B for dioxin/furans [4, p. 0001]. The data were validated according to EPA Region I Tier III requirements [4, p. 0001]. The four background samples were used to establish background conditions including the non-ubiquity of TCDD in the environment.

Background Concentration (Sediment)

Sample ID	Sampling Location	Depth	Date	Reference
SD-31	Drainage channel	0 - 6 inches	9 September 1998	35, Table 1, Figure 1C
SD-32 (Duplicate of SD-31)	Drainage channel	0 - 6 inches	9 September 1998	35, Table 1, Figure 1C
SD-33	Woonasquatucket River	0 - 3 inches	9 September 1998	35, Table 1, Figure 1C
SD-34	Woonasquatucket River	0 - 3 inches	9 September 1998	35, Table 1, Figure 1C

TCDD was detected in one of the four sediment samples (SD-33) [4, p. 0033]. The four background samples (SD-31, SD-32, SD-33, and SD-34) were used to document background conditions in upstream reaches of the Woonasquatucket River and the drainage channel.

The background samples SD-31 and SD-32, collected from the most upstream portion of the drainage channel, will be utilized as background samples for downstream sediment samples collected from the drainage channel. Sediment samples SD-31 and SD-32 consisted of medium-to-coarse sand, traces of silt, with some gravel [3, Volume I, p. 39]. Although the matrix of the background samples SD-31 and SD-32 do not correspond exactly with both the contaminated samples collected downstream along the drainage channel (SD-29 and SD-30), they are representative of the depositional environment upstream of the site. It was not possible to collect upstream sediment samples along the drainage channel which would be more representative of the downstream sediment matrices.

The background sediment samples SD-33 and SD-34, collected from the Woonasquatucket River, will be utilized as background samples for downstream sediment samples collected from the Woonasquatucket River. Downstream sediment samples were compared to either sediment sample SD-33 or sediment sample SD-34 based on the similarity of sample matrices between background and contaminated samples [3, Volume I, pp. 33, 37, 39]. Sediment sample SD-33 consisted mostly of medium-to-coarse sand, while sediment sample SD-34 consisted mostly of silt with trace sand and organics [3, Volume I, p. 39]. Contaminated samples were determined by using Table 2-3 of the HRS Final Rule [1, p. 51589; 4, p. 0033; 68, pp. 08 - 11].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
SD-31 (AAL24037)	TCDD	0.00184 UJ ppb	0.00040 ppb	4, p. 0033; 19; 68, p. 08; 74; 75
SD-32 (AAL24038) (Duplicate of SD-31)	TCDD	0.00156 UJ ppb	0.00141 ppb	4, p. 0033; 19; 68, p. 09; 74; 75
SD-33 (AAL24039R)	TCDD	0.01907 J ppb	0.00272 ppb	4, p. 0033; 68, p. 10; 74; 75
SD-34 (AAL24040)	TCDD	0.00968 UJ ppb	0.002899 ppb	4, p. 0033; 19; 68, p. 11; 74; 75

Contaminated Samples (Sediment)

Sediment samples SD-10, SD-11, SD-22, SD-26, SD-27, SD-29, and SD-30 were collected on 9 September 1998 by START according to the EPA approved Task Work Plan [3, Volume I, pp. 33, 37, 39; 16, p. 1, Table 2]. Sediment samples SD-10, SD-11, and SD-22 will be compared to reference sample SD-34, because the matrix of these samples consisted of mostly silt with trace sand and they were collected from the Woonasquatucket River [3, Volume I, pp. 33, 37, 39; 35, p. 0011; 78, p. 2]. Sediment samples SD-26 and SD-27 will be compared to reference sample SD-33 because the matrix of these samples consisted of mostly medium-to-coarse sand and they were collected from the Woonasquatucket River [3, Volume I, pp. 37, 39; 35, p. 0011; 78, p. 2]. While the Woonasquatucket River downstream sediment sample SD-22 and the corresponding background sample SD-34 were collected at a depth of 0 to 3 inches, the remaining downstream sediment samples were collected at varying depth intervals between 0 and 12 inches [3, Volume I, pp. 33, 37, 39].

Sediment samples SD-29 and SD-30 will be compared to reference samples SD-31/SD-32 because all of these sediment samples were collected from the drainage channel [3, Volume I, p. 39; 35, p. 0011; 78, p. 2]. Sediment samples SD-29, SD-31, and SD-32 are all mostly medium-to-coarse sand, while sample SD-30 consists of muck. Lacking a background sample of more similar composition, this sample has also been compared to sediment samples SD-31 and SD-32. The sediment samples were analyzed for dioxins/furans by EPA Method 1613B [4, p.0001]. The data were validated according to EPA Region I Tier III requirements [4, p. 0001].

Sample ID	Sampling Location	Depth	Date	Reference
SD-10	Woonasquatucket River	0 - 6 inches	9 September 1998	35, Table 1, Figure 1B
SD-11	Woonasquatucket River	0 - 12 inches	9 September 1998	35, Table 1, Figure 1B
SD-22	Woonasquatucket River	0 - 3 inches	9 September 1998	35, Table 1, Figure 1B
SD-26	Woonasquatucket River	0 - 6 inches	9 September 1998	35, Table 1, Figure 1C
SD-27	Woonasquatucket River	0 - 6 inches	9 September 1998	35, Table 1, Figure 1C
SD-29	Drainage channel	0 - 6 inches	9 September 1998	35, Table 1, Figure 1C
SD-30	Drainage channel	0 - 6 inches	9 September 1998	35, Table 1, Figure 1C

The following analytical results document the presence of TCDD in the Woonasquatucket River and in the drainage channel downstream of the PPEs to the surface water from the site.

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
SD-10 (AAL24016)	TCDD	0.16094 J ppb	0.001045 ppb	4, p. 0029; 68, p. 01; 74
SD-11 (AAL24017)	TCDD	0.26441 J ppb	0.000439 ppb	4, p. 0029; 68, p. 02; 74
SD-22 (AAL24028)	TCDD	7.46807 J ppb	0.001027 ppb	4, p. 0031; 68, p. 03; 74
SD-26 (AAL24032)	TCDD	0.09224 J ppb	0.001203 ppb	4, p. 0032; 68, p. 04; 74; 79
SD-27 (AAL24033)	TCDD	1.33296 J ppb	0.00047 ppb	4, p. 0032; 68, p. 05; 74
SD-29 (AAL24035)	TCDD	0.0546 J ppb	0.000721 ppb	4, p. 0032; 68, p. 06; 74
SD-30 (AAL24036)	TCDD	15.7381 J ppb	0.008723 ppb	4, p. 0032; 68, p. 07; 74

ppb = Fg/kg

Attribution:

Shallow soil samples were collected from the source on the site on 16 and 17 February 1999 [61, pp. 1, 2, 4, Sections 3.2, 3.2.4]. Analyses of the shallow soil samples collected from Source 1 indicate the presence of TCDD greater than or equal to the background shallow soil sample's SQL value [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. Of the four background sediment samples collected from the Woonasquatucket River and the drainage channel on 9 September 1998, only one sample, SD-33, indicated the presence of TCDD above detection limits [4, p. 0033]. TCDD was present at higher concentrations in sediment samples near the site and gradually decreased in concentration at downstream locations [4, pp. 0029, 0031, 0032]. The distribution of TCDD contamination along the Woonasquatucket River adjacent to and downstream of the site suggests that TCDD is, at least in part, attributable to releases from the identified source located at the site.

Because TCDD is not naturally occurring and not ubiquitous in the North Providence area, its presence at elevated concentrations in the source at the site and observed releases to the surface water pathway as evidenced by sediment in the drainage channel and the Woonasquatucket River downstream of the site support at least partial attribution of TCDD to the site [1, p. 51588, Section 2.2.2].

Based on various sampling events, it is not likely that other sources downstream of the site are significant sources of TCDD. Sediment samples collected downstream of Source 1 do not show a significant increase in concentrations of TCDD, but instead show a gradual decrease in TCDD concentrations with increasing downstream distance from the site, indicating that contamination is not coming from an unidentified source area downstream of Source 1 at the site [62, Attachment B, pp. 03 - 10].

Hazardous Substances Released:

TCDD

Available background information does not document how the fill disposed of on the site came to be contaminated. From at least 1921 to 1940, the site was used for textile manufacturing by the Centredale Worsted Mill and then the Olneyville Wool Combing Company [6, p. 2; 45, p. 002]. Between 1943 and 1971, the site was used by the Atlantic Chemical Company/Metro-Atlantic, Inc., a chemical manufacturer, and New England Container Company, Inc. a drum recycling facility [6, p. 0003]. Aerial photographs taken during the 1960s and 1970s show areas of uncovered, outdoor drum storage in the central area of the site, along with disturbed areas of fill from unknown source(s) in the southern portion of the site [46 - 51]. No additional information regarding the activities of these firms on the site, including information regarding waste disposal practices, was available. During the early 1970s, the former mill building that housed the textile industry and the chemical companies on the site was demolished [36, p. 2]. The fate of the demolition debris is unknown. The Brook Village apartment building was constructed sometime between 1976 and 1979 on Lot 200 at the northern end of the site, and the Centredale Manor apartment building was constructed in 1982 on Lot 250 at the southern end of the site [6, p. 4; 50; 51].

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Observed Release Factor Value: 550

4.1.2.1.2 POTENTIAL TO RELEASE

Because observed release to the Woonasquatucket River and the drainage channel from the site is established based on chemical analysis, Potential to Release was not evaluated [1, p. 51609, Section 4.1.2.1.2].

4.1.2.2 WASTE CHARACTERISTICS

4.1.2.2.1 Toxicity/Persistence

The Toxicity Factor Value and the Persistence Factor Values are assigned to the hazardous substances associated with the sources and releases at the site based on the values presented in the Superfund Chemical Data Matrix (SCDM) [2].

Hazardous Substance	Source	Toxicity Factor Value	Persistence Factor Value	Toxicity/ Persistence Factor Value (Table 4-12)	Reference
TCDD	1	10,000	1	10,000	2, p. B-18

NA = Not available.

From HRS Table 4-12, a Toxicity Factor Value of 10,000 and a Persistence Factor Value of 1 are assigned a Toxicity/Persistence Factor Value of 10,000 [1, p. 51613].

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Toxicity/Persistence Factor Value: 10,000

4.1.2.2.2 Hazardous Waste Quantity

Source	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5)	Is source hazardous constituent quantity data complete? (Yes/No)
1	6.47	No

Sum of values: 6.47

Based on HRS Section 2.4.2.2, if the Hazardous Constituent Quantity is not adequately determined for one or more sources and if any target for the surface water pathway is subject to Level I or Level II concentrations, a factor value is assigned from Table 2-6 or a value of 100, whichever is greater, as the Hazardous Waste Quantity Factor Value for that pathway [1, pp. 51591, 51592].

4.1.2.2.3 Waste Characteristics Factor Category Value

The Toxicity/Persistence Factor Value for TCDD (10,000) is multiplied by the Hazardous Waste Quantity Factor Value for the watershed (100) in order to determine the Waste Characteristics Product, subject to a maximum value of 1×10^8 [1, pp. 51592, 51613]. $10{,}000 \times 100 = 1 \times 10^6$. From HRS Table 2-7, a Waste Characteristics Product of 1×10^6 is assigned a Waste Characteristics Factor Category Value of 32 [1, p. 51592].

Toxicity/persistence factor value × hazardous waste quantity factor value: 1×10^6

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Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 32

4.1.2.3 DRINKING WATER TARGETS

Level I Concentrations

No drinking water intakes exist within the 15-mile downstream pathway [41].

Most Distant Level II Sample

No drinking water intakes exist within the 15-mile downstream pathway [41].

4.1.2.3.1 Nearest Intake

No drinking water intakes exist within the 15-mile downstream pathway [41].

Potential Contamination:

No drinking water intakes exist within the 15-mile downstream pathway [41].

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Nearest Intake Factor Value: 0

4.1.2.3.3 Resources

Surface water quality from the most upstream PPE of the Woonasquatucket River to the combined sewer outfall (CSO) located at Glenbridge Avenue in Providence, Rhode Island is designated as Class B1 [15, p. A-8]. Class B1 waters are designated for primary and secondary activities, and as fish and wildlife habitat, and shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses in which primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges [15, pp. A-2, A-3]. Since Class B1 waters are designated by RI DEM for primary and secondary contact recreational activities, the Woonasquatucket River is considered a designated recreation area, excluding drinking water use, and therefore is assigned a Resource Factor Value of 5 [1, p. 51617, Section 4.1.2.3.3].

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Resources Factor Value: 5

4.2.3.2 WASTE CHARACTERISTICS

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

The Toxicity Factor Value, the Persistence Factor Value, and the Bioaccumulation Factor Value are assigned to the hazardous substances associated with the sources and releases at the site based on the values presented in SCDM [2, p. B-81].

Hazardous Substance	Source	Toxicity Factor Value	Persistence Factor Value	Bioaccu-mulation Value	Toxicity/ Persistence/ Bioaccumulation Factor Value (Table 4-16)	Reference
TCDD	1	10,000	1	5,000	5×10^7	2, p. B-18

From HRS Table 4-12, a Toxicity Factor Value of 10,000 and a Persistence Factor Value of 1 are assigned a Toxicity/Persistence Factor Value of 10,000 [1, p. 51613]. From HRS Table 4-16, a Toxicity/Persistence Factor Value of 10,000 and a Bioaccumulation Factor Value of 5,000 are assigned a Toxicity/Persistence/Bioaccumulation Factor Value of 5×10^7 [1, p. 51619].

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Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^7

4.1.3.2.2 Hazardous Waste Quantity

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5)	Is source hazardous constituent quantity data complete? (Yes/No)
1	6.47	No

Sum of values: 6.47

Based on HRS Section 2.4.2.2, if the Hazardous Constituent Quantity is not adequately determined for one or more sources and if any target for the surface water pathway is subject to Level I or Level II concentrations, a factor value is assigned from Table 2-6 or a value of 100, whichever is greater, as the Hazardous Waste Quantity Factor Value for that pathway [1, pp. 51591, 51592].

4.1.3.2.3 Waste Characteristics Factor Category Value

The Toxicity/Persistence Factor Value for TCDD (10,000) is multiplied by the Hazardous Waste Quantity Factor Value for the watershed (100) in order to determine the Waste Characteristics Product, subject to a maximum value of 1×10^8 [1, pp. 51591, 51620]. $10{,}000 \times 100 = 1 \times 10^6$.

Toxicity/Persistence Factor Value × Hazardous Waste Quantity Factor Value: 1×10^6

The product of the Toxicity/Persistence Factor Value and the Hazardous Waste Quantity Factor Value for the watershed are multiplied by the Bioaccumulation Potential Factor Value (5,000), subject to a maximum value of 1×10^{12} [1, p. 51620]. $1 \times 10^6 \times 5{,}000 = 5 \times 10^9$.

(Toxicity/Persistence × Hazardous Waste Quantity) × Bioaccumulation Potential Factor Value: 5×10^9

From HRS Table 2-7, a Waste Characteristics Product of 5×10^9 is assigned a Waste Characteristics Factor Category Value of 180 [1, pp. 51592].

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Hazardous Waste Quantity Assigned Value: 100
Waste Characteristics Factor Category Value: 180

4.1.3.3 HUMAN FOOD CHAIN THREAT-TARGETS

The Woonasquatucket River is considered a recreational fishery [3, Volume II, p. 34; 65; 93]. According to the Rhode Island Department of Fish and Wildlife, the following fish species are available in the Woonasquatucket River: Blue Gill, White Sucker, Pumkinseed, Large Mouth Bass, American Eel, Golden Shiner, Redfin Pickerel, Creek Chubsucker, Chain Pickerel, Yellow Bullhead, and Rainbow Trout [93]. In June 1996, EPA and Providence Urban Initiative personnel caught three eels from the Woonasquatucket River in the area of the site [42, p. 1]. The three eels were combined into one composite sample for each tissue type (muscle and offal) [82, p. 01]. The muscle and offal samples were submitted to an EPA laboratory for chlorinated pesticides and PCBs, metals, and dioxin/furan analyses. The analytical results indicated the presence of dioxin at elevated levels (0.0917 ppb in eel muscle) [82, p. 08]. Based on elevated dioxin levels detected in eels, a fish consumption advisory was issued by the Rhode Island Department of Health (RI DOH) in 1996 [42, p. 1].

Actual Human Food Chain Contamination

Sediment Samples

The observed releases of contaminants to sediments from the site are established by chemical analysis [4, pp. 0029-0033]. On 9 September 1998, START personnel conducted sediment sampling along the Woonasquatucket River. Analytical results indicate the presence of TCDD when compared to background sample concentrations in accordance with Table 2-3 of the HRS Final Rule [4, pp. 0029-0033].

Sample ID	Distance from Most Downstream Probable Point of Entry	Hazardous Substance	Bioaccumulation Potential Factor Value
SD-10	1.3 miles	TCDD	5,000
SD-11	1.3 miles	TCDD	5,000
SD-22	0.8 miles	TCDD	5,000
SD-26	0.25 miles	TCDD	5,000
SD-27	0.1 miles	TCDD	5,000

Closed Fisheries

Based on elevated dioxin levels detected in fish, a fish consumption advisory was issued by the RI DOH [42, p. 1]. Warning signs have been posted along the Woonasquatucket River which state: “WARNING...FISH CONTAMINATED...DO NOT EAT” [63]. The text on the signs was printed in nine different languages, including English [63].

Identity of fishery	Hazardous Substance
Woonasquatucket River	TCDD

An observed release of TCDD to sediments from the site has been established by chemical analysis [4, pp. 0029-0033]. Of the four background sediment samples collected from the Woonasquatucket River and the drainage channel on 9 September 1998, only one sample, SD-33, indicated the presence of TCDD above detection limits [4, p. 0033]. TCDD was present at higher concentrations in sediment samples collected near the site and gradually decreased in concentration at downstream locations [4, pp. 0029, 0031, 0032]. The distribution of TCDD contamination along the Woonasquatucket River adjacent to and downstream of the site suggests that TCDD is, at least in part, attributable to releases from the identified source located at the site. Because the fishery was closed for human consumption as a result of TCDD contamination, which is at least partially attributable to releases from the site, the Woonasquatucket River fishery is subject to actual human food chain contamination [1, p. 51620, Section 4.1.3.3; 4, pp. 0029-0033; 42, p. 2].

Sample ID	Distance from Most Downstream Probable Point of Entry	Hazardous Substance
SD-10	1.3 miles	TCDD
SD-11	1.3 miles	TCDD

Benthic Tissue

Sample ID	Distance from the probable point of entry	Organism
NE		

Level I

In June 1996, EPA and Providence Urban Initiative personnel caught three eels from the Woonasquatucket River in the area of the site [42, p. 1]. The three eels were combined into one composite sample for each tissue type (muscle and offal) [82, p. 01]. The muscle and offal samples were submitted to an EPA laboratory for chlorinated pesticides and PCBs, metals, and dioxin/furan analyses. The analytical results indicated the presence of dioxin at elevated levels (0.0917 ppb in eel muscle) [82, p. 08]. Based on the results of this sampling event, a fish consumption advisory was issued by RI DOH [42, p. 1]. However, since the location where the eels were collected is not known to be within the boundaries of an observed release, and because eels are not essentially sessile benthic organisms, results from the 1996 eel sampling event have not been used in this evaluation.

Most Distant Level II Sample

Sample ID: SD-10
Distance from the most downstream probable point of entry: 1.3 miles
Reference: 14

Level II Fisheries

Identity of fishery	Extent of the Level II Fishery (Relative to Most Downstream Probable Point of Entry)
Woonasquatucket River	1.3 miles

4.1.3.3.1 **Food Chain Individual**

The Woonasquatucket River fishery is subject to actual contamination, based on the observed release of hazardous substances (TCDD) to the fishery by chemical analysis of sediment samples, and because the fishery was closed due to site-related contamination [4, pp. 0029-0033]. An observed release of a hazardous substance (TCDD) having a Bioaccumulation Factor Value of 500 or greater (5,000) to the in-water segment for the watershed containing fisheries has been established [4, pp. 0029-0033]. Fisheries that are determined to be actual contamination targets based on the chemical analysis of sediment samples are evaluated as subject to Level II contamination since no health-based benchmarks are established for sediment samples [1, p. 51620, Section 4.1.3.3]. Therefore, a Food Chain Individual Factor Value of 45 is assigned [1, p. 51620, Section 4.1.3.3.1].

Sample ID: SD-10, SD-11, SD-22, SD-26, SD-27
Hazardous Substance: TCDD
Bioaccumulation Potential: 5,000

Identity of Fishery	Type of Surface Water Body	References	Dilution Weight
Woonasquatucket River	Small to Moderate Stream	1, p. 51613, Table 4-13; 17; 21, p. 144; 22	0.1

==========

Food Chain Individual Factor Value: 45

4.1.3.3.2 Population

4.1.3.3.2.1 Level I Concentrations

There is insufficient information to document Level I concentrations.

Identity of Fishery	Annual Production (pounds)	Human Food Chain Population Value	Reference
NE (Insufficient information)			

Sum of Human Food Chain Population Values: NE

==========

Level I Concentrations Factor Value: NE

4.1.3.3.2.2 Level II Concentrations

The Woonasquatucket River is considered a recreational fishery [3, Volume II, p. 34; 65; 93]. Based on elevated dioxin levels detected in fish, a fish consumption advisory was issued by RI DOH in 1996 [42, p. 1; 63]. The fishery is still open for catch-and-release fishing along its entire length [65]. No information regarding human food chain production from the fishery prior to the advisory is available [65]. Because the Woonasquatucket River was a recreational fishery prior to the consumption advisory, the annual production of fish for human consumption from the Woonasquatucket River was considered to be greater than 0 pounds [3, Volume II, p. 34]. The 1.3-mile reach of the Woonasquatucket River downstream of the most upstream PPE and upstream of sample SD-10 is evaluated as an actual Level II contamination target [1, p. 51620, Section 4.1.3.3]. The 5.1-mile reach of the Woonasquatucket River downstream of SD-10 is evaluated as a potential contamination target [1, p. 51620, Section 4.1.3.3].

Identity of Fishery	Annual Production (pounds)	Human Food Chain Population Value	Reference
Woonasquatucket River	>0	0.03	1, p. 51621; 3, Volume II, p. 34

==========

Level II Concentrations Factor Value: 0.03

4.1.3.3.2.3 Potential Human Food Chain Contamination

The Woonasquatucket River is considered a recreational fishery [3, Volume II, p. 34; ; 65; 93]. According to the Rhode Island Department of Fish and Wildlife, the following fish species are available in the Woonasquatucket River: Blue Gill, White Sucker, Pumkinseed, Large Mouth Bass, American Eel, Golden Shiner, Redfin Pickerel, Creek Chubsucker, Chain Pickerel, Yellow Bullhead, and Rainbow Trout [93]. Based on elevated dioxin levels detected in fish, a fish consumption advisory was issued by RI DOH in 1996 [42, p. 1]. The fishery is still open for catch-and-release fishing along its entire length [65]. No information regarding human food chain production from the fishery prior to the advisory is available [65]. Because the Woonasquatucket River was a recreational fishery prior to the consumption advisory, the annual production of fish for human consumption from the Woonasquatucket River was considered to be greater than 0 pounds [3, Volume II, p. 34]. The 1.3-mile reach of the Woonasquatucket River downstream of the most upstream PPE and upstream of sample SD-10 is evaluated as an actual contamination target [1, p. 51620, Section 4.1.3.3]. The 5.1-mile reach of the Woonasquatucket River downstream of SD-10 is evaluated as a potential contamination target, along with the remainder of the downstream pathway including the Providence River and Narragansett Bay [1, p. 51620, Section 4.1.3.3].

Identity of Fishery	**Annual Production (pounds)**	**Type of Surface Water Body**	**Average Annual Flow**	**Ref.**	**Population Value (P_i)**	**Dilution Weight (D_i)**	**$P_i \times D_i$**
Woonasquatucket River	>0	Small to moderate stream	73 cfs	65	0.03	0.1	0.003
Providence River	>0	Coastal tidal waters	NA	70; 77; 83	0.03	0	0
Narragansett Bay	>0	Coastal tidal waters	NA	71	0.03	0	0

Sum of $P_i \times D_i$: 0.003006 [1, p. 51621, Section 4.1.3.3.2.3, Table 4-18]
(Sum of $P_i \times D_i$) ÷ 10: 0.0003006 [1, p. 51621, Section 4.1.3.3.2.3, Table 4-18]

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Potential Human Food Chain Contamination Factor Value: 0.0003006

4.1.4.2 WASTE CHARACTERISTICS

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

The Ecosystem Toxicity Factor Value and the Persistence Factor Value are assigned to the hazardous substances associated with the sources and releases at the site based on the values presented in SCDM [2].

Hazardous Substance	Source	Ecosystem Toxicity Factor Value	Persistence Factor Value	Ecosystem Toxicity/ Persistence Factor Value (Table 4-20)	Reference
TCDD	1	10,000	1	10,000	2, p. B-18

Hazardous Substance	Ecosystem Toxicity Persistence Factor Value	Bio-accumulation Factor Value (Section 4.1.3.2.1.2)	Ecosystem Toxicity/ Persistence/ Bioaccumulation Factor Value (Table 4-21)	Reference
TCDD	10,000	5000	5×10^7	2, p. B-18

From HRS Table 4-21, and Ecosystem Toxicity/Persistence Factor Value of 10,000 and a Bioaccumulation Factor Value of 5,000 are assigned an Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value of 5×10^7 [1, p. 51623].

==========

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^7

4.1.4.2.2. Hazardous Waste Quantity

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5)	Is source hazardous constituent quantity data complete? (Yes/No)
1	6.47	No

Sum of values: 6.47

Based on HRS Section 2.4.2.2, if the Hazardous Constituent Quantity is not adequately determined for one or more sources and if any target for the surface water pathway is subject to Level I or Level II concentrations, a factor value is assigned from Table 2-6 or a value of 100, whichever is greater, as the Hazardous Waste Quantity Factor Value for that pathway [1, pp. 51591, 51592].

4.1.4.2.3. Waste Characteristics Factor Category Value

The Ecosystem Toxicity Factor Value for the watershed (10,000) and the Persistence Factor Value for TCDD (1) are multiplied in order to determine the Ecosystem Toxicity/Persistence Factor Value (10,000) [1, p. 51624, Section 4.1.4.2.1.4, Table 4-20]. The Ecosystem Toxicity/Persistence Factor Value for the watershed (10,000) is multiplied by the Hazardous Waste Quantity Factor Value for the watershed (100) in order to determine the Waste Characteristics Product, subject to a maximum value of 1×10^8 [1, pp. 51592, 51624]. $10{,}000 \times 100 = 1 \times 10^6$.

Ecosystem Toxicity/Persistence Factor Value × Hazardous Waste Quantity Factor Value: 1×10^6

The Waste Characteristics Product for the watershed (subject to a maximum value of 1×10^8) is multiplied by the Bioaccumulation Potential Factor Value (5,000), to generate a second product, subject to a maximum value of 1×10^{12} [1, p. 51624]. $1 \times 10^6 \times 5{,}000 = 5 \times 10^9$.

(Ecosystem Toxicity/Persistence × Hazardous Waste Quantity) × Bioaccumulation Potential Factor Value: 5×10^9

From HRS Table 2-7, the second Waste Characteristics Product (5×10^9) is assigned a Waste Characteristics Factor Category Value of 180 [1, pp. 51592, 51624].

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Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 180

4.1.4.3 **ENVIRONMENTAL THREAT - TARGETS**

Surface water quality from the most upstream PPE of the Woonasquatucket River to the CSO located at Glenbridge Avenue in Providence, Rhode Island is designated as Class B1 (see Figure 5 of Attachment A of this document) [15, p. A-8]. Class B1 waters are designated for primary and secondary contact recreational activities or 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 [15, pp. A-2, A-3]. The Woonasquatucket River from the CSO located at Glenbridge Avenue in Providence, Rhode Island to the confluence with the Providence River, Providence, Rhode Island is designated as Class B1{a} [15, p. A-8]. Class B1{a} waters have to meet all Class B criteria, but have a partial use designation due to impacts from CSOs [15, pp. A-3, A-4]. Class B waters are designated for fish and wildlife habitat and primary and secondary contact recreational activities. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. They shall have good aesthetic value [15, p. A-2].

Surface water quality of the Providence River from its confluence with the Moshassuck and Woonasquatucket Rivers in Providence, Rhode Island south to a line extending from a point on a shore due east of Naushon Avenue in Warwick, Rhode Island to the western terminus of Beach Road in East Providence, Rhode Island, including Watchemoket Cove, is designated as Class SB1{a} [15, p. A-11]. Class SB1{a} waters are designated for primary and secondary contact recreational activities and fish and wildlife habitat. They shall be suitable for aquacultural uses, navigation, and industrial cooling. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges [15, pp. A-3, A-4]. Class SB1{a} waters have to meet all Class SB criteria, but have a partial use designation due to impacts from CSOs [15, pp. A-3, A-4].

The Providence River south of a line from a point on shore due east of Naushon Avenue in Warwick, Rhode Island to the western terminus of Beach Road in East Providence, Rhode Island and north of a line from Conimicut Point in Warwick, Rhode Island to Old Tower at Nayatt Point in Barrington, Rhode Island is designated as Class SB{a} [15, p. A-11]. Class SB{a} waters are designated for primary and secondary contact recreational activities; shellfish harvesting for controlled relay and depuration; and fish and wildlife habitat. These waters shall be suitable for aquacultural usage, navigation, and industrial cooling. These waters shall have good aesthetic value. These waters may have a partial use designation due to impacts from CSOs [15, pp. A-3, A-4].

Surface water quality of upper Narragansett Bay, from the Conimicut Point-Nayatt Point boundary south, including the waters south of a line from Adams Point in Barrington, Rhode Island to Jacobs Point in Warren, Rhode Island, to a line extending from Warwick Point in Warwick, Rhode Island through Providence Point on Prudence Island to Popasquash Point in Bristol, Rhode Island is designated as Class SA [15, p. A-11]. Class SA waters are considered waters which are designated for shellfish harvesting for direct human consumption, primary and secondary contact recreational activities, and fish and wildlife habitat, and are suitable for aquacultural usage, navigation, and industrial cooling. These waters shall have good aesthetic value [15, p. A-3]

These water quality classifications denote the water quality goals for the waterbody as listed in rule 8.B of the regulations, not the present conditions [15, p. A-2]. Water quality standards are intended to protect public health, safety and welfare, enhance the quality of water and serve the purposes of the Clean Water Act and Chapter 46-12 of the General Laws of Rhode Island [15, p. 10].

The Class B1 designation for the Woonasquatucket River by RI DEM indicates that it meets the requirement for the environmental threat target “State-designated areas for the protection or maintenance of aquatic life” designated under section 305(a) of the Clean Water Act [1, p. 51624, Table 4-23].

Narragansett Bay is designated as a sensitive area under the National Estuary Program [37]. The National Estuary Program designation indicates that Narragansett Bay meets the requirements for the environmental threat target "Sensitive areas identified under National Estuary Program or Near Coastal Waters Program" [1, p. 51624, Table 4-23].

Wetlands located along the Woonasquatucket River to Lymansville Dam and along the drainage channel on the site are subject to Level II concentrations [1, p. 51625, Section 4.1.4.3.1.2; 27]. There are also additional wetlands along the remainder of the surface water pathway subject to potential contamination (See Figure 4 in Attachment A of this document) [13; 27].

Most Distant Level II Sample

The observed release to surface water from the site is established by chemical analysis [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. The most distant Level II sediment sample, designated SD-10, was collected from the Lymansville Dam area in Providence, Rhode Island [3, Volume I, pp. 8, 33; 14].

Sample ID: SD-10
Distance from the most downstream probable point of entry: 1.3 miles
Reference: 3, Volume I, pp. 8, 33; 4, p. 0029; 14

4.1.4.3.1 Sensitive Environments

4.1.4.3.1.1. Level I Concentrations

The observed release to surface water from the site is established by sediment sample analytical results [4, p. 0029-0033]. Sensitive environments that are determined to be actual contamination targets based on sediment sample analytical results, for which no ecological-based benchmarks are applicable, are evaluated as subject to actual contamination at Level II [1, p. 51625, Section 4.1.4.3.1]. Therefore, no Level I sensitive environments have been identified.

Sensitive Environments

NA

Sum of Sensitive Environments Value: NA

Wetlands

NA

Wetland Value: NA

Sum of Sensitive Environments Value + Wetland Value: 0

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Level I Concentrations Factor Value: 0

4.1.4.3.1.2. Level II Concentrations

Sensitive environments which were determined to be actual contamination targets based on chemical analysis of sediment samples are evaluated using Level II concentrations [1, p. 51625, Section 4.1.4.3.1]. An observed release to surface water from the site has been established as far south as Lymansville Dam area in Lymansville, Rhode Island, 1.3 miles downstream of the most downstream PPE [3, Volume II, p. 23; 4, pp. 0029-0033].

Sensitive Environments

The Woonasquatucket River is designated as Class B1 (from PPE to the most downstream sediment sample which documents Level II actual contamination) under water quality standards that are intended to protect public health, safety, and welfare, enhance the quality of water and serve the purposes of the Clean Water Act and Chapter 46-12 of the General Laws of Rhode Island [15, p. 10].

Sensitive Environment	Distance from Probable Point of Entry to Nearest Point of Sensitive Environment	Sensitive Environment Value(s)	Reference
State-designated area for the protection of or maintenance of aquatic life	0 feet	5	4, pp. 0029-0033; 35, Figures 1B, 1C; 62, Figures 3A, 3B; 84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19

Sum of Sensitive Environments Value: 5

Wetlands

Approximately 1.2 miles of wetland frontage exists along the Woonasquatucket River and drainage channel from the PPEs to the most downstream sample location which documents Level II contamination [13; 27]. Greater than 1 to 2 miles of wetland frontage is assigned a Wetland Rating Value of 50 [1, p. 51625, Table 4-24].

Wetland	Wetland Frontage	Reference
Woonasquatucket River wetlands	0.8 miles	13; 27
Drainage channel wetlands	0.4 miles	13; 27

Total Wetland Frontage: 1.2 miles

Wetland Value: 50

Sum of Sensitive Environments Value + Wetland Value: 55

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Level II Concentrations Factor Value: 55

4.1.4.3.1.3 Potential Contamination

The mean annual flow rate of the portion of the Woonasquatucket River between the most downstream sediment sample documenting Level II contamination of the fishery and the 15-mile downstream target distance limit is documented by one USGS gaging station. The USGS maintains gaging station Number 01114500 on the Woonasquatucket River approximately 0.1 miles upstream of the most upstream PPE to the Woonasquatucket River [17; 21, p. 144]. The drainage basin of the Woonasquatucket River upstream of USGS gaging station No. 01114500 is 38.3 mi^2 [21, p. 144]. The mean annual flow rate of the Woonasquatucket River measured at USGS gaging station 01114500 is 73.3 cfs, based on records from 1941 to 1997 [21, p. 144]. Based on the drainage basin area and mean annual flow rate of the Woonasquatucket River, a mean annual flow rate estimating factor specific to the Woonasquatucket River can be calculated as 73.3 cfs ÷ 38.3 mi^2, which equals 1.91cfs/mi^2. From the most upstream PPE to the Woonasquatucket River, the river flows 6.4 miles downstream to its mouth at the Providence River, where its drainage basin area is 50.72 mi^2 [22; 23]. Using the mean annual flow rate estimating factor specific to the Woonasquatucket River of 1.91 cfs/mi^2, the estimated mean annual flow rate at the mouth of the Woonasquatucket River is 50.72 mi^2 × 1.91 cfs/mi^2, which equals 96.88 cfs. Therefore, the entire reach of the Woonasquatucket River downstream of the site has a mean annual flow rate between 10 and 100 cfs. From HRS Table 4-13, a small to moderate stream (greater than 10 cfs to 100 cfs mean annual flow rate) is assigned a dilution weight of 0.1 [1, p. 51613].

Sensitive Environments

One sensitive environment was identified along the 13.7 miles of the hazardous substance migration pathway between the most downstream sediment sample that documents Level II contamination and the 15-mile downstream target distance limit. Narragansett Bay is designated as a sensitive area identified under the National Estuary Program [37, p. 1 of 3]. Sensitive areas identified under the National Estuary Program are assigned a Sensitive Environment Value of 100 [1, p. 51624, Table 4-23].

Type of Surface Water Body	Sensitive Environment	Sensitive Environment Value(s)	Reference
Coastal tidal waters	Sensitive areas identified under National Estuary Program or Near Coastal Waters Program	100	1, p. 51624, Table 4-23; 37, p. 1 of 3

Wetlands

Approximately 0.4 miles of wetland frontage exist from the most downstream sediment sample location that documents Level II actual contamination to Lymansville Dam within the 15-mile downstream target distance limit [13; 27]. Wetland frontage between 0.1 and 1 mile is assigned a Wetland Rating Value of 25 [1, p. 51625, Table 4-24].

Type of Surface Water Body	Wetlands Frontage	Wetlands Value for Type of Surface Water Body	Reference
Small to moderate stream	0.4	25	13; 27

Type of Surface Water Body	Sum of Sensitive Environment Values (S_j)	Wetland Frontage Value (W_j)	Dilution Weight (D_j)	$D_j \times (W_J + S_J)$
Small to moderate stream	0	25	0.1	2.5
Coastal tidal waters	100	0	0.0001	0.01

Sum of $D_j(W_j + S_j)$: 2.51
(Sum of $D_j(W_j + S_j)$)/10: 0.251

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Potential Contamination Factor Value: 0.251

4.2 GROUND WATER TO SURFACE WATER MIGRATION COMPONENT

Not evaluated.

5.0 SOIL EXPOSURE PATHWAY

5.0.1 GENERAL CONSIDERATIONS

Letter (A, B, etc.) by which this area is to be identified: A

Name and description of the area: Contaminated Fill (Contaminated Soil)

The Contaminated Fill area (Area A) is an area of soil contaminated with TCDD. Area A is defined as the area within the following 11 shallow soil sample locations: CMS-030, CMS-031, CMS-050, CMS-060, CMS-061, CMS-067, CMS-098, CMS-131, CMS-134, CMS-152, and CMS-242 (see Figure 3 in Attachment A of this document) [7, p. 1 of 4; 18; 61, Appendix C, pp. 30, 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. Each of the aforementioned shallow soil samples establish observed contamination within Area A with TCDD at concentrations greater than or equal to the SQL of the background shallow soil sample, CMS-026 [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19].

Based on visual observations and GIS data, approximately 50% of Area A is covered with maintained asphalt paving and building footprints and approximately 40% of the source is covered with maintained lawns [3, Volume II, pp. 25 - 27, 32, 33; 7, pp. 1 of 4, 2 of 4]. The southern end of the contaminated soil source, approximately 10% of the total area of Area A, has no apparent cover and waste material is visible at the surface [3, Volume II, pp. 25 - 27, 33].

Using GIS and ArcView software, the area of observed contamination with TCDD (within the boundaries of the 11 shallow soil sample locations) is an estimated 113,328 square feet [7, pp. 1 of 4, 4 of 4]. The area of observed contamination does not include the portion of Area A which lies under maintained asphalt paving or within the footprints of on-site buildings [1, p. 51646; 7, pp. 1 of 4, 2 of 4, 4 of 4].

Location of the area, with reference to a map of the site:

Area A occupies most of the parcels designated by the North Providence Tax Assessor's Office as Plat Number 14, Lots 200 and 250 (see Figure 3 in Attachment A of this document) [7, pp. 1 of 4, 4 of 4; 12]. Area A is bounded by 11 shallow soil sample locations, and extends approximately 135 feet south of the southernmost parking area to the south, within 10 feet of the western side of the drainage swale to the east, to the shallow soil sample location CMS-030 to the north of the Brook Village apartment building, and parallel to the Woonasquatucket River to the west [7, pp. 1 of 4, 3 of 4; 18].

Background Samples

REAC personnel collected shallow soil samples from the site on 16 and 17 February 1999 [61, pp. 1, 2, Section 3.2]. The shallow soil samples were analyzed for dioxins/furans by EPA Method 8290 [61, p. 4, Section 3.2.5; 84, p. 1; 85, p. 1; 86, p. 1; 87, p. 1]. One of the samples, CMS-026, was selected as the reference shallow soil sample due to its location outside the contaminated fill area at the site, as evidenced by its non-detection of TCDD [86, p. 16].

Shallow soil sample CMS-026 was described as loam [61, Appendix C, p. 30]. The matrix of the reference shallow soil sample is comparable to the 11 shallow soil samples used to establish observed contamination [61, Appendix C, pp. 30, 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. Additionally, the reference shallow soil sample and the 11 shallow soil samples used to establish observed contamination were all collected from a depth of 0 to 3 inches [61, p. 4, Section 3.2.4].

Because TCDD is not naturally-occurring, it is sufficient to document its presence in this source by the chemical analysis of contaminated source samples. However, background concentrations have been provided to further support association of TCDD to Area A, and to demonstrate TCDD is not ubiquitous to the area.

Sample ID	Depth	Date	Reference
CMS-026	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
CMS-026	TCDD	0.0047 UJ ppb	0.0047 UJ ppb	86, p. 16; 89

For the purposes of this package, shallow soil sample concentrations greater than or equal to the background shallow soil sample concentration for CMS-026 can be used to establish observed contamination [1, pp. 51589, 51646].

Contaminated Samples

On 16 and 17 February 1999, REAC personnel collected 222 shallow soil samples (not including QA/QC samples) from the site and from the floodplain downstream of the site [61, pp. 1, 2, 4, Section 3.2, 3.2.4]. Sampling activities were conducted in accordance with the EPA Region I, EPA ERT, RI DEM, and the Centredale Manor Management Action Committee approved Task Work Plan, dated 5 February 1999 and approved 10 February 1999 [61, pp. 1, 2, Section 3.2; 91, pp. 1, 2]. The samples were submitted to a private laboratory for dioxin/furan analysis by EPA Method 8290 [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01]. The data were validated according to EPA Region I Tier III requirements [84, p. 01; 85, p. 01; 86, p. 01; 87, p. 01].

Among the 11 selected shallow soil samples, TCDD was detected at a maximum concentration of 115.82 ppb in the contaminated fill, in shallow soil sample CMS-060 [85, p. 15]. Concentrations of TCDD were greater than or equal to the background shallow soil sample's SQL value in all 11 of the aforementioned shallow soil samples collected from and delineating Area A at the site [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19].

Sample ID	Depth	Date	Reference
CMS-030	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 34
CMS-031	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 35
CMS-050	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 53
CMS-060	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 63
CMS-061	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 64
CMS-067	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 70
CMS-098	0 to 3 inches	17 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 101
CMS-131	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 135
CMS-134	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 138
CMS-152	0 to 3 inches	16 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 156
CMS-242	0 to 3 inches	17 February 1999	61, p. 4, Section 3.2.4, Appendix C, p. 249

TCDD was detected in each of the above-mentioned shallow soil samples collected on 16 and 17 February 1999 [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. The background shallow soil concentration of TCDD has been established using analytical results for shallow soil sample CMS-026. Shallow soil sample CMS-026 was described as loam, which is comparable to the samples that are used to document observed contamination [61, Appendix C, pp. 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. Therefore, for the purpose of this package, shallow soil sample concentrations which are greater than or equal to the background sample's SQL value can be used to establish observed contamination [1, p. 51646].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Background Sample Concentration	Reference
CMS-030	TCDD	0.094 J ppb	0.000989 ppb	0.0047 UJ ppb	86, p. 16; 89; 90
CMS-031	TCDD	0.103 J ppb	0.000986 ppb	0.0047 UJ ppb	86, p. 16; 89; 90
CMS-050	TCDD	0.053 J ppb	0.000995 ppb	0.0047 UJ ppb	85, p. 14; 86, p. 16; 89; 90
CMS-060	TCDD	115.82 $J ppb	0.09998 ppb	0.0047 UJ ppb	85, p. 15; 86, p. 16; 89; 90
CMS-061	TCDD	0.161 J ppb	0.000988 ppb	0.0047 UJ ppb	85, p. 15; 86, p. 16; 89; 90
CMS-067	TCDD	0.115 J ppb	0.09877 ppb	0.0047 UJ ppb	85, p. 16; 86, p. 16; 89; 90
CMS-098	TCDD	28.04 $J ppb	0.09954 ppb	0.0047 UJ ppb	86, p. 16; 87, p. 15; 89; 90
CMS-131	TCDD	3.3 $J ppb	0.09690 ppb	0.0047 UJ ppb	84, p. 14; 86, p. 16; 89; 90
CMS-134	TCDD	15.52 $ ppb	0.09972 ppb	0.0047 UJ ppb	84, p. 15; 86, p. 16; 89; 90
CMS-152	TCDD	1.3 $ ppb	0.09933 ppb	0.0047 UJ ppb	84, p. 15; 86, p. 16; 89; 90
CMS-242	TCDD	20.27 $J ppb	0.09963 ppb	0.0047 UJ ppb	86, p. 16; 87, p. 19; 89; 90

TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
ppb = parts per billion
J = Indicates estimated result.
UJ = Indicates non-detect result.
$ = TCDD reported from a 1:100 dilution analysis.

Note: ppb = Fg/kg

Attribution

Available background information does not document how the fill disposed of on the site came to be contaminated. From at least 1921 to 1940, the site was used for textile manufacturing by the Centredale Worsted Mill and then the Olneyville Wool Combing Company [6, p. 2; 45, p. 002]. Between 1943 and 1971, the site was used by the Atlantic Chemical Company/Metro-Atlantic, Inc., a chemical manufacturer, and New England Container Company, Inc., a drum recycling facility [6, p. 0003]. Aerial photographs taken during the 1960s and 1970s show areas of uncovered, outdoor drum storage in the central area of the site, along with disturbed areas of fill from unknown source(s) in the southern portion of the site [46 - 51]. No additional information regarding the activities of these firms on the site, including information regarding waste disposal practices, was available. During the early 1970s, the former mill building that housed the textile industry and the chemical companies on the site was demolished [36, p. 2]. The fate of the demolition debris is unknown. The Brook Village apartment building was constructed sometime between 1976 and 1979 on Lot 200 at the northern end of the site, and the Centredale Manor apartment building was constructed in 1982 on Lot 250 at the southern end of the site [6, p. 4; 50; 51].

During the late 1970s and early 1980s, drums containing hazardous substances were discovered and removed from the site. Some of the drums were partially buried within fill at the site, and many were in poor condition and are suspected to have leaked their contents into the ground [52 - 57]. RI DEM personnel reported chemical deposits and vegetation "kill areas" throughout the drum disposal area, apparently the result of spillage or leakage from the drums [52, p. 1]. Between February and April 1982, visible drums were removed from the site to a secure landfill or regular landfill (depending on whether they contained hazardous substances) under the supervision of RI DEM [55, p. 0001; 60, pp. 0023, 0024].

The site is the only known source of TCDD in the area, although historical information regarding waste disposal at the site is not available. Attribution of hazardous substances in Area A at the site is based primarily on analytical data.

On 16 and 17 February 1999, REAC personnel collected 222 shallow soil samples from the site and from the floodplain downstream of the site [61, pp. 1, 2, Section 3.2, p. 4, Section 3.2.4]. Eleven shallow soil samples (CMS-030, CMS-031, CMS-050, CMS-060, CMS-061, CMS-067, CMS-098, CMS-131, CMS-134, CMS-152, and CMS-242) were collected at a depth interval of 0 to 3 inches from sample locations in contaminated fill in Area A at the site [61, p. 4, Section 3.2.4].

In the 11 selected shallow soil samples, TCDD was detected at a maximum concentration of 115.82 ppb in the contaminated fill, in shallow soil sample CMS-060 [85, p. 15]. Concentrations of TCDD were greater than or equal to the background shallow soil sample's SQL value in all 11 of the aforementioned shallow soil samples collected from Area A at the site [84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. Therefore, attribution of hazardous substances to the area is documented by chemical analysis of samples collected from the area.

Area Hazardous Waste Quantity

The Hazardous Waste Quantity of Area A was calculated based on the Area Factor Value of contaminated soil. The Hazardous Constituent Quantity and Hazardous Wastestream Quantity Values were not evaluated for Area A because insufficient information was available [1, p. 51647, Table 5-2]. The Volume Factor Value was not calculated for Area A because a "contaminated soil" area type may not be evaluated for the Volume Factor Value [1, p. 51647, Table 5-2].

Hazardous Constituent Quantity

There is insufficient information to evaluate the source for Hazardous Constituent Quantity.

Hazardous Substance	Constituent Quantity		Reference
	(pounds)	(Mass-S)	
NE (Insufficient information)			

Sum:

Hazardous Constituent Quantity Value (S): NE

Hazardous Wastestream Quantity

There is insufficient information to evaluate the source for Hazardous Wastestream Quantity.

Hazardous Wastestream	Quantity (pounds)	References
NE (Insufficient information)		

Sum:

Hazardous Wastestream Quantity Value (W): NE

Volume

Since a volume measurement of Area A is not applicable for the soil exposure pathway, a value of 0 is assigned [1, p. 51591, Section 2.4.2.1.3].

Dimension of source (yd^3 or gallons):

References(s):

Volume Assigned Value: 0

Area

The area of Area A was determined by considering the sampling locations of observed contamination with TCDD and the area lying between such locations, with the exception of the parts of Area A which are covered with maintained asphalt paving and building footprints [1, p. 51646, Section 5.0.1; 3, Volume II, pp. 25, 26 ; 7, pp. 1 of 4, 2 of 4, 4 of 4; 18].

The area of Area A was calculated as follows. Sample locations which document observed contamination with TCDD (CMS-030, CMS-031, CMS-050, CMS-060, CMS-061, CMS-067, CMS-098, CMS-131, CMS-134, CMS-152, and CMS-242) were located using global positioning system hardware and plotted on a scale drawing of the site via GIS and ArcView software. The boundary of the area of observed contamination comprising Area A is the line connecting these sample location points. In order to calculate the area of Area A, ArcView calculated the area of the polygon which was drawn connecting the above-mentioned sample locations [7, pp. 1 of 4, 3 of 4]. Subsequently, the areas of asphalt paving and the areas of the footprints of the Brook Village building, the Centredale Manor building, a gazebo, and a maintenance shed were calculated (in the same manner) and subtracted from the total area of the polygon. [7, pp. 1 of 4, 4 of 4] Area A (not including the paved areas and building footprints) is approximately 113,328 square feet [7, p. 1 of 4].

Area of area of observed contamination (ft^2): 113,328

Reference(s): 7, p. 1 of 4; 18

The area of a “contaminated soil” area is divided by 34,000 to assign a Hazardous Waste Quantity to the area [1, p. 51647, Table 5-2]. 113,328 square feet ÷ 34,000 = 3.33

Area Assigned Value: 3.33

Area Hazardous Waste Quantity Value

The Hazardous Waste Quantity Value for Area A was assigned based on the Area Factor Value (3.33) [1, p. 51591, Section 2.4.2.1.5].

==========

Area of Observed Contamination Hazardous Waste Quantity Value: 3.33

Summary of Site Contamination

Level I Samples

Area A

The concentrations of TCDD detected in all 11 shallow soil samples used to document observed contamination in Area A are greater than the screening concentration for cancer risk for TCDD (0.004 ppb) [2, p. B-81; 84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. Out of the 11 shallow soil samples used to document observed contamination, five shallow soil samples were collected within 200 feet of the Centredale Manor and Brook Village apartment buildings. The nearest of the shallow soil samples (CMS-098) to the Centredale Manor apartment building was collected approximately 50 feet west of the Centredale Manor apartment building on Plat 14, Lot 250 [7, p. 3 of 4; 12; 18]. The nearest of the shallow soil samples (CMS-031) to the Brook Village apartment building was collected approximately 120 feet north of the Brook Village apartment building on Plat 14, Lot 200 [7, p. 3 of 4; 12; 18].

Sample ID: CMS-030, CMS-031, CMS-050, CMS-098, CMS-134
Reference for Benchmarks: 2, p. B-81

Hazardous Substance	Hazardous Substance Concentration	Benchmark Concentration	Benchmark
TCDD	0.094 J ppb (CMS-030)	0.004 ppb	Screening concentration for cancer risk
TCDD	0.103 J ppb (CMS-031)	0.004 ppb	Screening concentration for cancer risk
TCDD	0.053 J ppb (CMS-050)	0.004 ppb	Screening concentration for cancer risk
TCDD	28.04 $ J ppb (CMS-098)	0.004 ppb	Screening concentration for cancer risk
TCDD	15.52 $ ppb (CMS-134)	0.004 ppb	Screening concentration for cancer risk

J = Indicates estimated result.
$ = Indicates 1:100 dilution ratio.

Level II Samples

The concentrations of TCDD detected in all 11 shallow soil samples used to document observed contamination are greater than the cancer risk concentration for TCDD (0.004 ppb) [2, p. B-81; 84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. Therefore, because no shallow soil samples used to document observed contamination with TCDD are at Level II, Level II concentrations will not be evaluated.

Sample ID	Hazardous Substance
NA	

5.1 **RESIDENT POPULATION THREAT**

Two residences (the Brook Village and Centredale Manor apartment buildings) are located on Lot 200 and Lot 250, respectively, and within the area of observed contamination. The residences listed in the following table are located within 200 feet of shallow soil samples CMS-030, CMS-031, CMS-098, CMS-131, and CMS-134, which document observed contamination with TCDD at concentrations exceeding the cancer risk concentration (see Figure 3 in Appendix A of this document) [2, p. B-18; 84, pp. 14, 15; 86, p. 16; 87, p. 15].

Sample ID	**Location of Population Relative to Observed Contamination**
CMS-030	Sample CMS-030 was collected within 200 feet of the Brook Village apartment building, on the same property (Plat 14, Lot 200).
CMS-031	Sample CMS-031 was collected within 200 feet of the Brook Village apartment building, on the same property (Plat 14, Lot 200).
CMS-098	Sample CMS-098 was collected within 200 feet of the Centredale Manor apartment building, on the same property (Plat 14, Lot 250).
CMS-131	Sample CMS-131 was collected within 200 feet of the Centredale Manor apartment building, on the same property (Plat 14, Lot 250).
CMS-134	Sample CMS-134 was collected within 200 feet of the Centredale Manor apartment building, on the same property (Plat 14, Lot 250).

5.1.1 Likelihood of Exposure

An area of observed contamination is located within the property boundaries of two residences and within 200 feet of the residences; therefore a Likelihood of Release Factor Category Value of 550 is assigned [1, p. 51646, Section 5.1.1].

==========

Resident Population Threat Likelihood of Exposure Factor Category Value: 550

5.1.2 Waste Characteristics

5.1.2.1 Toxicity

Shallow soil samples from the site were collected on 16 and 17 February 1999 at depths no greater than 2 feet [61, p. 4, Section 3.2.4, Appendix C, pp. 30, 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. The samples document observed contamination with TCDD at concentrations greater than or equal to the background shallow soil sample's SQL value of the same hazardous substance, which were collected from the same vicinity, at comparable depths, and analyzed using the same analytical methods [18; 61, p. 4, Sections 3.2.4 and 3.2.5; 84, p. 1; 85, p. 1; 86, p. 1; 87, p. 1].

Hazardous Substance	Toxicity Factor Value	Reference
TCDD	10,000	2, p. B-18

The hazardous substance with the highest toxicity (TCDD) is used to assign the value to the Toxicity Factor for the Residential Population Threat [1, p. 51646, Section 5.1.2.1].

==========

Toxicity Factor Value: 10,000

5.1.2.2 Hazardous Waste Quantity

The Hazardous Waste Quantity Factor Value was assigned as specified in Section 2.4.2, based on the Area Factor Value for Area A, and the Hazardous Constituent Quantity Factor Value for Area A.

Area Letter	Area Hazardous Waste Quantity Value	Constituent Quantity Data Complete (Yes/No)
A	3.33	No

Sum of values: 3.33

Based on HRS Section 2.4.2.2, if the Hazardous Constituent Quantity is not adequately determined for one or more sources and if any target for the soil exposure pathway is subject to Level I or Level II concentrations, a factor value is assigned from Table 2-6 or a value of 10, whichever is greater, as the Hazardous Waste Quantity Factor Value for that pathway [1, pp. 51591, 51592].

5.1.2.3 Calculation of Waste Characteristics Factor Category Value

The Toxicity Factor Value for TCDD (10,000) is multiplied by the Hazardous Waste Quantity Factor Value for the site (10) in order to determine the Waste Characteristics Product, subject to a maximum value of 1×10^8 [1, p. 51591, Section 2.4.3.1]. $10{,}000 \times 10 = 100{,}000$

Toxicity Factor Value × Hazardous Waste Quantity Factor Value: 100,000

From HRS Table 2-7, a Waste Characteristics Product of 100,000 is assigned a Waste Characteristics Factor Category Value of 18 [1, p. 51592].

==========

Hazardous Waste Quantity Factor Value: 10
Waste Characteristics Factor Category Value: 18

5.1.3 TARGETS

5.1.3.1 Resident Individual

Shallow soil sample locations CMS-030, CMS-031, CMS-098, CMS-131, and CMS-134 are located on the properties identified by the North Providence Tax Assessor's office as Plat 14, Lots 200 and 250 [12; 18]. The Brook Village and Centredale Manor apartment buildings are located on Lot 200 and Lot 250, respectively, and are located within 200 feet of the above-mentioned shallow soil sample locations. Shallow soil samples CMS-030, CMS-031, CMS-098, CMS-131, and CMS-134, collected at a depth of 0 to 3 inches, document observed contamination with TCDD at concentrations ranging from 0.094 ppb to 28.04 ppb, which are greater than the cancer risk concentration for TCDD (0.004 ppb) [1, pp. 51646, Section 5.0.1; 2, p. B-81; 84, pp. 14, 15; 86, p. 16; 87, p. 15]. Since Lot 200 and Lot 250 are residential properties and the area of observed contamination on the properties is within 200 feet of the residences on the properties, a Level I resident individual is documented [1, p. 51647, Section 5.1.3].

Area Letter: A
Level of Contamination: Level I

Reference: 2, p. B-81; 84, pp. 14, 15; 86, p. 16; 87, p. 15

A resident individual is subject to Level I concentrations; therefore, a Resident Individual Factor Value of 50 is assigned [1, p. 51647, Section 5.1.3.1].

==========

Resident Individual Factor Value: 50

5.1.3.2 Resident Population

The number of residents or students on properties subject to observed contamination was documented using available population information, and was not estimated.

5.1.3.2.1 Level I Concentrations

The residents of the Centredale Manor apartment building, located on Plat 14, Lot 250, which is within 200 feet of the area of observed contamination (Area A), are subject to a Level I concentration of TCDD [1, p. 51647; 2, p. B-81; 84, pp. 14, 15; 86, p. 16; 87, p. 15]. According to the manager of the Centredale Manor apartment building, building files indicate that the number of resident individuals is 133 [8]. According to the manager of the Brook Village apartment building, building files indicate that the number of resident individuals is 125 [10]. Therefore, the total number of resident individuals occupying the Centredale Manor and the Brook Village apartment buildings is 258 [8; 10]

Area Letter	Resident Individuals	Total
A	258	258

References: 8; 10

Sum of individuals subject to Level I concentrations: 258

5.1.3.2.2 Level II Concentrations

The concentrations of TCDD detected in all 11 shallow soil samples used to document observed contamination are greater than the cancer risk concentration for TCDD (0.004 ppb) [2, p. B-81; 84, pp. 14, 15; 85, pp. 14, 15, 16; 86, p. 16; 87, pp. 15, 19]. Therefore, because no shallow soil samples document observed contamination with TCDD at Level II, Level II concentrations cannot be evaluated.

Area Letter	Resident Individuals		Total
	Residences	County Multiplier	
NE			

Sum of individuals subject to Level II concentrations: NE

The total number of resident individuals subject to Level I concentrations (258) is multiplied by 10 to assign the Resident Population Factor Value [1, p. 51647, Section 5.1.3.2.1]. 258 × 10 = 2,580. The number of resident individuals subject to Level II concentrations cannot be evaluated due to a lack of shallow soil samples which document Level II concentrations.

==========

Level I Concentrations Factor Value: 2,580
Level II Concentrations Factor Value: NE

5.1.3.3 Workers

Area A

The Brook Village and Centredale Manor apartment buildings are located within 200 feet of an area of observed contamination on the same properties [18]. According to the managers of the Brook Village apartment building and the Centredale Manor apartment building, each building has two full-time employees who are regularly on each of the properties (totaling four full-time employees) [9; 10]. For the purposes of this evaluation, workers associated with the Brook Village and Centredale Manor apartment buildings are considered to work regularly on or within 200 feet of an area of observed contamination, and are, therefore, subject to actual contamination [1, p. 51647, Section 5.1.3].

Area Letter	Number of Workers
A	4

References: 9; 10

Total workers: 4

With the number of workers on a site between 1 to 100, a Worker Factor Value of 5 is assigned [1, p. 51647, Table 5-4].

5.1.3.4 Resources

Resource Descriptor(s): None

There is no documentation in available files that suggest resources as defined under HRS Section 5.1.3.4 are present on the area of observed contamination. Therefore, the Resource Value is assigned a 0 [1, p. 51647, Section 5.1.3.4].

==========

Workers Factor Value: 5
Resources Factor Value: 0

5.1.3.5 Terrestrial Sensitive Environments

Area A

Available information does not document terrestrial sensitive environments as defined by HRS Section 5.1.3.5, Table 5-5, in Area A [1, pp. 51647, 51648].

Area Letter	Terrestrial Sensitive Environment	Value
A	none	0

The Terrestrial Sensitive Environments Value is assigned by multiplying the Residential Population Likelihood of Exposure Value (550), the Waste Characteristics Value (100), and the Terrestrial Sensitive Environments rating Value (0), and dividing by 82,500 [1, p. 51648, Section 5.1.3.5].

Likelihood of exposure factor category value (LE): 550
Waste characteristics factor category value (WC): 10
Terrestrial sensitive environments value (ES): 0
Product (LE × WC × ES) = 0
(LE × WC × ES) ÷ 82,500 = 0

Because the Terrestrial Sensitive Environments Value is less than 60, the Terrestrial Sensitive Environments Value is assigned as the Terrestrial Sensitive Environments Factor Value of 0 [1, p. 51648].

==========

Terrestrial Sensitive Environments Factor Value: 0

5.2 NEARBY POPULATION THREAT

5.2.1 Likelihood of Exposure

The Attractiveness/Accessibility Value for Area A was assigned based on values from HRS Table 5-6 [1, p. 51648].

5.2.1.1 Attractiveness/Accessibility

Area A

Area A is located on portions of Plat 14, Lot 200 and Lot 250. Vehicular and pedestrian access to the area is unrestricted from U.S. Route 44 to the north; however, vehicular access is restricted by the Woonasquatucket River to the west, woods and the drainage channel to the south, and the drainage channel to the east [3, Volume I, p. 19, Volume II, p. 25]. On 9 September 1998, a elderly gentleman (presumably a resident of the Centredale Manor apartment building) was observed sunbathing in a wooded area in the southern section of Plat 14, Lot 250, which is included in Area A [39]. For the purpose of this evaluation, based on the documented use of the property for recreation, Area A is considered an accessible and unique recreation area [1, p. 51648, Table 5-6].

Area Letter	Descriptor(s) for Area	Value	Reference
A	Accessible and unique recreational area	75	1, p. 51648, Table 5-6; 39

From HRS Table 5-6, an area of observed contamination which is a designated recreation area is assigned an Attractiveness/Accessibility Factor Value of 75 [1, p. 51648].

==========

Attractiveness/Accessibility Factor Value: 75

5.2.1.2 Area of Contamination

The Area of Contamination Factor Value for the site is based on the area of observed contamination documented for Area A [1, p. 51648, Section 5.2.1.2].

Area Letter	Size of Area of Observed Contamination (sq ft)	Reference
A	113,328	7, pp. 1 of 4, 2 of 4, 4 of 4

Total Area of Observed Contamination: 113,328 square feet

An area of observed contamination greater than 5,000 to 125,000 square feet is assigned an Area of Contamination Factor Value of 20 [1, p. 51648, Table 5-7].

5.2.1.3 Likelihood of Exposure Factor Category

From HRS Table 5-8, an Attractiveness/Accessibility Factor Value of 75 and an Area of Contamination Factor Value of 20 are assigned a Likelihood of Exposure Factor Category Value of 50 [1, p. 51648].

==========

Area of Contamination Factor Value: 20

Nearby Population Threat Likelihood of Exposure Factor Category Value: 50

5.2.2 WASTE CHARACTERISTICS

5.2.2.1 Toxicity

Shallow soil samples were collected from the area of observed contamination on 16 and 17 February 1999 at depths no greater than 2 feet [61, p. 4, Section 3.2.4, Appendix C, pp. 30, 34, 35, 53, 63, 64, 70, 101, 135, 138, 156, 249]. The samples document observed contamination with TCDD at concentrations greater than or equal to the background shallow soil sample's SQL value of the same hazardous substance, which were collected from the same vicinity, at comparable depths, and analyzed using the same analytical methods [18; 61, p. 4, Sections 3.2.4 and 3.2.5; 84, p. 1; 85, p. 1; 86, p. 1; 87, p. 1].

Hazardous Substance	Toxicity Factor Value	Reference
TCDD	10,000	2, p. B-81

The hazardous substance with the highest Toxicity Factor Value (TCDD) is used to assign the value to the Toxicity Factor Value for the Nearby Population Threat [1, p. 51648, Section 5.2.2.1].

==========

Toxicity Factor Value: 10,000

5.2.2.2 Hazardous Waste Quantity

The Hazardous Waste Quantity Value was assigned as specified in Section 2.4.2, based on the Area Factor Value for Area A [1, pp. 51591, Table 2-5, 51647, Table 5-2].

Area Letter	Area Hazardous Waste Quantity Value	Constituent Quantity Data Complete (Yes/No)
A	3.33	No

Sum of values: 3.33

Based on HRS Section 2.4.2.2, if the Hazardous Constituent Quantity is not adequately determined for one or more sources and if any target for the soil exposure pathway is subject to Level I or Level II concentrations, a factor value is assigned from Table 2-6 or a value of 10, whichever is greater, as the Hazardous Waste Quantity Factor Value for that pathway [1, pp. 51591, 51592].

5.1.2.3 Calculation of Waste Characteristics Factor Category Value

The Toxicity Factor Value for TCDD (10,000) is multiplied by the Hazardous Waste Quantity Factor Value for the site (10) in order to determine the Waste Characteristics Product, subject to a maximum value of 1×10^8 [1, p. 51647, Section 5.1.2.3]. 10,000 × 10 = 100,000.

Toxicity Factor Value × Hazardous Waste Quantity Factor Value: 100,000

A Waste Characteristics Product of 100,000 is assigned a Waste Characteristics Factor Category Value of 18 [1, p. 51592, Table 2-7].

==========

Hazardous Waste Quantity Factor Value: 10
Waste Characteristics Factor Category Value: 18

5.2.3 TARGETS

5.2.3.1 Nearby Individual

Shallow soil sample locations CMS-030, CMS-031, CMS-098, CMS-131, and CMS-134 are located on the properties identified by the North Providence Tax Assessor's office as Plat 14, Lots 200 and 250 [12; 18]. The Brook Village and Centredale Manor apartment buildings are located on Lot 200 and Lot 250, respectively, and are located within 200 feet of the above-mentioned shallow soil sample locations. Shallow soil samples CMS-030, CMS-031, CMS-098, CMS-131, and CMS-134, collected at a depth of 0 to 3 inches, document observed contamination with TCDD at a concentrations ranging from 0.094 ppb to 28.04 ppb, which are greater than the cancer risk concentration for TCDD (0.004 ppb) [1, pp. 51646, Section 5.0.1; 2, p. B-81; 61, p. 4, Section 3.2.4; 84, pp. 14, 15; 86, p. 16; 87, p. 15]. Since Lot 200 and Lot 250 are residential properties and the area of observed contamination on the properties is within 200 feet of the residences on the properties, a Level I resident individual is documented [1, p. 51647]. Since one or more persons meet the criteria for a resident individual, the Nearby Individual Factor is assigned a value of 0 [1, pp. 51648, 51649, Section 5.2.3.1].

Area Letter	Distance to Residence or School	Reference
A	Less than 200 feet	7, p. 3 of 4; 18

==========

Nearby Individual Factor Value: 0

5.2.3.2 Population Within 1 Mile

The Population Within 1-Mile Factor has not been evaluated. Area A is an area of contaminated soil defined by 11 shallow soil samples locations which are located on Plat 14, Lots 200 and 250 (see Figure 3 in Attachment A of this document) [12; 18]. Samples from these locations document actually-contaminated resident populations. Upon consultation with EPA Region I, it was determined that the effort required to document the nearby population for the HRS Documentation Record beyond Plat 14, Lots 200 and 250 would be both cost-prohibitive and unnecessary, since an estimate of the nearby residential targets indicated that they would not significantly affect the pathway score.

Travel Distance Category (miles)	Number of People	Distance-Weighted Value (Table 5-10)	Reference
>0 to ¼	NE	NE	
>¼ to ½	NE	NE	
>½ to 1	NE	NE	

Sum of Distance-weighted Values: NE

==========

Population Within 1 Mile Factor Value: NE

6.0 AIR PATHWAY - Not Evaluated

6.0.1 GENERAL CONSIDERATIONS

Rationale for not evaluating the Air Pathway is provided in the HRS Review Cover Sheet.

A copy of figures 1, 2, 3, 4, 5, and 6 are available at the EPA Headquarters Superfund Docket:

U.S. CERCLA Docket Office
Crystal Gateway #1, 1st Floor
1235 Jefferson Davis Highway
Arlington, VA 22202

Telephone: (703) 603-8917
E-Mail: superfund.docket@epa.gov