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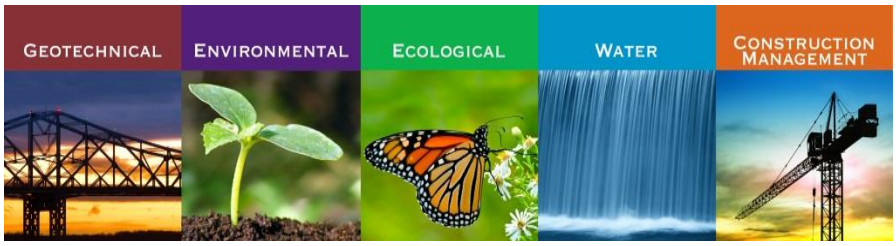

SHORT TERM RESPONSE ACTION PLAN (STRAP) - ADDENDUM
HOLDER 18/21 CAPPING PROJECT

642 Allens Avenue
Providence, Rhode Island

May 10, 2016
GZA File No.: 03.0033554.00

PREPARED FOR:
Rhode Island Department of Environmental Management (RIDEM)
Providence, Rhode Island

ON BEHALF OF:
nationalgrid

GZA GeoEnvironmental, Inc.
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May 10, 2016
File No. 03.00033554.00

Via E-Mail and U.S. Mail

Mr. Joseph Martella
Rhode Island Department of Environmental Management (RIDEM)
Office of Waste Management
235 Promenade Street
Providence, Rhode Island 02908

Re: Short Term Response Action Plan (STRAP) Addendum
Holder 18/21 Capping Project
642 Allens Avenue
Providence, Rhode Island
RIDEM Case No. 98-004 / Site Remediation File No. SR-28-1152

Dear Mr. Martella:

On behalf of the Narragansett Electric Company d/b/a National Grid (National Grid), GZA GeoEnvironmental, Inc. (GZA) is pleased to present to the Rhode Island Department of Environmental Management (RIDEM) this addendum to the Short Term Response Action Plan (STRAP) for the Holder 18/21 Capping Project which was submitted to the Department on April 27, 2016. This addendum has been prepared to address comments from RIDEM related to shallow soil quality in the former oxide box area which were discussed during our May 4, 2016 meeting. In addition, this addendum addresses subsequent communications with RIDEM related to groundwater monitoring well decommissioning and replacement, asphalt capping and construction dewatering.

This STRAP Addendum is subject to the attached Limitations.

PROPOSED ADDITIONAL EXCAVATION ACTIVITIES

Boring location B-8 was performed by VHB in 2003 within the former oxide box area. The boring log indicates that B-8 was completed in oxide box type material with evidence of blue staining and wood chips throughout. One soil sample was collected from B-8 at a depth of 1-2 feet below ground surface (bgs). Total petroleum hydrocarbons (TPH) were detected in this sample in excess of the RIDEM UCL of 30,000 mg/kg at a concentration of 40,000 mg/kg and naphthalene was detected in excess of the RIDEM UCL of 10,000 mg/kg at a concentration of 15,400 mg/kg. Additional soil data in the vicinity of B-8 is shown on the attached "Existing Data" Figure. TPH and naphthalene in the vicinity of B-8 was detected less than the UCL in samples (collected at approximately the same depths) located approximately 25 -30 feet north, west, northwest, northeast and southwest of B-8. The closest samples in the southeastern corner were collected from VHB TP-100 and VHB TP-101, approximately 60 feet away from B-8, and at depth (minimum 4-5 feet bgs).

As part of the STRAP activities, GZA proposes to excavate an approximate 10 foot by 10 foot area centered on location B-8 to a depth of approximately 3 feet bgs. Confirmatory soil samples will be collected from the sidewalls and bottom for laboratory analysis as part of pre-excavation activities or post-excavation during construction. Consistent with Department guidance, for excavations with any sidewall greater than 25 linear feet and no deeper than 5 feet, discrete grab samples will be collected

at a frequency of 1 per every 25 feet of sidewall and 1 bottom sample every 625 square feet. Collected soil samples will be submitted for TPH analysis via EPA Method 8100M and naphthalene analysis via EPA Method 8270D. Results of the confirmatory soil sampling will be compared to the applicable UCLs. Excavation will proceed until confirmatory soil sample results are below the UCLs for TPH and naphthalene. Excavation will not proceed below the water table. Excavated soils from the UCL area will be segregated and temporarily stockpiled for off-Site transport and disposal at a licensed receiving facility pre-approved by National Grid. The excavated area will be backfilled with excess soil generated as part of the STRAP capping earthwork and completed with an impermeable cap as described in the April 27, 2016 STRAP.

UPDATED AIR EMISSIONS CALCULATION

As requested by RIDEM, GZA has updated the air emission calculations included in the April 27, 2016 STRAP submittal to take into account the UCL soil removal effort described above. For background information on how these numbers were calculated, please refer to the April 27, 2016 STRAP.

GZA currently estimates that excavation of the UCL will be limited to less than 100 square foot area and would generate approximately 10 to 20 cubic yards of soil. For the purpose of development of the updated air emission calculations, GZA conservatively assumed that the proposed B-8 removal will require excavation of an approximate 2,700 square foot area to a depth of 3 feet bgs which would result in the generation of approximately 300 cubic yards (CY) of soil. Table D-1 (attached to this letter) presents the data collected proximate to the proposed B-8 removal area.

Utilizing both the average and maximum concentrations for the potential emission calculation (including the B-8 removal data), GZA conservatively calculated the total emissions potential (in pounds (lbs)) for all the detected VOCs with minimum quantities included in Appendix A of RIDEM's Air Pollution Control (APC) Regulation No. 9. This calculation assumes that all the mass of the VOCs in the associated soil is emitted, providing conservative upper bounds to potential excavation emissions. As indicated in the attached Table D-2, benzene, naphthalene, toluene and total xylenes have an excavation emissions potential exceeding the RIDEM annual minimum quantities (10 lbs/year, 3 lbs/year, 9,000 lbs/year and 3,000 lbs/year, respectively) based on both the average and maximum measured concentrations.

Based on these calculations, benzene, naphthalene, toluene and xylenes were further evaluated using emissions modeling consistent with published EPA guidance to estimate the predicted emissions that would be generated during the planned STRAP implementation activities.

The modeling results for all STRAP excavation activity (include the B-8 removal area) are presented in the attached Table D-3. GZA assumed that one re-handling event would occur for each of the earthwork activities when the excavated soil was loaded from stockpiles to trucks for subgrade backfilling on-Site or for off-Site disposal.

The attached Table D-3 and the table below presents a summary of the total model predicted excavation emissions for benzene, naphthalene, toluene and total xylenes (in pounds) compared to RIDEM's Minimum Quantities (in pounds/year) published in APC Regulation No. 9, Appendix A.

Analyte	Total Modeled Excavation Emissions (lbs)	RIDEM Annual Minimum Quantity (lbs)
Benzene	4.47	10
Naphthalene	0.94	3
Toluene	8.68	9,000
Total Xylenes	4.17	3,000

The results of this predictive modeling indicate that the earthwork activities do not have the potential to increase emissions by greater than the minimum quantities as specified in Appendix A of RIDEM APC Regulation No. 9, and therefore, a minor source permit is **not** required for the STRAP implementation work, including the proposed UCL soil removal around B-8.

GROUNDWATER MONITORING WELL DECOMMISSIONING AND REPLACEMENT

Based on anticipated grade changes, National Grid plans to decommission and replace certain groundwater monitoring wells within the proposed STRAP Area work limits. Specifically, seven (7) monitoring wells located within the STRAP capping area will be decommissioned: RCA-11, VHB-8R, VHB-10, VHB-18, GZ-320D, GZ-401, and GZ-403. Based on the historical groundwater conditions, two of these wells (VHB-10 and GZ-320D) will be replaced when capping activities are complete. Details regarding the comprehensive proposed modifications to the groundwater monitoring activities at the Site in anticipation of the H18/21 STRAP work as well as future facility construction redevelopment projects will be submitted to RIDEM under separate cover.

ASPHALT REMEDIAL CAP

As detailed in the STRAP, several types of engineered caps have been designed to mitigate potential direct exposure to underlying impacted soils and limit further degradation of groundwater. These caps consist of asphalt, crushed stone, topsoil and rip rap engineered caps, with certain section of the capped area equipped with an impermeable liner (within the limits of the Oxide Box Area). For the asphalt cap outside of the Oxide Box Area, the engineered cap will consist of 2-inches of binder course asphalt overlain with 2-inches of top course. Based on discussions with RIDEM, National Grid acknowledges that this proposed asphalt cap profile represents a modification from RIDEM's definition of an equivalent 2-foot engineered soil cap for new construction. However, given the proposed use of the Site and subsequent communications, National Grid understands that RIDEM will approve the proposed asphalt cap profile for the Holder 18/21 Capping Project as presented in the April 2016 STRAP. For future capping projects at the Site where new asphalt is proposed (i.e., not replaced), asphalt capping will be consistent with the RIDEM 2-foot engineered soil cap equivalent (typically 6-inches of clean imported subbase overlain by 4-inches of asphalt).

CONSTRUCTION DEWATERING

The April 2016 STRAP included a contingency item for the management, treatment and on-Site discharge of groundwater in the event that significant groundwater is encountered during the proposed STRAP activities. The proposed dewatering, groundwater treatment and discharge presented in the April 2016 STRAP was developed consistent with a *Temporary Groundwater Discharge Approval* issued by RIDEM's Office of Waste Management (OWM) under Rule 13 of the October 2014 *Rules for the Discharge of Non-Sanitary Wastewater and Other Fluid to or Below the Ground Surface.* It is noted that significant dewatering is unlikely to be performed during the STRAP work. If dewatering is required, it is anticipated that a limited volume of water will be generated and managed/treated in batches (i.e., per fractionation tank or approximately 20,000 gallons). Continuous management, treatment and discharge of groundwater is not anticipated. As such, the proposed sampling protocol

presented in the April 2016 STRAP indicates that samples will be collected on the first day of operation of the treatment system and at a rate of one effluent sample per 20,000 gallons of groundwater treated (equivalent to one fractionation tank volume).

Should you have any questions or comments regarding the information presented herein, please do not hesitate to contact the undersigned or Amy Willoughby from National Grid at (401) 258-5410.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Sophia Narkiewicz, P.E.
Project Engineer

Margaret S. Kilpatrick, P.E.
Senior Project Manager

James J. Clark, P.E.
Senior Principal

MSK:lal

Attachment: Limitations
"Existing Data" Figure
Updated Air Emission Calculations
Table D-1 Summary of Analytical Data used in Emissions Calculations
Table D-2 Excavation Emissions Potentials
Table D-3 Predicted Excavation Emissions
Excavation Emissions Calculations

cc: Amy Willoughby, National Grid

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LIMITATIONS

LIMITATIONS

1. This Short Term Response Action Plan Addendum has been prepared on behalf of and for the exclusive use of The Narragansett Electric Company d/b/a National Grid (National Grid), solely for use in documenting the work completed as described herein at the 642 Allens Avenue Former MGP ("Site") under the applicable provisions of the State of Rhode Island Department of Environmental Management Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Remediation Regulations). This report and the findings contained herein shall not, in whole or in part, be disseminated or conveyed to any other party, nor used by any other party in whole or in part, without the prior written consent of GZA GeoEnvironmental, Inc.(GZA) or National Grid.

2. GZA's work was performed in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area, and GZA observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. GZA's findings and conclusions must be considered not as scientific certainties, but rather as our professional opinion concerning the significance of the limited data gathered during the course of the study. No other warranty, express or implied is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during the work described herein.

3. The observations described in this report were made under the conditions stated therein. The conclusions presented in the report were based upon services performed and observations made by GZA.

4. In the event that National Grid or others authorized to use this report obtain information on environmental or hazardous waste issues at the Site not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this report.

5. The conclusions and recommendations contained in this report are based in part upon the data obtained from environmental samples obtained from relatively widely spread subsurface explorations. The nature and extent of variations between these explorations may not become evident until further exploration. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the boring logs.

7. In the event this work included the collection of water level data, these readings have been made in the test pits, borings and/or observation wells at times and under conditions stated on the exploration logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall and other factors different from those prevailing at the time measurements were made.

8. The conclusions contained in this report are based in part upon various types of chemical data and are contingent upon their validity. These data have been reviewed and interpretations made in the report. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their flow paths may occur due to seasonal water table fluctuations, past disposal practices, the passage of time, and other factors. Should additional chemical data become available in the future, these data should be reviewed by GZA and the conclusions and recommendations presented herein modified accordingly.

“EXISTING DATA” FIGURE

B-8 Soil Removal
Scale 1" = 25 feet
Existing Data

UPDATED AIR EMISSION CALCULATIONS

Table D-1 Summary of Analytical Data used in Emissions Calculation

Holder 18/21 Capping Project
642 Allens Avenue
Providence, Rhode Island

	RIDEM GB Leachability Criteria	RIDEM I/C DEC	RIDEM UCL	Units	Average	Maximum	C18	D64	D65	D66	D67	D68	D69	D70	D71	E01		E02		E03	E09	
							0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	4-6 FT	0-2 FT	4-6 FT	0-2 FT	0-2 FT	2-4 FT
							12/13/99	12/11/99	12/11/99	12/11/99	12/22/99	12/23/99	12/23/99	12/23/99	12/23/99	12/11/99	12/11/99	12/13/99	12/13/99	12/19/99	12/14/99	
Volatile Organic Compounds (VOCs)																						
2-Butanone	NE	10,000	10,000	mg/kg	0.282	1.6	0.07	0.09	0.049	0.085	0.075	0.07	0.07	0.08	0.055	0.11	0.085	0.08	0.075	0.095	0.095	0.07
Acetone	NE	10,000	10,000	mg/kg	0.293	2.3	0.07	0.09	0.085	0.085	0.075	0.07	0.07	0.08	0.055	0.11	0.085	0.12	0.077	0.083	0.061	0.07
Benzene	4.3	200	10,000	mg/kg	0.954	43	0.07	0.09	0.2	0.085	0.18	0.07	0.07	0.08	0.055	0.11	0.085	0.08	0.075	0.095	0.095	0.07
Ethylbenzene	62	10,000	10,000	mg/kg	1.11	22	0.07	0.09	0.13	0.085	0.075	0.07	0.07	0.08	0.055	0.11	0.085	0.08	0.075	0.095	0.095	0.07
Isopropylbenzene	NE	10,000	10,000	mg/kg	0.227	3.2	0.07	0.09	0.085	0.085	0.075	0.07	0.07	0.08	0.055	0.11	0.085	0.08	0.075	0.095	0.095	0.07
Methylene Chloride	NE	760	10,000	mg/kg	0.235	2.7	0.07	0.34	0.24	0.085	0.075	0.07	0.07	0.08	0.055	0.25	0.2	0.25	0.23	0.28	0.095	0.07
Naphthalene	NE	10,000	10,000	mg/kg	123	9,650	0.07	0.09	0.085	0.085	0.21	0.07	0.07	0.08	0.055	0.11	0.085	0.58	0.72	0.095	0.095	0.07
Styrene	64	1,900	10,000	mg/kg	0.877	62	0.07	0.09	0.085	0.085	0.075	0.07	0.07	0.08	0.055	0.11	0.085	0.08	0.075	0.095	0.095	0.07
Toluene	54	10,000	10,000	mg/kg	3.832	194	0.07	0.09	0.085	0.085	0.24	0.07	0.07	0.08	0.055	0.11	0.085	0.08	0.075	0.095	0.095	0.07
Xylenes (Total)	NE	10,000	10,000	mg/kg	6.738	336	0.07	0.09	0.085	0.085	0.3	0.07	0.07	0.08	0.055	0.11	0.085	0.08	0.075	0.095	0.095	0.07
Semi-Volatile Organic Compounds (SVOCs)																						
Naphthalene	NE	10,000	10,000	mg/kg	189	15,400	1.75	1.85	1.75	1.8	1.8	1.8	1.8	1.85	1.8	0.63	1.85	1.75	1.85	1.95	1.8	1.9

Notes:
NE = Not Established
NA = Not Analyzed
Table only indicates the compounds that were detected and have a RIDEM Minimum Quantity, other compounds were analyzed for, but not detected.
Blue shading indicates compound was not detected - value shown is half the detection limit.
Table only shows explorations within a cut area of the Limits of Work
Averages presented in the table include half the detection limit (if reported)
Gray shaded cells and **bolded text** indicates the concentration exceeds the RIDEM Method 1 GB Leachability Criteria.
Concentrations **bolded and underlined** exceed the RIDEM Method 1 Industrial/Commercial Direct Exposure Criteria (I/C-DEC).
A concentration with a bold border exceeds the RIDEM Upper Concentration Limit (UCL).
Sample depths noted here are from original grade. This table presents data that has since been disturbed or regraded. As such, the final grades are unknown and as such the modified sampling depths are unknown.

Table D-1 Summary of Analytical Data used in Emissions Calculation

Holder 18/21 Capping Project
642 Allens Avenue
Providence, Rhode Island

	RIDEM GB Leachability Criteria	RIDEM I/C DEC	RIDEM UCL	Units	Average	Maximum	E11	E12	E13	E14	E15	E19	E20		E23		E24		E25		E26		E27		E29	
							0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	2-4 FT	0-2 FT	4-6 FT	0-2 FT	2-4 FT	0-2 FT	2-4 FT	0-2 FT	2-4 FT	0-2 FT	2-4 FT	0-2 FT	4-6 FT
							12/14/99	12/14/99	12/14/99	12/15/99	12/15/99	12/15/99	12/15/99		12/16/99		12/16/99		12/17/99		12/17/99		12/20/99		12/17/99	
Volatile Organic Compounds (VOCs)																										
2-Butanone	NE	10,000	10,000	mg/kg	0.282	1.6	0.08	0.075	0.07	0.055	1.4	0.075	0.07	0.09	0.063	0.06	0.065	0.048	0.055	0.05	0.07	0.06	0.065	0.07	0.06	0.28
Acetone	NE	10,000	10,000	mg/kg	0.293	2.3	0.034	0.075	0.07	0.032	1.4	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.06	0.046	0.048	0.06	0.065	0.07	0.06	0.28
Benzene	4.3	200	10,000	mg/kg	0.954	43	0.08	0.075	0.07	0.055	1.4	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.055	0.05	0.07	0.24	0.061	0.07	0.06	0.28
Ethylbenzene	62	10,000	10,000	mg/kg	1.11	22	0.08	0.075	0.07	0.055	1	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.055	0.05	0.07	0.06	0.065	0.07	0.06	0.28
Isopropylbenzene	NE	10,000	10,000	mg/kg	0.227	3.2	0.08	0.075	0.07	0.055	1.4	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.055	0.05	0.07	0.06	0.065	0.07	0.06	0.28
Methylene Chloride	NE	760	10,000	mg/kg	0.235	2.7	0.08	0.075	0.07	0.055	1.4	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.095	0.05	0.098	0.06	0.065	0.07	0.06	0.28
Naphthalene	NE	10,000	10,000	mg/kg	123	9,650	0.08	0.075	0.07	0.055	68	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.15	0.05	0.029	0.06	0.06	0.07	0.048	12
Styrene	64	1,900	10,000	mg/kg	0.877	62	0.08	0.075	0.07	0.055	1.4	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.055	0.05	0.07	0.06	0.065	0.07	0.06	0.28
Toluene	54	10,000	10,000	mg/kg	3.832	194	0.08	0.075	0.07	0.055	1.4	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.055	0.05	0.07	0.06	0.064	0.07	0.06	0.28
Xylenes (Total)	NE	10,000	10,000	mg/kg	6.738	336	0.08	0.075	0.07	0.055	1.4	0.075	0.07	0.09	0.075	0.06	0.065	0.048	0.055	0.05	0.07	0.06	0.065	0.07	0.06	0.28
Semi-Volatile Organic Compounds (SVOCs)																										
Naphthalene	NE	10,000	10,000	mg/kg	189	15,400	1.95	1.9	0.67	1.8	6.6	1.8	2	2.1	1.95	1.8	1.8	1.8	0.94	1.75	0.77	1.8	1.8	1.8	1.8	13

Notes:
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Sample depths noted here are from original grade. This table presents data that has since been disturbed or regraded. As such, the final grades are unknown and as such the modified sampling depths are unknown.

Table D-1 Summary of Analytical Data used in Emissions Calculation

Holder 18/21 Capping Project
642 Allens Avenue
Providence, Rhode Island

	RIDEM GB Leachability Criteria	RIDEM I/C DEC	RIDEM UCL	Units	Average	Maximum	E33	E34		E35		E38	E39	E40	E41		E42	E43		E44		E45	E46	E53		E57
							0-2 FT	0-2 FT	4-6 FT	0-2 FT	4-6 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	2-4 FT	0-2 FT	0-2 FT	4-6 ft	0-2 FT	2-4 FT	0-2 FT	0-2 FT	0-2 FT	4-6 FT	0-2 FT
							12/20/99	12/20/99		12/20/99		12/21/99	1/26/00	12/21/99	12/21/99		12/21/99	12/21/99		12/22/99		12/22/99	12/22/99	12/22/99		2/2/00
Volatile Organic Compounds (VOCs)																										
2-Butanone	NE	10,000	10,000	mg/kg	0.282	1.6	0.085	0.105	1.6	0.08	0.65	0.08	0.75	0.09	0.07	0.55	0.08	0.06	0.08	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Acetone	NE	10,000	10,000	mg/kg	0.293	2.3	0.085	0.105	1.6	0.08	0.65	0.08	0.75	0.09	0.07	0.55	0.08	0.06	0.08	0.075	0.75	0.1	0.075	0.09	0.065	2.3
Benzene	4.3	200	10,000	mg/kg	0.954	43	0.085	0.043	1.6	0.08	0.65	0.08	0.75	0.09	0.12	0.55	0.08	0.045	0.32	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Ethylbenzene	62	10,000	10,000	mg/kg	1.11	22	0.085	0.105	14	0.3	22	0.08	0.75	0.09	0.07	10	0.08	0.06	0.19	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Isopropylbenzene	NE	10,000	10,000	mg/kg	0.227	3.2	0.085	0.105	1.6	0.061	3.2	0.08	0.75	0.09	0.07	1.4	0.08	0.06	0.08	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Methylene Chloride	NE	760	10,000	mg/kg	0.235	2.7	0.085	0.105	1.6	0.042	0.65	2.7	0.75	0.084	0.087	0.55	0.056	0.025	0.08	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Naphthalene	NE	10,000	10,000	mg/kg	123	9,650	0.24	0.48	390	0.16	180	0.79	0.75	0.16	0.16	90	0.14	0.048	0.51	0.075	0.18	0.2	0.075	0.09	0.17	0.75
Styrene	64	1,900	10,000	mg/kg	0.877	62	0.085	0.105	62	0.08	0.65	0.08	0.75	0.09	0.07	0.55	0.08	0.06	0.08	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Toluene	54	10,000	10,000	mg/kg	3.832	194	0.085	0.105	**97**	0.26	0.65	0.08	0.75	0.09	0.26	0.55	0.08	0.053	0.21	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Xylenes (Total)	NE	10,000	10,000	mg/kg	6.738	336	0.085	0.105	210	0.08	0.65	0.08	0.75	0.09	0.48	9.7	0.08	0.036	0.08	0.075	0.75	0.1	0.075	0.09	0.065	0.75
Semi-Volatile Organic Compounds (SVOCs)																										
Naphthalene	NE	10,000	10,000	mg/kg	189	15,400	1.85	1.2	1.9	3.3	67	0.43	0.61	3.8	7.3	780	1.6	0.15	1.6	0.67	1.9	0.48	1.9	1.7	1.85	2.05

Notes:
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NA = Not Analyzed
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Table only shows explorations within a cut area of the Limits of Work
Averages presented in the table include half the detection limit (if reported)
Gray shaded cells and **bolded text** indicates the concentration exceeds the RIDEM Method 1 GB Leachability Criteria.
Concentrations **bolded and underlined** exceed the RIDEM Method 1 Industrial/Commercial Direct Exposure Criteria (I/C-DEC).
A concentration with a bold border exceeds the RIDEM Upper Concentration Limit (UCL).
Sample depths noted here are from original grade. This table presents data that has since been disturbed or regraded. As such, the final grades are unknown and as such the modified sampling depths are unknown.

Table D-1 Summary of Analytical Data used in Emissions Calculation

Holder 18/21 Capping Project
642 Allens Avenue
Providence, Rhode Island

	RIDEM GB Leachability Criteria	RIDEM I/C DEC	RIDEM UCL	Units	Average	Maximum	E93		F01		F02	F03	F04	F08	F14	F15	F16	F18	F33	F53	RCA-11	C21	E10		E15		B-8
							0-2 FT	4-6 FT	0-2 FT	4-6 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	0-2 FT	4-6 FT	0-2 FT	0-2 FT	2-4 FT	0-2 FT	4-6 FT	1-2 FT
							3/7/00		1/4/00		1/4/00	1/4/00	1/4/00	1/5/00	1/6/00	1/6/00	1/6/00	1/6/00	1/7/00	1/19/00	1994	12/14/99	12/14/99		12/15/99		2003
Volatile Organic Compounds (VOCs)																											
2-Butanone	NE	10,000	10,000	mg/kg	0.282	1.6	0.6	0.5	0.07	0.08	0.085	0.1	0.09	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.65	0.5	0.5	0.5	0.5	0.5	0.5
Acetone	NE	10,000	10,000	mg/kg	0.293	2.3	0.6	0.5	0.046	0.08	0.056	0.11	0.09	0.075	0.08	0.085	0.065	0.088	0.085	0.9	0.65	0.5	0.085	0.5	0.5	0.5	0.5
Benzene	4.3	200	10,000	mg/kg	0.954	43	0.6	0.5	0.07	0.08	0.085	0.1	0.056	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.025	0.5	0.5	0.5	0.5	**43**	**27.2**
Ethylbenzene	62	10,000	10,000	mg/kg	1.11	22	0.6	0.5	0.07	0.08	0.085	0.1	0.09	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.025	0.5	0.5	0.5	1	18	19.7
Isopropylbenzene	NE	10,000	10,000	mg/kg	0.227	3.2	0.6	0.5	0.07	0.08	0.085	0.1	0.09	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.025	0.5	0.5	0.5	0.5	0.5	0.5
Methylene Chloride	NE	760	10,000	mg/kg	0.235	2.7	0.6	0.5	0.07	0.08	0.085	0.1	0.16	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.025	0.5	0.5	0.5	0.5	0.5	0.5
Naphthalene	NE	10,000	10,000	mg/kg	123	9,650	0.48	0.5	0.07	0.08	0.085	0.1	0.09	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.05	0.5	0.5	0.5	68	630	9650
Styrene	64	1,900	10,000	mg/kg	0.877	62	0.6	0.5	0.07	0.08	0.085	0.1	0.09	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.025	0.5	0.5	0.5	0.5	0.5	2.78
Toluene	54	10,000	10,000	mg/kg	3.832	194	0.6	0.5	0.07	0.08	0.085	0.1	0.09	0.075	0.08	0.085	0.065	0.08	0.085	0.9	0.025	0.34	0.5	0.5	0.5	43	**194**
Xylenes (Total)	NE	10,000	10,000	mg/kg	6.738	336	0.6	0.5	0.07	0.08	0.085	0.1	0.09	0.075	0.08	0.085	0.065	0.08	0.085	1.7	0.15	0.5	0.5	0.5	0.5	23	336
Semi-Volatile Organic Compounds (SVOCs)																											
Naphthalene	NE	10,000	10,000	mg/kg	189	15,400	1.85	1.8	1.9	1.9	1.95	1.9	1.95	1.3	1.8	2	1.75	1.9	1.95	1.85	0.5	0.5	0.5	0.5	6.6	670	**<u>15400</u>**

<u>Notes:</u>
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NA = Not Analyzed
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Blue shading indicates compound was not detected - value shown is half the detection limit.
Table only shows explorations within a cut area of the Limits of Work
Averages presented in the table include half the detection limit (if reported)
Gray shaded cells and **bolded text** indicates the concentration exceeds the RIDEM Method 1 GB Leachability Criteria.
Concentrations **<u>bolded and underlined</u>** exceed the RIDEM Method 1 Industrial/Commercial Direct Exposure Criteria (I/C-DEC).
A concentration with a bold border exceeds the RIDEM Upper Concentration Limit (UCL).
Sample depths noted here are from original grade. This table presents data that has since been disturbed or regraded. As such, the final grades are unknown and as such the modified sampling depths are unknown.

Table D-1 Summary of Analytical Data used in Emissions Calculation

Holder 18/21 Capping Project
642 Allens Avenue
Providence, Rhode Island

	RIDEM GB Leachability Criteria	RIDEM I/C DEC	RIDEM UCL	Units	Average	Maximum	GZ-322S S-2	GZ-324 S-2	SPC-1	SPC-2	SPC-3	SPC-4	SPC-5	SPC-6	SPC-7	SPC-8	SPC-9	SPC-10	SPC-11	SPC-12
							2-4 FT	2-4 FT	Former MHA Stockpile Samples											
							5/20/14	5/20/14	1/25/2011	1/25/2011	1/25/2011	1/25/2011	1/26/2011	1/26/2011	1/26/2011	1/25/2011	1/26/2011	1/26/2011	1/26/2011	1/26/2011
Volatile Organic Compounds (VOCs)																				
2-Butanone	NE	10,000	10,000	mg/kg	0.282	1.6	0.5	0.5	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Acetone	NE	10,000	10,000	mg/kg	0.293	2.3	0.5	0.5	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Benzene	4.3	200	10,000	mg/kg	0.954	43	0.0228	0.146	0.025	0.025	0.025	0.11	0.025	0.025	0.051	0.025	0.025	0.025	0.16	0.057
Ethylbenzene	62	10,000	10,000	mg/kg	1.11	22	0.0217	4	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Isopropylbenzene	NE	10,000	10,000	mg/kg	0.227	3.2	0.5	0.213	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Methylene Chloride	NE	760	10,000	mg/kg	0.235	2.7	0.5	0.5	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Naphthalene	NE	10,000	10,000	mg/kg	123	9,650	0.48	56.2	0.05	0.05	0.05	3.8	0.05	0.05	0.13	0.05	0.05	0.05	0.17	0.05
Styrene	64	1,900	10,000	mg/kg	0.877	62	0.0354	0.5	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Toluene	54	10,000	10,000	mg/kg	3.832	194	0.106	0.146	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Xylenes (Total)	NE	10,000	10,000	mg/kg	6.738	336	0.129	17.9	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Semi-Volatile Organic Compounds (SVOCs)																				
Naphthalene	NE	10,000	10,000	mg/kg	189	15,400	1.55	55.7	0.345	0.365	0.365	31	2.2	0.74	0.83	0.77	0.375	0.365	1.1	1.1

Notes:
NE = Not Established
NA = Not Analyzed
Table only indicates the compounds that were detected and have a RIDEM Minimum Quantity, other compounds were analyzed for, but not detected.
Blue shading indicates compound was not detected - value shown is half the detection limit.
Table only shows explorations within a cut area of the Limits of Work
Averages presented in the table include half the detection limit (if reported)
Gray shaded cells and **bolded text** indicates the concentration exceeds the RIDEM Method 1 GB Leachability Criteria.
Concentrations **bolded and underlined** exceed the RIDEM Method 1 Industrial/Commercial Direct Exposure Criteria (I/C-DEC).
A concentration with a bold border exceeds the RIDEM Upper Concentration Limit (UCL).
Sample depths noted here are from original grade. This table presents data that has since been disturbed or regraded. As such, the final grades are unknown and as such the modified sampling depths are unknown.

Table D-2 Excavation Emissions Potential

Holder 18/21 Capping Project
642 Allens Avenue
Providence, RI

GZA Job 03.0033554.00
5/6/2016

Site-Specific		
Volume of Soil - Excavation	5,420	(cy)
Volume of Soil Moved	5,420	(cy)
Volume of Soil Moved	4,073	(m^3)

Constants			
Typical Bulk Density	1.5	(g/cm^3)	Eklund 1997 Default

Conversion Factors	
ft/m	3.3
ft^3/cy	27
g/lb	454
g/kg	1000

Analyte	Average Measured Concentration in Soil (µg/g)	Maximum Measured Concentration in Soil (µg/g)	Total Excavation Emissions Potential[1] (lb)	Total Excavation Emissions Potential[2] (lb)	RIDEM Annual Minimum Quantity (lb)
2-Butanone	0.282	1.6	3.79E+00	2.15E+01	4.00E+03
Acetone	0.293	2.3	3.94E+00	3.10E+01	2.00E+04
Benzene	0.954	43	1.28E+01	5.79E+02	1.00E+01
Ethylbenzene	1.11	22	1.49E+01	2.96E+02	9.00E+03
Isopropylbenzene	0.227	3.2	3.05E+00	4.31E+01	1.00E+03
Methylene Chloride	0.235	2.7	3.16E+00	3.63E+01	2.00E+02
Naphthalene	195.29	15400	2.63E+03	2.07E+05	3.00E+00
Styrene	0.877	62	1.18E+01	8.34E+02	3.00E+03
Toluene	3.832	194	5.16E+01	2.61E+03	1.00E+03
Xylenes (Total)	6.738	336	9.07E+01	4.52E+03	3.00E+03

Notes:
1. Total Excavation Emissions Potential based on Average Measured Concentration in Soil.
2. Total Excavation Emissions Potential based on Maximum Measured Concentration in Soil.
3. Only detected analytes with Rhode Island Department of Environmental Management (RIDEM) minimum quanitity values are shown.
4. Naphthalene concentrations presented in this model are the maximum of napthalene analyzed as a VOC or as a PAH
5. cm = centimeter; m = meter; g = gram; µg = microgram; ft = feet, lb = pound; kg = kilogram; cy = cubic yard.
6. Yellow Highlighting indicates model inputs.
7. Orange Highlighting indicates the calculated Total Excavation Emissions Potential exceeds the RIDEM Minimum Quantity.

Table D-3 Predicted Excavation Emissions

Holder 18/21 Capping Project

642 Allens Avenue

Providence, RI

GZA Job 03.0033554.00

5/6/2016

Assumptions		
Assumed Average MW of NAPL	250	(g/mol)
Assumed NAPL Temperature	15	(°C)

Oxide Box Spot Removal		
Surface Area of Soil Removal	2700	(ft^2)
Average Depth of Soil Removal	3	(ft)
Excavation Surface Area	305	(m^2)
Pile Surface Area	305	(m^2)
Emitting Surface Area	610	(m^2)
Volume of Soil Moved	300	(cy)
Volume of Soil Moved	225	(m^3)

Shallow Regrading		
Shallow Regrading Surface Area	69,120	(ft^2)
Shallow Regrading Average Depth	2.0	(ft)
Excavation Surface Area	6,540	(m^2)
Pile Surface Area	6,540	(m^2)
Emitting Surface Area	13,080	(m^2)
Volume of Soil Moved	5,120	(cy)
Volume of Soil Moved	3,847	(m^3)
Site - Specific -Total		
Emitting Surface Area (SA)	13,691	(m^2)
Volume of Soil Moved	5,420	(cy)
Volume of Soil Moved (SV)	4,072	(m^3)

Constants			
Typical Bulk Density	1.5	(g/cm^3)	Eklund 1997 Default
R	8.21E-05	(m^3*atm/K/mol)	
R	8.31E-03	(kJ/K/mol)	
R	62,361	(mm Hg*cm^3/mol/K)	
Soil Gas to Atmosphere Exchange Constant (Dry, uncompacted Soils)	0.33	(%/100)	Eklund 1997 Default
Air-Filled Porosity (Dry, uncompacted Soils)	0.55		Eklund 1997 Default
Total Porosity (Uncompacted Soils)	0.55		Eklund 1997 Default
Gas-Phase Mass Transfer Coefficient	0.15	cm/s	Eklund 1997 Default
Time since Start of Excavation of Soil of Interest	60	s	Eklund 1997 Default
Time Period Excavated Soil are Emitting Contaminants	0.1	(hr)	Eklund 1997 Default
TOC of Soil	0.002	(g OC/g soil)	USEPA 1996 Default

Analyte	Average Measured Concentration in Soil (ug/g)	Partial Pressure[1] (atm)	Equilibrium Coefficient	Effective Diffusivity in Air (cm^2/s)	Total Excavation Emissions Potential[2] (lb)	Total Excavation Emissions (lb)	RIDEM Annual Minimum Quantity (lb)
Benzene	0.95	2.94E-04	3.73E-01	4.21E-02	1.28E+01	4.47	10
Naphthalene	195.3	1.06E-05	1.08E-04	2.66E-02	2.63E+03	0.94	3
Toluene	3.8	4.32E-04	1.61E-01	3.93E-02	5.16E+01	8.68	9000
Total Xylenes	6.7	1.46E-04	3.57E-02	2.75E-02	9.07E+01	4.17	3000

Notes:

1. The Partial Pressure was calculated using Raoult's Law.
2. If the calculated Total Excavation Emissions exceeds the Total Excavation Emissions Potential, the Total Excavation Emissions Potential was used as the Total Excavation Emissions.
3. All constants for total xylenes are the average of the individual constants for m-xylene, o-xylene, and p-xylene.
4. Only detected analytes with RIDEM minimum quanitity values are shown with Total Excavation Emissions Potentials above RIDEM minimum quantities.
5. Concentration units are in ug/g, which is equal to ppm.
6. MW = molecular weight; atm = atmosphere; kJ = kilojoules; mol = moles; NAPL = non-aqueous phase liquid; ppm = parts per million; mm Hg = millimeter mercury; cm = centimeter; m = meter; g = gram; ug = microgram; ft = feet, lb = pound; s = second; yr = year; hr = hour; < = less than the reporting limit; TOC = total organic carbon.
7. Yellow Highlighting indicates model inputs.
8. Purple Highlighting indicates the Total Excavation Emissions exceeds the Rhode Island Department of Environmental Management (RIDEM) Minimum Quantity.

APPENDIX D
EXCAVATION EMISSIONS CALCULATIONS
Holder 18/21 Capping Project
642 Allens Avenue
Providence, Rhode Island

To estimate potential volatile emissions associated with planned remediation activities at the 642 Allens Avenue Property ("the Site"), GZA GeoEnvironmental, Inc. (GZA) used the following modified versions of the equations given in Appendix D of "Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances" (Eklund 1997):

First, the total excavation emissions potential is calculated as a benchmark:

Total Excavation Emissions Potential:

$$E_{Potential} = C_{i,Soil} \times S_v \times \beta$$

Where,
$E_{Potential}$ = Total Mass of Component i in a given volume of soil in grams (g);
$C_{i,Soil}$ = Concentration of Component i in the Soil in micrograms of Component i per gram of Soil (ug/g);
β = Typical Bulk Density in grams per cubic centimeter (g/cm^3) (assumed to be 1.5 g/cm^3 – Eklund 1997); and
S_v = Total Volume of Soil Moved in cubic meters (m^3).

Average Total Emissions (detailed model):
If the Average Total Emissions calculated by this detailed model (Eklund 1997) exceeds the calculated Total Excavation Emissions Potential, the Total Excavation Emissions Potential will be used.

$$E = E_{PS} + E_{DIFF}$$

$$E_{PS} = \frac{P_i \, MW \, 10^6 \, E_a \, S_v \, ExC}{R \, T}$$

$$E_{DIFF} = \frac{(C)(10{,}000)(SA)(t_v)}{\left(\frac{E_a}{K_{eq} k_g}\right) + \left(\frac{\pi t}{D_e K_{eq}}\right)^{1/2}}$$

Where,
E = Total Emissions from Excavation of Soil in g;
E_{PS}= Total Emissions due to Soil Pore Space Gas in g;
E_{DIFF} = Total Emissions due to Diffusion in g;
P_i = Partial Pressure of Component i in millimeters of mercury (mm Hg)[1];
MW = Molecular Weight in grams per mole (g/mol);

[1] Note that because the impacts at the Site are primarily not separate phase, we have used the partial pressure as opposed to the vapor pressure of the pure component.

10^6 = Conversion Factor of cm^3/m^3;
E_a= Air-Filled Porosity (0.35 for wet, or compacted soil; 0.55 for dry, uncompacted soil – Eklund (1997));
S_v = Total Volume of Soil Moved in m^3;
ExC = Soil-Gas to Atmosphere Exchange Constant (0.10 for wet or high-clay content soils; 0.33 for dry, sandy soils from Eklund - 1997);
R = Universal Gas Constant in mm-Hg*cm^3/mol/K (62,361 mm-Hg*cm^3/mol/K);
T = Temperatures in K (assumed to be 15°C);
C = Mass Loading of Component i in soil in g/cm^3;
$10{,}000$ = Conversion Factor of square centimeters per square meter (cm^2/m^2); and
SA = Total Emitting Surface Area in square meters (m^2). GZA assumed the Total Emitting Surface Area to be the sides and bottom of the excavation and the sides and top of the stockpile.
D_e = Effective Diffusivity in Air in square centimeter per second (cm^2/s);
K_{eq} = Equilibrium Coefficient;
t_v = Time the Volume of Soil Moved is emitting in seconds (s) (360 s – Eklund (1997));
k_g = Gas-Phase Mass Transfer Coefficient in centimeter per second (cm/s) (Default of 0.15 cm/s – Eklund (1997)); and
t = Time that the Instantaneous Emission Rate approximates the Average Emission Rate over the 360 second period that Emissions from Freshly Excavated Soil are assumed to be Significant in s (60 s – Eklund (1997)).

P_i is calculated by:

For this scenario, the partial pressure was estimated using Raoult's Law assuming the constituents are in a mixture with the other organic matter in the soil.

Raoult's Law:

$$P_i = P_i^* x_i$$

Where,
P_i = Partial Pressure of the Component i in the Mixture;
P_i^* = Vapor Pressure of the pure Component i; and
x_i = Mole Fraction of the Component i in the Mixture (moles component/total moles).

$$x_i = \frac{10^{-6}\, C_{i,Mixture}\, MW_{Mixture}}{MW_i}$$

Where,
10^{-6} = Conversion Factor of kilogram per milligram (kg/mg);
$MW_{Mixture}$ = Molecular Weight of Mixture in g/mol (assumed to be 250 g/mol);
MW_i = Molecular Weight of Component i in g/mol; and
$C_{i,Mixture}$ = Concentration of Component i in the Mixture in milligrams of Component i per kilogram of Mixture (mg/kg).

$$C_{i,Mixture} = \frac{C_{i,Soil}}{TOC}$$

Where,
$C_{i,Mixture}$ = Concentration of Component i in the Mixture in milligrams of Component i per kilogram of Mixture (mg/kg);

$C_{i,Soil}$ = Concentration of Component i in the Soil in micrograms of Component i per gram of Soil (ug/g); and TOC = Fraction of Total Organic Carbon in the Soil (g/g). Because Site-specific TOC data was not available, the default value of 0.002 from the USEPA's Soil Screening Guidance: User's Guide (1996) was used to be conservative.

We've assumed a soil temperature of 15°C in our calculations. We have therefore utilized the Clausius-Clapeyron equation to calculate vapor pressures at 15°C from those in the literature (typically 25°C):
Clausius-Clapeyron Equation:

$$\ln\left(\frac{P_1}{P_2}\right) = \left(\frac{\Delta H_{vap}}{R}\right)\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Where,
P_1 = Vapor Pressure at a Known Point;
P_2 = Vapor Pressure at a Given Point;
T_1 = Temperature at a Known Point in Kelvin (K);
T_2 = Temperature at a Given Point in K;
ΔH_{vap} = Enthalpy of Vaporization of Component i in kilojoules per mole (kJ/mol); and
R = Universal Gas Constant in kilojoules per Kelvin per mole (8.314E-03 kJ/K/mol).

C (Mass Loading of Component i in soil in g/cm^3) is calculated by:

$$C = 10^{-6}\, C_{i,Soil}\, \beta$$

Where,
10^{-6} = Conversion Factor of gram per microgram (g/ug);
$C_{i,Soil}$ = Concentration of Component i in the Soil in micrograms of Component i per gram of Soil (ug/g); and
β = Typical Bulk Density in g/m^3; (assumed to be 1.5 g/m^3 – Eklund (1997)).

K_{eq} is calculated by:

$$K_{eq} = \frac{P_i\, MW_i\, E_a}{R\, T\, C}$$

Where,
P_i = Partial Pressure of the Component i in the Mixture in mm Hg;
MW_i = Molecular Weight of Component i in g/mol;
E_a= Air-Filled Porosity (0.35 for wet, or compacted soil; 0.55 for dry, uncompacted soil – Eklund (1997));
R = Universal Gas Constant in mm-Hg*cm^3/mol/K (62,361 mm-Hg*cm^3/mol/K);
T = Temperatures in K (assumed to be 15°C);
C = Mass Loading of Component i in soil in g/cm^3;

D_e is calculated by:

$$D_e = \frac{D_a\, (E_a)^{3.33}}{(E_T)^2}$$

Where,
D_a = Diffusivity in Air of Component i in cm^2/s (Default of 0.1 was used when chemical-specific values could not be found.);

E_a= Air-Filled Porosity (0.35 for wet, or compacted soil; 0.55 for dry, uncompacted soil – Eklund (1997)); and
E_T= Total Porosity (0.35 for compacted soil; 0.55 for uncompacted soil – Eklund (1997)).

For impacted soils to be managed on-Site (e.g., if it is not directly loaded into a truck but is first stockpiled), an additional Total Emissions due to Soil Pore Space Gas factor will be included in the Average Total Emissions to account for the additional emissions during soil handling and stockpiling. As a conservative measure, for losses during management of materials, GZA will utilize the Total Emissions due to Soil Pore Space Gas that was calculated above for losses during excavation. This is conservative since the concentrations in the re-handled soil will be lower than in the soil during excavation.

References:

Eklund, et al. 1997. Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances. Prepared for U.S. Environmental Protection Agency Office of Air and Radiation and Office of Research and Development Washington, D.C. EPA-600/R-97-116. October.

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