West Virginia Purchasing Division
2019 Washington Street, East
Charleston, WV 25305
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Welcome, Lu Anne Cottrill

Procurement | Budgeting | Accounts Receivable | Accounts Payable

Solicitation Response(SR) **Dept:** 0313 **ID:** ESR07292000000000516 **Ver.:** 1 **Function:** New **Phase:** Final

Modified by batch , 07/29/2020

Header 5

List View

General Information | Contact | Default Values | Discount | Document Information

Procurement Folder: 713506

Procurement Type: Central Master Agreement

Vendor ID: VS0000027684

Legal Name: National EC Services, Inc. dba Hull & Associates, LLC

Alias/DBA:

Total Bid: $105,000.00

Response Date: 07/29/2020

Response Time: 12:06

SO Doc Code: CRFQ

SO Dept: 0313

SO Doc ID: DEP2100000002

Published Date: 7/14/20

Close Date: 7/29/20

Close Time: 13:30

Status: Closed

Solicitation Description: Open-end contract for Environmental Risk Assessment

Total of Header Attachments: 5

Total of All Attachments: 5

Purchasing Division 2019 Washington Street East Post Office Box 50130 Charleston, WV 25305-0130	**State of West Virginia** **Solicitation Response**

Proc Folder : 713506

Solicitation Description : Open-end contract for Environmental Risk Assessment

Proc Type : Central Master Agreement

Date issued	Solicitation Closes	Solicitation Response	Version
	2020-07-29 13:30:00	SR 0313 ESR07292000000000516	1

VENDOR
VS0000027684 National EC Services, Inc. dba Hull & Associates, LLC

Solicitation Number: CRFQ 0313 DEP2100000002

Total Bid : $105,000.00 **Response Date:** 2020-07-29 **Response Time:** 12:06:43

Comments: Hull is willing to provide a discount for early payment if awarded this contract.

FOR INFORMATION CONTACT THE BUYER		
Joseph E Hager III (304) 558-2306 joseph.e.hageriii@wv.gov		
Signature on File	FEIN #	DATE

All offers subject to all terms and conditions contained in this solicitation

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Ln Total Or Contract Amount
1	Risk or hazard assessment	700.00000	HOUR	$150.000000	$105,000.00

Comm Code	Manufacturer	Specification	Model #
77101501			

Extended Description : Environmental Risk Assessor Open end contract for service, bid sheet represents an estimated number of hours for bidding purposes to establish a contracted set price per hour.

PROPERTY-SPECIFIC RISK ASSESSMENT

FOR THE:
FORMER RITTMAN PAPERBOARD FACILITY EAST OF RIVER STYX

LOCATED EAST OF RIVER STYX AT:
100 INDUSTRIAL AVENUE
RITTMAN, OHIO 44270

PREPARED FOR:
URBAN RENEWABLES II, LLC
6397 EMERALD PARKWAY, SUITE 200
DUBLIN, OHIO 43016

PREPARED BY:
HULL & ASSOCIATES, INC.
4 HEMISPHERE WAY
BEDFORD, OHIO 44146

MAY 2018

HULL
Environment / Energy / Infrastructure

TABLE OF CONTENTS

TABLE OF CONTENTS CONT'D

PAGE

TABLE OF CONTENTS CONT'D

LIST OF TABLES

TABLE OF CONTENTS CON'TD

LIST OF TABLES CONT'D

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Urban Renewables II, LLC retained Hull & Associates, Inc. (Hull) to prepare a Property-Specific Risk Assessment (PSRA) of a portion of the Former Rittman Paperboard Facility located east of River Styx including the former landfill, lagoons, and the Salt Street Impoundments located at 100 Industrial Avenue, Rittman, Ohio (Property). The PSRA was completed in accordance with the Ohio Voluntary Action Program (VAP), Ohio Administrative Code (OAC) Chapter 3745-300, effective May 26, 2016. It is reasonably anticipated that the Property will be utilized for commercial/industrial purposes.

The July 2015 Phase I report completed for the Property identified a total of three Identified Areas (IAs). Phase II sampling activities were implemented in order to further investigate the IAs at the Property. The results of the Phase II were utilized herein to provide an estimate of the hazards and risks posed to all receptor populations at the Property, based upon applicable standards and the acceptable hazard and risk goals established under the VAP based on current and reasonably anticipated future conditions at the Property.

Concentrations of chemicals of concern (COCs) in groundwater exceeded unrestricted potable use standards (UPUS) in the uppermost saturated zone. The uppermost saturated zone underlying the Property has been classified in accordance with OAC 3745-300-10(B) as a Class A groundwater. Groundwater in the lower saturated zone has been identified as a Critical Resource groundwater; detected concentrations of COCs in the lower saturated zone were further reviewed and determined to be within the range of naturally occurring background values. All COCs detected in the upper saturated zone are assumed to be attributable to an on-Property source or are naturally occurring; and COCs detected in the lower saturated zone have been determined to be reflective of naturally occurring background conditions. Exposure pathways based on potable use of groundwater in the upper saturated zone are incomplete. Specifically, a groundwater use restriction prohibiting potable use of the groundwater in the upper saturated zone underlying the Property will be established at the Property. In addition, the River Styx was identified adjacent to the Property as an important ecological resource (IER). An evaluation of potential groundwater migration to surface water was completed.

The receptor populations identified and the complete exposure pathways evaluated herein include the following:

- **On-Property Commercial/Industrial Workers:**
  - There are no unacceptable hazards and risks posed by direct contact exposures to soil.

- There are no unacceptable hazards or risks posed by direct contact exposures to lagoon and borrow pond sediment.
- There are no unacceptable hazards or risks posed by direct contact exposures to lagoon and borrow pond surface water.
- There are no unacceptable hazards or risks associated with potentially cumulative and aggregate exposures from direct contact with soil, direct contact with lagoon and borrow pond sediment, and direct contact with lagoon and borrow pond surface water (after arsenic exposures are further evaluated).
- There are no unacceptable exposures to lead in environmental media at the Property.

- **On-Property Construction/Excavation Workers:**
  - There are no unacceptable hazards or risks posed by direct contact exposures to soil.
  - There are no unacceptable hazards or risks posed by direct contact exposures to shallow groundwater.
  - There are no unacceptable hazards or risks posed by direct contact exposures to lagoon and borrow pond sediments.
  - There are no unacceptable hazards or risks posed by direct contact exposures to lagoon and borrow pond surface water.
  - There are no unacceptable hazards or risks associated with potentially cumulative and aggregate exposures from direct contact with soil (surface and subsurface), groundwater, lagoon and borrow pond sediment, and lagoon and borrow pond surface water.
  - There are no unacceptable exposures to lead in environmental media at the Property.
- **All Receptor Populations:**
  - There are no unacceptable hazards or risks posed to all receptor populations through potable use of groundwater in the lower saturated zone.
- **Off-Property Important Ecological Resources:**
  - There are no unacceptable hazards or risks associated with the potential migration of groundwater to the off-Property Important Ecological Resource (IER), the River Styx.

Based on the results of this PSRA, compliance with applicable standards as necessary to secure a NFA letter under the Ohio VAP requires the following activities at the Property:

- The establishment of an institutional control that restricts the Property to commercial/industrial land use as defined in OAC 3745-300-08(C)(2)(b);
- The establishment of an institutional control that precludes the use of groundwater at the Property, in accordance with OAC 3745-300-11(C)(3); and
- The establishment of an Activity and Use Limitation that requires a demonstration be made that the indoor air exposure pathway meets acceptable hazard and risk goals prior to

occupancy of any potential future buildings constructed on the portion of the Property located north of Salt Street.

1.0 INTRODUCTION

1.1 General

Urban Renewables II, LLC (Client) retained Hull & Associates, Inc. (Hull) to prepare a Property-Specific Risk Assessment (PSRA) for a portion of the Former Rittman Paperboard Facility located east of River Styx including the former landfill, lagoons, and the Salt Street Impoundment located at 100 Industrial Avenue in Rittman, Wayne County, Ohio (Property). The Property, commonly referred to as the Former Rittman Paperboard Landfill Property, is shown on Figure 1. The PSRA was completed in accordance with the Ohio Voluntary Action Program (VAP), Ohio Administrative Code (OAC) 3745-300-09, effective August 1, 2014.

The PSRA presented herein evaluates hazard and risk posed by exposures to COC concentrations in soil, groundwater, sediment and surface water in accordance with OAC 3745-300-09, effective August 1, 2014. This assumes that the Property will remain as-is and will be limited to commercial/industrial land use.

A *Phase I Property Assessment* and a *Phase I Update* (Phase I Update, Hull Document # UR2008.600.0014) was performed in accordance with the requirements of OAC 3745-300-06. The Phase II was completed in accordance with OAC 3745-300-07.

1.2 Purpose

This PSRA was prepared as a "mandatory application" of the Property-Specific Risk Assessment Rule in accordance with OAC 3745-300-09(A)(3)(a) since complete exposure pathways (*e.g.*, direct contact with groundwater) were identified at the Property that are not considered in the development of standards in OAC 3745-300-08. The PSRA provides an estimate of the hazards and risks posed to all receptor populations at the Property, based upon applicable standards and the acceptable hazard and risk goals established under the VAP. Compliance with applicable standards constitutes a determination that the hazardous substances and/or petroleum at the Property do not pose unacceptable hazards or risks to receptor populations at the Property, so that conditions at the Property will be protective of human health, safety, and the environment. The PSRA shows that applicable standards are met at the Property assuming:

- the establishment of an institutional control that restricts the use of the Property to commercial/industrial land use; and
- the establishment of an institutional control that prohibits the use of groundwater at the Property for any purpose, except for investigation and remediation.

1.3 Property Description

A Property Plan showing the general Property layout and characteristics is presented as Figure 2. As shown on the figure, the Property is bisected by railroad tracks traversing east-west through the middle of the Property. Salt Street, located north of the railroad tracks, is contained within the northern portion of the Property. The entire Property is located east of River Styx, although former production activities associated with the Property address occurred on the adjoining property west of the River Styx.

The northern portion of the Property is currently occupied by an inactive Class III Residual Waste Landfill (landfill) as well as former settling and aeration ponds. The southern portion of the Property is occupied by three former impoundments commonly referred to as the Salt Street Impoundments that have undergone eutrophication and are currently heavily vegetated. These Property features are no longer actively operating, however, are subject to routine maintenance activities.

The Property is evaluated in this PSRA under current Property conditions based upon anticipated and continued commercial/industrial land use.

The Property layout depicting the location of Property features, including all sampling locations utilized within this PSRA is illustrated on Figure 3.

2.0 HAZARD IDENTIFICATION

2.1 General

This section provides a brief description of the Property and the sampling and analysis of environmental media to determine medium-specific concentrations of COCs identified during the Phase II investigation.

2.2 Property-Specific Geology and Hydrogeology

A detailed evaluation of the Property-specific geology and hydrogeology was performed in accordance with OAC 3745-300-07(E)(2) within the Phase II. The Property lies within a buried glacial valley. In general, soils consist of surficial fill material (clay fill, cinders, bottom ash), followed by alluvium silty/clay, which contains the upper saturated unit. This unit overlies a 30 to 50-foot thick of low permeability lacustrine clay. The lower saturated unit is located within a unit of sand and gravel outwash deposits, located beneath the lacustrine clay. In general, groundwater was measured in monitoring wells within the upper saturated (shallow unit) ranging from 5 to 22 feet bgs. Groundwater monitoring wells were installed to depths ranging between 16 to 37 feet bgs. Bedrock was only encountered in one of the deep monitoring wells (HDMW-7) at the Property; depth to bedrock at other portions of the Property is unknown given the variability in the deep buried valley. However, bedrock at the bottom of the buried valley consists of the Cuyahoga Formation, which is comprised of shales, sandstones, and conglomerate. In general, groundwater flow in both saturated zones is in a west-southwest direction towards the River Styx.

2.3 Property Investigation

The Phase I report identified 3 Identified Areas (IAs) at the Property; the Phase I Update report identified an additional IA (IA-4: Cinders and Ash Placement Areas). Analytical results obtained as part of Phase II sampling activities indicate that IA-3 does not require further evaluation since analytical results from the IA sampling activities are either all non-detect or are all below applicable standards. IA-4 was initially identified as a pre-IA, sampled, and removed from further evaluation since all detected concentrations were below their respective standards. However, as a result of Ohio EPA Technical Assistance Comments, IA-4 was formally denoted as an IA. Due to the chronology of submittal documents, direct contact soil hazard and risk estimates for IA-4 were quantified separately as part of the Response to Ohio EPA's TA Comments and submitted separately under separate cover. In summary, direct contact soil hazards and risks are acceptable at IA-4 for all receptors identified within this PSRA, therefore, further evaluation of IA-4 soil is not necessary. Refer to the Responses to Ohio EPA's TA Comments that assesses direct contact exposures to IA-4 soil as well as its effect on cumulative exposures at the Property.

The results of all sampling and assessment activities for soil, groundwater, sediment and surface water to address all of IAs are summarized in the Phase II report.

The identification of the COCs in the IAs, the identification of potential sources and affected media within the IAs, and the determination of the concentrations of COCs within the IAs were performed in accordance with OAC 3745-300-07(E)(3), (E)(4), (E)(5), and (F)(6), respectively. The hazardous substances COCs at the Property include analytes from the following parameter groups as identified in the Phase I report:

- Resource Conservation and Recovery Act (RCRA) 8 metals plus transitional metals cobalt, nickel, copper, molybdenum, vanadium and zinc;
- Polynuclear aromatic hydrocarbons (PAHs); and
- Polychlorinated biphenyls (PCBs).

Volatile organic compounds (VOCs) were not identified as a class of COCs for the Property. This was due to a lack of a source of VOCs at the Property that, when combined with historical analytical VOC data, did not reveal any evidence of a release of VOCs at the Property. A review of historical non-VAP certified analytical data, including VOC data indicating very few VOCs were detected at very low concentrations, is presented further below in Section 2.4 and presented in Appendix A.

An evaluation of non-hazardous substances is required in accordance with Appendix A of the Director's Final Findings and Orders (DFFO) dated December 29, 2014. As a result, non-hazardous constituents were also identified for each IA in the Phase I Report. Further evaluation of non-hazardous constituents was not completed as part of this PSRA; rather, evaluation of non-hazardous constituents is included in the *Adverse Effects Compliance Report* (AECR; Hull, 2017) being submitted concurrently under separate cover. When taken together, the PSRA for hazardous chemicals combined with the AECR for the non-hazardous constituents, all potential exposures and risks for the entire Property are addressed.

2.4 Evaluation of Data

A large volume of analytical data obtained from soil, sediment, groundwater and surface water environmental media exists for the Property. The analytical results collected during the 2015 and 2016 Phase II investigations as well as select historical sampling events were submitted for chemical analysis by a VAP Certified Laboratory in accordance with OAC 3745-300-04. However, a rather large portion of the analytical data, particularly the groundwater and surface water environmental media, were collected under alternative regulatory programs or for supplemental investigation purposes. Therefore, the analytical data sets for each environmental media were determined as follows:

- Soil – analytical data collected outside the programmatic requirements of the VAP were not used for further evaluation as part of this PSRA. The non-certified soil analytical data was not utilized herein since: (1) a minimum of three samples per IA have been collected and analyzed by a VAP certified laboratory; (2) the known sampling locations are not associated with any of the IAs currently identified for the Property; (3) the physical locations of some sampling locations cannot be determined; and (4) the proportion of detected COCs that are identified as a hazardous substance in the non-certified soil analytical data set is approximately 55% and each of the maximum detected concentrations is below its respective commercial/industrial generic direct contact soil standard. Refer to Tables A-1 and A-2 in Appendix A for a summary of soil sampling locations not utilized herein, as well as a comparison of the maximum detected concentrations of each hazardous substance COC against its respective direct contact soil standard, respectively.

- Groundwater – a large volume of groundwater analytical data exists for the Property. In order to determine the analytical data set subject to further evaluation as part of this PSRA, the following considerations were taken into account: the cessation date of pumping activities from the company production water wells located west of the River Styx and the observed/anticipated impact on water chemistry; changes in sampling methodology (i.e., bailer sampling vs. low-flow sampling); confirmation sampling in accordance with OAC 3745-300-07(E)(1)(d)(iii)(a); and the nature and extent of detected concentrations of hazardous substances in groundwater. As a result, the groundwater analytical dataset identified for further evaluation as part of this PSRA consists of groundwater analytical data collected during 2013, 2014, 2015 and 2016. As shown in Table A-3 of Appendix A, a minimum of 10% of the sample population from the previous investigations has been confirmed in accordance with the aforementioned rule reference. Specifically, a minimum of 5 groundwater samples (i.e., 10%) are required to confirm the previous analytical dataset; a total of 18confirmatory groundwater samples were collected during the 2015 and 2016 Phase II investigation activities.

- Sediment – analytical data collected outside of the programmatic requirements of the VAP were not evaluated as part of this PSRA. This dataset was excluded since: (1) each of the sampling locations is located outside the limits of current IAs; (2) pre-existing VAP certified data are available for the majority of the lagoons where non-VAP certified data exists; and (3) a minimum of three sediment samples were collected per IA as part of the 2015 Phase II investigation activities. A summary of the sediment samples not utilized as part of this PSRA is included in Table A-4 of Appendix A.

- Surface Water – a large volume of analytical data exists for the surface water environmental medium. This includes surface water collected from lagoons, impoundments, wetlands, borrow pits, and the River Styx. Consistent with the rationale for the groundwater environmental medium, only analytical data collected during the 2013 investigation activities as well as the 2015 and 2016 Phase II investigation activities were utilized as part of this PSRA. In addition, only surface water sampling locations that are applicable to the evaluation of the existing IAs were utilized herein. In other words, additional surface water analytical data may be available for select areas of the Property (i.e., lagoons, etc.), however, since these areas were not identified within the limits of an IA, they were not further evaluated. As shown in Table A-5 of Appendix A, a minimum of 10% of the sample population from the previous investigation identified for further evaluation has been confirmed in accordance with OAC 3745-300-07(E)(1)(d)(iii)(a). Specifically, a minimum of 1 surface water sample (i.e., 10%) is required to confirm the previous analytical dataset; a total of 3 confirmatory surface water samples were collected during the 2015 Phase II investigation activities from the same sampling location at Lagoon 21. Therefore, the requirements of the aforementioned rule have been satisfied.

A summary of the soil sampling locations retained for further evaluation as part of this PSRA is presented in Table 2-1. Note that although VAP certified data exists for each of the 2015 Phase II soil sampling locations, not all of these sampling locations have been retained for further evaluation (and are therefore not presented in Table 2-1) since several of the sampling locations were collected with the objective of establishing whether select portions of the Property should be identified as an IA or to confirm historical findings (i.e., PCBs within IA-3). As presented in the Phase II report, the analytical results from these pre-IA determination soil sampling locations as well as IA-3 indicate that all detected concentrations are below their respective VAP generic direct contact soil standards. As a result, no additional IAs were determined following the 2015 Phase II investigation activities and the pre-IA soil sampling locations, located outside of the confirmed IAs, were not utilized herein. A summary of the soil sampling locations collected during the 2015 Phase II investigation and not utilized herein is presented in Table A-6 in Appendix A.

A summary of groundwater sampling locations and corresponding dates that were retained for further evaluation within this PSRA is presented in Table 2-2.

A summary of the sediment sampling locations utilized in this PSRA for further evaluation is presented in Table 2-3. Note that although additional VAP certified sediment sampling locations may be available, only sediment sampling locations that correspond to existing IAs has been utilized herein. Refer to Table A-7 in Appendix A for a summary of sediment sampling locations that consist of VAP certified data but have not been utilized herein since they are outside the limits of current IAs.

A summary of surface water sampling locations that were retained for further evaluation within this PSRA is presented in Table 2-4.

A summary of all sampling locations at the Property is presented on Figure A-1 for reference purposes.

2.5 Selection of Chemicals of Concern for Further Evaluation

The COCs evaluated in this PSRA were selected in accordance with OAC 3745-300-07 (F)(6) and OAC 3745-300-09 (D)(3)(a). Note that this PSRA only addresses COCs that are identified as hazardous substances under the VAP; further evaluation of non-hazardous constituents is presented in the *Adverse Effects Compliance Report* (AECR; Hull, 2017). As such, information regarding non-hazardous constituents in environmental media at the Property has not been presented within this PSRA.

The evaluations in this PSRA were completed on the basis of two exposure units at the Property: the portion of the Property located north of Salt Street and east of River Styx has been evaluated as Exposure Unit North (EU-North); the portion of the Property located south of Salt Street and east of River Styx and commonly referred to as the Salt Street Impoundments has been evaluated as Exposure Unit South (EU-South).

Chemicals detected in soil at least once were selected as COCs for further evaluation in the PSRA. Table 2-5 provides a summary of the minimum and maximum detected COC concentrations and the detection frequency for each COC detected in surface soil samples (0-2 ft below ground surface) collected from EU-North at the Property. Note that all soil samples retained for further evaluation in this PSRA were collected within the upper 2 feet of the ground surface since: (1) identified sources consist of surficial releases at IA-2 and IA-3; (2) identified sources at IA-1 consist of surficial and subsurface releases; however, soil data from the landfill material collected within the uncapped portion, the partially capped portion and the fully capped portion of the landfill all meet applicable hazard and risk goals (as indicated herein), thus indicating that surface soil is adequate for evaluation purposes; and, (3) the point of compliance is reasonably anticipated to include the 0-2 ft below ground surface interval. As a result, the summary statistics for each COC detected in total soil (i.e., surface and subsurface soil) within EU-North is identical to the information included in Table 2-5 for the surface soil analytical dataset and has not been re-presented as a separate table herein.

Chemicals detected in groundwater at least once within EU-North were selected as COCs for further evaluation in the PSRA. A summary of the minimum and maximum detected COC concentrations and the detection frequency for each COC detected in groundwater in the upper saturated zone within EU-North is presented in Table 2-6. A summary of the minimum and maximum detected COC concentrations and detection frequency for each COC detected in groundwater in the lower saturated zone within EU-North is presented in Table 2-7.

Chemicals detected at least once in sediment samples within EU-North were selected as COCs for further evaluation in this PSRA. A summary of the minimum and maximum detected COC concentrations and the detection frequency for each COC detected in sediment is presented in Table 2-8.

Chemicals detected at least once in lagoon/borrow pit surface water samples within EU-North were selected as COCs for further evaluation in the PSRA. A summary of the minimum and maximum detected COC concentrations and the detection frequency for each COC detected in surface water is presented in Table 2-9.

Chemicals detected in River Styx surface water samples were retained for further evaluation. A summary of the minimum and maximum detected COC concentrations and the detection frequency for each COC detected in surface water is presented in Table 2-10.

No COCs were retained for further evaluation within EU-South as part of this PSRA. As indicated in the Phase II report, no detected concentrations were observed in the soil analytical data set obtained from IA-3 located within EU-South. Specifically, no PCBs were detected in the soil samples collected to further investigate IA-3 where PCBs were previously detected at one location within the immediate vicinity of a utility pole. Additionally, as indicated above, pre-IA determination soil sampling at the Salt Street Impoundments did not identify the presence of any additional IAs within EU-South. As a result, no quantitative evaluation of EU-South was deemed necessary within the context of this PSRA. Nonetheless, all available analytical results (including both Certified and Non-Certified VAP data) were utilized in completion of a separate quantitative risk evaluation of EU-South to alleviate any uncertainties associated with potential future use of this portion of the Property. The quantitative evaluation of analytical results associated with EU-South is included in Appendix B.

Sample locations utilized for further evaluation within this PSRA for all media are depicted on Figure 3.

3.0 EXPOSURE ASSESSMENT

This section of the PSRA provides a summary of the Property setting, identifies the receptor populations at the Property, and evaluates the completeness of the exposure pathways at the Property.

3.1 Current and Future Land Use

The Property is currently vacant industrial land that is occupied by a former landfill and a lagoon system within EU-North and three impoundments within EU-South. It is bound to the west by River Styx, to the north by East Ohio Street, to the east by Morning Star Drive and vacant wooded land to the south. Residential dwellings sparsely occupy land further to the north and east; and a combination of active and inactive commercial/industrial land occupies land further to the west and east. The Rittman publicly owned treatment works (POTW) is also located on the east adjoining property.

3.2 Identification of Receptor Populations

Receptor populations at the Property have been identified in accordance with OAC 3745-300-07(E)(6). Based upon the current and anticipated continued use of the Property in the future, it was evaluated as commercial/industrial land use. Therefore, the current and reasonably anticipated future receptor populations at the Property and adjacent off-Property areas include the following:

- On-Property Commercial/Industrial Workers;
- On-Property Construction/Excavation Workers;
- Off-Property Commercial/Industrial Workers;
- Off-Property Residents;
- On-Property Important Ecological Resources; and,
- Off-Property Important Ecological Resources.

3.2.1 On-Property Commercial/Industrial Workers

The On-Property Commercial/Industrial Worker receptor population is representative of an adult that may be working at the facility buildings and/or grounds on a daily basis, and potential visitors who may come to the Property during the business day. This receptor population is evaluated consistent with the commercial land use category defined in OAC 3745-300-08(C)(2)(b) within a 2-foot POC, in accordance with OAC 3745-300-07(I)(1)(a)(i)(b). The generic numerical direct contact soil standards for the commercial/industrial land use category are included in Table II within Appendix A of OAC 3745-300-08.

As indicated herein, current land use at the Property consists of routine maintenance activities associated with managing the former landfill and lagoon system. Therefore, evaluation of the On-Property Commercial/Industrial Worker for future active commercial/industrial land use is protective of the current routine maintenance worker receptor population.

3.2.2 On-Property Construction/Excavation Workers

The On-Property Construction/Excavation Worker is representative of a worker involved in any short-term construction, excavation or other potentially intrusive activities at the Property. This receptor population is anticipated to be involved in intrusive activities during any potential utility work or other invasive activity at the Property. This receptor population is evaluated consistent with the construction or excavation activities category defined in OAC 3745-300-08(C)(2)(d) within a 10-foot POC, in accordance with OAC 3745-300-07(I)(1)(a)(i)(c). The generic numerical direct contact soil standards for construction or excavation activities are contained in Table III within Appendix A of OAC 3745-300-08.

3.2.3 Off-Property Commercial/Industrial Workers

Due to the presence of COCs in groundwater underlying the Property that may migrate to off-Property locations, the Off-Property Commercial/Industrial Worker has been identified as a potential off-Property receptor population. The Off-Property Commercial/Industrial Worker may be exposed to COCs in groundwater in the upper saturated zone that may emanate from the Property (*i.e.*, potentially complete exposure pathways associated with groundwater).

3.2.4 Off-Property Residents

Due to the presence of COCs in groundwater underlying the Property that may migrate to off-Property locations, the Off-Property Resident has been identified as a potential off-Property receptor population. The Off-Property Resident may be exposed to COCs in groundwater in the upper saturated zone that may emanate from the Property (*i.e.*, potentially complete exposure pathways associated with groundwater).

3.2.5 Important Ecological Resources

Important ecological resources (IERs), as defined in OAC 3745-300-01(A)(64), were identified both on-Property and off-Property. Two On-Property IERs are located on the southern portion of the Property; they include the historically delineated areas identified as Wetland C and Wetland R. Historical correspondence with the U.S. Army Corps of Engineers (USACOE) identifies these two wetland areas as waters of the U.S. that are subject to regulation under Section 404 of the Clean Water Act. Refer to the Phase I report for a copy of the correspondence from the USACOE.

The off-Property IER is located adjacent to the Property due to the presence of River Styx which bounds the Property to the west and is considered a surface water body of the state. Therefore, the off-Property IER will be evaluated further herein. This includes evaluation of potential human recreational users within the river as well as aquatic life.

No additional on-Property or off-Property IERs were identified for the Property. Refer to Figure 4 for the locations of the on-Property and off-Property IERs.

3.3 Exposure Pathway Completeness Determination

The Site Conceptual Model (SCM) provides a diagrammatic representation of the complete and potentially complete exposure pathways at the Property. The SCM for EU-North is found on Figure 5A; the SCM for EU-South is found on Figure 5B. The SCM summarizes the pathway completeness determination conducted in accordance with OAC 3745-300-07 (F)(1). The complete and incomplete exposure pathways at EU-North and EU-South are also summarized on Table 3-1 and Table 3-2, respectively. The SCMs and Tables 3-1 and 3-2 identify the complete or potentially complete exposure pathways to on-Property and off-Property receptor populations associated with each exposure unit identified at the Property. Potentially complete exposure pathways at the Property, irrespective of EU, include the following:

1. Direct contact with surface soil exposures, including incidental ingestion and dermal contact with soil, and inhalation of volatile and particulate emissions from surface soil to outdoor air by On-Property Commercial/Industrial Workers;
2. Inhalation of volatile COCs in soil and landfill gases to indoor by On-Property Commercial/Industrial Workers;
3. Direct contact with surface and subsurface soil exposures, including incidental ingestion and dermal contact with soil, and inhalation of volatile and particulate emissions from soil to outdoor air by On-Property Construction/Excavation Workers;
4. Direct contact with shallow groundwater exposures, including incidental ingestion and dermal contact by On-Property Construction/Excavation Workers;
5. Direct contact with lagoon/borrow pond water exposures, including incidental ingestion and dermal contact from lagoon/borrow pond water by On-Property Commercial/Industrial Workers and On-Property Construction/Excavation Workers;
6. Direct contact with lagoon/borrow pond sediment exposures, including incidental ingestion and dermal contact from lagoon/borrow pond sediment by On-Property Commercial/Industrial Workers and On-Property Construction/Excavation Workers;
7. Potable use of groundwater from the upper saturated zone by On-Property Commercial/Industrial Workers, On-Property Construction/Excavation Workers, Off-Property Commercial/Industrial Workers and Off-Property Residents;
8. Potable use of groundwater from the lower saturated zone by On-Property Commercial/Industrial Workers, On-Property Construction/Excavation Workers, Off-Property Commercial/Industrial Workers and Off-Property Residents;

9. Exposures to COCs in sediment and surface water within the two On-Property IERs by ecological receptors; and

10. Exposures to COCs in groundwater on the Property that may emanate from the Property to the off-Property IER (i.e., River Styx).

As presented in the Phase II Report, the potentiometric surface of the upper saturated zone at the Property slopes towards the River Styx. Therefore, evaluation of COCs in groundwater that may emanate off-Property to the River Styx has been evaluated further herein. Based upon the direction of groundwater flow in conjunction with the limited COC list identified for each IA, additional exposure pathways associated with groundwater emanating off-Property (i.e., off-Property groundwater-to-indoor air exposures) does not require further evaluation. The River Styx is the POC and acts as a hydraulic barrier preventing migration of the shallow groundwater to the west.

3.3.1 Elimination of Select Exposure Pathways from Further Evaluation

3.3.1.1 Vapor Intrusion Exposure Pathway

VOCs were not identified as COCs for any of the determined IAs for the Property and accordingly, were not included on the analyte list during Phase II investigations completed at the Property. However, some semi-volatile organic compounds (SVOCs), specifically, polynuclear aromatic hydrocarbons (PAHs) and mercury were analyzed for and detected in soil at the Property. Two of the PAHs, benzo(a)anthracene and naphthalene, and mercury are subject to further evaluation as part of the vapor intrusion exposure pathway in accordance with applicable vapor intrusion guidance. However, upon further review of these three COCs, it was determined that evaluation of these COCs with respect to the vapor intrusion exposure pathway was not deemed necessary at this time. There are currently no buildings located on the Property, and at this time there are no plans to construct a building. However, the limited detections of select SVOCs and mercury may require further evaluation in the future prior to building occupancy. Despite Ohio EPA rescinding portions of the 2010 Ohio EPA Vapor Intrusion (VI) Guidance document applicable soil-to-indoor air screening evaluations, the sufficiently volatile COCs detected in soil were subject to a soil-to-indoor air (SIA) screening evaluation per the specifications in the 2010 VI guidance for completeness. At this time, given that there are no plans to construct a building, soil gas samples were not collected at the Property. Additionally, as noted further below, due to the presence of the landfill, a building occupancy activity and use limitation (i.e., remedy or demonstration obligations) is already intended to be placed on the Property based on the potential presence of landfill gases. Nonetheless, the conservative SIA screening evaluation was conducted for completeness, and is included in Appendix C.

The inhalation of landfill gases (*i.e.,* methane) by on-Property receptor populations does not require further evaluation. In accordance with the Permit to Install (PTI) application developed by Bowser-Morner, the landfill at the Property is identified as a captive landfill and as such is exempt from explosive gas monitoring regulations included in OAC 3745-27-12 due to the provisions of OAC 3745-30-06(E). As a result, further evaluation of landfill gases, specifically methane, associated with the former landfill at the Property, was not deemed necessary within the context of this PSRA. It should be noted, however, that provisions for soil gas sampling will be incorporated into an environmental covenant for the Property stipulating that a demonstration must be made that potential landfill gases at the Property will not impact the vapor intrusion exposure pathway in the event a habitable structure is erected within the immediate proximity of the former landfill.

3.3.1.2 Inhalation of Soil to Outdoor Air

Inhalation of particulate emissions from surface soils to outdoor air by Off-Property Commercial/Industrial Workers and Off-Property Residents is a potentially complete pathway with insubstantial exposure that does not require further quantitative evaluation. The concentration of COCs in air resulting from particulate emissions from soil to outdoor air decreases geometrically with increasing distance from the source. Thus, compliance with the commercial/industrial direct contact soil standards on the Property is considered protective of the exposures of off-Property receptor populations to fugitive dust.

3.3.1.3 On-Property IERs

Two IERs were identified at the Property within the Salt Street Impoundments. A single IA (IA-3: Historical PCBs) was identified as an IA at this portion of the Property; however, this IA is not located within the vicinity of either of the two On-Property IERs. In addition, analytical results from the sampling activities at this IA indicated that no PCBs were present. Furthermore, additional sampling activities at the Salt Street Impoundments as part of pre-IA determination activities did not reveal the presence of any additional IAs at the Salt Street Impoundments. Finally, no historical operations were conducted within the geographical locations of the On-Property IERs. Therefore, further evaluation of the On-Property IERs at the Salt Street Impoundments has not been deemed necessary within this PSRA.

3.3.1.4 EU-South

No complete exposure pathways were identified for EU-South. As discussed in Section 2, no COCs were retained for further evaluation within EU-South. As indicated in the Phase II report, no PCBs were detected in the soil samples from IA-3 located within EU-South. Additionally, pre-IA determination soil sampling at the Salt Street Impoundments did not identify the presence of any additional IAs within EU-South. As a result, there were no IAs determined to exist in EU-South; therefore, no quantitative evaluation of EU-South was deemed necessary in accordance with the VAP and within the context of this PSRA. Nonetheless, to alleviate any uncertainties associated with potential future use of this portion of the Property, available analytical results from EU-South were utilized in completion of a separate quantitative risk evaluation. The quantitative evaluation of analytical results associated with EU-South is included in Appendix B, which demonstrates that applicable target hazard and risk goals are achieved for potential future commercial/industrial use of this portion of the Property. Refer to Appendix B for a complete discussion of the pathways evaluated and the hazard and risk estimates for EU-South.

3.4 Groundwater Classification and Groundwater Response Requirements

As described in the Phase II report, concentrations of COCs in groundwater exceeded unrestricted potable use standards (UPUS) in the uppermost saturated zone during more than one sampling event and groundwater in the lower saturated zone is utilized for potable purposes. Therefore, groundwater in the uppermost saturated zone underlying the Property has been classified in accordance with OAC 3745-300-10(B)(2) as Class A groundwater. Groundwater in the lower saturated zone is utilized for potable purposes has been classified in accordance with OAC 3745-300-10(B)(1) as a Critical Resource groundwater. All COCs detected in groundwater are assumed to be attributable to an on-Property source or are reflective of naturally occurring background conditions. Therefore, the appropriate groundwater response requirements for the COCs detected in the upper and lower saturated zones are described in OAC 3745-300-07, OAC 3745-300-10(D) and OAC 3745-300-10(E).

3.4.1 Upper Saturated Zone

Exposure pathways based on the potable use of groundwater are incomplete for the upper saturated zone. A groundwater use restriction prohibiting extraction of the groundwater underlying the Property will be established at the Property; therefore, the exposures of On-Property Commercial/Industrial Worker and On-Property Construction/Excavation Worker receptor populations to groundwater through drinking, cooking, or bathing will be precluded. The River Styx has been identified as an alternative point of compliance in accordance with OAC 3745-300-10(E)(3)(a)(ii) since groundwater in the upper saturated zone at the Property is in hydraulic communication with River Styx; the River Styx is hydraulically downgradient of the Property; and the River Styx is adjacent west of the entire Property boundary. Thus, all complete exposure pathways for on-Property and off-Property receptor populations not related to potable use of the groundwater in the upper saturated zone were evaluated in accordance with OAC 3745-300-07. These exposure pathways include:

- Direct contact exposures to shallow groundwater were evaluated for the On-Property Construction/Excavation Worker given that groundwater was encountered in monitoring wells within 10 feet of the ground surface.
- Migration of groundwater in the upper saturated zone, which is in hydraulic communication with River Styx, to River Styx surface water was evaluated to ensure the protection of aquatic life and human health in the river.

Note that exposures associated with volatile emissions from groundwater to indoor air (*i.e.,* the vapor intrusion exposure pathway) were not identified as complete exposure pathways for the Property. Refer to Section 3.3.1 above for further explanation regarding the vapor intrusion exposure pathway. Additional groundwater classification information is provided in the Phase II report.

3.4.2 Lower Saturated Zone

COCs were detected in groundwater from the lower saturated zone exceeding UPUS. As a result, groundwater in the lower saturated zone was classified in accordance with OAC 3745-300-10(B). Nevertheless, for the reasons discussed in the Phase II report as well as in Section 6.6 of this PSRA, concentrations of COCs in the lower saturated zones identified as exceeding UPUS were not determined to pose a risk to human health or the environment.

3.5 Representative Concentration and Exposure Point Concentration

The representative concentration is the concentration of a COC at the Property that is compared to the appropriate standard for each receptor population. When the representative concentration is measured in the environmental medium to which the receptor is directly exposed (*e.g.*, dermal contact with soil, ingestion of groundwater), the representative concentration is referred to as the exposure point concentration (EPC). The representative concentration in soil for each receptor population was determined in accordance with OAC 3746-300-07(F)(6)(c)(i) or (ii). Where applicable, a 95% Upper Confidence Limit (UCL) of the arithmetic mean of the applicable data set was calculated using the USEPA ProUCL Version 5.1. The datasets and ProUCL output files are included in Appendix D.

For evaluation of the direct contact soil exposures of the On-Property Commercial/Industrial Worker receptor population in EU-North, the EPC is either the maximum detected concentration or the 95% UCL of each COC detected in EU-North surface soil samples (0-2 ft below ground surface). These data are summarized in Table 2-5.

For evaluation of the direct contact soil exposures of the On-Property Construction/Excavation Worker receptor population, the EPC is the maximum detected concentration of each COC detected in all soil samples identified for further evaluation at the Property, irrespective of depth interval. Note that the surface soil dataset and the total soil (surface soil and subsurface soil) dataset are identical. Therefore, these data used for the evaluation of the On-Property Construction/Excavation Worker are also summarized in Table 2-5.

For the evaluation of direct contact with groundwater exposures of the On-Property Construction/Excavation Worker, the maximum detected concentration of each COC reported from groundwater samples retained for further evaluation as part of the PSRA was utilized as the EPC. These data are summarized in Table 2-6.

For the evaluation of potable use of groundwater in the lower saturated zone by On-Property Commercial/Industrial Workers, Off-Property Commercial/Industrial Workers and Off-Property Residents, the maximum detected concentrations of each COC reported from groundwater samples retained for further evaluation as part of the PSRA was utilized as the EPC. These data are summarized in Table 2-7.

Occasional operations at the Property include maintenance of the lagoons (i.e., de-watering activities). Thus, evaluations of direct contact with lagoon and borrow pond sediment and water exposures by the On-Property Commercial/Industrial Worker and the On-Property Construction/Excavation Worker were completed. The maximum detected concentration of each COC reported in sediment was utilized as the EPC for the direct contact with sediment evaluation. These data are summarized in Table 2-8. The maximum detected concentration of each COC reported in lagoon and borrow pond surface water was utilized as the EPC for the direct contact with surface water evaluation. These data are summarized in Table 2-9.

For evaluation of groundwater migration to the off-Property IER, the maximum detected concentration of each COC reported from groundwater samples collected from monitoring wells screened in the upper saturated zone at the Property were used as the representative concentration (Table 2-6). In addition, summary statistics for COCs reported in River Styx surface water, which has been utilized to further assess the groundwater to surface water exposure pathway, are presented in Table 2-10.

4.0 TOXICITY ASSESSMENT

4.1 General

The Toxicity Assessment section presents the toxicity criteria for each COC selected for further evaluation in the PSRA. The toxicity criteria are derived from dose-response data from laboratory or epidemiological studies. From each laboratory or epidemiological study, the dose-response curve characterizes the relationship between the dose of a chemical and the frequency of an adverse health effect in an exposed population (U.S. EPA, 1989). The dose is the quantity of the chemical that enters the body through one or more routes of exposure. Although some toxicity criteria are based upon evaluations of human exposures (*e.g.*, occupational exposures), most of the information concerning the dose-response relationship of chemicals is based on data collected from animal studies and an assumption that human responses are similar. The dose-response relationship is often established under controlled laboratory conditions in order to minimize responses due to confounding variables.

4.2 Toxicity Criteria for the Derivation of Property-Specific Standards

In this PSRA, the toxicity criteria are mathematically evaluated with chemical-specific and route-specific intakes or exposure concentrations to calculate a target medium-specific concentration that is deemed protective of a defined receptor population (*e.g.*, the Construction/Excavation Worker). The calculation of these standards is described in Section 5.

4.2.1 Toxicity Criteria from the Information Hierarchy

Toxicity criteria in the Virginia Department of Environmental Quality's (VA-DEQ) Voluntary Remediation Program (VRP) Construction Trench: Contact with Groundwater calculation spreadsheet (vrp64.xls, revised 8/5/2014) as well as Surface Water Risk Calculations: Trespassers, Recreational calculation spreadsheet (swcalcs.slsx, revised 8/5/2014), which are both consistently updated with toxicity information from U.S. EPA's Regional Screening Levels (RSLs) were primarily used for calculation of direct contact with groundwater for construction/excavation activities and direct contact with lagoon and pond water for construction/excavation activities and/or commercial/industrial activities. The toxicity criteria generally follow the information hierarchy in OAC 3745-300-09(D)(3)(c)(i). Toxicity criteria which differed from the values in Ohio EPA's *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures* (May, 2016) were changed to the Ohio EPA VAP values.

The subchronic toxicity criteria used for the calculation of direct contact with groundwater for the On-Property Construction/Excavation Worker are summarized in Table 4-1; the subchronic toxicity criteria used for the calculation of direct contact with surface water for the On-Property Construction/Excavation Worker and On-Property Commercial/Industrial Worker are summarized in Table 4-2. Note that since exposures to lagoon and pond water by the On-Property Commercial/Industrial Worker are more consistent with a long-term maintenance worker with very limited and intermittent exposures, subchronic toxicity criteria was also used to quantify hazards and risks associated with direct contact with lagoon and pond water by the On-Property Commercial/Industrial Worker.

It is worth noting that barium and manganese, both of which were detected in groundwater and surface water at the Property, have been identified for further evaluation as non-hazardous constituents pursuant to Appendix A of the DFFO dated December 29, 2014. Nevertheless, both of these COCs have also been evaluated further herein as hazardous substances in both groundwater and lagoon and pond water.

4.2.2 Toxicity Criteria for Soil and Sediment COCs Without VAP Standards

VAP generic standards do not exist for the sediment environmental medium. In lieu of calculating Property-specific direct contact sediment standards, the VAP generic direct contact soil standards for each applicable receptor population were utilized to quantify hazards and risks to the On-Property Commercial/Industrial Worker and the On-Property Construction/Excavation Worker who may come into direct contact with lagoon and borrow pond sediment.

VAP generic standards are not available for six of the COCs detected in soil and/or sediment at the Property: aluminum, barium, total chromium, cobalt, molybdenum, and vanadium. Supplemental criteria were utilized for three of these chemicals from Ohio EPA CIDARS spreadsheet, Revised 5-26-2016 (Ohio EPA, 2016). The supplemental criteria from CIDARS were used to evaluate detected concentrations of barium, cobalt and vanadium.

Aluminum and molybdenum are not identified as hazardous substances in accordance with OAC 3745-300-01(A)(59). Therefore, further evaluation of aluminum and molybdenum in soil and/or sediment at the Property was not deemed necessary.

Historical operations at the facility are not reasonably known to have resulted in the presence of chromium VI (hexavalent chromium) in any environmental media at the Property. The historical uses of the Property do not include any known uses or sources of chromium, hexavalent chromium or dichromic acid and as such, chromium was not identified as a COC. Historical operations at the Property do not include any sources of chromium as listed in the ATSDR toxicological profile for chromium (ATSDR, 2012). Industries involved in the use of chromium include; the metallurgical industry (chromium used to produce stainless steels, alloy cast irons, nonferrous alloys and other miscellaneous materials), the refractory industry (chromium used in chrome and chrome-magnesite, magnesite-chrome bricks and granular chrome-bearing and granular chromite, which are used as linings for high temperature industrial furnaces) and various chemical industries (both chromium III and chromium VI are used primarily in pigments) (ATSDR, 2012). Other uses of chromium VI include metal finishing, wood preservatives and chromium III in leather tanning. Smaller amounts of chromium are used as catalysts and in miscellaneous applications, such as drilling muds, chemical manufacturing, textiles, toners for copying machines, magnetic tapes, and dietary supplements. None of these industrial applications were identified historically at this Property. Chromium is released to and found in environmental media worldwide from various sources including domestic waste water effluents, releases from metal manufacturing, ocean sewage dumping, chemical manufacturing, smelting and refining of nonferrous metals, and atmospheric fallout (ATSDR, 2012).

A review of the total chromium analytical data from the Property indicates that the maximum detected concentration of total chromium observed in soil and sediment at the Property is 218 mg/kg. This maximum detected concentration is considerably higher than the next highest detection at 53.6 mg/kg and all other detections in soil and sediment. The maximum detected concentration of total chromium in soil is considerably less than the generic direct contact commercial/industrial soil standard of 1,000,000 mg/kg for chromium III, but marginally above the generic direct contact commercial/industrial soil standard of 210 mg/kg for chromium VI. None of the other total chromium detections in soil or sediment collected at the Property exceed either of the VAP direct contact soil standards for commercial/industrial land use. In addition, the 95% UCL for total chromium soil concentrations of 72.5 mg/kg is considerably less than either the generic direct contact commercial/industrial soil standard for either chromium III or chromium VI. Due to the lack of historical operations at the Property involving chromium VI (hexavalent chromium) as well as a review of the total chromium concentrations in soil and sediment at the Property, additional evaluation of hexavalent chromium at the Property, including chromium speciation, was deemed not necessary. As a result, the standard for chromium III (trivalent chromium) was utilized for comparison purposes herein.

5.0 DERIVATION OF PROPERTY-SPECIFIC STANDARDS

Property-specific standards were developed through this PSRA in accordance with OAC 3745-300-09(A)(3) and include the following:

- Direct contact with groundwater standards for the On-Property Construction/Excavation Worker receptor population; and
- Direct contact with water standards, specifically lead, for the On-Property Construction/Excavation Worker and On-Property Commercial/Industrial Worker receptor populations.

In addition, an evaluation of potential direct contact exposures to lagoon and borrow pond surface water at the Property by the On-Property Commercial/Industrial Worker and On-Property Construction/Excavation Worker were undertaken by the direct estimation of chemical-specific hazard and risk from surface water concentrations (*i.e.*, forward hazard and risk evaluations).

Thus, a combination of generic numerical standards, and Property-specific standards, and direct estimation of hazard and risk were used to determine acceptable levels for COCs in the soil, groundwater, and lagoon/borrow pond surface water with respect to the on-Property receptor populations in accordance with OAC 3745-300-09(B). Detailed, step-wise discussions of the derivation of the Property-specific standards for the applicable receptor populations are provided in the sections below.

5.1 Derivation of Direct Contact Groundwater Standards

An evaluation of the incidental ingestion, dermal contact, and inhalation exposures to volatile emissions from groundwater in an excavation trench was completed for the On-Property Construction/Excavation Worker. The evaluation was performed by using the Construction Trench: Contact with Groundwater calculation spreadsheet (vrp64.xls, revised 8/5/2014) from the VA-DEQ VRP for all COCs detected in groundwater in the upper saturated zone. The VA-DEQ VRP spreadsheet quantifies oral, dermal and inhalation exposures consistent with U.S. EPA guidance. The spreadsheet includes a model which predicts the partitioning of VOCs from groundwater to trench air, thereby calculating a target groundwater concentration based on an acceptable level of inhalation exposures. However, note that VOCs were not identified as a COC based upon historical operations at the Property; therefore, partitioning of VOCs is not applicable, although included in the model regardless.

The VA-DEQ VRP spreadsheet also calculates a target groundwater concentration (identified as a "screening level" in the spreadsheet) based on aggregate ingestion, dermal contact and inhalation exposures. The multi-pathway target groundwater concentration was calculated as a "direct contact groundwater standard" in this PSRA, using the version of the VA-DEQ spreadsheet updated August 2014. Toxicity criteria or physico-chemical values in the VA-DEQ spreadsheet which differed from the values in VAP *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures* (May 2016) were changed to the Ohio EPA VAP values, as shown in Appendix E.

The exposure factor values for the evaluation of the On-Property Construction/Excavation Worker are shown in Table 5-1. The value for exposure time of 4 hours/day and the incidental groundwater ingestion rate of 0.02 L/day were each based on best professional judgment. The inhalation module of the spreadsheet contains two modes (*i.e.*, alternate values) for air circulations per hour (*i.e.*, ACH) in the trench, based on trench dimensions. An ACH value of 360 hr^{-1} was selected by the model (based on trench dimensions of 8 feet by 6 feet by 5 feet). The target hazard quotient and ELCR were set at one and 1×10^{-5}, respectively.

The direct contact groundwater standards for COCs detected in groundwater are shown in Table 5-2.

5.2 Evaluation of the Direct Contact with Lagoon/Pond Water Pathway

5.2.1 All COCs Excluding Lead

This section provides a discussion of the evaluation of the quantitative direct contact with lagoon and borrow pond surface water exposure pathway evaluations undertaken for the Property. These evaluations were completed due to the absence of promulgated standards for surface water environmental media. The methods for directly estimating hazards and risks utilizing the lagoon and borrow pond water analytical results are presented below.

A quantitative evaluation of direct contact exposures from concentrations of COCs detected in lagoon and borrow pond surface water was completed for the On-Property Commercial/Industrial Worker and On-Property Construction/Excavation Worker. Note that this evaluation did not distinguish whether the COCs originated from the lagoon or the borrow ponds. This evaluation was undertaken by the direct estimation of chemical-specific hazard and risk (*i.e.*, forward hazard and risk evaluation) from the lagoon and borrow pond surface water concentrations, irrespective of origin as indicated herein.

An evaluation of the incidental ingestion and dermal direct contact exposures from lagoon and borrow pond surface water was completed for the On-Property Commercial/Industrial Worker and On-Property Construction/Excavation Worker. The evaluations were performed by using the Surface Water Risk Calculations: Trespassers, Recreational calculation spreadsheet (swcalcs.slsx, revised 8/5/2014) from the VA-DEQ VRP for all COCs detected in lagoon and borrow pond water, irrespective of IA location. The VA-DEQ VRP spreadsheet quantifies oral and dermal exposures to surface water consistent with U.S. EPA guidance; this spreadsheet can also quantify exposures from fish ingestion. However, given that fish ingestion is an incomplete exposure pathway with respect to the lagoon and borrow ponds, this pathway was excluded.

The exposure factor values for the quantitative evaluation of both the On-Property Commercial/Industrial Worker and the On-Property Construction/Excavation Worker are shown in Table 5-3. In general, the exposure factor values have been modified such that they are consistent with default exposure factor values included in the VAP Support Document (Ohio EPA, 2016) or are consistent with applicable U.S. EPA guidance. Of particular note is the exposure frequency of 60 days/year utilized for the quantitative evaluation of the On-Property Commercial/Industrial Worker. Maintenance activities associated with the lagoons and borrow ponds (i.e., de-watering, etc.) is not reasonably anticipated to be completed every working day throughout the commercial/industrial worker's career. Rather, maintenance of the lagoons and borrow ponds is reasonably anticipated to be completed on a seasonal basis at infrequent intervals (*e.g.,* once or twice per month). Therefore, a conservative exposure frequency of 60 days/year was utilized for further evaluation based on best professional judgement.

The exposure factor values utilized for the direct contact with lagoon and borrow pond water are presented in Table 5-3. A print-out of the calculation spreadsheet is provided in Appendix F.

5.2.2 Derivation of Direct Contact with Water Standards for Lead

A generic direct contact water standard for lead was calculated using the CalEPA of Toxic Substances Control lead risk assessment spreadsheet model (LeadSpread Version 7, 2007) for predicting blood lead concentrations in children and adults. The model was calibrated to the direct contact soil standard for the Construction/Excavation Worker (400 mg/kg) for the purpose of estimating lead intakes based on soil ingestion exposures. The default values recommended by Cal/EPA for lead in air and respirable dust were retained in the calculation. Exposure to lead via home-grown produce was excluded as a pathway due to reasonable assumptions regarding the activities of the On-Property Construction/Excavation Worker at the Property. The soil ingestion rate parameter was chosen as 200 mg/day (*i.e.,* the soil ingestion rate of a Construction/Excavation Worker cited in the VAP Support Document, Ohio EPA, 2016). The parameter value for skin surface area exposed was increased from the Cal/EPA default value of 2,900 cm^2 to 3,300 cm^2 (Table 4, Ohio EPA, 2016), and the soil-to-skin adherence factor was increased from the Cal/EPA default value of 70 ug/cm^2 to 300 ug/cm^2 (Table 4, Ohio EPA, 2016). The geometric standard deviation was increased from 1.6 to 2.1 (Part D Section 2.1, p. 45, Ohio EPA, 2016) and the value for lead relative bioavailability was increased from 0.44 to 0.6 (Section III.C, p. 78, Ohio EPA, 2008). The incidental water ingestion rate was assumed to be 0.02 liters/day, based on the value recommended for excavation trench exposures by the Virginia Department of Environmental Protection (2016). For all other input parameters, the Cal/EPA spreadsheet default values were retained (California Department of Toxic Substances Control, 2007).

The direct contact water standard for construction/excavation activities was developed iteratively by adjusting the concentration of lead in groundwater to achieve the maximum allowable blood lead concentration of 10 ug/dL predicted for the 95th percentile of the modeled Construction/Excavation Worker population, based on default exposure assumptions, and a lead concentration in soil equal to the direct contact soil standard (400 mg/kg). A groundwater concentration of 2,070 ug/L correlated with a predicted 95th-percentile blood lead concentration of 10.0 ug/dL for the occupational adult scenario; this value is 2,100 ug/L when rounded to two significant figures (corresponding to a 95th-percentile blood lead concentration of 10 ug/dL) and represents the direct contact water lead standard based on construction/excavation activities. The spreadsheet print-out of the derivation of the direct contact groundwater lead standard for construction/excavation worker lead risk assessment is located in Appendix G.

Note that the evaluation of the direct contact to lead in water exposures for the On-Property Construction/Excavation Worker is protective of the direct contact to lead water exposures for the On-Property Commercial/Industrial Worker. This is largely attributed to the fact that the generic soil direct contact soil standard for commercial/industrial land use of 800 mg/kg is double the generic soil direct contact soil standard for construction/excavation activities of 400 mg/kg. As a result, a standard for the direct contact with lead in water was not calculated for the On-Property Commercial/Industrial Worker receptor population.

6.0 CHARACTERIZATION OF HAZARD AND RISK

This section provides an evaluation of the hazards and risks posed to on-Property and off-Property receptor populations resulting from exposures to hazardous substances at the Property. Non-cancer hazards and excess lifetime cancer risks (ELCRs) are characterized separately for each receptor population. The uncertainties in each estimate of hazard or risk are discussed at the end of this section.

6.1 Summary of Evaluations for Characterization of Hazard and Risk

The complete exposure pathways were evaluated by the use of the following:

1. Generic numerical and Property-specific direct contact soil standards for commercial/industrial land use were used to evaluate exposures resulting from soil ingestion, dermal contact with soil, inhalation of particulate emissions from soil to outdoor air, and inhalation of volatile emissions from soil to outdoor air by the On-Property Commercial/Industrial Worker receptor population. The exposures to multiple COCs were evaluated in accordance with the procedures described in OAC 3745-300-09(B) and (D)(3)(d).
2. Generic numerical and Property-specific direct contact soil standards for commercial/industrial land use were used to evaluate exposures resulting from sediment ingestion and dermal contact with sediment by the On-Property Commercial/Industrial Worker. Note that due to the nature of the generic direct contact soil standards, the inhalation of particulate emissions from sediment to outdoor air, and inhalation of volatile emissions from sediment to outdoor air by the On-Property Commercial/Industrial Worker receptor population has also been quantified. The exposures to multiple COCs were evaluated in accordance with the procedures described in OAC 3745-300-09(B) and (D)(3)(d).
3. Evaluation of potential direct contact exposures to lagoon and borrow pond water for the On-Property Commercial/Industrial Worker receptor population by the direct estimation of chemical-specific hazard and risk from lagoon and borrow pond water concentrations (*i.e.*, forward hazard and risk evaluation).
4. Generic numerical and Property-specific direct contact soil standards for construction and excavation activities were used to evaluate exposures resulting from soil ingestion, dermal contact with soil, inhalation of particulate emissions from soil to outdoor air, and inhalation of volatile emissions from soil to outdoor air by the On-Property Construction/Excavation Worker receptor population. The exposures of this receptor population to multiple COCs were evaluated in accordance with the procedures described in OAC 3745-300-09 (B) and (D)(3)(d).
5. Property-specific direct contact groundwater standards for construction and excavation activities were used to evaluate potential exposures resulting from ingestion, dermal contact, and inhalation from groundwater to outdoor air by the On-Property Construction/Excavation Worker. The potential exposures to multiple COCs were evaluated in accordance with the procedures described in OAC 3745-300-09 (B) and (D)(3)(d).
6. Generic numerical and Property-specific direct contact soil standards for construction/excavation activities were used to evaluate exposures resulting from sediment ingestion and dermal contact with sediment by the On-Property Construction/Excavation Worker. Note that due to the nature of the generic direct contact soil standards, the

inhalation of particulate emissions from sediment to outdoor air, and inhalation of volatile emissions from sediment to outdoor air by the On-Property Construction/Excavation Worker receptor population has also been quantified. The exposures to multiple COCs were evaluated in accordance with the procedures described in OAC 3745-300-09(B) and (D)(3)(d).

7. Evaluation of potential direct contact exposures to lagoon and borrow pond water for the On-Property Construction/Excavation Worker receptor population was completed by the direct estimation of chemical-specific hazard and risk from lagoon and borrow pond water concentrations (*i.e.*, forward hazard and risk evaluation).

8. Generic numerical Unrestricted Potable Use Standards (UPUS) were used to evaluate potable use of groundwater in the lower saturated zone beneath the Property.

9. State of Ohio, Ohio River Drainage Basin Outside the Mixing Zone Average (OMZA) and Human Health Non-drinking Water Quality Standards (WQS) for the protection of aquatic life and human health, respectively in accordance with OAC 3745-1 for evaluation of the off-Property IER, the River Styx.

6.2 General Approach to the Evaluation of Cumulative and Aggregate Hazard and Risk Posed to On-Property Receptor Populations

Both non-cancer and cancer endpoints were evaluated, as appropriate, for each COC in each environmental medium. For each COC with a non-cancer endpoint, a non-cancer hazard ratio was derived as the ratio of the representative concentration of each COC to the single chemical non-cancer endpoint value for the COC. The non-cancer hazard ratio for each COC is equivalent to its hazard quotient (HQ), as described in OAC 3745-300-09(D)(3)(d)(ii)(a); the sum of the hazard ratios is the cumulative non-cancer hazard ratio, which is equivalent to the hazard index (HI) as described in OAC 3745-300-09(D)(3)(d)(ii)(b). The multiple chemical evaluations conducted here did not consider the toxic endpoint(s) (*i.e.,* target organ, mode of action or mechanism of action) of each COC with a non-cancer endpoint. Simple additivity was assumed among all COCs with a non-cancer endpoint, irrespective of toxic endpoint.

For each complete exposure pathway, a cancer risk ratio was derived for each COC with a cancer endpoint as the ratio of the exposure point concentration of each COC to the single-chemical cancer endpoint value for the COC. The cancer risk ratio for each COC is equivalent to the proportion of the target single-chemical excess lifetime cancer risk (ELCR) of 1×10^{-5} that is attributed to the COC, as described in OAC 3745-300-09(B)(1)(a) and OAC 3745-300-09(D)(3)(d)(i)(a). The sum of the single-chemical risk ratios is the cumulative cancer risk ratio, which is equivalent to the proportion of the target single-chemical ELCR attributed to pathway-specific exposures to all COCs with a cancer endpoint at the Property, as described in OAC 3745-300-09(D)(3)(d)(i)(b).

As applicable, pathway-specific multi-chemical (*i.e.*, cumulative) HI and ELCRs were summed to calculate the multi-chemical and multi-pathway (*i.e.*, cumulative and aggregate) HI and ELCR to represent the hazards and risks potentially posed to each receptor population at the Property for the non-cancer and cancer endpoints as described in OAC 3745-300-09(D)(3)(d)(ii)(c) and OAC 3745-300-09(D)(3)(d)(i)(c), respectively. The summation of estimated hazard and risk among all COCs within each exposure pathway, followed by the further summation of pathway-specific HI and ELCR for all exposure pathways, represents a very conservative approach to risk characterization. This approach likely represents an overestimation of hazard and risk posed to the on-Property receptor populations.

The acceptable HI and ELCR for aggregate and cumulative exposures of each of the receptor populations are 1 and 1 x 10^{-5}, respectively, in accordance with OAC 3745-300-09(B)(2) and OAC 3745-300-09(B)(1)(a), respectively. The estimated non-cancer hazard and cancer risk posed to each receptor population are discussed below.

6.3 EU-North: On-Property Commercial/Industrial Worker Receptor Population

The characterization of non-cancer hazard and ELCR resulting from direct contact with soil exposures, direct contact sediment exposures, and direct contact lagoon and borrow pond water exposures by the On-Property Commercial/Industrial Worker receptor population are presented below.

6.3.1 Direct Contact with Surface Soil Exposures

The characterization of non-cancer hazard and ELCR resulting from potential direct contact with soil exposures by the On-Property Commercial/Industrial Worker receptor population within EU-North are presented in Table 6-1. As shown in Table 6-1, the cumulative non-cancer hazard ratio is 0.0735, which corresponds to an HI of 0.07 when rounded to one significant digit, and is below the target HI of one. The cumulative cancer risk ratio presented in Table 6-1 is 0.351, which corresponds to an ELCR of 4 x 10^{-6} when rounded to one significant digit, and is below the target ELCR of 1 x 10^{-5}.

6.3.2 Direct Contact with Sediment Exposures

The characterization of non-cancer hazard and ELCR resulting from potential direct contact with sediment exposures by the On-Property Commercial/Industrial Worker receptor population within EU-North are presented in Table 6-2. As shown in Table 6-2, the cumulative non-cancer hazard ratio is 0.200, which corresponds to an HI of 0.2 when rounded to one significant digit, and is below the target HI of one. The cumulative cancer risk ratio presented in Table 6-2 is 0.491, which corresponds to an ELCR of 5 x 10^{-6} when rounded to one significant digit, and is below the target ELCR of 1 x 10^{-5}.

6.3.3 Lagoon and Borrow Pond Water Exposures

Water samples were collected from Lagoon 21 as well as the borrow ponds within IA-1. The maximum detected concentrations of each COC detected in the water samples were used to directly estimate the hazard and risk from potential direct contact exposures. The characterization of non-cancer hazard and

ELCR resulting from potential direct contact exposures to detected COCs by the On-Property Commercial/Industrial Worker receptor population is presented in Table 6-3. The non-cancer HQ presented in Table 6-3 is 0.04, which is below the target HQ of one. The cumulative ELCR is 2 x 10^{-6} when rounded to one significant digit and is below the target ELCR of 1 x 10^{-5}.

6.3.4 Cumulative and Aggregate Non-Cancer Hazard and Excess Lifetime Cancer Risk

The HI and ELCR for the potentially cumulative and aggregate multi-pathway exposures of the current On-Property Commercial/Industrial Worker receptor population *via* direct contact with soil, direct contact with sediment, and direct contact with lagoon and borrow pond water were estimated, as presented in Table 6-4. The potentially cumulative and aggregate multi-pathway non-cancer HI for the On-Property Commercial/Industrial Worker is 0.3 when rounded to one significant digit, which is below the target HI of one (1). The potentially cumulative and aggregate multi-pathway ELCR for the On-Property Commercial/Industrial Worker is 1 x 10^{-5} when rounded to one significant digit, which is equivalent to the target ELCR of 1 x 10^{-5}.

6.4 On-Property Construction/Excavation Worker Receptor Population

The characterization of non-cancer hazard and ELCR resulting from potential exposures to soils at the Property, potential exposures to shallow groundwater, potential exposures to sediment, and potential exposures to lagoon and borrow pond water by the On-Property Construction/Excavation Worker receptor population are presented below.

6.4.1 Direct Contact with Soil Exposures

The characterization of non-cancer hazard and excess lifetime cancer risk resulting from potential direct contact soil exposures of the On-Property Construction/Excavation Worker receptor population are presented in Table 6-5. This evaluation was completed based on the maximum detected concentrations of each COC reported in the soil analytical dataset evaluated for the Property, irrespective of depth interval. However, as noted herein, the total soil (surface and subsurface soil) analytical dataset is equivalent to the surface soil analytical dataset. The cumulative non-cancer hazard ratio is 0.187, which corresponds to an HI of 0.2 when rounded to one significant digit, and is below the target HI of one. The cumulative cancer risk ratio presented in Table 6-5 is 0.040, which corresponds to an ELCR of 4 x 10^{-7} when rounded to one significant digit and is below the target ELCR of 1 x 10^{-5}.

6.4.2 Direct Contact with Groundwater Exposures

The characterization of non-cancer hazard and excess lifetime cancer risk resulting from potential direct contact exposures to shallow groundwater of the On-Property Construction/Excavation Worker receptor population are presented in Table 6-6 for all COCs in the groundwater analytical dataset used for the

Property. The cumulative non-cancer hazard ratio from direct contact with shallow groundwater exposures of the On-Property Construction/Excavation Worker is 0.049 which corresponds to an HI of 0.05 when rounded to one significant digit and is substantially below the target HI of one. The cumulative cancer risk ratio presented in Table 6-6 is 0.030, which corresponds to an ELCR of 3 x 10^{-7} when rounded to one significant digit and is below the target ELCR of 1 x 10^{-5}.

6.4.3 Direct Contact with Sediment Exposures

The characterization of non-cancer hazard and ELCR resulting from potential direct contact with sediment exposures at Lagoon 21 and the borrow ponds by the On-Property Construction/Excavation Worker receptor population are presented in Table 6-7. As shown in Table 6-7, the cumulative non-cancer hazard ratio is 0.3495, which corresponds to an HI of 0.3 when rounded to one significant digit, and is below the target HI of one. The cumulative cancer risk ratio presented in Table 6-7 is 0.031, which corresponds to an ELCR of 3 x 10^{-7} when rounded to one significant digit, and is below the target ELCR of 1 x 10^{-5}.

6.4.4 Lagoon and Borrow Pond Water Exposures

Water samples were collected from Lagoon 21 as well as the borrow ponds within IA-1. The maximum detected concentrations of each COC detected in the water samples were used to directly estimate the hazard and risk from potential direct contact exposures. The characterization of non-cancer hazard and ELCR resulting from potential direct contact exposures to detected COCs by the On-Property Construction/Excavation Worker receptor population is presented in Table 6-8. The non-cancer HQ presented in Table 6-8 is 0.07, which is substantially below the target HQ of one. The cumulative ELCR is 2 x 10^{-7} when rounded to one significant digit and is below the target ELCR of 1 x 10^{-5}.

6.4.5 Cumulative and Aggregate Non-Cancer Hazard and Excess Lifetime Cancer Risk

The HI and ELCR for the potentially cumulative and aggregate multi-pathway exposures of the On-Property Construction/Excavation Worker receptor population *via* direct contact with soils, direct contact with shallow groundwater, direct contact with lagoon and pond sediment, and direct contact with lagoon and pond water were estimated as presented in Table 6-9. The potentially cumulative and aggregate multi-pathway non-cancer HI for the On-Property Construction/Excavation Worker is 0.7, which is below the target HI of one (1). The potentially cumulative and aggregate multi-pathway ELCR for the On-Property Construction/Excavation Worker is 1 x 10^{-6} when rounded to one significant digit, which is below the target ELCR of 1 x 10^{-5}.

6.5 Lead: All Receptor Populations

Lead was not evaluated with respect to the multiple chemical evaluations, in accordance with OAC 3745-300-08(C)(3)(e). Exposures to lead were evaluated separately as discussed below.

6.5.1 Lead in Soil

The generic numerical direct contact soil standards for lead for commercial/industrial land use and construction/excavation activities are 800 mg/kg and 400 mg/kg, respectively, as found in Table II and Table III within Appendix A of OAC 3745-300-08. As shown in Tables 2-5, the maximum detected concentration of lead in soil samples collected at the Property is 682 mg/kg (at UR2023, 0-2'). This value is below the direct contact standard for the commercial/industrial use but exceeds the direct contact standard for construction/excavation activities.

A review of the analytical data for lead in soil indicates that the maximum detected concentration of 682 mg/kg is the only concentration in the soil dataset that exceeds its respective soil direct contact standard. Since the On-Property Construction/Excavation Worker is not reasonably anticipated to spend the majority of the exposure duration at a single isolated area (i.e., UR2023), a 95% UCL was calculated to determine the average concentration that the receptor would be exposed to in soil. The 95% UCL was calculated utilizing U.S. EPA's ProUCL software program and all of the lead in soil analytical results utilized for further evaluation as part of this PSRA. The 95% UCL for lead in soil at the Property was calculated as 222 mg/kg; this value is below the soil direct contact standard for construction/excavation activities of 400 mg/kg. As a result, risk mitigation measures to protect the On-Property Construction/Excavation Worker to a single concentration of lead in soil that exceeds its respective direct contact soil standard is not necessary. Refer to Appendix D for a print-put of the ProUCL calculations.

6.5.2 Lead in Groundwater

As presented in Tables 2-6 and 2-7, lead was not detected in groundwater in the upper or lower saturated zones at the Property. Therefore, further evaluation of lead in groundwater was not deemed necessary within this PSRA.

6.5.3 Lead in Sediment

As presented in Table 2-8, the maximum detected concentration of lead in sediment from lagoon and borrow pond sediment samples was 87.7 mg/kg at location UR2017. This concentration is below both of the generic numerical direct contact soil standards for lead for commercial/industrial land use and construction/excavation activities of 800 mg/kg and 400 mg/kg, respectively. Therefore, further evaluation of lead in sediment samples at the Property was not deemed necessary within this PSRA.

6.5.4 Lead in Lagoon and Borrow Pond Water

As presented in Table 2-9, lead was detected in only one water sample obtained from Lagoon 21 during the Phase II sampling activities (at sample location UR2021). A Property-specific numerical direct contact water standard for lead for the On-Property Construction/Excavation Worker receptor population was calculated using CalEPA's lead risk assessment spreadsheet model for a construction/excavation worker scenario, as described above in Section 5.1. The Property-specific direct contact groundwater standard for lead for construction/excavation activities is 2,100 ug/L. As presented in Table 2-9, the maximum detected concentration of lead in lagoon and borrow pond water was 135 ug/L, which is below its respective direct contact water standard.

Note that the evaluation of direct contact with water exposures by the On-Property Construction/Excavation Worker is considered protective of the On-Property Commercial/Industrial Worker who may also come into direct contact with lagoon and borrow pond water at the Property. This is attributed to utilizing the more conservative soil direct contact standard of 400 mg/kg for construction/excavation activities in the calculation of the lead in water standard. In addition, given that the maximum concentration of lead in lagoon and borrow pond water was 135 ug/L coupled with the single detected concentration of lead in lagoon and borrow pond water samples, development of a direct contact water standard for commercial/industrial land use, which would be higher than the construction/excavation water standard, was not deemed necessary.

6.6 Groundwater Response Requirements: All Receptors

This section specifically addresses potable use of groundwater by all applicable receptor populations identified within this PSRA. The evaluation of exposures resulting from complete and potentially complete exposure pathways other than potable use of groundwater are detailed in Sections 6.4.2 and 6.8.

6.6.1 Potable Use of Groundwater

Groundwater in the lower saturated zone has been classified as a Critical Resource groundwater in accordance with OAC 3745-300-10(B). As shown in Table 6-10, a total of four COCs were detected in groundwater from the lower saturated zone analytical dataset utilized within this PSRA. As shown in the table, two of the COCs, arsenic and manganese exceed their respective UPUS. Although these two COCs exceed their respective UPUS in the lower saturated zone, each of these COCs were further evaluated within the Phase II report and determined to within the range of naturally occurring background levels existing regionally within Wayne County.

6.7 On-Property Important Ecological Resources

As indicated above in Section 3.2, two IERs were identified on-Property. However, further evaluation of these on-Property IERs was not deemed necessary due to the proximity of the sole Salt Street IA to the IERs (i.e., IA-3), analytical results obtained from pre-IA determination sampling, and the lack of historical operations within the IERs. Refer to Section 3.3.1.3 for further details regarding the On-Property IERs.

6.8 Off-Property Important Ecological Resources

An IER, as defined in OAC 3745-300-01 (A)(64), was identified adjacent to the Property due to the presence of River Styx, which is considered a surface water body of the state. The off-Property IER evaluation includes an evaluation of potential human recreational users within the river as well as aquatic life. To evaluate potential migration of COCs in groundwater to the IER, groundwater analytical results, irrespective of monitoring well location, were compared to the State of Ohio, Ohio River Drainage Basin OMZAs for the protection of aquatic life and human-health non-drinking water quality standards for the protection of recreational users per OAC 3745-1. This is a conservative evaluation as it does not consider the monitoring well's proximity to the river. A water hardness value of 200 mg $CaCO_3$ /L was utilized for metals that have hardness-dependent standards by reviewing the hardness data collected from River Styx during surface water sampling activities. Specifically, the range of observed hardness concentrations (as presented in Table 2-10) was 213,000 ug/L to 254,000 ug/L, which is equivalent to a hardness range of 213 mg/L to 254 mg/L.

As shown in Table 6-11, the maximum concentrations of three COCs (barium, cobalt and total dissolved solids) were reported in the uppermost saturated zone underlying the Property above their respective OMZAs. No concentrations were observed to exceed any of their respective human health non-drinking water criteria.

River Styx surface water sampling activities were completed as part of Phase II investigation activities to further evaluate the groundwater to surface water exposure pathway. The analytical results for the three COCs in groundwater that exceed their respective OMZAs (i.e., barium, cobalt and total dissolved solids) were evaluated further by reviewing the River Styx surface water analytical results. As presented in Table 6-12, the maximum detected concentration of barium and TDS in River Styx surface water are both below their respective water quality standards; cobalt was not detected in River Styx surface water samples.

It should be noted that pursuant to OAC 3745-1-24, this portion of the River Styx has been designated as a Modified Warm Water Habitat (MWH). In accordance with OAC 3745-1-07(B)(1)(d), a MWH designation indicates that a use attainment study has determined that these surface waters are not capable of supporting and maintaining warmwater organisms due to the extensive modifications of the surface water body. As such, attainment of surface water quality criteria in this portion of the River Styx is not reasonably anticipated. However, as presented above, the concentrations of those COCs identified in on-Property groundwater, are either not detected in River Styx surface water or are detected at levels less than their respective water quality criteria, indicating that the groundwater emanating from the Property is not adversely impacting the IER, the River Styx.

Based upon the information presented herein, further evaluation of the groundwater to surface water exposure pathway is not necessary as it specifically relates to hazardous substances. Refer to the Adverse Effects Compliance Report (Hull, 2016) for further evaluation of the groundwater to surface water exposure pathway as it specifically relates to non-hazardous substances.

6.9 Uncertainty Analysis

This PSRA has provided estimates of non-cancer hazard and excess lifetime cancer risks for receptor populations identified at the Property. These estimates are based upon a combination of regulatory criteria, default assumptions and Property-specific information. The uncertainty associated with these numerical risk assessment estimates is generally very large, “on the range of an order of magnitude or greater” (U.S. EPA, 1989). The purpose of this Uncertainty Analysis is to provide information regarding the primary sources of uncertainty in the estimates of non-cancer hazard and excess lifetime cancer risk associated with releases of hazardous substances or petroleum at the Property, including the Property-specific information presented in this PSRA.

Hazard Identification. Across the Property, sampling locations in soil were biased, as possible, to areas where COCs were most likely to be present, as determined from information available prior to field sampling, including the IAs from the Phase I and on conditions encountered in the field during drilling operations. Chemical analyses were conducted by a VAP Certified Laboratory, using standardized SW-846 methods developed by U.S. EPA, in accordance with OAC 3745-300-07(D). Thus, it is likely that the concentrations of COCs reported in the Phase II report are adequately representative of conditions at the Property. It is likely that the use of biased sampling results is an overestimate of the representative concentrations within each IA at the Property. In addition, the maximum concentrations of COCs detected in each environmental medium at the Property were used as the representative concentrations in the quantitative evaluations. The use of the maximum detected concentration likely represents an overestimate of the cumulative risk and hazard posed to each receptor population at the Property, as it assumes that the receptor will be simultaneously exposed to the maximum concentration of each COC irrespective of the location of the maximum detection. Therefore, the quantitative estimates of hazard and risk posed to on-Property receptor populations from exposures likely represent an overestimate.

Exposure Assessment. The exposure factor values used in the derivation of generic numerical standards represent the default values or distributions recommended by Ohio EPA (2016) for the commercial/industrial worker and the construction/excavation worker receptor populations. These exposure factors represent a combination of upper-bound and central tendency exposure factor point values, or probability distributions incorporating central tendency and upper-bound values and produce an estimate of exposure analogous to the Reasonable Maximum Exposure (RME) scenarios developed by U.S. EPA (1989). The RME and RME-like exposure scenarios are, by definition, conservative estimates of exposure (*i.e.*, biased to the upper end of the range of possible exposures). Instances where best professional judgement was utilized to quantitatively assess exposures are likely an overestimate as well since current routine maintenance operations are substantially less than the exposures assumed herein and are not reasonably anticipated to increase as part of any potential future redevelopment activities.

Toxicity Assessment. Although there is considerable uncertainty in the derivation of non-cancer endpoint toxicity criteria, the systematic method of quantitatively correcting for this uncertainty is consistently biased toward an underestimation of the "safe dose" associated with the intake of a specific chemical *via* a particular route of exposure. When applied consistently over a large number of chemicals, this bias likely results in an overestimate of the non-cancer hazard associated with exposures to one or more non-carcinogenic chemicals at the Property.

Similarly, although there is considerable uncertainty in the derivation of cancer endpoint toxicity criteria, the systematic method of quantitatively adjusting for this uncertainty is consistently biased toward an overestimation of the tumorigenic potential associated with the intake of a specific chemical *via* a particular route of exposure. When applied consistently over a large number of chemicals, the bias likely results in an overestimate of the excess lifetime cancer risk associated with exposures to one or more carcinogenic chemicals at the Property.

Several of the COCs at the Property do not have chemical-specific toxicity criteria, and were evaluated on the basis of dose-response information from toxicological surrogates. There is considerable uncertainty associated with the selection and use of toxicological surrogates for those COCs without chemical-specific toxicity criteria available from the information hierarchy described in OAC 3745-300-09(D)(3)(c). Each toxicological surrogate was selected on the basis of qualitative comparisons of the structure and known toxicity between the COC and the candidate surrogate chemical. Once a toxicological surrogate chemical was selected, the toxicity criteria for the surrogate chemical were used without any further quantitative modification or adjustment (*i.e.*, no additional uncertainty factors or modifying factors were applied). In some cases, the selection of the toxicological surrogate is presumptively conservative. In other cases, the actual toxicity of a COC may be greater than or less than the surrogate chemical selected for the evaluation. Thus, the uncertainty associated with the use of toxicological surrogates is potentially two-tailed; that is, the use of toxicological surrogates may underestimate or overestimate the actual toxicity of the COC. Nonetheless, the application of toxicity criteria based on toxicological surrogates in the derivation of generic or Property-specific numerical standards may result in an estimate of non-cancer hazard or excess lifetime cancer risk that is greater than an estimate wherein chemicals that lacked toxicity criteria were not quantitatively evaluated at all.

Risk Characterization. In this assessment, the multiple chemical adjustments of generic and Property-specific numerical standards assumed additivity across multiple chemicals within an exposure pathway for each receptor population. This practice, although generally conservative, ignores possible synergisms or antagonisms with other chemicals that may be present in the environment and affect the absorption, metabolism (metabolic activation or detoxification), and ultimately the net toxicity of the chemicals of concern. Therefore, there is a significant amount of uncertainty associated with the assumption of additivity used in this assessment.

7.0 CONCLUSIONS

This PSRA shows that, following implementation of institutional controls, the Property complies with applicable standards in accordance with the VAP. The requirements necessary to meet applicable standards for the Property to secure an NFA letter pursuant to the Ohio VAP are identified further below.

The applicable standards at the Property include generic direct contact soil standards for commercial/industrial land use and construction/excavation activities found in Appendix A of OAC 3745-300-08; UPUS found in Appendix A of OAC 3745-300-08; and surface water quality standards for the Ohio River drainage basin found in OAC 3745-1. The applicable standards also include Property-specific standards derived in this PSRA, in accordance with the procedures contained in OAC 3745-300-09, including: direct contact with groundwater standards for construction/excavation activities; and direct estimation of lagoon and borrow pond water analytical results. The findings of this PSRA with respect to compliance with applicable standards for the complete exposure pathways are summarized below for each receptor population:

- **On-Property Commercial/Industrial Workers:**
  - There are no unacceptable hazards and risks posed by direct contact exposures to soil.
  - There are no unacceptable hazards or risks posed by direct contact exposures to lagoon and borrow pond sediments.
  - There are no unacceptable hazards or risks posed by direct contact exposures to lagoon and borrow pond surface water.
  - There are no unacceptable hazards or risks associated with potentially cumulative and aggregate exposures from direct contact with soil, direct contact with lagoon and borrow pond sediment, and direct contact with lagoon and borrow pond surface water.
  - There are no unacceptable exposures to lead in environmental media at the Property.
- **On-Property Construction/Excavation Workers:**
  - There are no unacceptable hazards or risks posed by direct contact soil exposures to all COCs detected in soil samples at the Property.
  - There are no unacceptable hazards or risks posed by direct contact with shallow groundwater exposures to all COCs detected in shallow groundwater at the Property.
  - There are no unacceptable hazards or risks posed by direct contact sediment exposures to all COCs detected in lagoon and borrow pond sediment samples at the Property.
  - There are no unacceptable hazards or risks posed by direct contact exposures to lagoon and borrow pond surface water.

- There are no unacceptable hazards and risks associated with potentially cumulative and aggregate exposures from direct contact with soil (surface and subsurface), groundwater, lagoon and borrow pond sediment, and lagoon and borrow pond surface water.
- There are no unacceptable exposures to lead in environmental media at the Property.

- **All Receptor Populations:**
  - There are no unacceptable hazards and risks posed to all receptor populations through potable use of groundwater in the lower saturated zone.
- **Off-Property Important Ecological Resources:**
  - There are no unacceptable hazards and risks associated with the potential migration of groundwater to the off-Property IER, the River Styx.

Based on the results of this PSRA, compliance with applicable standards as necessary to secure a NFA letter under the Ohio VAP requires the following activities at the Property:

- The establishment of an institutional control that restricts the Property to commercial/industrial land use as defined in OAC 3745-300-08(C)(2)(b);
- The establishment of an institutional control that precludes the potable use of groundwater at the Property, in accordance with OAC 3745-300-11(C)(3); and
- The establishment of an Activity and Use Limitation that requires a demonstration be made that the indoor air exposure pathway meets acceptable hazard and risk goals prior to occupancy of any potential future buildings constructed on the portion of the Property located north of Salt Street.

8.0 REPORT LIMITATIONS

The conclusions and recommendations presented herein are based on the level of effort and investigative techniques defined under the Scope of Work. Hull has conducted this investigation in a manner consistent with sound engineering practices and with professional judgment. No other warranty or guarantee, expressed or implied, is made. This report does not attempt to evaluate past or present compliance with federal, state and local environmental or land use laws and regulations, except to the extent the compliance relates to releases of hazardous substances or petroleum and to factors which may affect the eligibility of the Property under the Voluntary Action Program. Hull makes no guarantees regarding the completeness or accuracy of any information obtained in review of public or private files. Furthermore, this report is prepared for, and made available for the sole use of Urban Renewables II, LLC and as otherwise provided in the Service Agreement among the parties; and the contents thereof may not be used or relied upon by any other person without the express written consent and authorization of Urban Renewables II, LLC and Hull.

9.0 REFERENCES

A variety of technical documents and publications were referred to during the course of this project. Some of the references consulted are presented below. Referenced documents and publications may or may not have been reviewed in their entirety. The guidelines and procedures presented in the documents and publications referenced have not been strictly adhered to unless stated otherwise.

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TABLES

TABLE 2-1

SUMMARY OF SOIL SAMPLING LOCATIONS

Sample Location	Sample Top (ft)	Sample Bottom (ft)	Field Sample ID	Sample Date	Identified Area	Exposure Unit	Sample Area	Sample Type[a]
UR2001	0	2	UR2005:UR2001:S000020	11/20/15	IA-1	North	Landfill	Surf
UR2002	0	1	UR2005:UR2002:S000010	11/20/15	IA-1	North	Landfill	Surf
UR2003	0	2	UR2005:UR2003:S000020	11/20/15	IA-1	North	Landfill	Surf
UR2004	0	1.5	UR2005:UR2004:S000015	11/20/15	IA-1	North	Landfill	Surf
UR2005	0	2	UR2005:UR2005:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2006	0	2	UR2005:UR2006:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2007	0	1	UR2005:UR2007:S000010	11/23/15	IA-1	North	Landfill	Surf
	1	2	UR2005:UR2007:S010020	11/23/15	IA-1	North	Landfill	Surf
UR2008	0	2	UR2005:UR2008:S000020	11/20/15	IA-1	North	Landfill	Surf
UR2009	0	2	UR2005:UR2009:S000020	11/20/15	IA-1	North	Landfill	Surf
UR2010	0	1	UR2005:UR2010:S000010	11/23/15	IA-1	North	Landfill	Surf
UR2010	0	2	UR2005:UR2010:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2011	0	2	UR2005:UR2011:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2012	0	2	UR2005:UR2012:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2013	0	2	UR2005:UR2013:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2014	0	2	UR2005:UR2014:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2015	0	2	UR2005:UR2015:S000020	11/20/15	IA-1	North	Landfill	Surf
UR2019	0	2	UR2005:UR2019:S000020	11/23/15	IA-1	North	Landfill	Surf
UR2023	0	2	UR2005:UR2023:S000020	11/20/15	IA-2	North	Leachate	Surf
UR2024	0	2	UR2005:UR2024:S000020	11/20/15	IA-2	North	Leachate	Surf
UR2025	0	1.9	UR2005:UR2025:S000019	11/20/15	IA-2	North	Retention Pond	Surf
UR2026	0	2	UR2005:UR2026:S000020	11/20/15	IA-2	North	Retention Pond	Surf

Notes:

a. Surf refers to soil samples collected within the 0-2 foot below ground surface sampling interval.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 2-2

SUMMARY OF GROUNDWATER SAMPLING LOCATIONS

Sample Location	Field Sample ID	Sample Date	Exposure Unit	Groundwater Zone
HSMW-7	UR2008:HSMW7:G080316	8/3/2016	North	Shallow
HSMW-8	UR2005:HSMW8:G120315	12/3/2015	North	Shallow
HSMW-9	UR2005:HSMW9:G120315	12/3/2015	North	Shallow
HSMW-10	UR2005:HSMW10:G120315	12/3/2015	North	Shallow
MW-2	UR2002:MW2:G050813	5/8/2013	North	Deep
	UR2002:MW2:G101613	10/16/2013		
	UR2004:MW2:G050614	5/6/2014		
	UR2005:MW2:G120315	12/3/2015		
MW-3	UR2002:MW3:G050913	5/9/2013	North	Deep
	UR2002:MW3:G101613	10/16/2013		
	UR2002:MW3:G121713R	12/17/2013		
	UR2004:MW3:G050614	5/6/2014		
	UR2005:MW3:G120315	12/3/2015		
MW-4	UR2002:MW4:G050813	5/8/2013	North	Deep
	UR2002:MW4:G101613	10/16/2013		
	UR2002:MW4:G121713R	12/17/2013		
	UR2004:MW4:G050514	5/5/2014		
	UR2005:MW4:G120315	12/3/2015		
MW-6	UR2002:MW6:G050813	5/8/2013	North	Shallow
	UR2002:MW6:G082813	8/28/2013		
	UR2004:MW6:G050514	5/5/2014		
	UR2004:MW6:G050514A	5/5/2014		
	UR2005:MW-6:G120415	12/4/2015		
MW-11R	UR2002:MW11R:G050913	5/9/2013	North	Shallow
	UR2002:MW11R:G101613	10/16/2013		
	UR2004:MW11R:G050514	5/5/2014		
	UR2005:MW-11R:G120415	12/4/2015		
MW-12B	UR2002:MW12B:G050813	5/8/2013	North	Shallow
	UR2002:MW12B:G101713	10/17/2013		
	UR2004:MW12B:G050614	5/6/2014		
	UR2005:MW-12B:G120415	12/4/2015		
MW-13AP	UR2002:MW13AP:G050813	5/8/2013	North	Shallow
	UR2002:MW13AP:G082813	8/28/2013		
	UR2004:MW13AP:G050514	5/5/2014		
MW-14P	UR2002:MW14P:G050813	5/8/2013	North	Shallow
	UR2002:MW14P:W082813	8/28/2013		
	UR2004:MW14P:G050514	5/5/2014		
MW-15P	UR2002:MW15P:G050813	5/8/2013	North	Shallow
	UR2002:MW15P:G101613	10/16/2013		
	UR2004:MW15P:G050514	5/5/2014		

TABLE 2-2

SUMMARY OF GROUNDWATER SAMPLING LOCATIONS

Sample Location	Field Sample ID	Sample Date	Exposure Unit	Groundwater Zone
MW-16L	UR2002:MW16L:G050813	5/8/2013	North	Shallow
	UR2002:MW16L:G101713	10/17/2013		
	UR2004:MW16L:G050614	5/6/2014		
	UR2005:MW16L:G120315	12/3/2015		
MW-16P	UR2002:MW16P:G050813	5/8/2013	North	Shallow
	UR2002:MW16P:G101613	10/16/2013		
	UR2004:MW16P:G050514	5/5/2014		
MW-17	UR2002:MW17:G050813	5/8/2013	North	Deep
	UR2002:MW17:G101613	10/16/2013		
	UR2004:MW17:G050514	5/5/2014		
	UR2005:MW-17:G120415	12/4/2015		
MW-30	UR2002:MW30:G050813	5/8/2013	North	Shallow
	UR2002:MW30:G101613	10/16/2013		
	UR2004:MW30:G050514	5/5/2014		
	UR2005:MW-30:G120415	12/4/2015		
	UR2005:MW-30:G120415A	12/4/2015		
MW-40	UR2002:MW40:G050813	5/8/2013	North	Deep
	UR2002:MW40:G101613	10/16/2013		
	UR2004:MW40:G050514	5/5/2014		
MW-41	UR2002:MW41:G050813	5/8/2013	North	Deep
	UR2002:MW41:G101713	10/17/2013		
	UR2004:MW41:G050514	5/5/2014		
	UR2005:MW-41:G120415	12/4/2015		
MW-42	UR2002:MW42:G050913	5/9/2013	North	Deep
	UR2002:MW42:G101613	10/16/2013		
	UR2004:MW42:G050614	5/6/2014		
Background Monitoring Wells				
HDMW-6	UR2008:HDMW6:G080316	8/3/2016	NA	Deep
	UR2008:HDMW6:G080316A	8/3/2016		
HDMW-7	UR2008:HDMW7:G080316	8/3/2016	NA	Deep
HDMW-8	UR2008:HDMW8:G080316	8/3/2016	NA	Deep

TABLE 2-3

SUMMARY OF LAGOON AND BORROW POND SEDIMENT SAMPLING LOCATIONS

Sample Location	Sample Top (ft)	Sample Bottom (ft)	Field Sample ID	Sample Date	Exposure Unit	Sample Area
HSS4	0	2	SSD001:HSS4:S000020	9/15/2011	North	Lagoon 21
UR2016	0	1	UR2005:UR2016:D000010	11/24/2015	North	Borrow Ponds
UR2017	0	1	UR2005:UR2017:D000010	11/24/2015	North	Borrow Ponds
UR2018	0	1	UR2005:UR2018:D000010	11/24/2015	North	Borrow Ponds
UR2020	0	1	UR2005:UR2020:D000010	11/24/2015	North	Lagoon 21
UR2021	0	1	UR2005:UR2021:D000010	11/24/2015	North	Lagoon 21
UR2022	0	1	UR2005:UR2022:D000010	11/24/2015	North	Lagoon 21

TABLE 2-4

SUMMARY OF LAGOON AND BORROW POND SURFACE WATER SAMPLING LOCATIONS

Sample Location	Sample Date	Field Sample ID	Exposure Unit	Sample Area
Lagoon 21	9/11/2013	UR2002:LAG21:W091113	North	Lagoon 21
UR2016	11/23/2015	UR2005:MBP3:W112315	North	Borrow Ponds
UR2017	11/23/2015	UR2005:MBP2:W112315	North	Borrow Ponds
UR2018	11/23/2015	UR2005:MBP1:W112315	North	Borrow Ponds
		UR2005:MBP1:W112315A (Duplicate)	North	Borrow Ponds
UR2020	11/23/2015	UR2005:P21-3:W112315	North	Lagoon 21
UR2021	11/23/2015	UR2005:P21-2:W112315	North	Lagoon 21
UR2022	11/23/2015	UR2005:P21-1:W112315	North	Lagoon 21
RIV1	8/1/2016	UR2008:RIV1:W080116	NA	River Styx
	8/15/2016	UR2008:RIU1:W081516		
RIV2	8/1/2016	UR2008:RIV2:W080116	NA	River Styx
	8/15/2016	UR2008:RIU2:W081516		
RIV3	8/1/2016	UR2008:RIV3:W080116	NA	River Styx
	8/15/2016	UR2008:RIU3:W081516		
		UR2008:RIU3:W081516A (Duplicate)		
RIV4	8/1/2016	UR2008:RIV4:W080116	NA	River Styx
	8/15/2016	UR2008:RIU4:W081516		
RIV5	8/1/2016	UR2008:RIV5:W080116	NA	River Styx
	8/15/2016	UR2008:RIU5:W081516		
RIV6	8/1/2016	UR2008:RIV6:W080116	NA	River Styx
		UR2008:RIV6:W080116A (Duplicate)		
	8/15/2016	UR2008:RIU6:W081516		
RIV7	8/1/2016	UR2008:RIV7:W080116	NA	River Styx
	8/15/2016	UR2008:RIU7:W081516		
RIV8	8/1/2016	UR2008:RIV8:W080116	NA	River Styx
	8/15/2016	UR2008:RIU8:W081516		

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 2-5

EXPOSURE UNIT NORTH: SUMMARY OF CHEMICALS OF CONCERN DETECTED IN SOIL AT THE PROPERTY

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Sample Location of Maximum Detected Concentration	Sample Depth of Maximum Detected Concentration (ft)
Metals							
Arsenic	22	22	100%	6.2	50.2	UR2007	1-2
Barium	22	22	100%	35.4	270	UR2013	0-2
Cadmium	6	22	27%	0.68	1.3	UR2007	1-2
Chromium	22	22	100%	9.9	218	UR2023	0-2
Cobalt	22	22	100%	4.1	13.9	UR2010	0-1
Copper	22	22	100%	10.5	174	UR2023	0-2
Lead	22	22	100%	10.1	682	UR2023	0-2
Mercury	7	22	32%	0.29	2.6	UR2012	0-2
						UR2023	0-2
Molybdenum	22	22	100%	1.5	19.3	UR2023	0-2
Nickel	22	22	100%	11.3	36	UR2010	0-1
Silver	3	22	14%	0.7	9.1	UR2013	0-2
Vanadium	22	22	100%	21.6	98.1	UR2013	0-2
Zinc	22	22	100%	18.2	572	UR2023	0-2
Polynuclear Aromatic Hydrocarbons (PAHs)							
2-Methylnaphthalene	17	18	94%	0.015	1.8	UR2013	0-2
Anthracene	3	18	17%	0.017	0.046	UR2014	0-2
Benzo(a)anthracene	7	18	39%	0.0065	0.1	UR2013	0-2
Benzo(a)pyrene	3	18	17%	0.0087	0.035	UR2014	0-2
Benzo(b)fluoranthene	4	18	22%	0.0062	0.039	UR2014	0-2
Benzo(k)fluoranthene	2	18	11%	0.021	0.032	UR2014	0-2
Chrysene	12	18	67%	0.0061	0.12	UR2013	0-2
Dibenz(a,h)anthracene	1	18	6%	0.0071	0.0071	UR2002	0-1
Fluoranthene	12	18	67%	0.0064	0.18	UR2013	0-2
Fluorene	3	18	17%	0.0063	0.056	UR2014	0-2

TABLE 2-5

EXPOSURE UNIT NORTH: SUMMARY OF CHEMICALS OF CONCERN DETECTED IN SOIL AT THE PROPERTY

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Sample Location of Maximum Detected Concentration	Sample Depth of Maximum Detected Concentration (ft)
Indeno(1,2,3-c,d)pyrene	1	18	6%	0.012	0.012	UR2002	0-1
Naphthalene	17	18	94%	0.014	1.4	UR2013	0-2
Pyrene	14	18	78%	0.0062	0.2	UR2013	0-2
Inorganics							
Total Solids (%)	22	22	100%	13.5	35.6	UR2023	0-2

TABLE 2-6

EXPOSURE UNIT NORTH: SUMMARY OF CHEMICALS OF CONCERN DETECTED IN THE UPPER SATURATED ZONE

Parameter	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Sample Location of Maximum Detected Concentration	Sample Date of Maximum Detected Concentration
Metals							
Arsenic	19	38	50%	6.3	90.1	HSMW-8	12/3/2015
Barium	30	32	94%	16.1	336	HSMW-8	12/3/2015
Cobalt	3	10	30%	10.7	33.7	HSMW-7	8/3/2016
Manganese	31	32	97%	30	13000	MW-16P	5/8/2013
Molybdenum	2	10	20%	17	17	MW-30	12/4/2015
Nickel	2	10	20%	40.2	63.1	HSMW-9	12/3/2015
Zinc	2	10	20%	118	185	HSMW-9	12/3/2015
Inorganics[a]							
Total Dissolved Solids	32	32	100%	328,000	3,500,000	MW-13AP	5/8/2013

Notes:

a. Refer to the Adverse Effects Compliance Report (Hull, 2016) for a full listing of inorganic compounds and non-hazardous substances.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 2-7

EXPOSURE UNIT NORTH: SUMMARY OF CHEMICALS OF CONCERN DETECTED IN THE LOWER SATURATED ZONE

Parameter	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Sample Location of Maximum Detected Concentration	Sample Date of Maximum Detected Concentration
Metals							
Arsenic	22	26	85%	8	45	MW-2	5/6/2014
Barium	19	19	100%	20	80	MW-2	5/6/2014
Manganese	19	19	100%	24	490	MW-42	5/6/2014
Molybdenum	2	5	40%	14.1	15.4	MW-2	12/3/2015
Inorganics[a]							
Total Dissolved Solids	19	19	100%	330,000	820,000	MW-3	5/9/2013

Notes:

a. Refer to the Adverse Effects Compliance Report (Hull, 2016) for a full listing of inorganic compounds and non-hazardous substances.

TABLE 2-8

EXPOSURE UNIT NORTH: SUMMARY OF CHEMICALS OF CONCERN DETECTED IN LAGOON/BORROW POND SEDIMENT SAMPLES

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Sample Location of Maximum Detected Concentration	Sample Depth of Maximum Detected Concentration (ft)
Metals							
Aluminum	1	1	100%	11000	11000	HSS4	0-2
Arsenic	7	7	100%	13.8	37.7	UR2020	0-1
Barium	7	7	100%	43.1	215	UR2020	0-1
Beryllium	1	1	100%	1.4	1.4	HSS4	0-2
Cadmium	1	7	14%	4.4	4.4	UR2017	0-1
Chromium	7	7	100%	13.7	41.8	UR2017	0-1
Cobalt	7	7	100%	9.5	27.9	UR2017	0-1
Copper	6	6	100%	25.7	105	UR2021	0-1
Lead	7	7	100%	17.5	87.7	UR2017	0-1
Mercury	4	7	57%	0.35	0.47	UR2021	0-1
Molybdenum	6	6	100%	4	6.6	UR2018	0-1
Nickel	7	7	100%	26	57.6	UR2017	0-1
Selenium	1	7	14%	6.5	6.5	HSS4	0-2
Thallium	1	1	100%	5.2	5.2	HSS4	0-2
Vanadium	7	7	100%	21.9	41.8	UR2018	0-1
Zinc	7	7	100%	192	2920	UR2017	0-1
Polynuclear Aromatic Hydrocarbons (PAHs)							
2-Methylnaphthalene	2	3	67%	0.022	0.094	UR2018	0-1
Naphthalene	3	5	60%	0.012	0.079	UR2018	0-1
Total Petroleum Hydrocarbons (TPH)							
TPH (C06-C12)	1	1	100%	2.2	2.2	HSS4	0-2
Inorganics							
Total Solids (%)	7	7	100%	37.6	81.5	UR2020	0-1

TABLE 2-9

EXPOSURE UNIT NORTH: SUMMARY OF CHEMICALS OF CONCERN DETECTED IN LAGOON/BORROW POND SURFACE WATER

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Sample Location of Maximum Detected Concentration	Sample Date of Maximum Detected Concentration
Metals							
Arsenic	2	8	25%	17	98.8	UR2021	11/23/2015
Barium	7	7	100%	26	374	UR2021	11/23/2015
Cadmium	1	8	13%	2.1	2.1	UR2021	11/23/2015
Chromium	1	8	13%	154	154	UR2021	11/23/2015
Cobalt	1	7	14%	19.9	19.9	UR2021	11/23/2015
Copper	1	8	13%	185	185	UR2021	11/23/2015
Lead	1	8	13%	135	135	UR2021	11/23/2015
Manganese	7	7	100%	100	1,180	UR2021	11/23/2015
Mercury	1	8	13%	0.0063	0.0063	Lagoon 21	9/11/2013
Molybdenum	3	8	38%	11.2	15	UR2021	11/23/2015
Nickel	2	8	25%	6.7	105	UR2021	11/23/2015
Silver	1	8	13%	11.5	11.5	UR2021	11/23/2015
Vanadium	1	7	14%	48.8	48.8	UR2021	11/23/2015
Zinc	2	8	25%	12	695	UR2021	11/23/2015
Inorganics[a]							
Total Dissolved Solids	7	7	100%	288	759	UR2017	11/23/2015

Notes:

a. Refer to the Adverse Effects Compliance Report (Hull, 2016) for a full listing of inorganic compounds and non-hazardous substances.

TABLE 2-10

SUMMARY OF CHEMICALS OF CONCERN DETECTED IN RIVER STYX SURFACE WATER

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Sample Location of Maximum Detected Concentration	Sample Date of Maximum Detected Concentration
Metals							
Barium	18	18	100%	26.5	36.5	RIV8	08/15/2016
Manganese	18	18	100	37.2	83.2	RIV7	08/01/2016
Inorganics							
Total Dissolved Solids	18	18	100	408,000	844,000	RIV5	08/01/2016
Total Hardness	18	18	100	213,000	254,000	RIV6	08/01/2016

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-1

EXPOSURE UNIT NORTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
ON-PROPERTY PATHWAYS						
On-Property Commercial / Industrial Workers	Surface soil	Surface soil (0-2 feet)	Direct contact	Surface soil	Soil ingestion	**Complete pathway: Comparison to Generic Direct Contact Soil Standards for Commercial/Industrial Land Use.**
					Dermal contact with soil	
			Particulate emissions from soil to outdoor air	Outdoor Air	Inhalation of particulate emissions	
			Volatile emissions from soil to outdoor air		Inhalation of volatile emissions	
	Surface and subsurface soil	Surface and subsurface soil (>2 feet)	Volatile emissions from soil to indoor air	Indoor air	Inhalation of volatile emissions	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property. Detections of benzo(a)anthracene, naphthalene and mercury in soil were reviewed and eliminated from further concern.
			Leaching from soils to groundwater in upper saturated zone	Water supply	Potable use of water	Incomplete Pathway: Groundwater in the upper saturated zone is assumed to be Class A groundwater. A groundwater use restriction will be established for the Property.
	Sub-slab vapor	Sub-slab vapor	Volatile emissions from sub-slab vapor to indoor air	Inhalation of volatile emissions	Inhalation of volatile emissions	Incomplete Pathway: Volatile compounds are not a contaminant of concern for the Property. In addition, there are no current buildings at the Property and an Activity and Use Limitation will be placed on the Property prior to occupancy of any potential future buildings within the vicinity of the former landfill.
	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	Incomplete Pathway: This receptor population is not evaluated for intrusive activities.
					Dermal contact with groundwater	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	Incomplete Pathway: Groundwater in the upper saturated zone is assumed to be Class A groundwater. A groundwater use restriction will be established for the Property.
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete Pathway: Volatile compounds are not a contaminant of concern for the Property. In addition, there are no current buildings at the Property and an Activity and Use Limitation will be placed on the Property prior to occupancy of any potential future buildings within the vicinity of the former landfill.

TABLE 3-1

EXPOSURE UNIT NORTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
On-Property Commercial / Industrial Workers	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Complete Pathway: Comparison to UPUS and naturally occurring background levels.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
	Sediment	Lagoon and borrow pond sediment	Direct contact	Surface soil	Soil ingestion	**Complete pathway: Comparison to Generic Direct Contact Soil Standards for Commercial/Industrial Land Use in lieu of readily available sediment direct contact standards.**
					Dermal contact with soil	
	Surface Water	Lagoon and borrow pond surface water	Direct contact	Surface water	Surface water ingestion	**Complete pathway: Direct estimation of hazard and risk associated with direct contact exposures to lagoon and borrow pond surface water.**
					Dermal contact with surface water	

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-1

EXPOSURE UNIT NORTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
ON-PROPERTY PATHWAYS						
On-Property Construction / Excavation Workers	Surface and subsurface soils	Surface and subsurface soil	Direct contact	Surface and subsurface soils	Soil ingestion	**Complete pathway: Comparison to Generic Direct Contact Soil Standards for Construction/Excavation Activities**
					Dermal contact with soil	
			Particulate emissions from soil to outdoor air	Outdoor Air	Inhalation of particulate emissions	
			Volatile emissions from soil to outdoor air	Outdoor Air	Inhalation of volatile emissions	
			Leaching from soils to groundwater in upper saturated zone	Water supply	Potable use of water	Incomplete Pathway: Groundwater in the upper saturated zone is assumed to be Class A groundwater. A groundwater use restriction will be established for the Property.
			Volatile emissions from soil to indoor air	Indoor air	Inhalation of volatile emissions	Incomplete pathway: This receptor population is based on a scenario with outdoor exposures only.
	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	**Complete pathway: Potential exposures to shallow groundwater evaluated through comparison to Property-specific direct contact groundwater standards.**
					Dermal contact with groundwater	
			Volatile emissions from groundwater to outdoor air		Inhalation of volatile eimssions	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	Incomplete Pathway: Groundwater in the upper saturated zone is assumed to be Class A groundwater. A groundwater use restriction will be established for the Property.
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete pathway: This receptor population is based on a scenario with outdoor exposures only.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-1

EXPOSURE UNIT NORTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
On-Property Construction / Excavation Workers	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Complete Pathway: Comparison to UPUS and naturally occurring background levels.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
	Sediment	Lagoon and borrow pond sediment	Direct contact	Surface soil	Soil ingestion	**Complete pathway: Comparison to Generic Direct Contact Soil Standards for Construction/Excavation Land Use in lieu of readily available sediment direct contact standards.**
					Dermal contact with soil	
	Surface Water	Lagoon and borrow pond surface water	Direct contact	Surface water	Surface water ingestion	**Complete pathway: Direct estimation of hazard and risk associated with direct contact exposures to lagoon and borrow pond surface water.**
					Dermal contact with surface water	

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-1

EXPOSURE UNIT NORTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
OFF-PROPERTY PATHWAYS						
Off-Property Commercial / Industrial Workers	On-Property surface soils	Surface soils	Particulate emissions from soil to outdoor air, and off-	Outdoor air	Inhalation of particulate emissions	**Potentially complete pathway with insubstantial exposures: Comparison to Generic and Property-specific Direct Contact Soil Standards for On-Property Commercial/Industrial Workers is considered protective of the Off-Property Commercial/Industrial**
		Surface soils	Volatile emissions from soil to outdoor air	Outdoor Air	Inhalation of volatile emissions	
	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	Incomplete Pathway: This receptor population is not evaluated for intrusive activities.
					Dermal contact with groundwater	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Complete pathway: Groundwater in the upper saturated zone has been demonstrated to meet UPUS at the downgradient Property boundary.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property.
Off-Property Commercial / Industrial Workers	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Complete Pathway: Comparison to UPUS and naturally occurring background levels.**
					Dermal contact with potable use water while	
					Inhalation of volatile emissions from potable use water while showering or bathing	

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-1

EXPOSURE UNIT NORTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
Off-Property Residents	On-Property surface soils	Surface soils	Particulate emissions from soil to outdoor air, and off-Property transport of fugitive dust	Outdoor air	Inhalation of particulate emissions	**Potentially complete pathway with insubstantial exposures: Comparison to Generic and Property-specific Direct Contact Soil Standards for On-Property Commercial/Industrial Workers is considered protective of the Off-Property Resident Population.**
		Surface soils	Volatile emissions from soil to outdoor air	Outdoor Air	Inhalation of volatile emissions	
	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	Incomplete Pathway: This receptor population is not evaluated for intrusive activities.
					Dermal contact with groundwater	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Complete pathway: Groundwater in the upper saturated zone has been demonstrated to meet UPUS at the downgradient Property boundary.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property.
	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Complete Pathway: Comparison to UPUS and naturally occurring background levels.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-1

EXPOSURE UNIT NORTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
OFF-PROPERTY PATHWAYS						
Off-Property Recreational Users (River Styx)	Surface water	Surface water	Direct contact	Surface water	Direct Contact with Surface Water	**Potentially complete pathway with insubstantial exposures: Evaluated through the comparison of River Styx surface water to Outside the Mixing Zone Average water quality standards for the protection of Human Health non-drinking water quality standards for the protection of recreational users per OAC 3745-1.**
	Upper saturated zone	Surface water	Discharge to surface water	Biota	Ingestion	
	Sediment	Sediment	Direct contact	Sediment	Direct contact with sediment	
Important Ecological Resources (River Styx)	Surface water	Surface water	Direct contact	Surface water	Direct Contact with Surface Water	**Potentially complete pathway with insubstantial exposures: Evaluated through the comparison of River Styx surface water to Outside the Mixing Zone Average water quality standards for the protection of aquatic life per OAC 3745-1.**
	Upper saturated zone	Surface water	Discharge to surface water	Biota	Ingestion	
	Sediment	Sediment	Direct contact	Sediment	Direct contact with sediment	

Notes:

a. Complete and potentially complete exposure pathways are denoted by **BOLD** type.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-2

EXPOSURE UNIT SOUTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
ON-PROPERTY PATHWAYS						
On-Property Commercial / Industrial Workers	Surface soil	Surface soil	Direct contact	Surface soil	Soil ingestion	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
					Dermal contact with soil	
			Particulate emissions from soil to outdoor air	Outdoor Air	Inhalation of particulate emissions	
			Volatile emissions from soil to outdoor air		Inhalation of volatile emissions	
	Surface and subsurface soil	Surface and subsurface soil	Volatile emissions from soil to indoor air	Indoor air	Inhalation of volatile emissions	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property.
			Leaching from soils to groundwater in upper saturated zone	Water supply	Potable use of water	Incomplete Pathway: Groundwater in the upper saturated zone is not utilized for potable purposes since groundwater in the lower zone is a Critical Resource groundwater. Nevertheless, a groundwater use restriction will be established for the Property.
	Sub-slab vapor	Sub-slab vapor	Volatile emissions from sub-slab vapor to indoor air	Inhalation of volatile emissions	Inhalation of volatile emissions	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property.
	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	Incomplete Pathway: This receptor population is not evaluated for intrusive activities.
					Dermal contact with groundwater	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	Incomplete Pathway: Groundwater in the upper saturated zone is not utilized for potable purposes since groundwater in the lower zone is a Critical Resource groundwater. Nevertheless, a groundwater use restriction will be established for the Property.
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-2

EXPOSURE UNIT SOUTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
On-Property Commercial / Industrial Workers	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
ON-PROPERTY PATHWAYS						
On-Property Construction / Excavation Workers	Surface and subsurface soils	Surface and subsurface soil	Direct contact	Surface and subsurface soils	Soil ingestion	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
					Dermal contact with soil	
			Particulate emissions from soil to outdoor air	Outdoor Air	Inhalation of particulate emissions	
			Volatile emissions from soil to outdoor air	Outdoor Air	Inhalation of volatile emissions	
			Leaching from soils to groundwater in upper saturated zone	Water supply	Potable use of water	Incomplete Pathway: Groundwater in the upper saturated zone is not utilized for potable purposes since groundwater in the lower zone is a Critical Resource groundwater. Nevertheless, a groundwater use restriction will be established for the Property.
			Volatile emissions from soil to indoor air	Indoor air	Inhalation of volatile emissions	Incomplete pathway: This receptor population is based on a scenario with outdoor exposures only.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 3-2

EXPOSURE UNIT SOUTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
On-Property Construction / Excavation Workers	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
					Dermal contact with groundwater	
			Volatile emissions from groundwater to outdoor air		Inhalation of volatile eimssions	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	Incomplete Pathway: Groundwater in the upper saturated zone is not utilized for potable purposes since groundwater in the lower zone is a Critical Resource groundwater. Nevertheless, a groundwater use restriction will be established for the Property.
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete pathway: This receptor population is based on a scenario with outdoor exposures only.
	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
Important Ecological Resources (Wetlands)	Surface water	Surface water	Direct contact	Surface water	Direct Contact with Surface Water	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
	Upper saturated zone	Surface water	Discharge to surface water	Surface water	Direct Contact with Surface Water	
	Sediment	Sediment	Direct contact	Sediment	Direct contact with sediment	

TABLE 3-2

EXPOSURE UNIT SOUTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
OFF-PROPERTY PATHWAYS						
Off-Property Commercial / Industrial Workers	On-Property surface soils	Surface soils	Particulate emissions from soil to outdoor air, and off-Property transport of fugitive dust	Outdoor air	Inhalation of particulate emissions	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
		Surface soils	Volatile emissions from soil to outdoor air	Outdoor Air	Inhalation of volatile emissions	
	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	Incomplete Pathway: This receptor population is not evaluated for intrusive activities.
					Dermal contact with groundwater	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	Incomplete Pathway: Groundwater in the upper saturated zone is not utilized for potable purposes since groundwater in the lower zone is a Critical Resource groundwater. Nevertheless, a groundwater use restriction will be established for the Property.
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property.
	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or bathing	

TABLE 3-2

EXPOSURE UNIT SOUTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
Off-Property Residents	On-Property surface soils	Surface soils	Particulate emissions from soil to outdoor air, and off-Property transport of fugitive dust	Outdoor air	Inhalation of particulate emissions	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
		Surface soils	Volatile emissions from soil to outdoor air	Outdoor Air	Inhalation of volatile emissions	
	Upper saturated zone	Groundwater in upper saturated zone	Direct contact	Groundwater pooled during excavation	Incidental ingestion of groundwater	Incomplete Pathway: This receptor population is not evaluated for intrusive activities.
					Dermal contact with groundwater	
			Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	Incomplete Pathway: Groundwater in the upper saturated zone is not utilized for potable purposes since groundwater in the lower zone is a Critical Resource groundwater. Nevertheless, a groundwater use restriction will be established for the Property.
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use water while showering or	
			Volatile emissions from groundwater to indoor air	Indoor air	Inhalation of volatile emissions from groundwater to indoor air	Incomplete Pathway: Volatile compounds are not contaminants of concern for the Property.
	Lower Saturated Zone	Groundwater in lower saturated zone	Pumping of groundwater for potable use	Water supply	Ingestion of potable use water	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
					Dermal contact with potable use water while showering or bathing	
					Inhalation of volatile emissions from potable use	

TABLE 3-2

EXPOSURE UNIT SOUTH: EXPOSURE PATHWAY COMPLETENESS DETERMINATION

RECEPTOR POPULATION	SOURCE MEDIUM	ANALYTICAL MEDIUM	TRANSPORT MECHANISM	CONTACT MEDIUM	ROUTE OF EXPOSURE	TYPE OF EVALUATION
OFF-PROPERTY PATHWAYS						
Important Ecological Resources (River Styx)	Surface water	Surface water	Direct contact	Surface water	Direct Contact with Surface Water	**Potentially complete exposure pathway with insubstantial exposures. Sampling results from the single IA at the Property as well as the single pre-IA did not reveal the presence of any contamination and did not identify any new IAs within the EU. Further evaluation of EU-South was not deemed necessary.**
	Upper saturated zone	Surface water	Discharge to surface water	Surface water	Direct Contact with Surface Water	
	Sediment	Sediment	Direct contact	Sediment	Direct contact with sediment	

Notes:

a. Complete and potentially complete exposure pathways are denoted by **BOLD** type.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 4-1

CHEMICAL-SPECIFIC SUBCHRONIC TOXICITY CRITERIA FOR THE DERIVATION OF PROPERTY-SPECIFIC DIRECT CONTACT GROUNDWATER STANDARDS

Chemical of Concern		Subchronic Oral & Dermal Reference Doses & Inhalation Reference Concentrations						Oral & Dermal Slope Factors & Inhalation Air Unit Risk Factors					
		Oral RfD		Dermal RfD		Inhalation RfC		Oral SF		Dermal SF		Inhalation URF	
		(mg/kg-day		(mg/kg-day)		(mg/m^3)		($[mg/kg\text{-}day]^{-1}$)		($[mg/kg\text{-}day]^{-1}$)		($[mg/m^3]^{-1}$)	
Inorganics													
Arsenic		3.00E-04	v	3.00E-04	v	1.50E-05	v	1.50E+00	v	1.50E+00	v	4.30E+00	v
Barium		2.00E-01	v	2.00E-01	v	5.00E-03	v	NA	v	NA	v	NA	v
Cobalt		3.00E-03	v	3.00E-03	v	2.00E-05	v	NA	v	NA	v	NA	v
Manganese		1.40E-01	v	1.40E-01	v	5.00E-05	v	NA	v	NA	v	NA	v
Molybdenum	b	--		--		--		--		--		--	
Nickel		2.00E-02	v	2.00E-02	v	2.00E-04	o	NA	v	NA	v	NA	v
Zinc		3.00E-01	v	3.00E-01	v	NA	v	NA	v	NA	v	NA	v

Notes:

a. Sources for toxicity criteria:

o: Indicates value listed in Virginia DEQ spreadsheet was updated to be consistent with the Ohio Voluntary Action Program. Values taken from the VAP 2016 Support Document.

v: indicates value listed is from the Virginia DEQ spreadsheet

b. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(60) and is therefore not quantitatively evaluated herein.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 4-2

CHEMICAL-SPECIFIC SUBCHRONIC TOXICITY CRITERIA FOR THE DERIVATION OF PROPERTY-SPECIFIC DIRECT CONTACT SURFACE WATER STANDARDS

Chemical of Concern		Subchronic Oral & Dermal Reference Doses				Oral & Dermal Slope Factors			
		Oral RfD		Dermal RfD		Oral SF		Dermal SF	
		(mg/kg-day		(mg/kg-day)		([mg/kg-day]$^{-1}$)		([mg/kg-day]$^{-1}$)	
Inorganics									
Arsenic		3.00E-04	v	3.00E-04	v	1.50E+00	v	1.50E+00	v
Barium		2.00E-01	o	2.00E-01	o	--	v	--	v
Cadmium (water)		1.00E-03	o	1.00E-03	o	--	v	--	v
Chromium	c	1.50E+00	o	1.50E+00	o	--	o	--	o
Cobalt		3.00E-03	v	3.00E-03	v	--	v	--	v
Copper		1.00E-02	v	1.00E-02	v	--	v	--	v
Manganese (nonfood)		1.40E-01	o	1.40E-01	o	--	v	--	v
Mercury		--	v	--	v	--	v	--	v
Molybdenum	b	--		--		--		--	
Nickel		2.00E-02	o	2.00E-02	o	--	v	--	v
Silver		5.00E-03	o	5.00E-03	o	--	v	--	v
Vanadium		1.00E-02	o	2.60E-04	o	--	v	--	v
Zinc		3.00E-01	v	3.00E-01	v	--	v	--	v

Notes:

a. Sources for toxicity criteria:
  o: Indicates value listed in Virginia DEQ spreadsheet was updated to be consistent with the Ohio Voluntary Action Program. Values taken from the VAP 2016 Support Document.
  v: indicates value listed is from the Virginia DEQ spreadsheet

b. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(60) and is therefore not quantitatively evaluated herein.

c. Trivalent chromium toxicity values were used due to a lack of historical use of hexavalent chromium. See text Section 4 for more details.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 5-1

DERIVATION OF PROPERTY-SPECIFIC DIRECT CONTACT GROUNDWATER STANDARDS:
EXPOSURE FACTOR VALUES FOR CONSTRUCTION/EXCAVATION ACTIVITIES

Exposure Parameter	Value	Units	Reference
Exposure Duration	1	yr	VAP Support Document (2016) [a]
Exposure Frequency	120	days/yr	VAP Support Document (2016)
Averaging Time: Non-cancer endpoint	365	days	ED x 365 days/year
Averaging Time: Cancer endpoint	25,550	days	70 yr (lifetime) x 365 days/year
Body Weight	70	kg	VAP Support Document (2016)
Incidental Ingestion Rate	0.02	L/day	Recommended value, Virginia DEQ VRP [b], Table 6-4
Total Skin Surface Area	20,000	cm^2	BW x SA:BW ratio
Percent Skin Surface Area Exposed	0.165	unitless	Skin Surface Area Exposed / Total Skin Surface Area
Skin Surface Area	3300	cm^2	VAP Support Document (2016)
Exposure Time (dermal contact)	4	hr/day	Recommended value, Virginia DEQ VRP Table 6-4
Exposure Time (inhalation)	4	hr/day	Recommended value, Virginia DEQ VRP Table 6-4
Permeability Constant	chemical-specific	cm/hr	VAP Support Document (2016)
Conversion Factor (dermal contact)	1.00E-03	L/cm^3	VAP Support Document (2016)
Conversion Factor (inhalation)	1.00E+03	L/m^3	VAP Support Document (2016)
Trench Width/Depth Ratio	1.20E+00	unitless	Calculated by model based on trench dimensions (8 ft length, 6 ft width, 5 ft depth)
Air Circulation Rate	3.60E+02	hr^{-1}	Selected by model on basis of trench width/depth ratio
Target Hazard Quotient	1.00E+00	unitless	VAP Support Document (2016)
Target Excess Lifetime Cancer Risk	1.00E-05	unitless	VAP Support Document (2016)

Notes:

a. Ohio EPA, May 2016. *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures*.

b. Virginia Department of Environmental Quality (DEQ) Voluntary Remediation Program (VRP) Construction Trench: Contact with Groundwater spreadsheet (vrp64.xls) model default. Revised 8/5/2014, available for downloading at: http://www.deq.virginia.gov/vrprisk/tables.html

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 5-2

PROPERTY-SPECIFIC DIRECT CONTACT GROUNDWATER STANDARDS FOR THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern		Property-Specific Direct Contact Groundwater Standards[a] (ug/L)		Single-Chemical Standard[b] (ug/L)
		Non-cancer Endpoint Value	Cancer Endpoint Value	
Inorganics				
Arsenic		1,900	2,900	1,900
Barium		1,256,900	NA[c]	1,256,900
Cobalt		25,000	NA	25,000
Manganese (nonfood)		879,800	NA	879,800
Molybdenum	d	--	--	--
Nickel		187,000	NA	187,000
Zinc		2,254,800	NA	2,254,800

Notes:

a. Direct contact groundwater standards for construction/excavation activities, calculated using the Virginia DEQ Construction Trench: Contact with Groundwater spreadsheet (vrp64.xls), Revised 8/5/2014, available for downloading at: http://www.deq.virginia.gov/vrprisk/tables.html

b. Standard: the lower of the non-cancer endpoint and cancer endpoint concentrations.

c. NA: Not Applicable.

d. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 5-3

EXPOSURE FACTOR VALUES FOR THE EVALUATION OF DIRECT CONTACT EXPOSURES WITH LAGOON AND BORROW POND WATER

Exposure Parameter	On-Property Commercial/ Industrial Worker		On-Property Construction/ Excavation Worker		Reference	
	Value	Units	Value	Units		
Receptor Age	Adult	unitless	Adult	unitless	Property-Specific	
Swimming Possible?	No	unitless	No	unitless	Property-Specific	
Absorbed dose per event	Chemical-specific	mg/cm^2 -event	Chemical-specific	mg/cm^2-event	EPA, 1992	a
Event frequency	1	events/day	1	events/day	EPA, 1992	a
Skin Surface Area Available for Contact	3,300	cm^2	3,300	cm2	VAP Support Document (2016)	b
Exposure Frequency	60	days/years	120	days/years	Property-Specific; VAP Support Document (2016)	b, c
Exposure Duration	25	years	1	years	VAP Support Document (2016)	b
Exposure Time	2	hours/day	2	hours/day	Property-Specific	d
Incidental Ingestion	0.005	liters/hour	0.005	liters/hour	EPA, 1989	e
Body Weight	70	kg	70	kg	VAP Support Document (2016)	b
Averaging Time (Cancer)	25,550	days	25,550	days	70 yr (lifetime) x 365 days/year	
Averaging Time (Non-cancer)	9,125	days	365	days	ED x 365 days/year	
Intake Factor (Cancer)	2.77	event-cm^2/kg-day	0.22	event-cm^2/kg-day	calculated	
Intake Factor (Non-cancer)	8	event-cm^2/kg-day	15	event-cm^2/kg-day	calculated	

Notes:

a. Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment. EPA/600/8-91/011B.

b. Ohio EPA, May 2016. *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures*.

c. An exposure frequency of 60 days/year was selected as a Property-specific value for the On-Property Commercial/Industrial Worker since it is reasonably anticipated that this would receptor would only participate in lagoon and borrow pond maintenance activities (i.e., de-watering) on an irregular basis throughout the year.

d. An exposure time of 2 hours/day was selected using best professional judgement.

e. USEPA, Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. EPA/540/1-89/002.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-1

EXPOSURE UNIT NORTH: CUMULATIVE HAZARD AND RISK ESTIMATES FOR DIRECT CONTACT WITH SURFACE SOIL EXPOSURES OF THE ON-PROPERTY COMMERCIAL/INDUSTRIAL WORKER

Chemical of Concern		Representative Concentration (mg/kg)[a]	Sample Location of Representative Concentration	Sample Depth of Representative Concentration (ft)	VAP Direct Contact Soil Standards for Commercial/Industrial Land Use (mg/kg)[b]			Single-Chemical Commercial/Industrial Direct Contact Soil Standard (mg/kg)[c]	Hazard Ratio[d]	Risk Ratio[d]
					Non-Cancer Endpoint	Cancer Endpoint	Soil Saturation			
Metals										
Arsenic		26	95% UCL	95% UCL	1,200	77	NA[e]	77	2.17E-02	3.38E-01
Barium	f	270	UR2013	0-2	680,000	NA	NA	680000	3.97E-04	NA
Cadmium		1.3	UR2007	1-2	2,600	130,000	NA	2,600	5.00E-04	1.00E-05
Chromium	g	72.48	95% UCL	95% UCL	1,000,000	NA	NA	1,000,000	7.25E-05	NA
Cobalt	f	13.9	UR2010	0-1	1,200	26,000	NA	1,200	1.16E-02	5.35E-04
Copper		174	UR2023	0-2	160,000	NA	NA	160,000	1.09E-03	NA
Lead	h	682	UR2023	0-2	NA	NA	NA	800	NA	NA
Mercury		2.6	UR2012, UR2023	0-2, 0-2	85	NA	3.1	3.1	3.06E-02	NA
Molybdenum	i	19.3	UR2023	0-2	--	--	--	--	--	--
Nickel		36	UR2010	0-1	74,000	900,000	NA	74,000	4.86E-04	4.00E-05
Silver		9.1	UR2013	0-2	20,000	NA	NA	20,000	4.55E-04	NA
Vanadium	f	98.1	UR2013	0-2	20,000	NA	NA	20,000	4.91E-03	NA
Zinc		572	UR2023	0-2	1,000,000	NA	NA	1,000,000	5.72E-04	NA
Polynuclear Aromatic Hydrocarbons (PAHs)										
Anthracene		0.046	UR2014	0-2	450,000	NA	NA	450,000	1.02E-07	NA
Benzo(a)anthracene		0.1	UR2013	0-2	NA	58	NA	58	NA	1.72E-03
Benzo(a)pyrene		0.035	UR2014	0-2	NA	5.8	NA	5.8	NA	6.03E-03
Benzo(b)fluoranthene		0.039	UR2014	0-2	NA	58	NA	58	NA	6.72E-04
Benzo(k)fluoranthene		0.032	UR2014	0-2	NA	580	NA	580	NA	5.52E-05
Chrysene		0.12	UR2013	0-2	NA	5,800	NA	5,800	NA	2.07E-05
Dibenz(a,h)anthracene		0.0071	UR2002	0-1	NA	5.8	NA	5.8	NA	1.22E-03
Fluoranthene		0.18	UR2013	0-2	60,000	NA	NA	60,000	3.00E-06	NA
Fluorene		0.056	UR2014	0-2	60,000	NA	NA	60,000	9.33E-07	NA
Indeno(1,2,3-c,d)pyrene		0.012	UR2002	0-1	NA	58	NA	58	NA	2.07E-04
2-Methylnaphthalene		1.8	UR2013	0-2	6,000	NA	NA	6,000	3.00E-04	NA
Naphthalene		1.4	UR2013	0-2	1,600	450	NA	450	8.75E-04	3.11E-03

Pyrene		0.2	UR2013	0-2	45,000	NA	NA	45,000	4.44E-06	NA
								Total Ratio	**0.0735**	**0.351**
								Hazard Index[j]	**0.07**	**--**
								Excess Lifetime Cancer Risk[k]	**--**	**4E-06**

Notes:

a. Representative concentration is either the maximum detected concentration or the 95% Upper Confidence Limit (UCL) of each chemical detected at least once in the soil samples collected within EU-North within the 2-ft point of compliance.

b. Ohio Voluntary Action Program (VAP) generic numerical standard for direct contact with soil for commercial/industrial land use, per OAC 3745-300-08, effective May 26, 2016.

c. Single-chemical standard represents the lowest of the non-cancer endpoint, cancer endpoint, and soil saturation values.

d. Multiple chemical evaluation performed in accordance with OAC 3745-300-08(A)(2)(b) effective May 26, 2016. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1.
A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of $1x10^{-5}$.

e. NA: not applicable

f. Ohio Voluntary Action Program Supplemental generic numerical standards for direct contact with soil for commmercial/industrial activities per Ohio EPA Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) spreadsheet, May 26, 2016.

g. Chromium at the Property is reasonably anticipated to primarily consist of trivalent chromium. Therefore, the generic direct contact soil standard for trivalent chromium has been utilized for the quantitative evaluation presented herein.

h. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.

i. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.

j. Corresponding hazard index (HI) equals the sum of hazard quotients associated with each non-cancer hazard ratio for each chemical with a non-cancer endpoint.

k. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks associated with each cancer risk ratio for each chemical with a cancer endpoint.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-2

EXPOSURE UNIT NORTH: CUMULATIVE HAZARD AND RISK ESTIMATES FOR DIRECT CONTACT WITH SEDIMENT EXPOSURES OF THE ON-PROPERTY COMMERCIAL/INDUSTRIAL WORKER

Chemical of Concern		Representative Concentration (mg/kg)[a]	Sample Location of Representative Concentration	Sample Depth of Representative Concentration (ft)	VAP Direct Contact Soil Standards for Commercial/Industrial Land Use (mg/kg)[b]			Single-Chemical Commercial/Industria l Direct Contact Soil Standard (mg/kg)[c]	Hazard Ratio[d]	Risk Ratio[d]
					Non-Cancer Endpoint	Cancer Endpoint	Soil Saturation			
Metals										
Aluminum	f	11000	HSS4	0-2	--	--	--	--	--	--
Arsenic		37.7	UR2020	0-1	1,200	77	NA[e]	77	3.14E-02	4.90E-01
Barium	g	215	UR2020	0-1	680,000	NA	NA	680,000	3.16E-04	NA
Beryllium		1.4	HSS4	0-2	7,800	97,000	NA	7,800	1.79E-04	1.44E-05
Cadmium		4.4	UR2017	0-1	2,600	130,000	NA	2,600	1.69E-03	3.38E-05
Chromium	h	41.8	UR2017	0-1	1,000,000	NA	NA	1,000,000	4.18E-05	NA
Cobalt	g	27.9	UR2017	0-1	1,200	26,000	NA	1,200	2.33E-02	1.07E-03
Copper		105	UR2021	0-1	160,000	NA	NA	160,000	6.56E-04	NA
Lead	i	87.7	UR2017	0-1	NA	NA	NA	800	NA	NA
Mercury		0.47	UR2021	0-1	85	NA	3.1	3.1	5.53E-03	NA
Molybdenum	f	6.6	UR2018	0-1	--	--	--	--	--	--
Nickel		57.6	UR2017	0-1	74,000	900,000	NA	74,000	7.78E-04	6.40E-05
Selenium		6.5	HSS4	0-2	20,000	NA	NA	20,000	3.25E-04	NA
Thallium	g	5.2	HSS4	0-2	41	NA	NA	41	1.27E-01	NA
Vanadium	g	41.8	UR2018	0-1	20,000	NA	NA	20,000	2.09E-03	NA
Zinc		2920	UR2017	0-1	1,000,000	NA	NA	1,000,000	2.92E-03	NA
Polynuclear Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene		0.094	UR2018	0-1	6,000	NA	NA	6,000	1.57E-05	NA
Naphthalene		0.079	UR2018	0-1	1,600	450	NA	450	4.94E-05	1.76E-04
								Total Ratio	**0.196**	**0.491**
								Hazard Index[j]	**0.2**	**--**
								Excess Lifetime Cancer Risk[k]	**--**	**5E-06**

Notes:

a. Representative concentration is the maximum detected concentration of each chemical detected at least once in sediment samples collected from Lagoon 21 and the borrow ponds at the Property.

b. Ohio Voluntary Action Program (VAP) generic numerical standard for direct contact with soil for a commercial/industrial land use category, per OAC 3745-300-08, effective May 26, 2016.
Soil direct contact standards were used in the absence of readily available sediment standards.

c. Single-chemical standard represents the lowest of the non-cancer endpoint, cancer endpoint, and soil saturation values.

d. Multiple chemical evaluation performed in accordance with OAC 3745-300-08(A)(2)(b) effective May 26, 2016. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1.
A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of $1x10^{-5}$.

e. NA: not applicable

f. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.

g. Ohio Voluntary Action Program Supplemental generic numerical standards for direct contact with soil for commercial/industrial land use per Ohio EPA Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) spreadsheet, May 26, 2016.

h. The VAP GNS for chromium (III) was used for evaluation of total chromium results.

i. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.

j. Corresponding hazard index (HI) equals the sum of hazard quotients associated with each non-cancer hazard ratio for each chemical with a non-cancer endpoint.

k. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks associated with each cancer risk ratio for each chemical with a cancer endpoint.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-3

EXPOSURE UNIT NORTH: RESIDUAL CUMULATIVE HAZARD AND RISK ESTIMATES FOR LAGOON AND BORROW POND WATER DIRECT CONTACT EXPOSURES OF THE ON-PROPERTY COMMERCIAL/INDUSTRIAL WORKER

Chemical of Concern		Representative Concentration (ug/L)[a]	Sample Location of Representative Concentration	Non-Cancer Hazard Quotient (unitless) [b]	Incremental Cancer Risk (unitless) [b]
Arsenic		98.8	UR2021	1.28E-02	2.06E-06
Barium		374	UR2021	7.29E-05	NA[c]
Cadmium		2.1	UR2021	8.19E-05	NA
Chromium		154	UR2021	5.59E-06	NA
Cobalt		19.9	UR2021	1.97E-03	NA
Copper		185	UR2021	1.80E-04	NA
Lead	d	135	UR2021	--	--
Manganese		1180	UR2021	2.02E-02	NA
Mercury	e	0.0063	Lagoon 21	NA	NA
Molybdenum	f	15	UR2021	--	--
Nickel		105	UR2021	1.40E-04	NA
Silver		11.5	UR2021	7.54E-05	NA
Vanadium		48.8	UR2021	3.05E-04	NA
Zinc		695	UR2021	7.59E-05	NA
			Cumulative HI[g]	**0.04**	**--**
			Cumulative ELCR[h]	**--**	**2E-06**

Notes:
a. Representative concentration is the reported concentration of each COC detected in lagoon and borrow pond water samples obtained from the Property, irrespective of IA.
b. Non-cancer hazard quotient and excess lifetime cancer risks calculated using the Virginia Department of Environmental Quality's Surface Water Risk Calculations: Trespassers, Recreational calculation spreadsheet (swcalcs.slsx, revised 8/5/2014).
c. NA - not applicable
d. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.
e. Oral and dermal routes of exposure are not assessed for mercury; only inhalation. Therefore, hazard and risk estimates were not quantified for mercury.
f. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.
g. Hazard index equals the sum of the hazard quotients for each chemical with a non-cancer endpoint.
h. Cumulative excess lifetime cancer risks (ELCR) equals the sum of excess lifetime cancer risk associated with the cancer risk for each chemical with a cancer endpoint.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-4

EXPOSURE UNIT NORTH: CHARACTERIZATION OF POTENTIALLY CUMULATIVE AND AGGREGATE HAZARD AND RISK FOR THE ON-PROPERTY COMMERCIAL/INDUSTRIAL WORKER

Exposure Pathway	Exposure Route	On-Property Commercial/Industrial Worker	
		Pathway-Specific Hazard Index	Pathway-Specific Excess Lifetime Cancer Risk
Direct Contact with Surface Soil	Ingestion, Dermal Contact, Inhalation	7.35E-02	3.51E-06
Direct Contact with Lagoon/Borrow Pond Sediment	Ingestion, Dermal Contact, Inhalation	1.96E-01	4.91E-06
Direct Contact with Lagoon/Borrow Pond Surface Water	Ingestion, Dermal Contact	3.59E-02	2.06E-06
Potentially Cumulative and Aggregate Multi-Pathway Hazard Index		**0.3**	**--**
Potentially Cumulative and Aggregate Multi-Pathway Excess Lifetime Cancer Risk		**--**	**1E-05**

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-5

CUMULATIVE HAZARD AND RISK ESTIMATES FOR DIRECT CONTACT WITH SURFACE AND SUBSURFACE SOIL EXPOSURES OF THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern		Representative Concentration (mg/kg)[a]	Sample Location of Representative Concentration	Sample Depth of Representative Concentration (ft)	VAP Direct Contact Soil Standards for Construction/Excavation Activities (mg/kg)[b]			Single-Chemical Construction/ Excavation Direct Contact Soil Standard (mg/kg)[c]	Hazard Ratio[d]	Risk Ratio[d]
					Non-Cancer Endpoint	Cancer Endpoint	Soil Saturation			
Metals										
Arsenic		50.2	UR2007	1-2	690	1,300	NA[i]	690	7.28E-02	3.86E-02
Barium	e	270	UR2013	0-2	320,000	NA	NA	320,000	8.44E-04	NA
Cadmium		1.3	UR2007	1-2	1,000	95,000	NA	1,000	1.30E-03	1.37E-05
Chromium	f	218	UR2023	0-2	890,000	NA	NA	890,000	2.45E-04	NA
Cobalt	e	13.9	UR2010	0-1	2,800	19,000	NA	2,800	4.96E-03	7.32E-04
Copper		174	UR2023	0-2	21,000	NA	NA	21,000	8.29E-03	NA
Lead	g	682	UR2023	0-2	NA	NA	NA	400	NA	NA
Mercury		2.6	UR2012, UR2023	0-2, 0-2	31	NA	3.1	3.1	8.39E-02	NA
Molybdenum	h	19.3	UR2023	0-2	--	--	--	--	--	--
Nickel		36	UR2010	0-1	23,000	660,000	NA	23,000	1.57E-03	5.45E-05
Silver		9.1	UR2013	0-2	11,000	NA	NA	11,000	8.27E-04	NA
Vanadium	e	98.1	UR2013	0-2	11000	NA	NA	11000	8.92E-03	NA
Zinc		572	UR2023	0-2	640,000	NA	NA	640,000	8.94E-04	NA
Polynuclear Aromatic Hydrocarbons (PAHs)										
Anthracene		0.046	UR2014	0-2	1,000,000	NA	NA	1,000,000	4.60E-08	NA
Benzo(a)anthracene		0.1	UR2013	0-2	NA	1,200	NA	1,200	NA	8.33E-05
Benzo(a)pyrene		0.035	UR2014	0-2	NA	120	NA	120	NA	2.92E-04
Benzo(b)fluoranthene		0.039	UR2014	0-2	NA	1,200	NA	1,200	NA	3.25E-05
Benzo(k)fluoranthene		0.032	UR2014	0-2	NA	12,000	NA	12,000	NA	2.67E-06
Chrysene		0.12	UR2013	0-2	NA	120,000	NA	120,000	NA	1.00E-06
Dibenz(a,h)anthracene		0.0071	UR2002	0-1	NA	120	NA	120	NA	5.92E-05
Fluoranthene		0.18	UR2013	0-2	160,000	NA	NA	160,000	1.13E-06	NA
Fluorene		0.056	UR2014	0-2	520,000	NA	NA	520,000	1.08E-07	NA
Indeno(1,2,3-c,d)pyrene		0.012	UR2002	0-1	NA	1,200	NA	1,200	NA	1.00E-05
2-Methylnaphthalene		1.8	UR2013	0-2	5,200	NA	NA	5,200	3.46E-04	NA
Naphthalene		1.4	UR2013	0-2	560	3,800	NA	560	2.50E-03	3.68E-04

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-5

CUMULATIVE HAZARD AND RISK ESTIMATES FOR DIRECT CONTACT WITH SURFACE AND SUBSURFACE SOIL EXPOSURES OF THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern	Representative Concentration (mg/kg)[a]	Sample Location of Representative Concentration	Sample Depth of Representative Concentration (ft)	VAP Direct Contact Soil Standards for Construction/Excavation Activities (mg/kg)[b]			Single-Chemical Construction/ Excavation Direct Contact Soil Standard (mg/kg)[c]	Hazard Ratio[d]	Risk Ratio[d]
				Non-Cancer Endpoint	Cancer Endpoint	Soil Saturation			
Pyrene	0.2	UR2013	0-2	390,000	NA	NA	390,000	5.13E-07	NA
							Total Ratio	**0.187**	**0.040**
							Hazard Index[j]	**0.2**	**--**
							Excess Lifetime Cancer Risk[k]	**--**	**4E-07**

Notes:

a. Representative concentration is the maximum detected concentration of each chemical detected at least once in the soil samples collected within EU-North, irrespective of depth.
b. Ohio Voluntary Action Program (VAP) generic numerical standard for direct contact with soil for a construction/excavation activity category, per OAC 3745-300-08, effective May 26, 2016.
c. Single-chemical standard represents the lowest of the non-cancer endpoint, cancer endpoint, and soil saturation values.
d. Multiple chemical evaluation performed in accordance with OAC 3745-300-08(A)(2)(b) effective May 26, 2016. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1. A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of 1×10^{-5}.
e. Ohio Voluntary Action Program Supplemental generic numerical standards for direct contact with soil for construction/excavation activities per Ohio EPA Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) spreadsheet, May 26, 2016.
f. Chromium at the Property is reasonably anticipated to primarily consist of trivalent chromium. Therefore, the generic direct contact soil standard for trivalent chromium has been utilized for the quantitative evaluation presented herein. Refer to Section 4.2.2 of the text for further discussion regarding chromium in soil.
g. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.
h. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.
i. NA: not applicable
j. Corresponding hazard index (HI) equals the sum of hazard quotients associated with each non-cancer hazard ratio for each chemical with a non-cancer endpoint.
k. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks associated with each cancer risk ratio for each chemical with a cancer endpoint.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
100 INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-6

CUMULATIVE HAZARD AND RISK ESTIMATES FOR POTENTIAL DIRECT CONTACT WITH GROUNDWATER EXPOSURES OF THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern		Representative Concentration (ug/L) [a]	Sample Location of Representative Concentration	Sample Date of Maximum Detected Concentration	Construction/Excavation Direct Contact Groundwater Standards[b] (ug/L)		Single-Chemical Standard[c] (ug/L)	Hazard Ratio[d]	Risk Ratio[d]
					Non-cancer Endpoint Value	Cancer Endpoint Value			
Metals									
Arsenic		90.1	HSMW-8	12/3/2015	1,900	2,982	1,900	4.74E-02	3.02E-02
Barium		336	HSMW-8	12/3/2015	1,278,011	NA[e]	1,278,011	2.63E-04	NA
Cobalt		33.7	HSMW-7	8/3/2016	25,000	NA	25,000	1.35E-03	NA
Manganese		13000	MW-16P	5/8/2013	894,608	NA	894,608	--	--
Molybdenum	f	17	MW-30	12/4/2015	--	--	--	--	--
Nickel		63.1	HSMW-9	12/3/2015	187,889	NA	187,889	3.36E-04	NA
Zinc		185	HSMW-9	12/3/2015	2,281,902	NA	2,281,902	8.11E-05	NA
							Total Ratio	**0.049**	**0.030**
							Corresponding HI [g]	**0.05**	**--**
							Corresponding ELCR [h]	**--**	**3E-07**

Notes:

a. The respresentative concentration is the maximum detected concentration of each COC detected in the upper saturated zone at the Property.

b. Property-specific direct contact groundwater standards for construction/excavation activities, calculated using the Virginia DEQ Construction Trench: Contact with Groundwater spreadsheet (vrp64.xls), Revised 8/5/2014, available for downloading at: http://www.deq.virginia.gov/vrprisk/tables.html

c. Standard: the lower of the non-cancer endpoint and cancer endpoint concentrations.

d. Multiple chemical evaluation performed in accordance with OAC 3745-300-08(C)(2)(b) effective May 26, 2016. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1. A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of $1x10^{-5}$.

e. NA: Not Applicable.

f. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.

g. Corresponding hazard index (HI) equals sum of hazard quotients for all chemicals evaluated with respect to the non-cancer endpoint.

h. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks for all chemicals evaluated with respect to the cancer endpoint.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-7

CUMULATIVE HAZARD AND RISK ESTIMATES FOR DIRECT CONTACT WITH LAGOON AND BORROW POND SEDIMENT EXPOSURES OF THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern		Representative Concentration (mg/kg)[a]	Sample Location of Representative Concentration	Sample Depth of Representative Concentration (ft)	VAP Direct Contact Soil Standards for Construction/Excavation Activities (mg/kg)[b]			Single-Chemical Construction/ Excavation Direct Contact Soil Standard (mg/kg)[c]	Hazard Ratio[d]	Risk Ratio[d]
					Non-Cancer Endpoint	Cancer Endpoint	Soil Saturation			
Metals										
Aluminum	f	11000	HSS4	0-2	--	--	--	--	--	--
Arsenic		37.7	UR2020	0-1	690	1,300	NA[e]	690	5.46E-02	2.90E-02
Barium	g	215	UR2020	0-1	320,000	NA	NA	320,000	6.72E-04	NA
Beryllium		1.4	HSS4	0-2	3,400	71,000	NA	3,400	4.12E-04	1.97E-05
Cadmium		4.4	UR2017	0-1	1,000	95,000	NA	1,000	4.40E-03	4.63E-05
Chromium	h	41.8	UR2017	0-1	890,000	NA	NA	890,000	4.70E-05	NA
Cobalt	g	27.9	UR2017	0-1	2,800	19,000	NA	2,800	9.96E-03	1.47E-03
Copper		105	UR2021	0-1	21,000	NA	NA	21,000	5.00E-03	NA
Lead	i	87.7	UR2017	0-1	NA	NA	NA	400	NA	NA
Mercury		0.47	UR2021	0-1	31	NA	3.1	3.1	1.52E-02	NA
Molybdenum	f	6.6	UR2018	0-1	--	--	--	--	--	--
Nickel		57.6	UR2017	0-1	23,000	660,000	NA	23,000	2.50E-03	8.73E-05
Selenium		6.5	HSS4	0-2	11,000	NA	NA	11,000	5.91E-04	NA
Thallium		5.2	HSS4	0-2	21	NA	NA	21	2.48E-01	NA
Vanadium	g	41.8	UR2018	0-1	11,000	NA	NA	11,000	3.80E-03	NA
Zinc		2920	UR2017	0-1	640,000	NA	NA	640,000	4.56E-03	NA

TABLE 6-7

Polynuclear Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene		0.094	UR2018	0-1	5,200	NA	NA	5,200	1.81E-05	NA
Naphthalene		0.079	UR2018	0-1	560	3,800	NA	560	1.41E-04	2.08E-05
								Total Ratio	**0.3495**	**0.031**
								Hazard Index[j]	**0.3**	**--**
								Excess Lifetime Cancer Risk[k]	**--**	**3E-07**

Notes:

a. Representative concentration is the maximum detected concentration of each chemical detected at least once in sediment samples collected from Lagoon 21 and the borrow ponds at the Property.

b. Ohio Voluntary Action Program (VAP) generic numerical standard for direct contact with soil for a construction/excavation activity category, per OAC 3745-300-08, effective May 26, 2016.

c. Single-chemical standard represents the lowest of the non-cancer endpoint, cancer endpoint, and soil saturation values.

d. Multiple chemical evaluation performed in accordance with OAC 3745-300-08(A)(2)(b) effective May 26, 2016. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1. A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of $1x10^{-5}$.

e. NA: not applicable

f. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.

g. Ohio Voluntary Action Program Supplemental generic numerical standards for direct contact with soil for construction/excavation activities per Ohio EPA Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) spreadsheet, May 26, 2016.

h. Chromium at the Property is reasonably anticipated to primarily consist of trivalent chromium. Therefore, the generic direct contact soil standard for trivalent chromium has been utilized for the quantitative evaluation presented herein. Refer to Section 4.2.2 of the text for further discussion regarding chromium at the Property.

i. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.

j. Corresponding hazard index (HI) equals the sum of hazard quotients associated with each non-cancer hazard ratio for each chemical with a non-cancer endpoint.

k. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks associated with each cancer risk ratio for each chemical with a cancer endpoint.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-8

CUMULATIVE HAZARD AND RISK ESTIMATES FOR POTENTIAL LAGOON AND BORROW POND WATER DIRECT CONTACT EXPOSURES OF THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern		Representative Concentration (ug/L)[a]	Sample Location of Representative Concentration	Non-Cancer Hazard Quotient (unitless) [b]	Incremental Cancer Risk (unitless) [b]
Arsenic		98.8	UR2021	2.57E-02	1.65E-07
Barium		374	UR2021	1.46E-04	NA[c]
Cadmium		2.1	UR2021	1.64E-04	NA
Chromium		154	UR2021	1.12E-05	NA
Cobalt		19.9	UR2021	3.94E-03	NA
Copper		185	UR2021	3.61E-04	NA
Lead	d	135	UR2021	--	--
Manganese		1180	UR2021	4.04E-02	NA
Mercury	e	0.0063	Lagoon 21	NA	NA
Molybdenum	f	15	UR2021	--	--
Nickel		105	UR2021	2.79E-04	NA
Silver		11.5	UR2021	1.51E-04	NA
Vanadium		48.8	UR2021	6.10E-04	NA
Zinc		695	UR2021	1.52E-04	NA
			Cumulative HI[g]	**0.07**	**--**
			Cumulative ELCR[h]	**--**	**2E-07**

Notes:

a. Representative concentration is the reported concentration of each COC detected in lagoon and borrow pond water samples obtained from the Property, irrespective of IA.

b. Non-cancer hazard quotient and excess lifetime cancer risks calculated using the Virginia Department of Environmental Quality's Surface Water Risk Calculations: Trespassers, Recreational calculation spreadsheet (swcalcs.slsx, revised 8/5/2014).

c. NA - not applicable

d. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.

e. Oral and dermal routes of exposure are not assessed for mercury; only inhalation. Therefore, hazard and risk estimates were not quantified for mercury.

f. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.

g. Hazard index equals the sum of the hazard quotients for each chemical with a non-cancer endpoint.

h. Cumulative excess lifetime cancer risks (ELCR) equals the sum of excess lifetime cancer risk associated with the cancer risk for each chemical with a cancer endpoint.

TABLE 6-9

SUMMARY OF POTENTIALLY CUMULATIVE AND AGGREGATE HAZARD AND RISK FOR THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Exposure Pathway	Exposure Route	On-Property Construction/Excavation Worker	
		Pathway-Specific Hazard Index	Pathway-Specific Excess Lifetime Cancer Risk
Direct Contact with Soil	Ingestion, Dermal Contact, Inhalation	1.87E-01	4.03E-07
Direct Contact with Groundwater	Ingestion, Dermal Contact, Inhalation	4.91E-02	3.02E-07
Direct Contact with Lagoon/Pond Sediment	Ingestion, Dermal Contact, Inhalation	3.50E-01	3.06E-07
Direct Contact with Lagoon/Pond Water	Ingestion, Dermal Contact	7.19E-02	1.65E-07
Potentially Cumulative and Aggregate Multi-Pathway Hazard Index		**0.7**	**--**
Potentially Cumulative and Aggregate Multi-Pathway Excess Lifetime Cancer Risk		**--**	**1E-06**

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE 6-10

COMPARISON OF CHEMICALS OF CONCERN DETECTED IN THE LOWER SATURATED ZONE TO VAP UPUS

Parameter	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	VAP Unrestricted Potable Use Standards[a] (ug/L)	
Metals							
Arsenic	22	26	85%	8	45	10	
Barium	19	19	100%	20	80	2000	
Manganese	19	19	100%	24	490	50	b
Molybdenum	2	5	40%	14.1	15.4	--	c

Notes:

a. Unrestricted potable use standards as contained in Appendix A of OAC 3745-300-08 effective May 26, 2016.

b. A VAP UPUS is not included in OAC 3745-300-08. Therefore, the Groundwater Adverse Effects Standard as included in Appendix A of the Director's Final Findings and Orders effective December 29, 2014 has been utilized herein for comparison purposes.

c. COC is not identified as a hazardous substance in accordance with OAC 3745-300-01(A)(59) and has therefore not been quantitatively evaluated within this PSRA.

Additional Notes:

1. Parameters in **BOLD** consist of concentrations that exceed their respective VAP UPUS.

TABLE 6-11

CHEMICALS OF CONCERN IN THE UPPER SATURATED ZONE COMPARED TO OHIO SURFACE WATER QUALITY STANDARDS

Chemical of Concern		Maximum Detected Concentration (ug/L)[a]	Monitoring Well	Sample Date	State of Ohio Water Quality Standards for the Ohio River Drainage Basin (ug/L) [b]	
					OMZA [c]	HH-NonDrink
Metals						
Arsenic	d	90.1	HSMW-8	12/3/2015	100	--[e]
Barium		336	HSMW-8	12/3/2015	220	--
Cobalt		33.7	HSMW-7	8/3/2016	24	--
Manganese		13,000	MW-16P	5/8/2013	--	--
Molybdenum	f	17	MW-30	12/4/2015	20,000	--
Nickel		63.1	HSMW-9	12/3/2015	94	4600
Zinc		185	HSMW-9	12/3/2015	220	69,000
Inorganics						
Total Dissolved Solids		3,500,000	MW-13AP	5/8/2013	1,500,000	--

Notes:

a. Represents the maximum detected concentration of each COC in the groundwater analytical dataset utilized for the Property irrespective of monitoring well location.

b. State of Ohio Water Quality Standards for the Ohio River Drainage Basin, effective January 12, 2015, per OAC 3745-1 where the River Styx is designated Modified Waterwater Habitat (MWH); Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Primary Contact Recreation (PCR) in accordance with Table 24-1 of OAC 3745-1-24.

c. OMZA - outside the mixing zone average surface water quality criteria for the protection of aquatic life. A water hardness value of 200 mg $CaCO_3$ /L was determined for metals that have hardness-dependent standards by utilizing hardness data obtained from River Styx. Refer to the Phase II for a summary of hardness data for the river.

d. The OMZA for this parameter is based upon the more conservative criteria for the protection of agricultural uses as included in Table 7-12 of OAC 3745-1-07 (effective January 4, 2016).

e. -- A water quality standard does not exist.

f. This COC is not identified as a COC under the VAP, however, a surface water quality criteria is readily available and therefore presented herein for transparency purposes.

Additional Notes:

1. Parameters in **BOLD** consist of concentrations that exceed their respective surface water quality criteria.

TABLE 6-12

CHEMICALS OF CONCERN IN RIVER STYX SURFACE WATER COMPARED TO OHIO SURFACE WATER QUALITY STANDARDS

Chemical of Concern[a]	Maximum Detected Concentration (ug/L)[b]	Monitoring Well	Sample Date	State of Ohio Water Quality Standards for the Ohio River Drainage Basin (ug/L)[c]	
				OMZA[d]	HH-NonDrink
Metals					
Barium	36.5	RIV8	8/15/2016	220	--[e]
Cobalt	ND[f]	--	--	24	--
Inorganics					
Total Dissolved Solids	844,000	RIV5	8/1/2016	1,500,000	--

Notes:

a. Chemical of concern reflects only those COCs where the groundwater concentration in Table 6-1 exceeds its respective water quality standard.

b. Maximum detected concentration observed from two River Styx surface water sampling events.

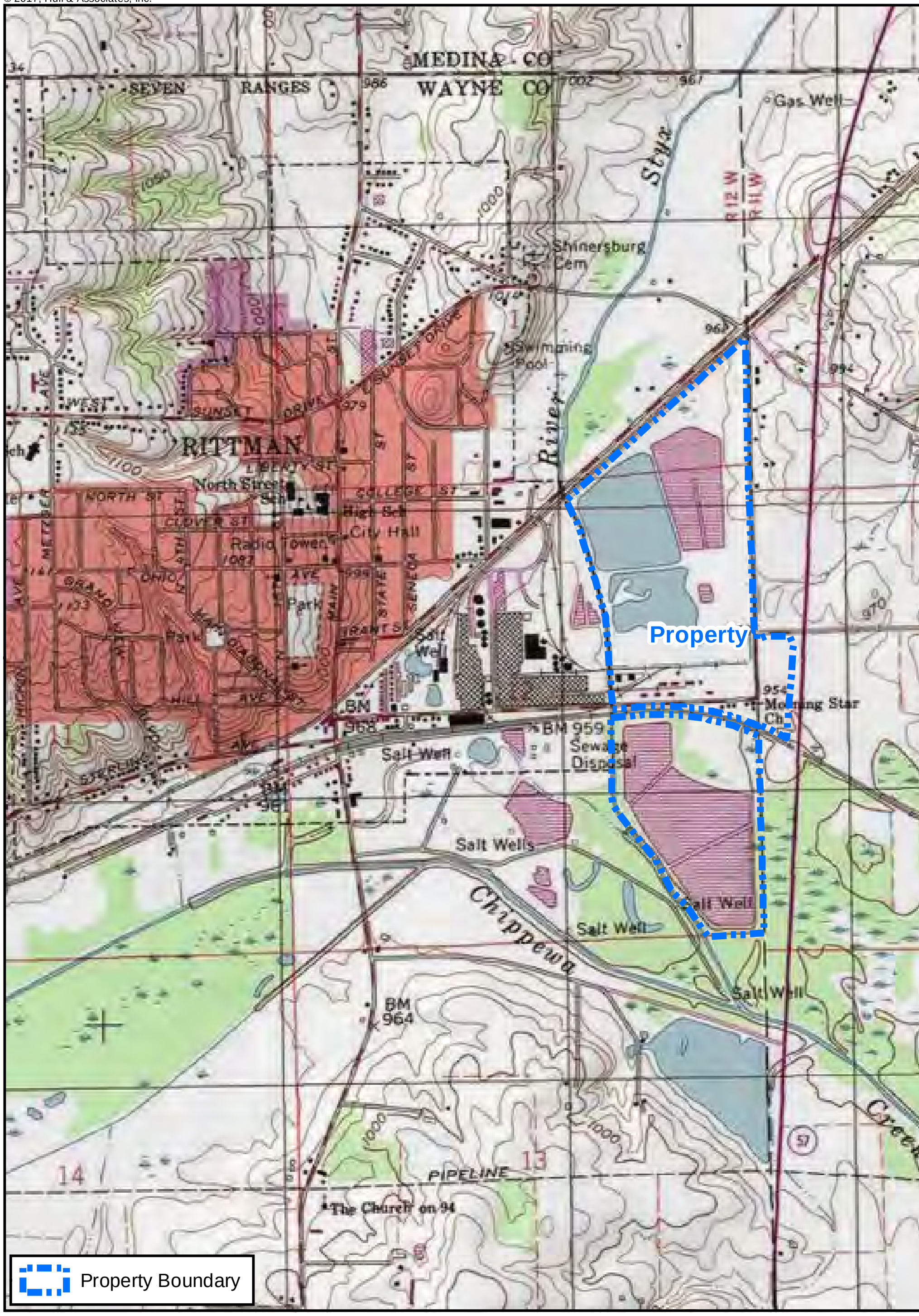
c. State of Ohio Water Quality Standards for the Ohio River Drainage Basin per OAC 3745-1 where the River Styx is designated Modified Waterwater Habitat (MWH); Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Primary Contact Recreation (PCR) in accordance with Table 24-1 of OAC 3745-1-24.

d. OMZA - outside the mixing zone average surface water quality criteria for the protection of aquatic life. A water hardness value of 200 mg CaCO3 /L was determined for metals that have hardness-dependent standards by utilizing hardness data obtained from River Styx. Refer to the Phase II for a summary of hardness data for the river.

e. -- A water quality standard does not exist.

f. ND - not detected; this COC was not detected in surface water samples obtained from River Styx.

FIGURES



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0 500 1,000 2,000 Feet
1:24,000

Quad: Rittman

Source: The topographic map was acquired through the USGS Topographic Map web service.

The aerial photo in the inset was acquired through the ESRI Imagery web service. Aerial photography dated 2015.

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Property-Specific Risk Assessment
Former Rittman Paperboard Facility East of River Styx

Property Location Map

100 Industrial Avenue
Rittman, Wayne County, Ohio

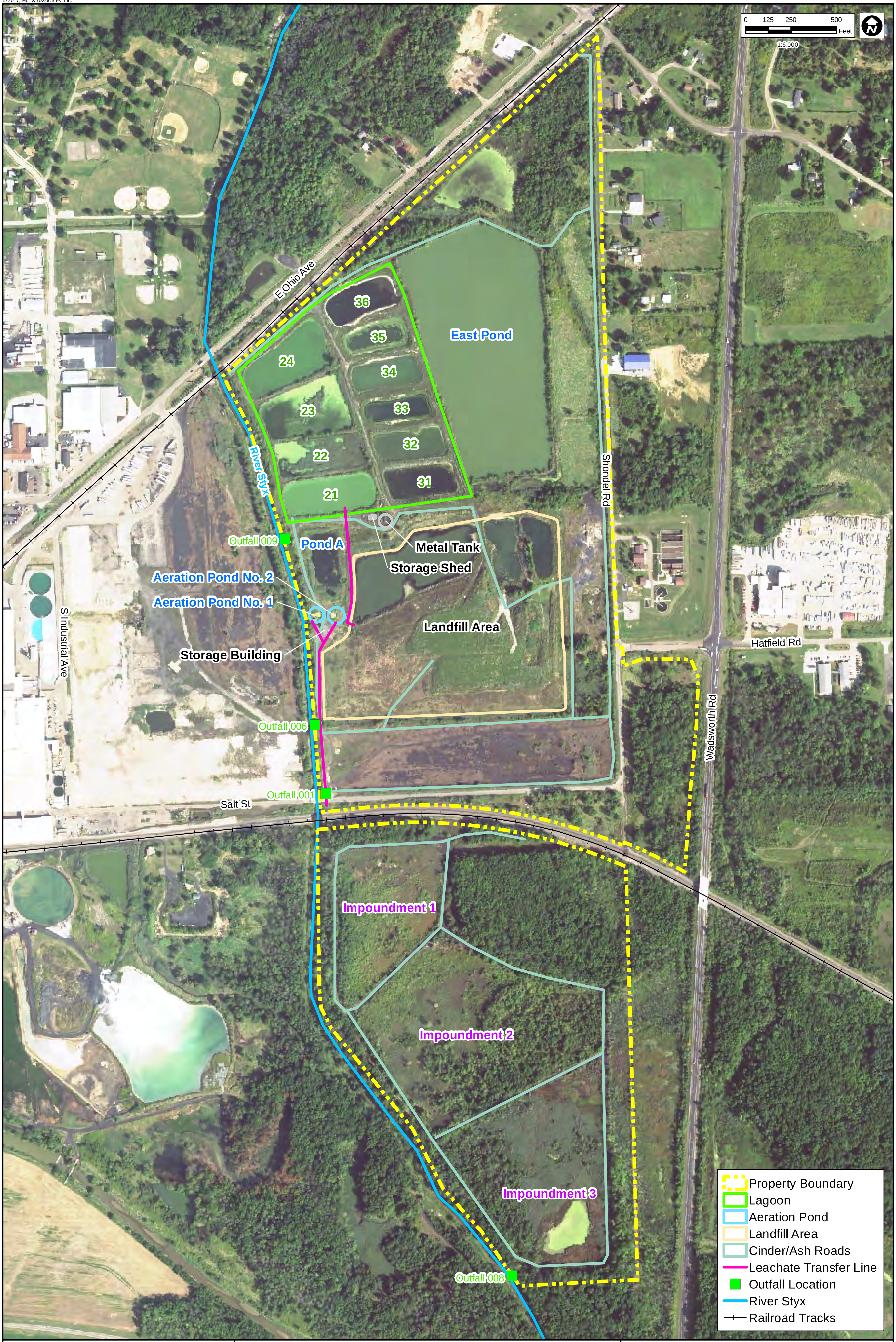
Date:
May 2018

File Name:
UR2008_06_Fig01_PLM.mxd

Edited: 11/17/2017 By: mopel

Figure
1

Produced using ArcGIS 10.3



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May 2018

Property-Specific Risk Assessment
Former Rittman Paperboard Facility East of River Styx

Property Layout

100 Industrial Avenue
Rittman, Wayne County, Ohio

Figure
2

Produced using ArcGIS 10.3

File Name: UR2008_06_Fig02_PropLayout.mxd

Edited: 11/17/2017 By: mopel

Notes:
1) Sampling locations presented herein represent those utilized within the PSRA. Refer to Section 2.0 for the rationale associated with the selection of sampling locations utilized in the PSRA.
2) The aerial photo was acquired through the USGS National Map. Aerial photography dated 11/17/2015.

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Property-Specific Risk Assessment
Former Rittman Paperboard Facility East of River Styx

Sampling Locations

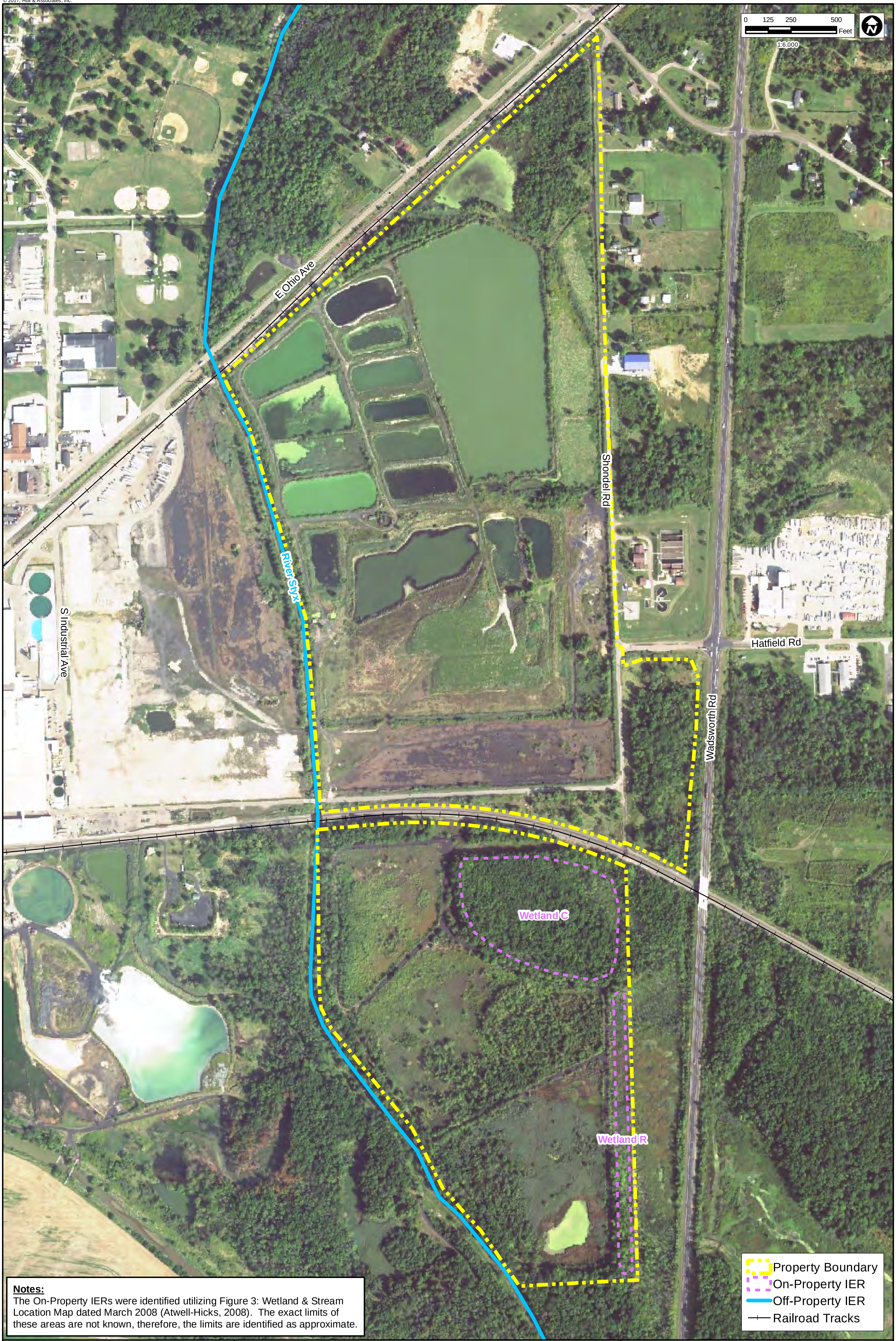
100 Industrial Avenue
Rittman, Wayne County, Ohio

Figure
3

File Name: UR2008_06_Fig03_SampLocs.mxd

Edited: 11/17/2017 By: mopel

Produced using ArcGIS 10.3



Notes:
The On-Property IERs were identified utilizing Figure 3: Wetland & Stream Location Map dated March 2008 (Atwell-Hicks, 2008). The exact limits of these areas are not known, therefore, the limits are identified as approximate.

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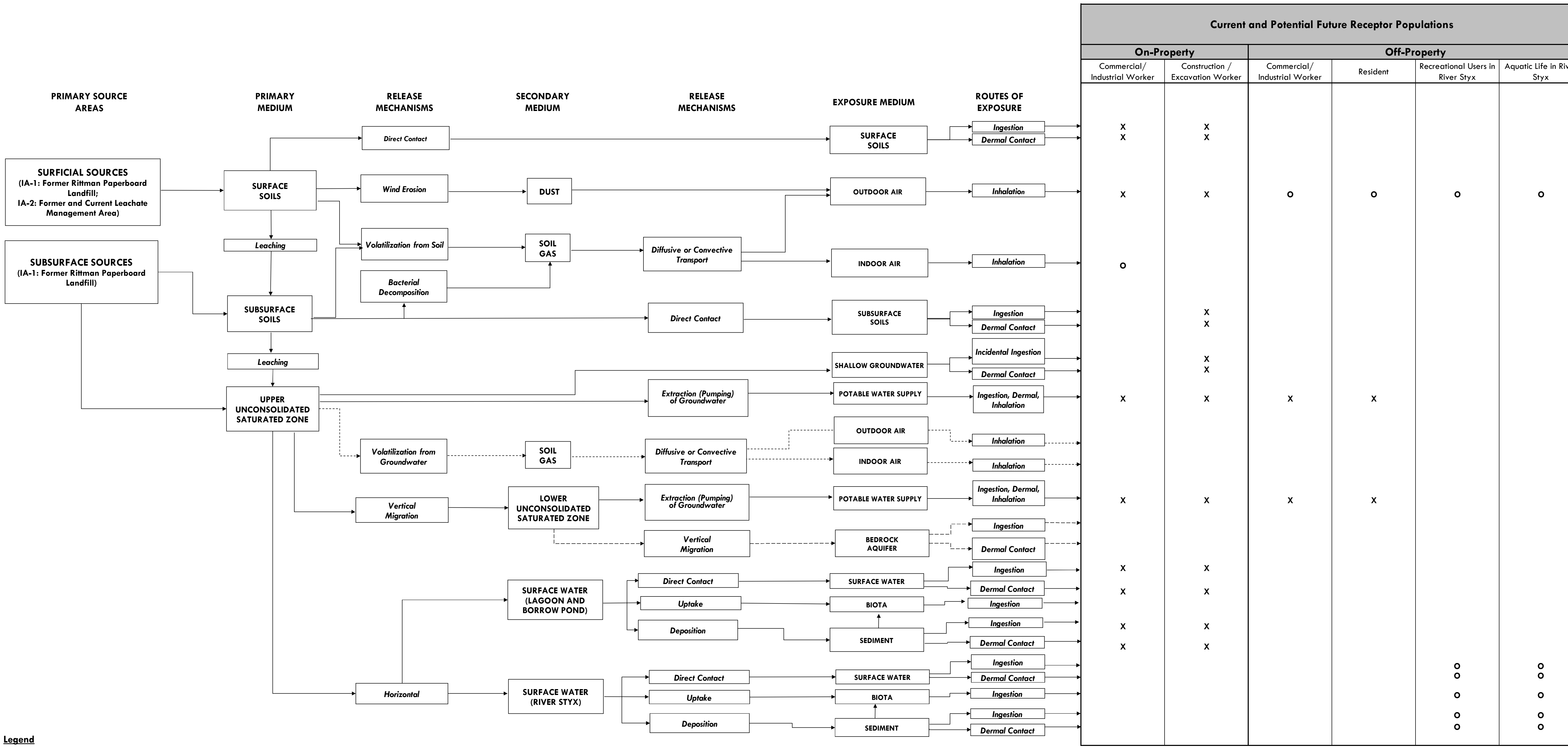
Property-Specific Risk Assessment
Former Rittman Paperboard Facility East of River Styx

Important Ecological Resources

100 Industrial Avenue
Rittman, Wayne County, Ohio

Figure
4

Produced using ArcGIS 10.3
File Name: UR2008_06_Fig04_IER.mxd
Edited: 11/17/2017 By: mopel



Legend

X = Complete pathway with potentially significant exposure

O = Potentially complete pathway with insubstantial exposure

= Incomplete pathway

→ Complete or potentially complete release mechanism

⇢ Incomplete or insignificant release mechanism

Notes:

1. Pathway completeness determination is based upon current and reasonably anticipated future use at the Property, and anticipates that the Property will be restricted to commercial/industrial use through the eventual recording of an Environmental Covenant.
2. Groundwater in the upper saturated zone is assumed to be Class A groundwater. A groundwater use restriction is anticipated for the Property. Groundwater in the lower unconsolidated saturated units is considered a Critical Resource Groundwater.
3. No Important Ecological Resources (IERs) are located within EU-North. The River Styx, an off-Property IER, is located adjacent west of the Property.

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MAY 2018

Former Rittman Paperboard Facility East of River Styx

Exposure Unit North: Site Conceptual Model

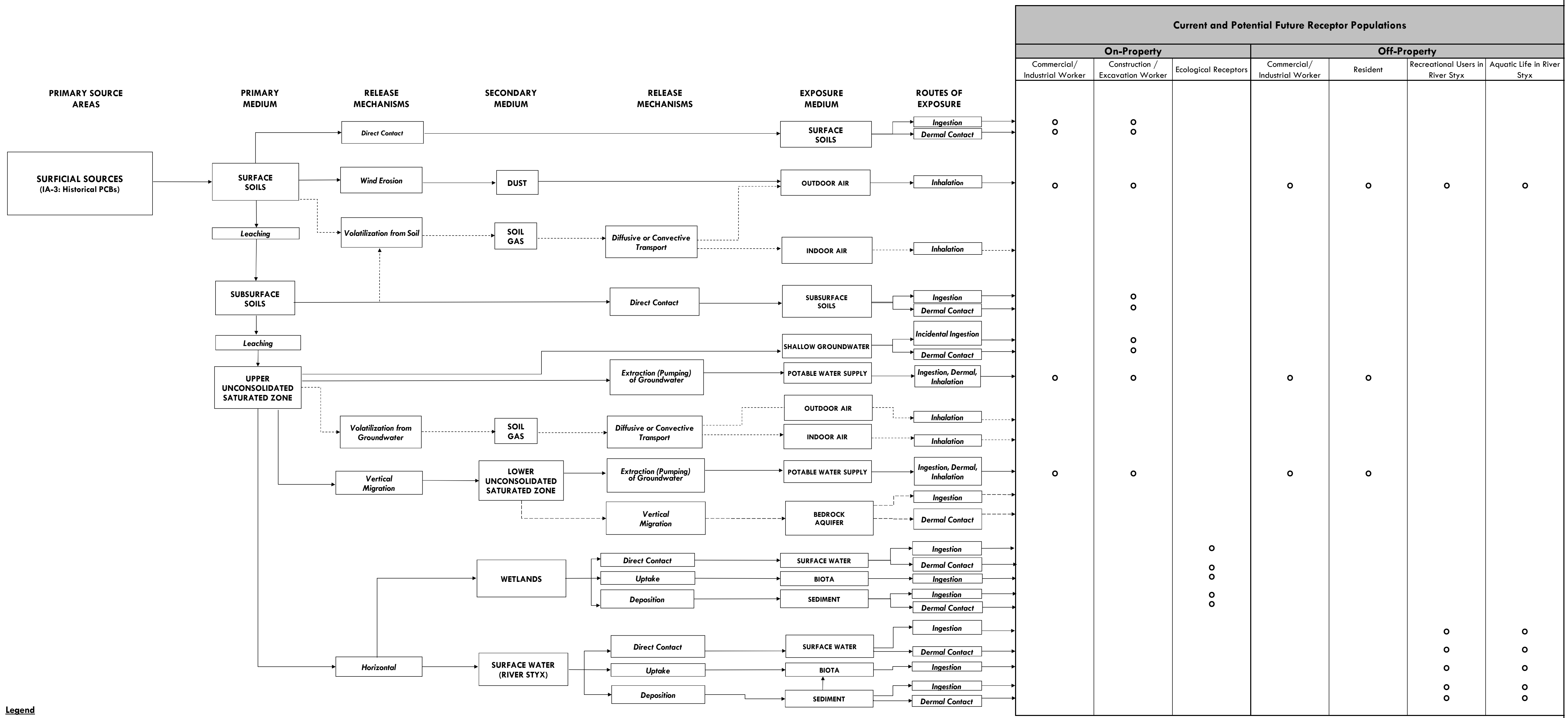
100 Industrial Avenue

Rittman, Wayne County, Ohio

5A

UR2008.600.0007.XLS

2/18/16 v.gill



Legend

X = Complete pathway with potentially significant exposure

O = Potentially complete pathway with insubstantial exposure

= Incomplete pathway

→ Complete or potentially complete release mechanism

⇢ Incomplete or insignificant release mechanism

Notes:

1. Pathway completeness determination is based upon current and reasonably anticipated future use at the Property, and anticipates that the Property will be restricted to commercial/industrial use through the eventual recording of an Environmental Covenant.
2. Groundwater in the upper saturated zone is assumed to be Class A groundwater. A groundwater use restriction is anticipated for the Property. Groundwater in the lower unconsolidated saturated units is considered a Critical Resource Groundwater.

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MAY 2018

Former Rittman Paperboard Facility East of River Styx

Exposure Unit South: Site Conceptual Model

100 Industrial Avenue
Rittman, Wayne County, Ohio

5B

UR2008.600.0007.XLS

2/18/16 v.gill

APPENDIX A

VAP Certified Data Verification

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-1

SUMMARY OF NON-VAP CERTIFIED SOIL SAMPLING LOCATIONS

Sample Location	Sample Date	Field Sample ID	Sample Top (ft)	Sample Bottom (ft)	Exposure Unit
B1	9/3/2013	UR2002:B1B2:Z050185	5	18.5	North
B2	9/3/2013	UR2002:B1B2:Z010095	1	9.5	North
B40-0-5	5/24/2006	B40-0-5	--[a]	--	--
B40-10-15	5/24/2006	B40-10-15	--	--	--
B40-15-20	5/24/2006	B40-15-20	--	--	--
B40-20-25	5/24/2006	B40-20-25	--	--	--
B40-25-30	5/24/2006	B40-25-30	--	--	--
B40-30-35	5/24/2006	B40-30-35	--	--	--
B40-35-40	5/24/2006	B40-35-40	--	--	--
B40-40-45	5/24/2006	B40-40-45	--	--	--
B40-45-50	5/24/2006	B40-45-50	--	--	--
B40-50-55	5/24/2006	B40-50-55	--	--	--
B40-5-10	5/24/2006	B40-5-10	--	--	--
B40-55-60	5/24/2006	B40-55-60	--	--	--
B40-60-65	5/24/2006	B40-60-65	--	--	--
B40-65-70	5/24/2006	B40-65-70	--	--	--
B40-70-75	5/24/2006	B40-70-75	--	--	--
DITCH MIDDLE	11/13/2008	DITCH MIDDLE	--	--	North
DITCH NORTH	11/13/2008	DITCH NORTH	--	--	North
DITCH SOUTH	11/13/2008	DITCH SOUTH	--	--	North
DUP	9/1/2006	DUP	--	--	--
MIDDLE LAGOON A 1 FOOT	8/28/2006	MIDDLE LAGOON A 1 FOOT	1	1	South
MIDDLE LAGOON A 1 FOOT	10/12/2007	MIDDLE LAGOON A (1 FOOT)	1	1	South
MIDDLE LAGOON A 6 FEET	8/28/2006	MIDDLE LAGOON A 6 FEET	6	6	South
MIDDLE LAGOON A 6 FEET	10/12/2007	MIDDLE LAGOON A (6 FEET)	6	6	South
MIDDLE LAGOON B 1 FOOT	8/28/2006	MIDDLE LAGOON B 1 FOOT	1	1	South
MIDDLE LAGOON B 1 FOOT	10/12/2007	MIDDLE LAGOON B (1 FOOT)	1	1	South
MIDDLE LAGOON B 6 FEET	8/28/2006	MIDDLE LAGOON B 6 FEET	6	6	South
MIDDLE LAGOON B 6 FEET	10/12/2007	MIDDLE LAGOON B (6 FEET)	6	6	South
MIDDLE LAGOON C 1 FOOT	8/28/2006	MIDDLE LAGOON C 1 FOOT	1	1	South
MIDDLE LAGOON C 1 FOOT	10/12/2007	MIDDLE LAGOON C (1 FOOT)	1	1	South
MIDDLE LAGOON C 6 FEET	8/28/2006	MIDDLE LAGOON C 6 FEET	6	6	South
MIDDLE LAGOON C 6 FEET	10/12/2007	MIDDLE LAGOON C (6 FEET)	6	6	South
MIDDLE LAGOON D 1 FOOT	8/28/2006	MIDDLE LAGOON D 1 FOOT	1	1	South
MIDDLE LAGOON D 1 FOOT	10/12/2007	MIDDLE LAGOON D (1 FOOT)	1	1	South

TABLE A-1

SUMMARY OF NON-VAP CERTIFIED SOIL SAMPLING LOCATIONS

Sample Location	Sample Date	Field Sample ID	Sample Top (ft)	Sample Bottom (ft)	Exposure Unit
MIDDLE LAGOON D 6 FEET	8/28/2006	MIDDLE LAGOON D 6 FEET	6	6	South
MIDDLE LAGOON D 6 FEET	10/12/2007	MIDDLE LAGOON D (6 FEET)	6	6	South
MIDDLE LAGOON E 1 FOOT	8/28/2006	MIDDLE LAGOON E 1 FOOT	1	1	South
MIDDLE LAGOON E 1 FOOT	10/12/2007	MIDDLE LAGOON E (1 FOOT)	1	1	South
MIDDLE LAGOON E 6 FEET	8/28/2006	MIDDLE LAGOON E 6 FEET	6	6	South
MIDDLE LAGOON E 6 FEET	10/12/2007	MIDDLE LAGOON E (6 FEET)	6	6	South
NORTH LAGOON A 1 FOOT	8/21/2006	NORTH LAGOON A 1 FOOT	1	1	South
NORTH LAGOON A 10.5 FOOT	8/21/2006	NORTH LAGOON A 10.5 FOOT	10.5	10.5	South
NORTH LAGOON B 1 FOOT	8/21/2006	NORTH LAGOON B 1 FOOT	1	1	South
NORTH LAGOON B 5 FEET 8"	8/21/2006	NORTH LAGOON B 5 FEET 8"	5	5	South
NORTH LAGOON C 1 FOOT	8/21/2006	NORTH LAGOON C 1 FOOT	1	1	South
NORTH LAGOON C 6 FEET 6"	8/21/2006	NORTH LAGOON C 6 FEET 6"	6	6	South
NORTH LAGOON D 1 FOOT	8/21/2006	NORTH LAGOON D 1 FOOT	1	1	South
NORTH LAGOON D 12 FEET 9"	8/21/2006	NORTH LAGOON D 12 FEET 9"	12	12	South
NORTH LAGOON E 1 FOOT	8/21/2006	NORTH LAGOON E 1 FOOT	1	1	South
NORTH LAGOON E 13 FEET	8/21/2006	NORTH LAGOON E 13 FEET	13	13	South
P8	9/4/2013	UR2002:P8:S120140	12	14	North
SOUTH LAGOON A 1FT	9/1/2006	SOUTH LAGOON A 1FT	1	1	South
SOUTH LAGOON A 6FT	9/1/2006	SOUTH LAGOON A 6FT	6	6	South
SOUTH LAGOON B 1FT	9/1/2006	SOUTH LAGOON B 1FT	1	1	South
SOUTH LAGOON B 6FT	9/1/2006	SOUTH LAGOON B 6FT	6	6	South
SOUTH LAGOON C 1FT	9/1/2006	SOUTH LAGOON C 1FT	1	1	South
SOUTH LAGOON C 3.5FT	9/1/2006	SOUTH LAGOON C 3.5FT	3.5	3.5	South
SOUTH LAGOON D 1FT	9/1/2006	SOUTH LAGOON D 1FT	1	1	South
SOUTH LAGOON D 6FT	9/1/2006	SOUTH LAGOON D 6FT	6	6	South
SOUTH LAGOON E 1FT	9/1/2006	SOUTH LAGOON E 1FT	1	1	South

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-1

SUMMARY OF NON-VAP CERTIFIED SOIL SAMPLING LOCATIONS

Sample Location	Sample Date	Field Sample ID	Sample Top (ft)	Sample Bottom (ft)	Exposure Unit
SOUTH LAGOON E 6FT	9/1/2006	SOUTH LAGOON E 6FT	6	6	South

Notes:
a. This information could not be confirmed, however, sampling location is likely associated with the former landfill.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-2

COMPARISON OF NON-VAP CERTIFIED SOIL ANALYTICAL DATA AGAINST APPLICABLE OHIO VAP GENERIC DIRECT CONTACT SOIL STANDARDS

Parameter		Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)[a]	Sample Location of Maximum Detected Concentration	Sample Depth of Maximum Detected Concentration (ft)	VAP Commercial/Industrial Generic Direct Contact Soil Standard (mg/kg)[b]	Maximum Exceeds Commercial/Industrial Direct Contact Soil Standard?	VAP Construction/Excavation Generic Direct Contact Soil Standard (mg/kg)[b]	Maximum Exceeds Construction/Excavation Direct Contact Soil Standard?
HAZARDOUS SUBSTANCES									
Metals									
Arsenic		1.03	20	B2	1-9.5	77	No	690	No
Barium	c	28.4	180	P8	12-14	68340	No	316000	No
Cadmium		0.202	0.737	SOUTH LAGOON D 1FT	1-1	2,600	No	1,000	No
Chromium	d	4.07	76.4	MIDDLE LAGOON C 1 FOOT	1-1	210	No	1200	No
Copper		6.7	62.7	MIDDLE LAGOON C 1 FOOT	1-1	160,000	No	21,000	No
Lead		7.54	182	MIDDLE LAGOON C 1 FOOT	1-1	800	No	400	No
Manganese	c	56	320	B2	1-9.5	79400	No	9882	No
Mercury		0.097	0.22	B2	1-9.5	3	No	3	No
Nickel		4.39	10.6	SOUTH LAGOON B 6FT	6-6	74,000	No	23,000	No
Zinc		30.7	310	B2	1-9.5	1,000,000	No	640,000	No
Polychlorinated Biphenyls (PCBs)									
Aroclor 1242		0.064	2.3	MIDDLE LAGOON C 6 FEET	6-6	20	No	440	No
Volatile Organic Compounds (VOCs)									
Acetone		0.044	0.1	DITCH NORTH	0-0	110,000	No	110,000	No
Ethylbenzene		0.005	0.005	NORTH LAGOON E 13 FEET	13-13	480	No	480	No
Methylene Chloride		0.0064	0.0073	DITCH NORTH	0-0	3,300	No	3,300	No

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-2

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Parameter	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)[a]	Sample Location of Maximum Detected Concentration	Sample Depth of Maximum Detected Concentration (ft)	VAP Commercial/Industrial Generic Direct Contact Soil Standard (mg/kg)[b]	Maximum Exceeds Commercial/Industrial Direct Contact Soil Standard?	VAP Construction/Excavation Generic Direct Contact Soil Standard (mg/kg)[b]	Maximum Exceeds Construction/Excavation Direct Contact Soil Standard?
Toluene	0.063	0.081	NORTH LAGOON E 13 FEET	13-13	820	No	820	No
Inorganics								
Cyanide	1.7	6.6	NORTH LAGOON B 1 FOOT	1-1	370	No	150	No
NON-HAZARDOUS SUBSTANCES								
Calcium	2600	24000	B2	1-9.5	--	--	--	--
Chloride	10.8	160	NORTH LAGOON B 1 FOOT	1-1	--	--	--	--
Iron	56.6	28000	B1	5-18.5	--	--	--	--
Magnesium	380	3900	B2	1-9.5	--	--	--	--
Phosphorous	49.7	591	MIDDLE LAGOON C 1 FOOT	1-1	82	Yes	430	Yes
Potassium	310	1100	B2	1-9.5	--	--	--	--
Sodium	120	240	B2	1-9.5	--	--	--	--
Sulfate	21.1	2500	B2	1-9.5	--	--	--	--

Notes:

a. Maximum detected concentration observed in the non-VAP certified soil analytical dataset, irrespective of depth interval or location.

b. Ohio Voluntary Action program direct contact soil standards as contained in OAC 3745-300-08, effective August 1, 2014.

c. Property-specific direct contact soil standard as originally contained in Ohio EPA's standards calculation workbook, September 2014 (Ohio EPA, unpublished).

d. The VAP standard for chromium VI was used for the evaluation of total chromium.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-3

VAP GROUNDWATER CONFIRMATION VERIFICATION

Sample Location	Sample Date	Field Sample ID	VAP Certified Data?
HDMW-6	8/3/2016	UR2008:HDMW6:G080316	Yes
	8/3/2016	UR2008:HDMW6:G080316A	Yes
HDMW-7	8/3/2016	UR2008:HDMW7:G080316	Yes
HDMW-8	8/3/2016	UR2008:HDMW8:G080316	Yes
HSMW-8	12/3/2015	UR2005:HSMW8:G120315	Yes
HSMW-9	12/3/2015	UR2005:HSMW9:G120315	Yes
HSMW-10	12/3/2015	UR2005:HSMW10:G120315	Yes
MW-2	5/8/2013	UR2002:MW2:G050813	No
	10/16/2013	UR2002:MW2:G101613	No
	5/6/2014	UR2004:MW2:G050614	No
	12/3/2015	UR2005:MW2:G120315	Yes
MW-3	5/9/2013	UR2002:MW3:G050913	No
	10/16/2013	UR2002:MW3:G101613	No
	12/17/2013	UR2002:MW3:G121713R	No
	5/6/2014	UR2004:MW3:G050614	No
	12/3/2015	UR2005:MW3:G120315	Yes
MW-4	5/8/2013	UR2002:MW4:G050813	No
	10/16/2013	UR2002:MW4:G101613	No
	12/17/2013	UR2002:MW4:G121713R	No
	5/5/2014	UR2004:MW4:G050514	No
	12/3/2015	UR2005:MW4:G120315	Yes
MW-6	5/8/2013	UR2002:MW6:G050813	No
	8/28/2013	UR2002:MW6:G082813	No
	5/5/2014	UR2004:MW6:G050514	No
	5/5/2014	UR2004:MW6:G050514A	No
	12/4/2015	UR2005:MW-6:G120415	Yes
MW-11R	5/9/2013	UR2002:MW11R:G050913	No
	10/16/2013	UR2002:MW11R:G101613	No
	5/5/2014	UR2004:MW11R:G050514	No
	12/4/2015	UR2005:MW-11R:G120415	Yes
MW-12B	5/8/2013	UR2002:MW12B:G050813	No
	10/17/2013	UR2002:MW12B:G101713	No
	5/6/2014	UR2004:MW12B:G050614	No
	12/4/2015	UR2005:MW-12B:G120415	Yes
MW-13AP	5/8/2013	UR2002:MW13AP:G050813	No
	8/28/2013	UR2002:MW13AP:G082813	No
	5/5/2014	UR2004:MW13AP:G050514	No
MW-14P	5/8/2013	UR2002:MW14P:G050813	No
	8/28/2013	UR2002:MW14P:W082813	No
	5/5/2014	UR2004:MW14P:G050514	No
MW-15P	5/8/2013	UR2002:MW15P:G050813	No
	10/16/2013	UR2002:MW15P:G101613	No
	5/5/2014	UR2004:MW15P:G050514	No

TABLE A-3

VAP GROUNDWATER CONFIRMATION VERIFICATION

Sample Location	Sample Date	Field Sample ID	VAP Certified Data?
MW-16L	5/8/2013	UR2002:MW16L:G050813	No
	10/17/2013	UR2002:MW16L:G101713	No
	5/6/2014	UR2004:MW16L:G050614	No
	12/3/2015	UR2005:MW16L:G120315	Yes
MW-16P	5/8/2013	UR2002:MW16P:G050813	No
	10/16/2013	UR2002:MW16P:G101613	No
	5/5/2014	UR2004:MW16P:G050514	No
MW-17	5/8/2013	UR2002:MW17:G050813	No
	10/16/2013	UR2002:MW17:G101613	No
	5/5/2014	UR2004:MW17:G050514	No
	12/4/2015	UR2005:MW-17:G120415	Yes
MW-30	5/8/2013	UR2002:MW30:G050813	No
	10/16/2013	UR2002:MW30:G101613	No
	5/5/2014	UR2004:MW30:G050514	No
	12/4/2015	UR2005:MW-30:G120415	Yes
	12/4/2015	UR2005:MW-30:G120415A	Yes
MW-40	5/8/2013	UR2002:MW40:G050813	No
	10/16/2013	UR2002:MW40:G101613	No
	5/5/2014	UR2004:MW40:G050514	No
MW-41	5/8/2013	UR2002:MW41:G050813	No
	10/17/2013	UR2002:MW41:G101713	No
	5/5/2014	UR2004:MW41:G050514	No
	12/4/2015	UR2005:MW-41:G120415	Yes
MW-42	5/9/2013	UR2002:MW42:G050913	No
	10/16/2013	UR2002:MW42:G101613	No
	5/6/2014	UR2004:MW42:G050614	No
		Number of Samples Not VAP Certified[a]	**51**
		Minimum Number of Confirmation Samples Required (10%)	**5.1**
		Number of Samples VAP Certified[a]	**18**

Notes:

a. Sample locations HSMW-8 through HSMW-10 and HDMW-6 through HDMW-8 were not included in this evaluation since these wells were installed during the 2015/2016 Phase II investigation activities.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-4

SUMMARY OF NON-VAP CERTIFIED SEDIMENT SAMPLES

Sample Location	Sample Date	Field Sample ID	Sample Type	Exposure Unit	VAP Certified Data?	Use in PSRA?	Comments
LAG31	9/25/2013	UR2002:LAG31:D09252013	Lagoon	North	No	No	Lagoon 31
LAG36	11/15/2013	UR2002:LAG36:D11152013	Lagoon	North	No	No	Lagoon 36
P-24B	7/28/2006	P-24B	Lagoon	North	No	No	Lagoon 24; VAP certified analytical data collected from sediment sample HSS-1.
P-32B	7/28/2006	P-32B	Lagoon	North	No	No	Lagoon 32; VAP certified analytical data collected from sediment sample HSS-3.
P-34B	7/28/2006	P-34B	Lagoon	North	No	No	Lagaoon 34; VAP certified analytical data collected from sediment sample HSS-2.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-5

VAP SURFACE WATER CONFIRMATION VERIFICATION

Sample Location	Sample Date	Field Sample ID	Comments	VAP Certified?
Lagoon 21	9/11/2013	UR2002:LAG21:W091113	Lagoon 21	No
UR2016	11/23/2015	UR2005:MBP3:W112315	Borrow Ponds	Yes
UR2017	11/23/2015	UR2005:MBP2:W112315	Borrow Ponds	Yes
UR2018	11/23/2015	UR2005:MBP1:W112315 UR2005:MBP1:W112315A (Duplicate)	Borrow Ponds	Yes
UR2020	11/23/2015	UR2005:P21-3:W112315	Lagoon 21	Yes
UR2021	11/23/2015	UR2005:P21-2:W112315	Lagoon 21	Yes
UR2022	11/23/2015	UR2005:P21-1:W112315	Lagoon 21	Yes
		Number of Samples Not VAP Certified		**1**
		Minimum Number of Confirmation Samples Required (10%)		**0.1**
		Number of Samples VAP Certified[a]		**3**

Notes:

a. Pursuant to OAC 3745-300-07(E)(1)(d)(iii)(a) that stipulates samples must be collected from the same sampling point, only sampling locations collected from Lagoon 21 were included in this confirmation check.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-6

SUMMARY OF VAP CERTIFIED SOIL SAMPLING LOCATIONS EXCLUDED FROM RISK ASSESSMENT

Sample Location	Sample Date	Sample Top (ft)	Sample Bottom (ft)	Field Sample ID	Property Area	Pre-IA Determination Area	Sample Type
UR2030	11/20/2015	0	2	UR2005:UR2030:S000020	North	Cinders/Ash	Surf
UR2031	11/20/2015	0	2	UR2005:UR2031:S000020	North	Cinders/Ash	Surf
UR2032	11/20/2015	0	1.8	UR2005:UR2032:S000018	North	Cinders/Ash	Surf
UR2032	11/20/2015	0	1.9	UR2005:UR2032:S000018	North	Cinders/Ash	Surf
UR2033	12/1/2015	0	2	UR2005:UR2033:S000020	South	SSI	Surf
UR2034	12/1/2015	0	2	UR2005:UR2034:S000020	South	SSI	Surf
UR2035	12/1/2015	0	2	UR2005:UR2035:S000020	South	SSI	Surf
UR2036	12/1/2015	0	2	UR2005:UR2036:S000020	South	SSI	Surf
UR2037	12/1/2015	0	2	UR2005:UR2037:S000020	South	SSI	Surf
UR2038	12/1/2015	0	2	UR2005:UR2038:S000020	South	SSI	Surf

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE A-7

SUMMARY OF VAP CERTIFIED SEDIMENT SAMPLING LOCATIONS NOT USED IN PSRA

Sample Location	Sample Date	Sample Top (ft)	Sample Bottom (ft)	Field Sample ID	VAP Certified?	Use in PSRA?	Comments
HSS1	9/15/2011	0	2	SSD001:HSS1:S000020	Yes	No	Outside the limits of existing IAs
HSS2	9/15/2011	0	2	SSD001:HSS2:S000020	Yes	No	Outside the limits of existing IAs
HSS3	9/15/2011	0	2	SSD001:HSS3:S000020	Yes	No	Outside the limits of existing IAs
HSS5	9/15/2011	0	2	SSD001:HSS5:S000020	Yes	No	Outside the limits of existing IAs
HSS6	9/15/2011	0	2	SSD001:HSS6:S000020	Yes	No	Outside the limits of existing IAs

Notes:
The aerial photo was acquired through the USGS National Map.
Aerial photography dated 11/17/2015.

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May 2018

Property-Specific Risk Assessment
Former Rittman Paperboard Facility East of River Styx

Summary of All Sampling Locations

100 Industrial Avenue
Rittman, Wayne County, Ohio

Figure
A-1

Produced using ArcGIS 10.3

File Name: UR2008_06_FigA1_SampLocs.mxd

Edited: 11/17/2017 By: mopel

APPENDIX B

Salt Street Impoundments Due Diligence Evaluation

APPENDIX B

RISK EVALUATION OF SALT STREET IMPOUNDMENTS (EU-South)

As detailed in the Property-Specific Risk Assessment (PSRA), Section 2.5, a quantitative evaluation of the Southern Exposure Unit (EU), EU-South, also referred to as the Salt Street Impoundments (SSI), was not completed based on the following rationale:

(1) The Phase II investigations associated with the only Identified Area within EU-South, IA-3 "Salt Street Impoundments Historical Polychlorinated Biphenyls (PCBs)", did not identify the presence of any PCBs.

(2) Additional VAP-Certified data associated with pre-IA determination soil sampling did not identify the presence of any additional IAs within EU-South.

(3) Historical analytical results available for EU-South are not VAP-Certified.

Therefore, based on the absence of IAs and VAP-Certified analytical results, no formal quantitative risk evaluation was completed for EU-South within the main PSRA. Nonetheless, to alleviate any uncertainty associated with demonstrating protection of human health and the environment, this quantitative evaluation of EU-South was completed to provide a better understanding of the potential hazards and risks (if any) at this portion of the Property. At this time, future use of EU-South is unknown; therefore, quantitative evaluations of EU-South utilize the receptor populations identified in the PSRA.

B.1 Summary of Analytical Data Utilized

An evaluation of available VAP-certified analytical results collected within the boundaries of EU-South were utilized with the objective of alleviating any uncertainties associated with not quantitatively evaluating EU-South within the PSRA. Investigations of EU-South included the collection of soil and groundwater samples. Groundwater analytical results from monitoring wells installed in EU-South were available dating back to March 2006 for the majority of the monitoring wells. However, only analytical results from groundwater samples collected after the cessation date of pumping activities (2006) from the company production wells located west of the River Styx, were used herein. Groundwater samples utilized herein include the two most recent quarterly monitoring events (*i.e.,* September 2007 and December 2007) as well as the most recent sampling event (*i.e.,* August 2011). Note that monitoring wells are screened in both the upper (*i.e.,* shallow) saturated unit and the lower (*i.e.,* deep) saturated unit in EU-South. Data from both the shallow and deep groundwater units are summarized herein; however, only analytical results associated with the shallow saturated unit were evaluated further with respect to complete exposure pathways.

A summary of the soil sampling locations is included in Table B-1. A summary of the groundwater sampling locations and events (separated by shallow and deep groundwater units) relied upon is included in Table B-2.

B.2 Selection of Chemicals of Concern for Further Evaluation

Chemicals detected at least once in soil and groundwater samples collected from EU-South were selected as COCs for further evaluation. Summary statistics for the COCs in soil retained for evaluation are presented in Table B-3. Summary statistics for the COCs in groundwater from the shallow unit are presented in Table B-4. Summary statistics for the COCs in groundwater from the deep unit are presented in Table B-5.

B.3 Preliminary Exposure Pathway Evaluation

The exposure pathway evaluation conducted to identify existing and potential exposure pathways pursuant to OAC 3745-300-07(F)(1) and receptor populations in accordance with OAC 3745-300-07(E)(6) presented in the PSRA was relied upon for evaluation of EU-South. Therefore, receptor populations evaluated herein include: On-Property Commercial/Industrial Workers, On-Property Construction/Excavation Workers, Off-Property Commercial/Industrial Workers, Off-Property Residents, and Off-Property Important Ecological Resources (IER). Based on available Property-specific information, and determinations made within the PSRA, the complete and potentially complete exposure pathways evaluated for EU-South are as follows:

1. Direct contact (including incidental ingestion, dermal contact, and inhalation of particulate and volatile emissions) with soils by On-Property Commercial/Industrial Workers and On-Property Construction/Excavation Workers;

2. Inhalation of volatile emissions from surface and subsurface soils and groundwater to indoor air by On-Property Commercial/Industrial Workers (unlikely scenario given that there are no future plans to construct a habitable structure on EU-South, evaluated based on qualitative discussion of bulk soil and groundwater results, as applicable);

3. Direct contact (including incidental ingestion, dermal contact, and inhalation of volatile emissions) from shallow groundwater by On-Property Construction/Excavation Workers; and,

4. Exposures to COCs in groundwater that may emanate from the Property to the Off-Property IER above applicable surface water quality standards (WQS).

Potentially complete exposure pathways with insubstantial exposure also include the inhalation of particulate and volatile emissions from surface soils on the Property to outdoor air at off-Property locations. Inhalation of particulate emissions from surface soils to outdoor air by the off-Property receptor populations is a potentially complete pathway with insignificant exposure that does not require further quantitative evaluation. The concentration of COCs in air resulting from particulate emissions from soil to outdoor air decreases geometrically with increasing distance from the source. Thus, compliance with the direct contact standards on the Property is considered protective of the exposures of off-Property receptor populations to fugitive dust and volatile emissions.

B.4 Representative Concentrations

The representative concentration is the concentration of a COC at the Property that is compared to the appropriate standard for each receptor population. When the representative concentration is measured in the environmental medium to which the receptor is directly exposed (*e.g.*, dermal contact with soil, ingestion of groundwater), the representative concentration is referred to as the exposure point concentration (EPC). For evaluation of the direct contact exposures to soil, the maximum detected soil concentration for all COCs detected were used as the EPCs. The maximum detected concentration of each COC in groundwater from the events summarized on Table B-2 was utilized to evaluate direct contact with shallow groundwater exposures of the On-Property Construction/Excavation Worker. The use of the maximum detected concentration as the EPC is a conservative evaluation of the available data.

B.5 Derivation of Standards

B.5.1 Soil-to-Indoor Air Screening Levels

There are no available VAP generic numerical standards (GNS) for evaluation of vapor intrusion from bulk soil to indoor air. Given that there are currently no buildings located on the Property, and at this time it is not anticipated that a building will be constructed in the future, a soil vapor investigation was not completed since there are relatively low detections of volatile COCs in soil from EU-South. Additionally, as summarized in Table B-3, there were no volatile COCs detected in soil samples from EU-South (only metals were detected). Therefore, the potentially complete soil-to-indoor air (SIA) exposure pathway does not require further evaluation, and derivation of SIA screening levels was not necessary.

B.5.2 Groundwater-to-Indoor Air Screening Evaluation

A groundwater-to-indoor air (GIA) screening level evaluation was completed for a commercial/industrial land use scenario in effort to avoid a potentially unnecessary activity and use limitation on future building occupancy. The GIA screening level evaluation was completed using the USEPA Vapor Intrusion Screening Level (VISL) Calculator (Version 3.4, June 2015). Specifically, the concentrations of the volatile COCs detected in shallow groundwater samples were input into the "GW_IA_calc" tab of the VISL calculator. The hazard quotient (HQ) and excess lifetime cancer risk (ELCR) for vapor intrusion from groundwater were calculated directly based on the reported concentrations of volatile COCs for a commercial exposure scenario from the pull down list in the model. The average groundwater temperature was changed from 25 to 11°C; the target cancer risk was set at 1×10^{-6} and the target hazard quotient was set at 1, consistent with VISL and the Ohio EPA VI guidance. For consistency with the VAP, the averaging time for non-carcinogens was changed from 26 years to 25 years. Vapor intrusion risk from groundwater to indoor air was calculated directly by the model utilizing the default generic groundwater attenuation factor of 0.001 in accordance with USEPA Guidance. A printout of the model is included in Attachment A.

B.5.3 Direct Contact with Groundwater Standards

An evaluation of the incidental ingestion, dermal contact, and inhalation exposures to volatile emissions from groundwater in an excavation trench was completed for the On-Property Construction/Excavation Worker. This evaluation was performed by using the Construction Trench: Contact with Groundwater calculation spreadsheet (vrp64.xls, revised 8/5/2014) from the Virginia Department of Environmental Quality's (VA-DEQ) Voluntary Remediation Program (VRP) for all COCs detected in shallow groundwater. A summary of the input parameters used in the model is included in Table B-6. The Property-specific direct contact groundwater standards are shown in Table B-7. A print-out of the spreadsheet is included in Attachment B. A Property-specific direct contact groundwater standard for lead was calculated using the California Environmental Protection Agency (CalEPA) lead risk assessment spreadsheet model, which is included in Attachment C.

B.6 General Approach to the Evaluation of Cumulative Hazard and Risk Posed to On-Property Receptor Populations

The non-cancer and cancer endpoints were each evaluated, as appropriate, for each COC detected in environmental media for each complete exposure pathway. For the evaluation of the exposures of each receptor population, a non-cancer hazard ratio was derived for each COC with a non-cancer endpoint, as the ratio of the representative concentration of each COC to the single-chemical non-cancer endpoint value for the COC. The non-cancer hazard ratio for each COC is equivalent to its hazard quotient (HQ), as described in OAC 3745-300-09 (D)(3)(d)(ii)(a); the sum of the hazard ratios is the cumulative non-cancer hazard ratio, which is equivalent to the hazard index (HI) as described in OAC 3745-300-09 (D)(3)(d)(ii)(b).

For the evaluation of the exposures of each receptor population, a cancer risk ratio was derived for each COC with a cancer endpoint, as the ratio of the representative concentration of each COC to the single-chemical cancer endpoint value for the COC. The cancer risk ratio for each COC is equivalent to the proportion of the acceptable excess lifetime cancer risk (ELCR) of 1×10^{-5} that is attributed to the COC, as described in OAC 3745-300-09 (B)(1)(a) and (D)(3)(d)(i)(a); the sum of the single-chemical risk ratios is the cumulative cancer risk ratio for the exposure pathway, which is equivalent to the proportion of the acceptable ELCR attributed to pathway-specific exposures to all COCs with a cancer endpoint in the exposure unit, as described in OAC 3745-300-09 (D)(3)(d)(i)(b).

The estimated non-cancer hazard and cancer risk posed by each exposure pathway to each receptor population are discussed below.

B.7 On-Property Commercial/Industrial Worker Receptor Population

B.7.1 Direct Contact with Soil Exposures

The non-cancer hazard ratio and cancer risk ratio attributable to the direct contact with soil exposure pathway (using all available soil results fromEU-South, irrespective of depth) for the On-Property Commercial/Industrial Worker receptor population are presented in Table B-8. The cumulative non-cancer hazard ratio is 0.0208, which corresponds to an HI of 0.02 when rounded to one significant digit and is substantially below the target HI value of unity (1). The cumulative cancer risk ratio is 0.449, which corresponds to an ELCR of 4×10^{-6} at one significant digit and is substantially below the ELCR goal of 1×10^{-5}.

B.7.2 Soil-to-Indoor Air Screening Evaluation

There were no volatile COCs reported in VAP-certified soil samples. Therefore, a screening level SIA evaluation was not completed.

B.7.3 Groundwater to Indoor Air Screening Evaluation

As indicated, there are currently no buildings on the Property and there are no known plans to construct a building on the Property in the future. Therefore, a comprehensive soil vapor investigation was not completed for cost purposes given that relatively low volatile COCs were reported at the Property. In effort to avoid an unnecessary activity and use limitation on future building occupancy (in the absence of soil gas data), a screening level GIA evaluation was completed. The potential future GIA exposure pathway was evaluated based on the maximum detected concentrations of volatile COCs reported in shallow groundwater. The maximum concentrations of the two volatile COC detected in shallow groundwater at EU-South (*i.e.,* acetone and chlorobenzene) were directly input into the USEPA VISL calculator. The non-cancer hazard quotient and excess lifetime cancer risk attributable to GIA exposures of a future On-Property Commercial/Industrial Worker are presented in Table B-9. Neither of the two detected VOCs have a carcinogenic endpoint. The non-cancer HQ values for each COC are substantially below the target HQ of one (1). Furthermore, the cumulative HI is also well below the target HI of one (1).

B.8 On-Property Construction/Excavation Worker Receptor Population

B.8.1 Direct Contact with Soil Exposures

The non-cancer hazard ratio and cancer risk ratio attributable to the direct contact with soil exposure pathway (using all available soil results from EU-South, irrespective of depth) for the On-Property Construction/Excavation Worker receptor population are presented in Table B-10. The non-cancer hazard ratio is 0.0297, which corresponds to an HI of 0.03 when rounded to one significant digit and is substantially below the target HI goal of unity (1). The cancer risk ratio is 0.0656, which corresponds to an ELCR of 7×10^{-7} when rounded to one significant digit and is substantially below the target ELCR goal of 1×10^{-5}.

B.8.2 Direct Contact with Shallow Groundwater Exposures

The non-cancer hazard ratio and cancer risk ratio attributable to the direct contact with groundwater exposure pathway for the On-Property Construction/Excavation Worker receptor population are presented in Table B-11. The non-cancer hazard ratio is 0.190, which corresponds to an HI of 0.2 when rounded to one significant digit and is below the target HI goal of unity (1). The cancer risk ratio is 0.0829, which corresponds to an ELCR of 8×10^{-7} when rounded to one significant digit and is substantially below the target ELCR goal of 1×10^{-5}.

B.9 Lead: All Receptors

Lead was not evaluated with respect to the multiple chemical evaluations, in accordance with OAC 3745-300-08 (C)(3)(E). As shown in Table B-3, the maximum detected lead concentration in soil samples collected at the Property, irrespective of depth or location is 327 mg/kg. This concentration is below the direct contact soil standard for both commercial/industrial land use (800 mg/kg) and construction/excavation activities (400 mg/kg). Based on the soil data collected to date, no further evaluation of lead in soil is necessary.

A Property-specific numerical direct contact groundwater standard for lead for the On-Property Construction/Excavation Worker receptor population was calculated using CalEPA's lead risk assessment spreadsheet model for a construction/excavation worker scenario. The Property-specific direct contact groundwater standard for lead for construction/excavation activities is 2,070 ug/L. As presented in Table B-4, the maximum detected concentration of lead in groundwater was 11 ug/L, which is substantially below its respective direct contact groundwater standard.

B.10 Off-Property Important Ecological Resources

As noted, the Property is adjacent to River Styx which is a surface water body of the state and an IER in accordance with OAC 3745-300-01(65). The Off-Property IER evaluation includes an evaluation of potential human recreational users within the river as well as aquatic life. To evaluate potential migration of COCs in groundwater to the IER, the maximum concentrations of each COC reported in groundwater was compared to the State of Ohio, Ohio River Drainage Basin outside the mixing zone average (OMZA) water quality criteria for the protection of aquatic life and human-health non-drinking water quality standards for the protection of recreational users per OAC 3745-1. As shown in Table B-12, maximum reported concentrations of arsenic and barium in groundwater are marginally above their respective OMZAs for the protection of aquatic life. Each of these maximum detected concentrations were reported in monitoring well

HMW-6, located farthest to the south of EU-South. In August 2016, surface water sampling of River Styx was completed as detailed further in the PSRA. Sampling of the river included one location upgradient of HSMW-6 (RIV5) and one location downgradient of HSMW-6 (RIV6). Arsenic was not detected above the laboratory reporting limit in either of the two samples from both the low flow and rain events. Barium was reported in the river (between the two nearest sample locations noted) at a maximum concentration of 31.8 ug/L, which is well below the OMZA of 220 ug/L. Therefore, there are no concerns with respect to the groundwater migration to surface water exposure pathway.

B.11 EU-South Conclusions

There were no IAs determined to exist in EU-South; therefore, no quantitative evaluation of EU-South was deemed necessary in accordance with the VAP as discussed in Section 2 of the PSRA. Nonetheless, to alleviate any uncertainties associated with potential future use of this portion of the Property, available analytical results from EU-South were quantitatively evaluated herein. The findings of this EU-South evaluation are summarized below for each receptor population evaluated:

- **On-Property Commercial/Industrial Workers:**
  - There are no unacceptable hazards and risks posed by direct contact exposures to soil.
  - There are no unacceptable hazards or risks posed by inhalation of shallow groundwater volatilizing to indoor air.
  - There are no unacceptable hazards or risks associated with potentially cumulative and aggregate exposures from direct contact with soil and inhalation of shallow groundwater volatilizing to indoor air.
  - There are no unacceptable exposures to lead in environmental media at EU-South.

- **On-Property Construction/Excavation Workers:**
  - There are no unacceptable hazards or risks posed by direct contact soil exposures soil.
  - There are no unacceptable hazards or risks posed by direct contact with shallow groundwater.
  - There are no unacceptable hazards and risks associated with potentially cumulative and aggregate exposures from direct contact with soil (surface and subsurface), and groundwater.
  - There are no unacceptable exposures to lead in environmental media at EU-South.

- **Off-Property Important Ecological Resources:**
  - There are no unacceptable hazards and risks associated with the potential migration of groundwater to the off-Property IER, the River Styx.

This evaluation demonstrates that applicable target hazard and risk goals are achieved for potential future commercial/industrial use of this portion of the Property.

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-1

SUMMARY OF SOIL SAMPLE LOCATIONS

Sample Location	Sample Depth (feet)	Sample Date	Field Sample ID
UR2027	0 - 2	12/1/2015	UR2005:UR2027:S000020
UR2028	0 - 2	12/1/2015	UR2005:UR2028:S000020
UR2029	0 - 2	12/1/2015	UR2005:UR2029:S000020
UR2033	0 - 2	12/1/2015	UR2005:UR2033:S000020
UR2034	0 - 2	12/1/2015	UR2005:UR2034:S000020
UR2035	0 - 2	12/1/2015	UR2005:UR2035:S000020
UR2036	0 - 2	12/1/2015	UR2005:UR2036:S000020
UR2037	0 - 2	12/1/2015	UR2005:UR2037:S000020
UR2038	0 - 2	12/1/2015	UR2005:UR2038:S000020

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-2

SUMMARY OF GROUNDWATER SAMPLE LOCATIONS

Sample Location	Sample Date	Field Sample ID
Shallow Groundwater Zone		
HSMW-1	8/22/2011	SSD005:GWSW1:0811
HSMW-2	8/22/2011	SSD005:GWSW2:0811
HSMW-3	8/22/2011	SSD005:GWSW3:0811
HSMW-4	8/22/2011	SSD005:GWSW4:0811
HSMW-5	8/22/2011	SSD005:GWSW5:0811
HSMW-6	8/22/2011	SSD005:GWSW6:0811
MW-19	9/25/2007	MW-19
	12/11/2007	MW-19
MW-20	9/25/2007	MW-20
	12/11/2007	MW-20
	8/22/2011	SSD005:GWMW20:0811
MW-21R	9/25/2007	MW-21R
	12/11/2007	MW-21R
	8/22/2011	SSD005:GWFD1:0811
	8/22/2011	SSD005:GWMW21R:0811
MW-32	9/25/2007	MW-32
	12/11/2007	MW-32
	8/22/2011	SSD005:GWMW32:0811
MW-33	8/22/2011	SSD005:GWMW33:0811
MW-34	9/25/2007	MW-34
	12/11/2007	MW-34
	8/22/2011	SSD005:GWMW34:0811
MW-35	9/25/2007	MW-35
	12/11/2007	MW-35
	8/22/2011	SSD005:GWMW35:0811
Deep Groundwater Zone		
HDMW-1	8/22/2011	SSD005:GWDW1:0811
HDMW-2	8/23/2011	SSD005:GWDW2:0811
HDMW-3	8/23/2011	SSD005:GWDW3:0811
HDMW-3	8/23/2011	SSD005:GWFD2:0811
HDMW-4	8/23/2011	SSD005:GWDW4:0811
HDMW-5	8/22/2011	SSD005:GWDW5:0811

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-3

SUMMARY OF CHEMICALS OF CONCERN DETECTED IN SOIL (ALL DEPTHS)

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Sample Location of Maximum Detected Concentration	Sample Depth (feet)
Metals / Inorganics							
Arsenic	2	6	33%	4.5	8.8	UR2037	0 - 2
Barium	6	6	100%	37.8	180	UR2037	0 - 2
Chromium	6	6	100%	34.3	70.3	UR2037	0 - 2
Cobalt	2	6	33%	4.6	5.1	UR2037	0 - 2
Copper	6	6	100%	66.9	142	UR2036	0 - 2
Lead	6	6	100%	63.2	327	UR2037	0 - 2
Molybdenum	6	6	100%	7.4	13.7	UR2037	0 - 2
Nickel	6	6	100%	8.9	14.6	UR2037	0 - 2
Vanadium	6	6	100%	14.9	27.4	UR2038	0 - 2
Zinc	6	6	100%	282	595	UR2036	0 - 2

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-4

SUMMARY OF CHEMICALS OF CONCERN DETECTED IN SHALLOW GROUNDWATER

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Sample Location	Sample Date
Metals / Inorganics							
Aluminum	1	13	8%	200	200	HSMW-5	8/22/2011
Arsenic	15	25	60%	12	230	HSMW-6	8/22/2011
Barium	2	13	15%	220	900	HSMW-6	8/22/2011
Boron	13	13	100%	310	730	HSMW-6	8/22/2011
Chromium	3	25	12%	7.5	22	MW-21R	12/11/2007
Cobalt	6	13	46%	7.1	17	HSMW-5	8/22/2011
Iron	21	25	84%	200	180,000	HSMW-6	8/22/2011
Lead	3	25	12%	6.0	11	MW-32	9/25/2007
Magnesium	13	13	100%	28,000	310,000	MW-32	8/22/2011
Manganese	13	13	100%	290	18,000	HSMW-5	8/22/2011
						MW-20	8/22/2011
Sodium	13	13	100%	27,000	140,000	MW-21R	8/22/2011
						MW-32	8/22/2011
Zinc	7	25	28%	26	130	MW-19	12/11/2007
Semi-Volatile Organic Compounds (SVOCs)							
Phenols	1	13	8%	48	48	MW-32	8/22/2011
Volatile Organic Compounds (VOCs)							
Acetone	6	25	24%	1.8	22	MW-21R	9/25/2007
Chlorobenzene	3	25	12%	1	1.2	MW-19	9/25/2007
Field Parameters / Other							
Field Conductivity	6	6	100%	1,680	4,060	MW-32	9/25/2007
Field Ph	6	6	100%	6	7	MW-35	9/25/2007
Field Temperature	6	6	100%	13	17	MW-21R	9/25/2007
Alkalinity	13	13	100%	140,000	690,000	MW-21R	8/22/2011
Ammonia	18	25	72%	290	19,000	HSMW-6	8/22/2011
Calcium	13	13	100%	130,000	540,000	HSMW-5	8/22/2011
Chemical Oxygen Demand	25	25	100%	21,000	250,000	MW-34	9/25/2007
Chloride	25	25	100%	11,000	220,000	MW-35	8/22/2011
Nitrate - Nitrite	4	12	33%	700	900	MW-34	9/25/2007
						MW-34	12/11/2007
						MW-35	12/11/2007
Nitrite Nitrogen	1	13	8%	130	130	HSMW-6	8/22/2011
Phosphate	3	13	23%	210	1,100	HSMW-6	8/22/2011
Phosphorous	9	12	75%	100	1,800	MW-19	9/25/2007
Potassium	2	13	15%	8,200	15,000	HSMW-6	8/22/2011
Sulfate	24	25	96%	1,600	2,600,000	MW-32	8/22/2011
Total Dissolved Solids	25	25	100%	610,000	4,200,000	MW-32	12/11/2007
Total Kjeldahl Nitrogen	8	18	44%	3,000	18,000	HSMW-6	8/22/2011

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-5

SUMMARY OF CHEMICALS OF CONCERN DETECTED IN DEEP GROUNDWATER

Chemical of Concern	Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Sample Location	Sample Date	VAP UPUS
Metals / Inorganics								
Antimony	1	6	17%	12	12	HDMW-5	8/22/2011	6
Barium	2	6	33%	280	280	HDMW-3	8/23/2011	2000
Boron	1	6	17%	220	220	HDMW-1	8/22/2011	3100
Iron	6	6	100%	800	2200	HDMW-1	8/22/2011	300
Magnesium	6	6	100%	21000	37000	HDMW-4	8/23/2011	20000
Manganese	6	6	100%	69	110	HDMW-5	8/22/2011	50
Sodium	6	6	100%	25000	36000	HDMW-1	8/22/2011	20000
Zinc	1	6	17%	50	50	HDMW-3	8/23/2011	4700
Field Parameters / Other								
Alkalinity	6	6	100%	210000	280000	HDMW-1	8/22/2011	180000
Ammonia	3	6	50%	260	470	HDMW-1	8/22/2011	
Calcium	6	6	100%	65000	100000	HDMW-4	8/23/2011	50000
Chemical Oxygen Demand	1	6	17%	42000	42000	HDMW-1	8/22/2011	
Chloride	6	6	100%	11000	20000	HDMW-4	8/23/2011	250000
Nitrite Nitrogen	1	6	17%	180	180	HDMW-4	8/23/2011	1000
Phosphate	1	6	17%	100	100	HDMW-1	8/22/2011	761500
Sulfate	6	6	100%	59000	170000	HDMW-4	8/23/2011	250000
Sulfate	6	6	100%	59000	170000	HDMW-5	8/22/2011	250000
Total Dissolved Solids	6	6	100%	340000	580000	HDMW-4	8/23/2011	500000

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-6

DERIVATION OF PROPERTY-SPECIFIC DIRECT CONTACT GROUNDWATER STANDARDS: EXPOSURE FACTOR VALUES FOR CONSTRUCTION/EXCAVATION ACTIVITIES

Exposure Parameter	Value	Units	Reference
Exposure Duration	1	yr	VAP Support Document (2016) [a]
Exposure Frequency	120	days/yr	VAP Support Document
Averaging Time: Non-cancer endpoint	365	days	ED x 365 days/year
Averaging Time: Cancer endpoint	25,550	days	70 yr (lifetime) x 365 days/year
Body Weight	70	kg	VAP Support Document (2014)
Incidental Ingestion Rate	0.02	L/day	Recommended value, Virginia DEQ VRP [b], Table 6-4
Total Skin Surface Area	20,000	cm^2	BW x SA:BW ratio
Percent Skin Surface Area Exposed	0.165	unitless	Skin Surface Area Exposed / Total Skin Surface Area
Skin Surface Area	3300	cm^2	VAP Support Document
Exposure Time (dermal contact)	4	hr/day	Recommended value, Virginia DEQ VRP Table 6-4
Exposure Time (inhalation)	4	hr/day	Recommended value, Virginia DEQ VRP Table 6-4
Permeability Constant	chemical-specific	cm/hr	VAP Support Document
Conversion Factor (dermal contact)	1.00E-03	L/cm^3	VAP Support Document
Conversion Factor (inhalation)	1.00E+03	L/m^3	VAP Support Document
Trench Width/Depth Ratio	1.20E+00	unitless	Calculated by model based on trench dimensions (8 ft length, 6 ft width, 5 ft depth)
Air Circulation Rate	3.60E+02	hr^{-1}	Selected by model on basis of trench width/depth ratio
Target Hazard Quotient	1.00E+00	unitless	VAP Support Document
Target Excess Lifetime Cancer Risk	1.00E-05	unitless	VAP Support Document

Notes:

a. Ohio EPA, May 2016. *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures*.

b. Virginia Department of Environmental Quality (DEQ) Voluntary Remediation Program (VRP) Construction Trench: Contact with Groundwater spreadsheet (vrp64.xls) model default. Revised 8/5/2014.

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-7

DIRECT CONTACT GROUNDWATER STANDARDS FOR THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern [a]	Property-Specific Direct Contact Groundwater Standards[b] (ug/L)		Single-Chemical Standard[c] (ug/L)
	Non-cancer Endpoint Value	Cancer Endpoint Value	
Inorganics			
Aluminum [d]	NA [e]	NA	NA
Arsenic	1,900	2,900	1,900
Barium	1,260,000	NA	1,260,000
Boron [d]	NA	NA	NA
Chromium	40,000	6,200	6,200
Cobalt	25,000	NA	25,000
Iron	4,400,000	NA	4,400,000
Lead	NA	NA	NA
Magnesium [d]	NA	NA	NA
Manganese	880,000	NA	880,000
Sodium	NA	NA	NA
Zinc	2,300,000	NA	2,300,000
Semi-Volatile Organic Compounds (SVOCs)			
Phenols	9,080	NA	9,080
Volatile Organic Compounds (VOCs)			
Acetone	4,900,000	NA	4,900,000
Chlorobenzene	26,000	NA	26,000

Notes:

a. Chemicals of Concern represent COCs reported in groundwater samples collected on EU-South of the Property.

b. Direct contact groundwater standards for construction/excavation activities, calculated using the Virginia DEQ Construction Trench: Contact with Groundwater spreadsheet (vrp64.xls), Revised 8/5/2014.

c. Standard: the lower of the non-cancer endpoint and cancer endpoint concentrations.

d. Chemical is not considered a hazardous substance per OAC 3745-300-01(A)(60), and was therefore not evaluated.

e. NA: Not Applicable.

f. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions.

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)
TABLE B-8

UMULATIVE HAZARD AND RISK ESTIMATE FOR DIRECT CONTACT WITH SOIL EXPOSURES OF THE ON-PROPERTY COMMERCIAL/INDUSTRIAL WORKE

Chemical of Concern		Representative Concentration (mg/kg) [a]	Sample Location	Sample Depth (feet)	Ohio VAP Commercial/Industrial Direct Contact Soil Standards (mg/kg) [b]			Single-Chemical Commercial/ Industrial Direct Contact Standard (mg/kg)	Hazard Ratio[d]	Risk Ratio[d]
					Non-cancer Endpoint Value	Cancer Endpoint Value	Soil Saturation			
Metals / Inorganics										
Arsenic		8.8	UR2037	0 - 2	1,200	77	NA [e]	77	7.33E-03	1.14E-01
Barium	f	180	UR2037	0 - 2	680,000	NA	NA	680,000	2.65E-04	NA
Chromium	g	70.3	UR2037	0 - 2	12,000	210	NA	210	5.86E-03	3.35E-01
Cobalt		5.1	UR2037	0 - 2	1,200	26,000	NA	1,200	4.25E-03	1.96E-04
Copper		142	UR2036	0 - 2	160,000	NA	NA	160,000	8.88E-04	NA
Lead	i	327	UR2037	0 - 2	--	--	--	800	--	--
Molybdenum	h	13.7	UR2037	0 - 2	NA	NA	NA	NA	NA	NA
Nickel		14.6	UR2037	0 - 2	74,000	900,000	NA	74,000	1.97E-04	1.62E-05
Vanadium	f	27.4	UR2038	0 - 2	20,000	NA	NA	20,000	1.37E-03	NA
Zinc		595	UR2036	0 - 2	1,000,000	NA	NA	1,000,000	5.95E-04	NA
								Total Ratio	**0.0208**	**0.449**
								Hazard Index[j]	**0.02**	**--**
								Excess Lifetime Cancer Risk[k]	**--**	**4E-06**

Notes:

a. Representative concentration is the maximum detected concentration of each chemical detected at least once, irrespective of sample depth, in the Salt Street Impoundments.

b. Ohio Voluntary Action Program (VAP) generic numerical standards for direct contact with soil for commercial/industrial land use per OAC 3745-300-08, effective May 26, 2016.

c. Single-Chemical Standard: the lowest of the non-cancer, cancer, and soil saturation values, as applicable.

d. Multiple chemical evaluation performed in accordance with OAC 3745-300-08(A)(2)(b) effective May 26, 2016. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1. A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of $1x10^{-5}$.

e. NA - not applicable

f. Ohio Voluntary Action Program Supplemental generic numerical standards for direct contact with soil for commercial/industrial land use per Ohio EPA Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) spreadsheet, May 26, 2016.

g. The VAP GNS for hexavalent chromium was conservatively used in evaluation of total chromium results.

h. Chemical is not considered a hazardous substance in accordance with OAC 3745-300-01(A)(59), and was therefore not evaluated.

i. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.

j. Corresponding hazard index (HI) equals the sum of hazard quotients associated with each non-cancer hazard ratio for each chemical with a non-cancer endpoint.

k. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks associated with each cancer risk ratio for each chemical with a cancer endpoint.

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-9

GROUNDWATER-TO-INDOOR AIR SCREENING EVALUATION FOR ON-PROPERTY COMMERCIAL/INDUSTRIAL LAND USE

Chemical of Concern [a]	Maximum Detected Concentration (ug/L)	Sample Location	Sample Date	Hazard Quotient [b]	Excess Lifetime Cancer Risk [b]
Volatile Organic Compounds (VOCs)					
Acetone	22	MW-21R	9/25/2007	1.2E-07	NA
Chlorobenzene	1.2	MW-19	9/25/2007	3.1E-04	NA

Notes:

a. The U.S. EPA Vapor Intrusion Screening Level (VISL) Calculator (Version 3.4, June 12, 2015), was used to identify COCs detected that are sufficiently volatile and toxic to require further evaluation for the GIA air pathway, which were detected during the most recent groundwater sampling event.

b. The maximum detected concentration of the single volatile COC reported in groundwater was used in the VISL calculator to directly estimate the hazard and risk for potential indoor air exposures.

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)
TABLE B-10

CUMULATIVE HAZARD AND RISK ESTIMATE FOR DIRECT CONTACT WITH SOIL EXPOSURES OF THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern		Representative Concentration (mg/kg) [a]	Sample Location	Sample Depth (feet)	Ohio VAP Construction/Excavation Worker Direct Contact Soil Standards (mg/kg) [b]			Single-Chemical Construction / Excavation Worker Direct Contact Standard (mg/kg)	Hazard Ratio[d]	Risk Ratio[d]
					Non-cancer Endpoint Value	Cancer Endpoint Value	Soil Saturation			
Metals / Inorganics										
Arsenic		8.8	UR2037	0 - 2	690	1,300	NA [e]	690	1.28E-02	6.77E-03
Barium	f	180	UR2037	0 - 2	320,000	NA	NA	320,000	5.63E-04	NA
Chromium	g	70.3	UR2037	0 - 2	19,000	1,200	NA	1,200	3.70E-03	5.86E-02
Cobalt		5.1	UR2037	0 - 2	2,800	19,000	NA	2,800	1.82E-03	2.68E-04
Copper		142	UR2036	0 - 2	21,000	NA	NA	21,000	6.76E-03	NA
Lead	i	327	UR2037	0 - 2	--	--	--	400	--	--
Molybdenum	h	13.7	UR2037	0 - 2	NA	NA	NA	NA	NA	NA
Nickel		14.6	UR2037	0 - 2	23,000	660,000	NA	23,000	6.35E-04	2.21E-05
Vanadium	f	27.4	UR2038	0 - 2	11,000	NA	NA	11,000	2.49E-03	NA
Zinc		595	UR2036	0 - 2	640,000	NA	NA	640,000	9.30E-04	NA
								Total Ratio	**0.0297**	**0.0656**
								Hazard Index[j]	**0.03**	**--**
								Excess Lifetime Cancer Risk[k]	**--**	**7E-07**

Notes:

a. Representative concentration is the maximum detected concentration of each chemical detected at least once, irrespective of sample depth, in the Salt Street Impoundments.

b. Ohio Voluntary Action Program (VAP) generic numerical standards for direct contact with soil for construction/excavation activities per OAC 3745-300-08, effective May 26, 2016.

c. Single-Chemical Standard: the lowest of the non-cancer, cancer, and soil saturation values, as applicable.

d. Multiple chemical evaluation performed in accordance with OAC 3745-300-08(A)(2)(b) effective August 1, 2014. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1. A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of 1×10^{-5}.

e. NA - not applicable

f. Ohio Voluntary Action Program Supplemental generic numerical standards for direct contact with soil for construction/excavation activities per Ohio EPA Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) spreadsheet, May 26, 2016

g. The VAP GNS for hexavalent chromium was conservatively used in evaluation of total chromium results.

h. Chemical is not considered a hazardous substance in accordance with OAC 3745-300-01(A)(59), and was therefore not evaluated.

i. Lead is not included in the multiple chemical evaluation. Lead is compared to a standard that takes into account other factors and assumptions in addition to the non-cancer hazard and cancer risk.

j. Corresponding hazard index (HI) equals the sum of hazard quotients associated with each non-cancer hazard ratio for each chemical with a non-cancer endpoint.

k. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks associated with each cancer risk ratio for each chemical with a cancer endpoint.

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-11

CUMULATIVE HAZARD AND RISK ESTIMATE FOR DIRECT CONTACT WITH GROUNDWATER EXPOSURES OF THE ON-PROPERTY CONSTRUCTION/EXCAVATION WORKER

Chemical of Concern [a]	Maximum Detected Concentration (ug/L)	Sample Location	Property-Specific Direct Contact Groundwater Standards[b] (ug/L)		Single-Chemical Standard[c] (ug/L)	Hazard Ratio [c]	Risk Ratio [c]
			Non-cancer Endpoint Value	Cancer Endpoint Value			
Inorganics							
Aluminum [d]	200	HSMW-5	NA [e]	NA	NA	NA	NA
Arsenic	230	HSMW-6	1,900	2,900	1,900	1.21E-01	7.93E-02
Barium	900	HSMW-6	1,260,000	NA	1,260,000	7.14E-04	NA
Boron [d]	730	HSMW-6	NA	NA	NA	NA	NA
Chromium	22	MW-21R	40,000	6,200	6,200	5.50E-04	3.55E-03
Cobalt	17	HSMW-5	25,000	NA	25,000	6.80E-04	NA
Iron	180000	HSMW-6	4,400,000	NA	4,400,000	4.09E-02	NA
Lead	11	MW-32	NA	NA	NA	NA	NA
Magnesium [d]	310000	MW-32	NA	NA	NA	NA	NA
Manganese	18000	HSMW-5 MW-20	880,000	NA	880,000	2.05E-02	NA
Sodium	140000	MW-21R MW-32	NA	NA	NA	NA	NA
Zinc	130	MW-19	2,300,000	NA	2,300,000	5.65E-05	NA
Semi-Volatile Organic Compounds (SVOCs)							
Phenols	48	MW-32	9,080	NA	9,080	5.29E-03	NA
Volatile Organic Compounds (VOCs)							
Acetone	22	MW-21R	4,900,000	NA	4,900,000	4.49E-06	NA
Chlorobenzene	1.2	MW-19	26,000	NA	26,000	4.62E-05	NA
				Total Ratio		**0.190**	**0.0829**
				Corresponding HI [f]		**0.2**	**--**
				Corresponding ELCR [g]		**--**	**8E-07**

Notes:

a. Property-specific direct contact groundwater standards for construction/excavation activities, calculated using the Virginia DEQ Construction Trench: Contact with Groundwater spreadsheet (vrp64.xls), Revised 8/5/2014.

b. Standard: the lower of the non-cancer endpoint and cancer endpoint concentrations.

c. Multiple chemical evaluation was performed in accordance with OAC 3745-300-08(A)(2)(b) effective May 26, 2016. A noncancer hazard ratio of 1 is equivalent to a hazard index of 1. A cancer risk ratio of 1 is equivalent to an excess lifetime cancer risk of $1x10^{-5}$.

d. Chemical is not considered a hazardous substance per OAC 3745-300-01(A)(60), and was therefore not evaluated.

e. NA: Not Applicable.

f. Corresponding hazard index (HI) equals sum of hazard quotients for all chemicals evaluated with respect to the non-cancer endpoint.

g. Corresponding excess lifetime cancer risk (ELCR) equals the sum of excess lifetime cancer risks for all chemicals evaluated with respect to the cancer endpoint.

APPENDIX B
RISK EVALUATION OF THE SALT STREET IMPOUNDMENTS (EU-South)

TABLE B-12

SUMMARY OF CHEMICALS OF CONCERN DETECTED IN SHALLOW GROUNDWATER

Chemical of Concern		Number of Detects	Number of Results	Detection Frequency	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Sample Location	Sample Date	Ohio River Basin OMZA[a,b]	Ohio River Basin NonDrink[a,b]
Metals / Inorganics										
Aluminum		1	13	8%	200	200	HSMW-5	8/22/2011	NA	NA
Arsenic	c	15	25	60%	12	230	HSMW-6	8/22/2011	100	NA
Barium		2	13	15%	220	900	HSMW-6	8/22/2011	220	NA
Boron		13	13	100%	310	730	HSMW-6	8/22/2011	3900	NA
Chromium		3	25	12%	7.5	22	MW-21R	12/11/2007	150	NA
Cobalt		6	13	46%	7.1	17	HSMW-5	8/22/2011	24	NA
Iron		21	25	84%	200	180,000	HSMW-6	8/22/2011	NA	NA
Lead		3	25	12%	6.0	11	MW-32	9/25/2007	16	ID
Magnesium		13	13	100%	28,000	310,000	MW-32	8/22/2011	NA	NA
Manganese		13	13	100%	290	18,000	HSMW-5	8/22/2011	NA	NA
							MW-20	8/22/2011		
Sodium		13	13	100%	27,000	140,000	MW-21R	8/22/2011	NA	NA
							MW-32	8/22/2011		
Zinc		7	25	28%	26	130	MW-19	12/11/2007	220	69000
Semi-Volatile Organic Compounds (SVOCs)										
Phenols		1	13	8%	48	48	MW-32	8/22/2011	400	4600000
Volatile Organic Compounds (VOCs)										
Acetone		6	25	24%	1.8	22	MW-21R	9/25/2007	NA	NA
Chlorobenzene		3	25	12%	1	1.2	MW-19	9/25/2007	47	21000

a. State of Ohio Water Quality Standards for the Ohio River Drainage Basin, effective January 12, 2015, per OAC 3745-1 where the River Styx is designated Modified Waterwater Habitat (MWH); Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Primary Contact Recreation (PCR) in accordance with Table 24-1 of OAC 3745-1-24.

b. OMZA - outside the mixing zone average surface water quality criteria for the protection of aquatic life. A water hardness value of 200 mg CaCO3 /L was determined for metals that have hardness-dependent standards by utilizing hardness data obtained from River Styx. Refer to the Phase II for a summary of hardness data for the river.

c. The OMZA for this parameter is based upon the more conservative criteria for the protection of agricultural uses as included in Table 7-12 of OAC 3745-1-07 (effective January 4, 2016).

ATTACHMENT A

USEPA VISL Calculator: Groundwater-to-Indoor Air Screening Evaluation

EPA-OLEM VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.5.1 (May 2016 RSLs)

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^oC)	Tgw	11	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m^3)	VI Carcinogenic Risk CR	VI Hazard HQ
67-64-1	Acetone	2.2E+01	1.68E-02	No IUR	1.2E-07
108-90-7	Chlorobenzene	1.2E+00	6.75E-02	No IUR	3.1E-04

Inhalation Unit Risk IUR $(ug/m^3)^{-1}$	IUR Source*	Reference Concentration RfC (mg/m^3)	RFC Source*	Mutagenic Indicator i
		3.10E+01	A	
		5.00E-02	P	

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	26	ATnc_C_GW	25	Atnc_GW	25
Exposure duration	(yrs)	ED_R_GW	26	ED_C_GW	25	ED_GW	25
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	250
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.03	AFss_C_GW	0.03	AFss_GW	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected Value
Trichloroethylene	mIURTCE_R_GW	1.00E-06	mIURTCE_C_GW	0.00E+00	mIURTCE_GW	0.00E+00
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	4.10E-06

Mutagenic Chemicals — The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 25 — This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride — See the Navigation Guide equation for Cia,c for vinyl chloride.

EPA-OLEM VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.5.1 (May 2016 RSLs)

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	11	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m^3)	VI Carcinogenic Risk CR	VI Hazard HQ

Inhalation Unit Risk IUR (ug/m^3)$^{-1}$	IUR Source*	Reference Concentration RfC (mg/m^3)	RFC Source*	Mutagenic Indicator i

Notation:

I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at: http://www.epa.gov/iris/subst/index.html
P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at: http://hhpprtv.ornl.gov/pprtv.shtml
A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html
CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml
S = See RSL User Guide, Section 5
X = PPRTV Appendix
Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).
VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).
TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).
Yellow highlighting indicates site-specific parameters that may be edited by the user.
Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.
Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

ATTACHMENT B

Derivation of Direct Contact Groundwater Standards for Construction/Excavation Activities

For Mass-Transfer Coefficients:

Kg,H2O	0.833	cm/s
MWH2O	18	
Kg,O2	0.002	cm/s
MWO2	32	
T	**77**	F
T	298	K
R	8.20E-05	atm-m3/mol-K

For Emission Flux and Concentration in Trench:

CF1	1.00E-03	L/cm3
CF2	1.00E+04	cm2/m2
CF3	3600	s/hr
F	**1**	
ACH	360	hr-1

Trench dimensions:

Length	**8**	ft
	2.44	m
Width	**6**	ft
	1.83	m
Depth	**5**	ft
	1.52	m
Width/Depth	1.20	

Inhalation Exposure Factors:

ET	0.17	4hrs/24hrs
EF	120	days/year
ED	1	year
BW	70	kg
AT-C	25550	days/year
AT-N	365	days/year

Oral Exposure Factors:

IR-W	0.02	L/day
CF	1000	ug/mg
EF	120	days/year
ED	1	years
BW	70	kg
AT-C	25550	days
AT-N	365	days

Dermal Exposure Factors:

EV	1	events/day
EF	120	days/years
ET	4	hours/day
ED	1	years
SA	3470	cm2
CF1	1000	cm3/L
CF2	0.001	mg/ug
BWa	70	kg
AT-C	25550	days
AT-N	365	days

Target Risk and Hazard Quotient:

TR	1.00E-05	
THQ	1	

Revised 8/5/14 **Groundwater Screening Levels (ingestion) for construction/utility workers in a trench: Groundwater less than 15 feet deep**	**CAS No.**	**Screening Level Groundwater Cancer GSL-c ug/L**	**Oral Cancer Slope Factor CSFo 1/(mg/kg-day)**	**Screening Level Groundwater Noncancer GSL-nc ug/L**	**Oral Reference Dose RfDo mg/kg-day**
Arsenic	7440-38-2	4.97E+03	1.50E+00	3.19E+03	3.00E-04
Barium	7440-39-3			2.13E+06	2.00E-01
Chromium	18540-29-9	1.49E+04	5.00E-01	9.58E+04	9.00E-03
Cobalt	7440-48-4			3.19E+04	3.00E-03
Iron	7439-89-6			7.45E+06	7.00E-01
Magnesium	7439-95-4				
Manganese (nonfood)	7439-96-5			1.49E+06	1.40E-01
Sodium	7440-23-5				
Zinc	7440-66-6			3.19E+06	3.00E-01
Acetone	67-64-1			9.58E+06	9.00E-01
Chlorobenzene	108-90-7			7.45E+05	7.00E-02
Phenol	108-95-2			3.19E+06	3.00E-01

Revised 8/5/14 Groundwater Screening Levels (dermal) for construction/utility workers in a trench: Groundwater less than 15 feet deep	CAS No.	Screening Level Groundwater Cancer GSL-c ug/L	Permeability Coefficient Kp cm/hr	Lag Time Per Event tau hr/event	Time To Reach Steady-State t* hour	Permeability Ratio B	Adjusted Dermal Cancer Slope Factor CSFo 1/(mg/kg-day)	Screening Level Groundwater Noncancer GSL-nc ug/L	Adjusted Dermal Reference Dose RfDo mg/kg-day	Fraction Absorbed FA
Arsenic	7440-38-2	7.16E+03	1.0E-03				1.50E+00	4.60E+03	3.00E-04	
Barium	7440-39-3		1.0E-03					3.07E+06	2.00E-01	
Chromium	18540-29-9	1.07E+04	2.0E-03				5.00E-01	6.90E+04	9.00E-03	
Cobalt	7440-48-4		4.0E-04					1.15E+05	3.00E-03	
Iron	7439-89-6		1.0E-03					1.07E+07	7.00E-01	
Magnesium	7439-95-4		1.0E-03							
Manganese (nonfood)	7439-96-5		1.0E-03					2.15E+06	1.40E-01	
Sodium	7440-23-5		1.0E-03							
Zinc	7440-66-6		6.0E-04					7.67E+06	3.00E-01	
Acetone	67-64-1		5.1E-04	2.22E-01	5.33E-01	1.53E-03		2.43E+07	9.00E-01	1.00E+00
Chlorobenzene	108-90-7		2.8E-02	4.5E-01	1.1E+00	1.13E-01		3.32E+04	7.00E-02	1.00E+00
Phenol	108-95-2		4.3E-01	3.5E-01	8.5E-01	1.62E-02		9.11E+03	3.00E-01	1.00E+00

Revised 8/5/14 Groundwater Screening Levels (inhalation) for construction/utility workers in a trench: Groundwater less than 15 feet deep	CAS No.	Molecular Weight MWi g/mol	Henry's Law Constant Hi atm-m3/mol	Gas-Phase Mass Transfer Coefficient KiG cm/s	Liquid-Phase Mass Transfer Coefficient KiL cm/s	Overall Mass Transfer Coefficient Ki cm/s	Inhalation Unit Risk Factor URF 1/(mg/m3)	Inhalation Reference Concentration RfCi mg/m3
Arsenic	7440-38-2	74.92					4.30E+00	1.50E-05
Barium	7440-39-3	137.33						5.00E-03
Chromium	18540-29-9	52					8.40E+01	3.00E-02
Cobalt	7440-48-4	58.93					9.00E+00	2.00E-05
Iron	7439-89-6	55.85						
Magnesium	7439-95-4	24.31						
Manganese (nonfood)	7439-96-5	54.94						5.00E-05
Sodium	7440-23-5	22.99						
Zinc	7440-66-6	65.39						
Acetone	67-64-1	58.08	3.50E-05	5.63E-01	1.48E-03	5.22E-04		3.10E+01
Chlorobenzene	108-90-7	112.56	3.11E-03	4.51E-01	1.07E-03	1.05E-03		5.00E-01
Phenol	108-95-2	94.11	3.33E-07	4.79E-01	1.17E-03	6.49E-06		2.00E-01

Revised 8/5/14 Groundwater Screening Levels (inhalation) for construction/utility workers in a trench: Groundwater less than 15 feet deep	CAS No.	Screening Level Air Cancer ASL-c ug/m3	Screening Level Air Noncancer ASL-nc ug/m3	Screening Level Air in Trench ASL ug/m3	Volatilization Factor VF L/m3	Screening Level Groundwater GSL ug/L
Arsenic	7440-38-2	2.97E+00	2.74E-01	2.74E-01		
Barium	7440-39-3		9.13E+01	9.13E+01		
Chromium	18540-29-9	1.52E-01	5.48E+02	1.52E-01		
Cobalt	7440-48-4	1.42E+00	3.65E-01	3.65E-01		
Iron	7439-89-6					
Magnesium	7439-95-4					
Manganese (nonfood)	7439-96-5		9.13E-01	9.13E-01		
Sodium	7440-23-5					
Zinc	7440-66-6					
Acetone	67-64-1		5.66E+05	5.66E+05	3.43E-02	1.65E+07
Chlorobenzene	108-90-7		9.13E+03	9.13E+03	6.87E-02	1.33E+05
Phenol	108-95-2		3.65E+03	3.65E+03	4.26E-04	8.58E+06

Revised 8/5/14 **Table 6.4** **Groundwater Screening Levels for construction/utility workers in a trench: Groundwater less than 15 feet deep**	**Screening Level Oral Cancer SLo-c ug/L**	**1/SLo-c L/ug**	**Screening Level Oral (RLo) Noncancer SLo-nc ug/L**	**1/SLo-nc L/ug**	**Screening Level Dermal Cancer SLd-c ug/L**	**1/SLd-c L/ug**	**Screening Level Dermal (RLd) Noncancer SLd-nc ug/L**	**1/SLd-nc L/ug**
Arsenic	4.97E+03	2.01E-04	3.19E+03	3.13E-04	7.16E+03	1.40E-04	4.60E+03	2.17E-04
Barium			2.13E+06	4.70E-07			3.07E+06	3.26E-07
Chromium	1.49E+04	6.71E-05	9.58E+04	1.04E-05	1.07E+04	9.31E-05	6.90E+04	1.45E-05
Cobalt			3.19E+04	3.13E-05			1.15E+05	8.69E-06
Iron			7.45E+06	1.34E-07			1.07E+07	9.31E-08
Magnesium								
Manganese (nonfood)			1.49E+06	6.71E-07			2.15E+06	4.66E-07
Sodium								
Zinc			3.19E+06	3.13E-07			7.67E+06	1.30E-07
Acetone			9.58E+06	1.04E-07			2.43E+07	4.12E-08
Chlorobenzene			7.45E+05	1.34E-06			3.32E+04	3.01E-05
Phenol			3.19E+06	3.13E-07			9.11E+03	1.10E-04

Revised 8/5/14 Table 6.4 Groundwater Screening Levels for construction/utility workers in a trench: Groundwater less than 15 feet deep	Screening Level Oral+Dermal Cancer SLod-c ug/L	Screening Level Oral + Dermal Noncancer SLod-nc ug/L	Screening Level Groundwater Oral + Dermal SLod ug/L	Screening Level Inhalation Cancer SLi-c ug/L	1/SLi-c L/ug	Screening Level Inhalation Noncancer SLi-nc ug/L	1/SLi-nc L/ug	Screening Level Groundwater Inhalation SLi ug/L
Arsenic	2.93E+03	1.89E+03	1.89E+03					
Barium		1.26E+06	1.26E+06					
Chromium	6.24E+03	4.01E+04	6.24E+03					
Cobalt		2.50E+04	2.50E+04					
Iron		4.40E+06	4.40E+06					
Magnesium								
Manganese (nonfood)		8.80E+05	8.80E+05					
Sodium								
Zinc		2.25E+06	2.25E+06					
Acetone		6.87E+06	6.87E+06			1.65E+07	6.06E-08	1.65E+07
Chlorobenzene		3.18E+04	3.18E+04			1.33E+05	7.53E-06	1.33E+05
Phenol		9.09E+03	9.09E+03			8.58E+06	1.17E-07	8.58E+06

Revised 8/5/14 Table 6.4 Groundwater Screening Levels for construction/utility workers in a trench: Groundwater less than 15 feet deep	Screening Level Groundwater Oral + Dermal + Inhalation Cancer SL-c ug/L	Screening Level Groundwater Oral + Dermal + Inhalation Noncancer SL-nc ug/L	Screening Level Groundwater Oral + Dermal + Inhalation SL ug/L
Arsenic	2.93E+03	1.89E+03	1.89E+03
Barium		1.26E+06	1.26E+06
Chromium	6.24E+03	4.01E+04	6.24E+03
Cobalt		2.50E+04	2.50E+04
Iron		4.40E+06	4.40E+06
Magnesium			
Manganese (nonfood)		8.80E+05	8.80E+05
Sodium			
Zinc		2.25E+06	2.25E+06
Acetone		4.85E+06	4.85E+06
Chlorobenzene		2.56E+04	2.56E+04
Phenol		9.08E+03	9.08E+03

ATTACHMENT C

Derivation of Direct Contact Groundwater Standard for Lead for Construction/Excavation Activities

LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT

MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	400
Lead in Water (ug/l)	2070
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT

	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	3.4	8.8	11.5	15.7	19.2	-43	278
BLOOD Pb, CHILD	135.9	351.8	458.8	624.3	765.6	-18497	-18329
BLOOD Pb, PICA CHILD	138.7	359.1	468.3	637.2	781.4	-9286	-9202
BLOOD Pb, OCCUPATIONA	3.0	7.7	10.0	13.6	16.7	-57	402

EXPOSURE PARAMETERS

	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		2.1	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	3300	
Soil adherence	ug/cm^2	300	200
Dermal uptake constant	(ug/dl)/(ug/da	0.0001	
Soil ingestion	mg/day	200	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/da	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/da	0.08	0.19
Water ingestion	l/day	0.02	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	720.0	

PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.6E-4	0.07	2%	6.8E-5	0.03	1%
Soil Ingestion	3.5E-3	1.41	41%	2.5E-3	1.01	34%
Inhalation, bkgrnd		0.05	1%		0.03	1%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		1.66	49%		1.66	56%
Food Ingestion, bkgrnd		0.23	7%		0.23	8%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.02	0%		0.02	0%
Soil Ingestion	7.0E-3	2.82	2%	1.4E-2	5.63	4%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		132.48	97%		132.48	96%
Food Ingestion, bkgrnd		0.54	0%		0.54	0%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

Click here for REFERENCES

APPENDIX C

Soil-to-Indoor Air Screening Evaluation

APPENDIX C: SOIL-TO-INDOOR SCREENING EVALUATION EU-NORTH

There are no available VAP generic numerical standards (GNS) for evaluation of vapor intrusion from bulk soil to indoor air. Given that there are currently no buildings located on the Property, and at this time it is not anticipated that a building will be constructed in the future, a soil vapor investigation was not completed since volatile organic compounds (VOCs) were not identified as chemicals of concern (COCs) associated with the Identified Areas (IAs) at the Property, and there were relatively low concentrations of semi-volatile COCs. The Ohio EPA Vapor Intrusion (VI) Guidance document, published in 2010[1], was utilized for reference in completion of this screening evaluation. However, it is recognized that in May 2016, Ohio EPA rescinded portions of the VI guidance applicable to use of the USEPA Johnson & Ettinger Model and the bulk soil-to-indoor air (SIA) screening evaluations. For this reason, it is understood that this screening evaluation, in the absence of soil gas data, does not constitute a complete evaluation of the vapor intrusion to indoor air exposure pathway. An activity and use limitation for future building occupancy (remedy or demonstration obligations) will be placed on the EU-North portion of the Property due to the potential presence of landfill gases. Therefore, it is anticipated that if building construction is planned in the future, the VI pathway will be further evaluated through the collection of soil gas samples. The evaluation provided herein is intended to determine the need for further evaluation of select semi-volatile COCs in addition to landfill gases in the future if building construction is planned at EU-North.

The SIA screening levels were calculated using Version 3.1 of the advanced U.S. EPA spreadsheet (SG-ADV) developed from the Johnson and Ettinger (J&E) model, with a combination of default and Property-specific input parameters. Conservative default assumptions provided in Ohio EPA's *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air Guidance* (Ohio EPA VI Guidance, 2010) and U.S. EPA's *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (U.S. EPA, 2004) were used in the evaluation. Specifically, the vadose zone soils interposed between the uppermost saturated zone and the building foundation were conservatively assumed to be composed of a single soil layer of sand; the building at the Property is assumed to be a slab-on-grade commercial building of default size (*i.e.,* 33 feet long, 33 feet wide and 10 feet high) with an indoor/outdoor pressure differential of 4 Pa and an indoor air exchange rate of 1 hr^{-1}; and receptors would be present at the Property consistent with a commercial scenario (*i.e.,* 250 days per year for 25 years). The target hazard index (HI) and target excess lifetime cancer risk (ELCR) were conservatively set at 0.1 and 1×10^{-6}, respectively in accordance with Ohio EPA guidance for use in a screening level evaluation. A summary of the model input parameters utilized for the derivation of SIA screening standards is presented in Table C-1.

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[1] Ohio EPA. 2010. *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air*. Division of Emergency and Remedial Response. May 2010.

In accordance with the USEPA *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA, 2015)[2] as well as recent trainings provided by Ohio EPA, the U.S. EPA Vapor Intrusion Screening Level (VISL) Calculator (Version 3.4, June 12, 2015)[3], was used to identify COCs detected in soil that are sufficiently volatile and toxic to require further evaluation for the SIA air pathway. It should be noted that certain SVOCs detected in soil (i.e., benzo(b)fluoranthene, chrysene, fluorene, 2-methylnaphthalene, and pyrene) were not evaluated in accordance with VISL, even though the Ohio EPA VI Guidance (2010) indicates these COCs should be evaluated for vapor intrusion. A total of three (3) COCs were identified for evaluation of the SIA pathway. The SIA screening levels are shown in Table C-2. The model output file is also included in this appendix.

As indicated in the Ohio EPA VI Guidance, there are large uncertainties associated with measuring concentrations of VOCs during soil sampling; nonetheless, "evaluation of bulk soil without requiring additional soil gas collection is useful for sites were VOCs are not risk drivers and relatively low concentrations in soil are encountered" (Ohio EPA Section 11.2, pg 36). In accordance with the Ohio EPA 2010 VI guidance (Section 11.2, pg 36), when bulk soil results from J&E modeling do not exceed a hazard quotient (HQ) of 0.1 and an excess lifetime cancer risk (ELCR) goal of 1×10^{-6}, further evaluation of soil for vapor intrusion is not necessary.

A comparison of the maximum detected concentration of each volatile COC in soil (as determined from the VISL calculator) to the SIA screening levels for commercial/industrial land use are presented in Table C-3. As shown in Table C-3, the maximum detected concentration of benzo(a)anthracene is below its respective SIA screening level; however, maximum detected concentrations of mercury and naphthalene in soil are above their respective SIA screening levels. Based on this, further evaluation of benzo(a)anthracene with respect to indoor air is not necessary. Although the maximum detected concentrations of mercury and naphthalene in soil were reported above their single-chemical SIA screening levels, the concentrations of these COCs detected at the Property are not at levels reasonably anticipated to pose a concern with respect to the potential future indoor air exposure pathway as described below.

The maximum detected concentration of mercury in all soil samples collected at the Property, irrespective of depth, is 2.6 mg/kg, reported at soil borings UR2012 and UR2023 (each from 0-2 feet bgs), which is above its respective SIA screening level of 0.025 mg/kg. Although present in soil, mercury concentrations at the Property are within the range of naturally occurring background concentrations in soil. Mercury was detected

[2] U.S. EPA. 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. OSWER Publication 9200.2-154, June 2015.
[3] U.S. EPA. 2015. Vapor Intrusion Screening Level Calculator, Version 3.4, June 12, 2015.

in 32% of the soil samples collected at the Property (irrespective of depth) at concentrations ranging from 0.29 mg/kg to 2.6 mg/kg. Mercury concentrations in soils in the eastern United States have been shown to range from 0.01 mg/kg to 3.4 mg/kg (Shacklette and Boerngen, 1984)[4]. Mercury in soils and surface waters exist in the mercuric (Hg^{+2}) and mercurous (Hg^{+1}) states; mercuric mercury, present as complexes and chelates with ligands, is probably the predominant form (ATSDR, 1999). These combined forms of inorganic mercury are not volatile and are not of interest with respect to migration to indoor air. Therefore, mercury in soil at concentrations at or near naturally-occurring levels is not likely to be in the elemental form (Hg^0) that is volatile and potentially available for migration to indoor air. Furthermore, while mercury was generally included as a COC in the soil sampling process, there is no specific indication that elemental mercury would have been released at the Property. The operations historically conducted at the Property do not lend themselves to being likely sources of elemental mercury contamination in soil. Based on this information, further evaluation of mercury with respect to the indoor air exposure pathway is not considered necessary.

The maximum detected concentration of naphthalene in all soil samples collected at the Property, irrespective of depth, is 1.4 mg/kg, reported at soil boring UR2013 from 0-2 feet bgs, which is above its respective SIA screening level of 0.066 mg/kg. However, it is not reasonably anticipated that concentrations of naphthalene would result in unacceptable indoor air exposures at a potential future building constructed at EU-North. Naphthalene was reported in 94% of soil samples (collected Property-wide) at concentrations ranging from 0.014 mg/kg to 1.4 mg/kg. The relatively low detections of naphthalene at the Property are not indicative of a source area (*i.e.,* VAP generic numerical direct contact soil standard for commercial/industrial use is 450 mg/kg). Furthermore, the SIA screening levels were developed based upon a series of conservative assumptions which are designed to act as a screening tool to identify COCs that may warrant further investigation. The SIA screening levels are based upon a hazard goal of 0.1 and a risk goal of $1x10^{-6}$, which are each an order of magnitude less than the VAP target hazard and risk goals of 1 and $1x10^{-5}$, respectively. Screening levels were calculated on the conservative assumption that a commercial building of default residential size (i.e., 1,076 ft^2) would be placed on the Property at a location such that the maximum detected concentration of each COC would underlie the entire potential future building footprint. This is not representative of Property-wide conditions. In addition, naphthalene has an organic-carbon partitioning coefficient (Koc) of 1,544 L/kg; a Koc value greater than 1,000 L/kg is generally considered indicative of moderately strong soil adsorption behavior of a chemical. This behavior reduces the likelihood that the chemical would completely partition to soil gas. Based on professional

[4] Shacklette, H.T., and Boerngen, J.D. 1984. *Element Concentrations in Soils and Other Surficial Materials in the Conterminous United States*. U.S. Geological Survey Professional Paper 1270. United States Government Printing Office, Washington, DC.

experience, concentrations of naphthalene in soil of this magnitude are generally not detected in soil gas samples. Therefore, it is anticipated that actual indoor air concentrations would be much less and that further investigation of naphthalene in soil with respect to potential future indoor air exposures is not necessary. Nonetheless, eleven (11) of the seventeen (17) detections of naphthalene reported in soil samples in EU-North exceed the conservative SIA screening level. Given that a future building occupancy activity and use limitation (remedy or demonstration obligation) is already intended to be placed on EU-North due to the potential presence of landfill gases, soil gas investigation of naphthalene could be completed in the future to rule out any potential vapor intrusion concerns with respect to this potentially volatile COC.

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
91203		Naphthalene

MORE ↓

ENTER Average soil temperature, T_S (^oC)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_t (cell G28)				OR	
11	15	15	152.4	15	0	0	S		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
S	1.66	0.375	0.054	0.002										

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	304.8	0.1	1	

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	0.1
				Used to calculate risk-based soil concentration.	

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
6.05E-02	8.38E-06	4.39E-04	25	10,373	491.14	748.40	1.54E+03	3.10E+01	3.4E-05	3.0E-03	S

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R ($\mu g/kg$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.321	ERROR	ERROR	0.003	9.94E-08	0.998	9.92E-08	4,000	1.00E+00	8.47E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
1.06E+06	3.77E-04	15	12,902	1.50E-04	6.44E-03	1.76E-04	9.78E-03	0.00E+00	0.00E+00	9.78E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
3.09E+00	2.06E+00	0.10	9.95E+01	9.78E-03	4.00E+02	3.08E+110	NA	NA	1.05E+02	1.21E-05	1.97E+09	NO

Finite source indoor attenuation coefficient, $\langle\alpha\rangle$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
8.78E-04	NA	1.81E-03	1.81E-03	3.4E-05	3.0E-03

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (μg/kg)	Indoor exposure soil conc., noncarcinogen (μg/kg)	Risk-based indoor exposure soil conc., (μg/kg)	Soil saturation conc., C_{sat} (μg/kg)	Final indoor exposure soil conc., (μg/kg)
6.64E+01	2.42E+02	6.64E+01	9.68E+04	6.64E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

VLOOKUP TABLES

Soil Properties Lookup Table

SCS Soil Type	K_s (cm/h)	α_1 (1/cm)	N (unitless)	M (unitless)	n (cm^3/cm^3)	θ_r (cm^3/cm^3)	Mean Grain Diameter (cm)	Bulk Density (g/cm^3)	θ_w (cm^3/cm^3)	SCS Soil Name
C	0.61	0.01496	1.253	0.2019	0.459	0.098	0.0092	1.43	0.215	Clay
CL	0.34	0.01581	1.416	0.2938	0.442	0.079	0.016	1.48	0.168	Clay Loam
L	0.50	0.01112	1.472	0.3207	0.399	0.061	0.020	1.59	0.148	Loam
LS	4.38	0.03475	1.746	0.4273	0.390	0.049	0.040	1.62	0.076	Loamy Sand
S	26.78	0.03524	3.177	0.6852	0.375	0.053	0.044	1.66	0.054	Sand
SC	0.47	0.03342	1.208	0.1722	0.385	0.117	0.025	1.63	0.197	Sandy Clay
SCL	0.55	0.02109	1.330	0.2481	0.384	0.063	0.029	1.63	0.146	Sandy Clay Loam
SI	1.82	0.00658	1.679	0.4044	0.489	0.050	0.0046	1.35	0.167	Silt
SIC	0.40	0.01622	1.321	0.2430	0.481	0.111	0.0039	1.38	0.216	Silty Clay
SICL	0.46	0.00839	1.521	0.3425	0.482	0.090	0.0056	1.37	0.198	Silty Clay Loam
SIL	0.76	0.00506	1.663	0.3987	0.439	0.065	0.011	1.49	0.180	Silt Loam
SL	1.60	0.02667	1.449	0.3099	0.387	0.039	0.030	1.62	0.103	Sandy Loam

Chemical Properties Lookup Table

CAS No.	Chemical	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)	URF extrapolated (X)	RfC extrapolated (X)	Toxicological surrogate (X)
56553	Benz(a)anthracene	1.77E+05	2.61E-02	6.75E-06	9.40E-03	4.90E-04	1.20E-05	25	710.75	1066.13	16,000	1.1E-04	0.0E+00	S			
67641	Acetone	2.36E+00	1.06E-01	1.15E-05	1.00E+06	1.43E-03	3.49E-05	25	329.20	508.10	6,955	0.0E+00	3.1E+01	L			
67663	Chloroform	3.98E+01	1.04E-01	1.00E-05	7.92E+03	1.50E-01	3.66E-03	25	334.32	536.40	6,988	2.3E-05	9.8E-02	L			
75092	Methylene chloride	1.17E+01	1.01E-01	1.17E-05	1.30E+04	8.96E-02	2.18E-03	25	313.00	510.00	6,706	1.0E-08	6.0E-01	L			
75150	Carbon disulfide	2.17E+01	1.06E-01	1.30E-05	2.16E+03	5.89E-01	1.44E-02	25	319.00	552.00	6,391	0.0E+00	7.0E-01	L			
78933	Methylethylketone (2-butanone)	4.51E+00	9.14E-02	1.02E-05	2.23E+05	2.33E-03	5.67E-05	25	352.50	536.78	7,481	0.0E+00	5.0E+00	L			
79016	Trichloroethylene	1.66E+02	7.90E-02	9.10E-06	1.47E+03	4.21E-01	1.03E-02	25	360.36	544.20	7,505	4.1E-06	2.0E-03	L	X		
91203	Naphthalene	1.54E+03	6.05E-02	8.38E-06	3.10E+01	1.80E-02	4.39E-04	25	491.14	748.40	10,373	3.4E-05	3.0E-03	S			
95476	o-Xylene	3.83E+02	8.47E-02	9.90E-06	1.06E+02	2.12E-01	5.18E-03	25	417.60	630.30	8,661	0.0E+00	1.0E-01	L			
100414	Ethylbenzene	4.46E+02	6.85E-02	8.46E-06	1.69E+02	3.22E-01	7.86E-03	25	409.34	617.20	8,501	2.5E-06	1.0E+00	L			
103651	n-Propylbenzene	8.13E+02	6.02E-02	7.83E-06	5.22E+01	4.29E-01	1.05E-02	25	432.20	630.00	9,123	0.0E+00	1.0E+00	L			X
108383	m-Xylene	3.83E+02	8.47E-02	9.90E-06	1.06E+02	2.12E-01	5.18E-03	25	412.27	617.05	8,523	0.0E+00	1.0E-01	L			
108883	Toluene	2.34E+02	7.78E-02	9.20E-06	5.26E+02	2.71E-01	6.62E-03	25	383.78	591.79	7,930	0.0E+00	5.0E+00	L			
110543	Hexane	1.32E+02	7.31E-02	8.17E-06	9.50E+00	7.36E+01	1.79E+00	25	341.70	508.00	6,895	0.0E+00	7.0E-01	L			
110827	Cyclohexane	1.46E+02	7.69E-02	9.11E-06	5.50E+01	6.13E+00	1.50E-01	25	353.70	553.40	7,154	0.0E+00	6.0E+00				
7439976	Mercury (elemental)	5.20E+01	3.07E-02	6.30E-06	2.00E+01	4.40E-01	1.07E-02	25	629.88	1750	14127	0.0E+00	3.0E-04	L			

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE C-1

INDOOR AIR MODEL INPUT ASSUMPTIONS FOR DERIVATION OF SOIL-TO-INDOOR AIR SCREENING LEVELS FOR COMMERCIAL/INDUSTRIAL LAND USE

Model Input Variables	SIA[a]		Reference
	Value	Units	
Depth below grade to bottom of enclosed space	15	cm	Default value for slab on grade structure (Ohio EPA, May 2010)[b]
Depth below grade to top of contamination	15	cm	Conservative estimate assumes contamination is directly beneath the slab.
Depth below grade to bottom of contamination	152.40	cm	Property-specific, based on the minimum depth to groundwater (5 ft), assumes contamination of the entire vadose zone.
SCS soil type directly above water table	--	--	Default soil type (Table 4, Ohio EPA, May 2010)
Average Soil Temperature	11	°C	Default (Table 5, Ohio EPA, May 2010)
SCS Soil Type of Vadose Zone	Sand (S)	--	Default soil type (Table 4, Ohio EPA, May 2010)
Dry Bulk Density	1.66	g/cm^3	Model Default for Sand
Total Porosity	0.375	cm^3/cm^3	Model Default for Sand
Water Filled Porosity	0.054	cm^3/cm^3	Model Default for Sand
Soil Organic Carbon Fraction	0.002	unitless	Model Default
Stratum A soil effective vapor permeability	9.92E-08	cm^2	Calculated by the model on the basis of sand soil type.
Building Length	1,000	cm	Default building size, 33 ft (Table 5, Ohio EPA, May 2010)
Building Width	1,000	cm	Default building size, 33 ft (Table 5, Ohio EPA, May 2010)
Building Height	304.8	cm	Default for slab on grade commercial structure (10 feet) (Table 5, Ohio EPA, May 2010)
Building Floor Thickness	10	cm	Default (Table 5, Ohio EPA, May 2010)
Crack Width	0.1	cm	Default (Table 5, Ohio EPA, May 2010)
Indoor Air Exchange Rate	1	1/h	Default value for commercial structure (Table 5, Ohio EPA, May 2010)
Pressure Differential	4	Pa	Default (Table 5, Ohio EPA, May 2010)
Average vapor flow rate into building (Q_{soil})	99.50	cm^3/sec	Calculated by model on the basis of soil type and building characteristics for slab on grade structure
Target Risk for Cancer endpoint	1.00E-06	unitless	Default (Table 5, Ohio EPA, May 2010)
Hazard Quotient for Non-cancer endpoint	0.1	unitless	Default (Table 5, Ohio EPA, May 2010)
Averaging time for Cancer endpoint	70	years	VAP Support Document, May 2016[c]
Averaging time for Non-cancer endpoint	25	years	VAP Support Document, May 2016
Exposure Duration	25	years	VAP Support Document, May 2016
Exposure Frequency (commercial/industrial)	250	days/year	VAP Support Document, May 2016

Notes:

a. Soil-to-indoor air

b. Ohio EPA, May 2010. *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air for Remedial Response and Voluntary Action Programs*.

c. Ohio EPA, May 2016. *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures*.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE C-2

SOIL-TO-INDOOR AIR SCREENING LEVELS FOR COMMERCIAL/INDUSTRIAL LAND USE

Chemical of Concern [a]	CAS Number	Soil-to-Indoor Air Screening Level (mg/kg) [b]			Single-Chemical Screening Level (mg/kg) [c]
		Non-Cancer Endpoint	Cancer Endpoint	Soil Saturation	
Inorganics					
Mercury	7439976	0.025	NA [d]	1,000	0.025
Semi-Volatile Organic Compounds (SVOCs)					
Benzo(a)anthracene	56553	NA	130	3.3	NOC [e]
Naphthalene	91203	0.24	0.066	97	0.066

Notes:

a. In accordance with the USEPA OSWER *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA, 2015) as well as recent trainings provided by Ohio EPA, the U.S. EPA Vapor Intrusion Screening Level (VISL) Calculator (Version 3.4, June 12, 2015), was used to identify COCs detected in soil that are sufficiently volatile and toxic to require further evaluation for the SIA air pathway. It should be noted that certain SVOCs detected in soil (benzo(b)fluranthene, chrysene, fluorene, 2-methylnaphthalene, and pyrene) were not evaluated in accordance with VISL even though the Ohio EPA VI Guidance (2010) indicates these COCs should be evaluated for vapor intrusion.

b. Soil-to-Indoor air screening levels were calculated using the USEPA Johnson & Ettinger model based on default input assumptions in accordance with the Ohio EPA 2010 Vapor Intrusion Guidance. Screening levels were developed based on a target hazard index of 0.1 and a target excess lifetime cancer risk of 1×10^{-6}.

c. Single-Chemical Screening Level: the lowest of the non-cancer, cancer, and soil saturation endpoint values.

d. NA - not applicable, endpoint-specific value is not applicable for this COC.

e. NOC - "not of concern" per the Johnson & Ettinger Model results tab, the “final indoor exposure soil concentration” is NOC as the risk-based screening level exceeds the soil saturation value for a solid in soils.

PROPERTY-SPECIFIC RISK ASSESSMENT
FORMER RITTMAN PAPERBOARD PROPERTY EAST OF RIVER STYX
101 S. INDUSTRIAL AVENUE, RITTMAN, OHIO

TABLE C-3

SOIL-TO-INDOOR AIR SCREENING EVALUATION FOR ON-PROPERTY COMMERCIAL/INDUSTRIAL LAND USE

Chemical of Concern [a]	CAS	Maximum Detected Concentration (mg/kg)	Sample Location of Maximum Detected Concentration	Sample Depth (feet)	Soil-to-Indoor Air Screening Level (mg/kg) [b]			Single-Chemical Screening Level (mg/kg) [c]	Maximum Detected Concentration Exceeds Single-Chemical Screening Level? [d]
					Non-Cancer Endpoint	Cancer Endpoint	Soil Saturation		
Inorganics									
Mercury	7439976	2.6	UR2012 UR2023	0-2 0-2	0.025	NA [e]	1000	0.025	**Yes**
Semi-Volatile Organic Compounds (SVOCs)									
Benzo(a)anthracene	56553	0.1	UR2013	0-2	NA	130	3.3	NOC [f]	No [f]
Naphthalene	91203	1.4	UR2013	0-2	0.24	0.066	97	0.066	**Yes**

Notes:

a. In accordance with the USEPA OSWER *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA, 2015) as well as recent trainings provided by Ohio EPA, the U.S. EPA Vapor Intrusion Screening Level (VISL) Calculator (Version 3.4, June 12, 2015), was used to identify COCs detected in soil that are sufficiently volatile and toxic to require further evaluation for the SIA air pathway. It should be noted that certain SVOCs detected in soil (acenaphthene, benzo(b)fluranthene, chrysene, dibenzofuran, fluorene, 2-methylnaphthalene, and pyrene) were not evaluated in accordance with VISL even though the Ohio EPA VI Guidance (2010) indicates these COCs should be evaluated for vapor intrusion.

b. Soil-to-Indoor air screening levels were calculated using the USEPA Johnson & Ettinger model based on default input assumptions in accordance with the Ohio EPA 2010 Vapor Intrusion Guidance. Screening levels were developed based on a target hazard index of 0.1 and a target excess lifetime cancer risk of 1×10^{-6}.

c. Single-Chemical Screening Level: the lowest of the non-cancer, cancer, and soil saturation endpoint values.

d. In accordance with the Ohio EPA 2010 VI guidance (Section 11.2, pg 36), when bulk soil results from J&E modeling do not exceed a HQ of 0.1 and an ELCR goal of 1 x 10-6, further evaluation of soil for vapor intrusion is not necessary.

e. NA - not applicable, endpoint-specific value is not applicable for this COC.

f. NOC - "not of concern" per the Johnson & Ettinger Model results tab, the “final indoor exposure soil concentration” is not of concern as the risk-based screening level exceeds the soil saturation value for a solid in soils.

APPENDIX D

ProUCL Print-Outs

Appendix D
ProUCL Input: Lead in Soil for Evaluation of Construction/Excavation Activities

Lead	d_Lead
682	1
313	1
167	1
75	1
72.3	1
66.9	1
64.5	1
60.4	1
49.3	1
39.1	1
33.1	1
28.1	1
24.4	1
24.2	1
23.7	1
21.4	1
19.2	1
15.2	1
13	1
12.8	1
11.3	1
10.1	1

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.111/14/2016 11:34:57 AM
From File	ProUCL.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	10.1	Mean	83
Maximum	682	Median	30.6
SD	149.9	Std. Error of Mean	31.96
Coefficient of Variation	1.806	Skewness	3.491

Normal GOF Test

Shapiro Wilk Test Statistic	0.496	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.385	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	138	95% Adjusted-CLT UCL (Chen-1995)	161
		95% Modified-t UCL (Johnson-1978)	142

Gamma GOF Test

A-D Test Statistic	1.678	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.78	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.25	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.192	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.804	k star (bias corrected MLE)	0.725
Theta hat (MLE)	103.2	Theta star (bias corrected MLE)	114.5
nu hat (MLE)	35.4	nu star (bias corrected)	31.9
MLE Mean (bias corrected)	83	MLE Sd (bias corrected)	97.48
		Approximate Chi Square Value (0.05)	19.99
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	19.29

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	132.4	95% Adjusted Gamma UCL (use when n<50)	137.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.142	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59	Minimum of Logged Data					2.313	Mean of logged Data					3.682
60	Maximum of Logged Data					6.525	SD of logged Data					1.083
61												
62	Assuming Lognormal Distribution											
63	95% H-UCL					135	90% Chebyshev (MVUE) UCL					122.9
64	95% Chebyshev (MVUE) UCL					147.5	97.5% Chebyshev (MVUE) UCL					181.6
65	99% Chebyshev (MVUE) UCL					248.6						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71	95% CLT UCL					135.6	95% Jackknife UCL					138
72	95% Standard Bootstrap UCL					135.9	95% Bootstrap-t UCL					263.8
73	95% Hall's Bootstrap UCL					327.5	95% Percentile Bootstrap UCL					139.5
74	95% BCA Bootstrap UCL					168.2						
75	90% Chebyshev(Mean, Sd) UCL					178.9	95% Chebyshev(Mean, Sd) UCL					222.3
76	97.5% Chebyshev(Mean, Sd) UCL					282.6	99% Chebyshev(Mean, Sd) UCL					401
77												
78	Suggested UCL to Use											
79	95% Chebyshev (Mean, Sd) UCL					222.3						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

Appendix D
ProUCL Input: Chromium and Arsenic in Soil for Evaluation of Commercial/Industrial Use

Chromium	Arsenic
218	50.2
53.6	48.6
38.8	35.5
30.1	32.9
29.8	29.2
28.4	26.8
27.2	25.5
27	19.7
26	18.5
25.2	18.2
23.8	17.3
22.9	17
22.9	16.1
21.7	14.2
20.4	14.1
19.9	12.8
19.5	12.4
18.2	11.4
17.3	11.3
16.6	8.4
13.9	7.7
9.9	6.2

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.112/14/2016 1:07:43 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
umber of Bootstrap Operations	2000

Arsenic

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	6.2	Mean	20.64
Maximum	50.2	Median	17.15
SD	12.21	Std. Error of Mean	2.603
Coefficient of Variation	0.592	Skewness	1.25

Normal GOF Test

Shapiro Wilk Test Statistic	0.87	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	25.12	95% Adjusted-CLT UCL (Chen-1995)	25.66
		95% Modified-t UCL (Johnson-1978)	25.23

Gamma GOF Test

A-D Test Statistic	0.363	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.144	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.186	etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.442	k star (bias corrected MLE)	3.003
Theta hat (MLE)	5.996	Theta star (bias corrected MLE)	6.873
nu hat (MLE)	151.4	nu star (bias corrected)	132.1
MLE Mean (bias corrected)	20.64	MLE Sd (bias corrected)	11.91
		Approximate Chi Square Value (0.05)	106.6
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	104.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	25.58	95% Adjusted Gamma UCL (use when n<50)	26

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.978	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.825	Mean of logged Data	2.875
Maximum of Logged Data	3.916	SD of logged Data	0.562

Assuming Lognormal Distribution

95% H-UCL	26.71	90% Chebyshev (MVUE) UCL	28.34
95% Chebyshev (MVUE) UCL	31.85	97.5% Chebyshev (MVUE) UCL	36.73

	A–E	F	G–K	L
65	99% Chebyshev (MVUE) UCL	46.3		
66				
67	**Nonparametric Distribution Free UCL Statistics**			
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
69				
70	**Nonparametric Distribution Free UCLs**			
71	95% CLT UCL	24.92	95% Jackknife UCL	25.12
72	95% Standard Bootstrap UCL	24.89	95% Bootstrap-t UCL	26.29
73	95% Hall's Bootstrap UCL	25.6	95% Percentile Bootstrap UCL	25.11
74	95% BCA Bootstrap UCL	25.98		
75	90% Chebyshev(Mean, Sd) UCL	28.44	95% Chebyshev(Mean, Sd) UCL	31.98
76	97.5% Chebyshev(Mean, Sd) UCL	36.89	99% Chebyshev(Mean, Sd) UCL	46.53
77				
78	**Suggested UCL to Use**			
79	95% Adjusted Gamma UCL	26		
80				
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
82	Recommendations are based upon data size, data distribution, and skewness.			
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
85				
86				
87	**Chromium**			
88				
89	**General Statistics**			
90	Total Number of Observations	22	Number of Distinct Observations	21
91			Number of Missing Observations	0
92	Minimum	9.9	Mean	33.23
93	Maximum	218	Median	23.35
94	SD	42.24	Std. Error of Mean	9.005
95	Coefficient of Variation	1.271	Skewness	4.36
96				
97	**Normal GOF Test**			
98	Shapiro Wilk Test Statistic	0.395	**Shapiro Wilk GOF Test**	
99	5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level	
100	Lilliefors Test Statistic	0.393	**Lilliefors GOF Test**	
101	5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level	
102	**Data Not Normal at 5% Significance Level**			
103				
104	**Assuming Normal Distribution**			
105	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
106	95% Student's-t UCL	48.73	95% Adjusted-CLT UCL (Chen-1995)	56.99
107			95% Modified-t UCL (Johnson-1978)	50.12
108				
109	**Gamma GOF Test**			
110	A-D Test Statistic	2.691	**Anderson-Darling Gamma GOF Test**	
111	5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level	
112	K-S Test Statistic	0.324	**Kolmogorov-Smirnov Gamma GOF Test**	
113	5% K-S Critical Value	0.188	Data Not Gamma Distributed at 5% Significance Level	
114	**Data Not Gamma Distributed at 5% Significance Level**			
115				
116	**Gamma Statistics**			
117	k hat (MLE)	2.031	k star (bias corrected MLE)	1.784
118	Theta hat (MLE)	16.36	Theta star (bias corrected MLE)	18.63
119	nu hat (MLE)	89.35	nu star (bias corrected)	78.5
120	MLE Mean (bias corrected)	33.23	MLE Sd (bias corrected)	24.88
121			Approximate Chi Square Value (0.05)	59.09
122	Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	57.83
123				
124	**Assuming Gamma Distribution**			
125	95% Approximate Gamma UCL (use when n>=50))	44.15	95% Adjusted Gamma UCL (use when n<50)	45.11
126				
127	**Lognormal GOF Test**			
128	Shapiro Wilk Test Statistic	0.782	**Shapiro Wilk Lognormal GOF Test**	

	A	B	C	D	E	F	G	H	I	J	K	L
129	5% Shapiro Wilk Critical Value					0.911	Data Not Lognormal at 5% Significance Level					
130	Lilliefors Test Statistic					0.253	**Lilliefors Lognormal GOF Test**					
131	5% Lilliefors Critical Value					0.184	Data Not Lognormal at 5% Significance Level					
132	**Data Not Lognormal at 5% Significance Level**											
133												
134	**Lognormal Statistics**											
135	Minimum of Logged Data					2.293	Mean of logged Data					3.238
136	Maximum of Logged Data					5.384	SD of logged Data					0.592
137												
138	**Assuming Lognormal Distribution**											
139	95% H-UCL					39.73	90% Chebyshev (MVUE) UCL					42.05
140	95% Chebyshev (MVUE) UCL					47.47	97.5% Chebyshev (MVUE) UCL					55
141	99% Chebyshev (MVUE) UCL					69.8						
142												
143	**Nonparametric Distribution Free UCL Statistics**											
144	**Data do not follow a Discernible Distribution (0.05)**											
145												
146	**Nonparametric Distribution Free UCLs**											
147	95% CLT UCL					48.04	95% Jackknife UCL					48.73
148	95% Standard Bootstrap UCL					47.35	95% Bootstrap-t UCL					106.6
149	95% Hall's Bootstrap UCL					114.1	95% Percentile Bootstrap UCL					50.43
150	95% BCA Bootstrap UCL					60.51						
151	90% Chebyshev(Mean, Sd) UCL					60.25	95% Chebyshev(Mean, Sd) UCL					72.48
152	97.5% Chebyshev(Mean, Sd) UCL					89.47	99% Chebyshev(Mean, Sd) UCL					122.8
153												
154	**Suggested UCL to Use**											
155	95% Chebyshev (Mean, Sd) UCL					72.48						
156												
157	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
158	Recommendations are based upon data size, data distribution, and skewness.											
159	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
160	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
161												

APPENDIX E

Derivation of Direct Contact with Groundwater Standards for Construction/Excavation Activities

For Mass-Transfer Coefficients:

Kg,H2O	0.833	cm/s
MWH2O	18	
Kg,O2	0.002	cm/s
MWO2	32	
T	**77**	F
T	298	K
R	8.20E-05	atm-m3/mol-K

For Emission Flux and Concentration in Trench:

CF1	1.00E-03	L/cm3
CF2	1.00E+04	cm2/m2
CF3	3600	s/hr
F	**1**	
ACH	360	hr-1

Trench dimensions:

Length	**8**	ft
	2.44	m
Width	**6**	ft
	1.83	m
Depth	**5**	ft
	1.52	m
Width/Depth	1.20	

Inhalation Exposure Factors:

ET	0.17	4hrs/24hrs
EF	120	days/year
ED	1	year
BW	70	kg
AT-C	25550	days/year
AT-N	365	days/year

Target Risk and Hazard Quotient:

TR	1.00E-05	
THQ	1	

Oral Exposure Factors:

IR-W	0.02	L/day
CF	1000	ug/mg
EF	120	days/year
ED	1	years
BW	70	kg
AT-C	25550	days
AT-N	365	days

Dermal Exposure Factors:

EV	1	events/day
EF	120	days/years
ET	4	hours/day
ED	1	years
SA	3,330	cm2
CF1	1000	cm3/L
CF2	0.001	mg/ug
BWa	70	kg
AT-C	25550	days
AT-N	365	days

Revised 8/5/14 Groundwater Screening Levels (ingestion) for construction/utility workers in a trench: Groundwater less than 15 feet deep	CAS No.	Screening Level Groundwater Cancer GSL-c ug/L	Oral Cancer Slope Factor CSFo 1/(mg/kg-day)	Screening Level Groundwater Noncancer GSL-nc ug/L	Oral Reference Dose RfDo mg/kg-day
Arsenic	7440-38-2	4.97E+03	1.50E+00	3.19E+03	3.00E-04
Barium	7440-39-3			2.13E+06	2.00E-01
Cobalt	7440-48-4			3.19E+04	3.00E-03
Manganese (nonfood)	7439-96-5			1.49E+06	1.40E-01
Nickel	7440-02-0			2.13E+05	2.00E-02
Zinc	7440-66-6			3.19E+06	3.00E-01

Revised 8/5/14 Groundwater Screening Levels (dermal) for construction/utility workers in a trench: Groundwater less than 15 feet deep	CAS No.	Screening Level Groundwater Cancer GSL-c ug/L	Permeability Coefficient Kp cm/hr	Lag Time Per Event tau hr/event	Time To Reach Steady-State t* hour	Permeability Ratio B	Adjusted Dermal Cancer Slope Factor CSFo 1/(mg/kg-day)	Screening Level Groundwater Noncancer GSL-nc ug/L	Adjusted Dermal Reference Dose RfDo mg/kg-day	Fraction Absorbed FA
Arsenic	7440-38-2	7.46E+03	1.0E-03				1.50E+00	4.80E+03	3.00E-04	
Barium	7440-39-3		1.0E-03					3.20E+06	2.00E-01	
Cobalt	7440-48-4		4.0E-04					1.20E+05	3.00E-03	
Manganese (nonfood)	7439-96-5		1.0E-03					2.24E+06	1.40E-01	
Nickel	7440-02-0		2.0E-04					1.60E+06	2.00E-02	
Zinc	7440-66-6		6.0E-04					7.99E+06	3.00E-01	

Revised 8/5/14 Groundwater Screening Levels (inhalation) for construction/utility workers in a trench: Groundwater less than 15 feet deep	CAS No.	Molecular Weight MWi g/mol	Henry's Law Constant Hi atm-m3/mol	Gas-Phase Mass Transfer Coefficient KiG cm/s	Liquid-Phase Mass Transfer Coefficient KiL cm/s	Overall Mass Transfer Coefficient Ki cm/s	Inhalation Unit Risk Factor URF 1/(mg/m3)	Inhalation Reference Concentration RfCi mg/m3
Arsenic	7440-38-2	74.92					4.30E+00	1.50E-05
Barium	7440-39-3	137.33						5.00E-03
Cobalt	7440-48-4	58.93					9.00E+00	2.00E-05
Manganese (nonfood)	7439-96-5	54.94						5.00E-05
Nickel	7440-02-0	58.69					2.60E-01	2.00E-04
Zinc	7440-66-6	65.39						

Revised 8/5/14 Groundwater Screening Levels (inhalation) for construction/utility workers in a trench: Groundwater less than 15 feet deep	CAS No.	Screening Level Air Cancer ASL-c ug/m3	Screening Level Air Noncancer ASL-nc ug/m3	Screening Level Air in Trench ASL ug/m3	Volatilization Factor VF L/m3	Screening Level Groundwater GSL ug/L
Arsenic	7440-38-2	2.97E+00	2.74E-01	2.74E-01		
Barium	7440-39-3		9.13E+01	9.13E+01		
Cobalt	7440-48-4	1.42E+00	3.65E-01	3.65E-01		
Manganese (nonfood)	7439-96-5		9.13E-01	9.13E-01		
Nickel	7440-02-0	4.91E+01	3.65E+00	3.65E+00		
Zinc	7440-66-6					

Revised 8/5/14 Table 6.4 Groundwater Screening Levels for construction/utility workers in a trench: Groundwater less than 15 feet deep	Screening Level Oral Cancer SLo-c ug/L	1/SLo-c L/ug	Screening Level Oral (RLo) Noncancer SLo-nc ug/L	1/SLo-nc L/ug	Screening Level Dermal Cancer SLd-c ug/L	1/SLd-c L/ug	Screening Level Dermal (RLd) Noncancer SLd-nc ug/L	1/SLd-nc L/ug
Arsenic	4.97E+03	2.01E-04	3.19E+03	3.13E-04	7.46E+03	1.34E-04	4.80E+03	2.09E-04
Barium			2.13E+06	4.70E-07			3.20E+06	3.13E-07
Cobalt			3.19E+04	3.13E-05			1.20E+05	8.34E-06
Manganese (nonfood)			1.49E+06	6.71E-07			2.24E+06	4.47E-07
Nickel			2.13E+05	4.70E-06			1.60E+06	6.26E-07
Zinc			3.19E+06	3.13E-07			7.99E+06	1.25E-07

Revised 8/5/14 Table 6.4 Groundwater Screening Levels for construction/utility workers in a trench: Groundwater less than 15 feet deep	Screening Level Oral+Dermal Cancer SLod-c ug/L	Screening Level Oral + Dermal Noncancer SLod-nc ug/L	Screening Level Groundwater Oral + Dermal SLod ug/L	Screening Level Inhalation Cancer SLi-c ug/L	1/SLi-c L/ug	Screening Level Inhalation Noncancer SLi-nc ug/L	1/SLi-nc L/ug	Screening Level Groundwater Inhalation SLi ug/L
Arsenic	2.98E+03	1.92E+03	1.92E+03					
Barium		1.28E+06	1.28E+06					
Cobalt		2.52E+04	2.52E+04					
Manganese (nonfood)		8.95E+05	8.95E+05					
Nickel		1.88E+05	1.88E+05					
Zinc		2.28E+06	2.28E+06					

Revised 8/5/14 Table 6.4 Groundwater Screening Levels for construction/utility workers in a trench: Groundwater less than 15 feet deep	Screening Level Groundwater Oral + Dermal + Inhalation Cancer SL-c ug/L	Screening Level Groundwater Oral + Dermal + Inhalation Noncancer SL-nc ug/L	Screening Level Groundwater Oral + Dermal + Inhalation SL ug/L
Arsenic	2.98E+03	1.92E+03	1.92E+03
Barium		1.28E+06	1.28E+06
Cobalt		2.52E+04	2.52E+04
Manganese (nonfood)		8.95E+05	8.95E+05
Nickel		1.88E+05	1.88E+05
Zinc		2.28E+06	2.28E+06

APPENDIX F

Surface Water Direct Contact Hazard and Risk Calculation Spreadsheet Print-Out

TABLE 3.16
VALUES USED FOR DAILY INTAKE CALCULATIONS
Site Name

Medium:	Surface Water
Exposure	Surface Water
Receptor	Construction Worker
Exposure	Dermal
Receptor	Adult
Swimming	n
	Y = Yes
	N = No

Intake Equation:
DAD=DAevent x IF
Intake Factor Equation:
IF=EV x SA x EF x ED x 1/BW x 1/AT

To calculate DAevent, see Guidance, Equations 3-10 to 3-12

Parameter Code	Parameter Definition	Units	VRP Default Value	Rationale/ Reference	User Defined Value	Rationale/ Reference
DAD	Dermally Absorbed Dose	mg/kg-day				
DAevent	Absorbed dose per event	mg/cm^2-event	Chemical specific	EPA, 1992		
EV	Event frequency	events/day	1	EPA, 1992		
SA	Skin Surface Area Availab for Contact	cm2	3,300 (1)	VAP Support		
EF	Exposure Frequency	days/years	120	VAP Support		
ED	Exposure Duration	years	1	VAP Support		
BW	Body Weight	kg	70	VAP Support		
AT-C	Averaging Time (Cancer)	days	25,550	70 yr (lifetime)		
AT-N	Averaging Time (Non-canc	days	365	ED x 365		
IF-C	Intake Factor (Cancer)	vent-cm^2/kg-da	2.21E-01	calculated		
IF-N	Intake Factor (Non-cancer	vent-cm^2/kg-da	1.55E+01	calculated		

DEQ= VRP Staff Professional Judgement
EPA, 1989 Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. EPA/540/1-89/002.
EPA, 1991 Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-03
EPA, 1992 Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment. EPA/600/8-91/011B.
EPA, 200 RAGS Part E
EPA, 201 EPA Exposure Factors Handbook: 2011 Edition
(1) Assumes feet and legs are exposed during wading.
(2) Assumes wading takes place 5 days per week, 9 months (approximately 39 weeks) per year.
(3) Assumes wading takes place 6 days per month, 4 months per year.

Revised 8/5/14 Chemical of Potential Concern	Cancer assificatio	Surface Water Concentration ug/L	Exposure Point Concentration (Dermal) (CW) mg/cm3	Dermally Absorbed Dose (Cancer) (DADc) mg/kg-day	Adjusted Dermal Cancer Slope Factor CSFd 1/(mg/kg-day)	Cancer Risk (DADc*CSFd) unitless	Dermally Absorbed Dose (Non-Cancer) (DADn) mg/kg-day	Adjusted Dermal Reference Dose (chronic) RfDd mg/kg-day	Adjusted Dermal Reference Dose (subchronic) RfDd mg/kg-day	Hazard Quotient (DADn/RfDd) unitless	Absorbed Dose per Event (DAevent) mg/cm2-event	Permeability Coefficient Kp cm/hr	Lag Time Per Event tau hr/event	Time To Reach Steady-State t* hour	Permeability Ratio B	Exposure Time (ET) hours/day	Fraction Absorbed FA
TAL Inorganics																	
Arsenic	A	98.8	9.88E-05	4.38E-08	1.50E+00	6.56E-08	3.06E-06	3.00E-04	3.00E-04	1.02E-02	1.98E-07	1.00E-03				2	
Barium	D	374	3.74E-04				1.16E-05	2.00E-01	2.00E-01	5.80E-05	7.48E-07	1.00E-03				2	
Cadmium (water)		2.1	2.10E-06				6.51E-08	1.00E-03	1.00E-03	6.51E-05	4.20E-09	1.00E-03				2	
Chromium	D	154	1.54E-04				9.55E-06	1.50E+00	1.50E+00	6.36E-06	6.16E-07	2.00E-03				2	
Cobalt		20	1.99E-05				2.47E-07	3.00E-04	3.00E-03	8.22E-04	1.59E-08	4.00E-04				2	
Copper	D	185	1.85E-04				5.73E-06	4.00E-02	1.00E-02	1.43E-04	3.70E-07	1.00E-03				2	
Manganese (nonfood)	D	1180	1.18E-03				3.66E-05	9.60E-04	9.60E-04	3.81E-02	2.36E-06	1.00E-03				2	
Mercury	D	0.0063	6.30E-09								1.26E-11	1.00E-03				2	
Nickel		105	1.05E-04				6.51E-07	2.00E-02	2.00E-02	3.25E-05	4.20E-08	2.00E-04				2	
Silver	D	12	1.15E-05				2.14E-07	5.00E-03	5.00E-03	4.28E-05	1.38E-08	6.00E-04				2	
Vanadium		49	4.88E-05				1.51E-06	1.00E-02	1.00E-02	1.51E-04	9.76E-08	1.00E-03				2	
Zinc	D	695	6.95E-04				1.29E-05	3.00E-01	3.00E-01	4.31E-05	8.34E-07	6.00E-04				2	

TABLE 3.17
VALUES USED FOR DAILY INTAKE CALCULATIONS
Site Name

Medium:	Surface Water
Exposure Medium	Surface Water
Receptor Populat	**Recreational**
Exposure Route:	Ingestion
Receptor Age:	**Adult**
	A = Adult
	C = Child
Swimming possib	**n**
	Y = Yes
	N = No

Intake Equation:
CDI=CW x IF
Intake Factor Equation:
IF=IR-W x EF x ED x ET x 1/BW x 1/AT

Parameter Code	Parameter Definition	Units	VRP Default Value	Rationale/ Reference	User Defined Value	Rationale/ Reference
CDI	Chronic Daily Intake	mg/kg-day				
CW	Chemical Concentration in W	mg/L				
IR-W	Ingestion Rate of Water	liters/hour	0.005	EPA, 1989		
EF	Exposure Frequency	days/year	120	P Support Document		
ED	Exposure Duration	years	1	P Support Document		
ET	Exposure Time	hours	2	DEQ		
BW	Body Weight	kg	70	P Support Document		
AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989		
AT-N	Averaging Time (Non-Cance	days	365	EPA, 1989		
IF-C	Intake Factor (Cancer)	liters/kg-day	6.71E-07	calculated		
IF-N	Intake Factor (Non-Cancer)	liters/kg-day	4.70E-05	calculated		

DEQ= VRP Staff Professional Judgement
EPA, 1989= Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A).
Office of Emergency and Remedial Response. EPA/540/1-89/002.
EPA, 1991= Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.
Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-03
EPA, 2011= EPA Exposure Factors Handbook: 2011 Edition
(1) Assumes swimming or wading takes place 5 days per week, 9 months (approximately 39 weeks) per year.
(2) Assumes swimming or wading takes place 6 days per month, 4 months per year.

Revised 8/5/14 Chemical of Potential Concern	Cancer Classification	Surface Water Concentration ug/L	Exposure Point Concentration (Oral) (CW) mg/L	Chronic Daily Intake (Cancer) (CDIc) mg/kg-day	Oral Cancer Slope Factor CSFo 1/(mg/kg-day)	Cancer Risk (CDIc*CSFo) unitless	Chronic Daily Intake (Non-Cancer) (CDIn) mg/kg-day	Oral Reference Dose (chronic) RfDo mg/kg-day	Oral Reference Dose (subchronic) RfDo mg/kg-day	Hazard Quotien (CDIn/RfDo) unitless
TAL Inogarics										
Arsenic	A	9.88E+01	9.88E-02	6.63E-08	1.50E+00	9.94E-08	4.64E-06	3.00E-04	3.00E-04	1.55E-02
Barium	D	3.74E+02	3.74E-01				1.76E-05	2.00E-01	2.00E-01	8.78E-05
Cadmium (water)		2.10E+00	2.10E-03				9.86E-08	1.00E-03	1.00E-03	9.86E-05
Chromium	D	1.54E+02	1.54E-01				7.23E-06	1.50E+00	1.50E+00	4.82E-06
Cobalt		1.99E+01	1.99E-02				9.35E-07	3.00E-04	3.00E-03	3.12E-03
Copper	D	1.85E+02	1.85E-01				8.69E-06	4.00E-02	1.00E-02	2.17E-04
Manganese (nonfood)	D	1.18E+03	1.18E+00				5.54E-05	2.40E-02	2.40E-02	2.31E-03
Mercury	D	6.30E-03	6.30E-06							
Nickel		1.05E+02	1.05E-01				4.93E-06	2.00E-02	2.00E-02	2.47E-04
Silver	D	1.15E+01	1.15E-02				5.40E-07	5.00E-03	5.00E-03	1.08E-04
Vanadium		4.88E+01	4.88E-02				2.29E-06	5.00E-03	1.00E-02	4.58E-04
Zinc	D	6.95E+02	6.95E-01				3.26E-05	3.00E-01	3.00E-01	1.09E-04

TABLE 3.18
VALUES USED FOR DAILY INTAKE CALCULATIONS
Site Name

Medium: Surface Water
Exposure Medium: Fish Tissue

Exposure Route: Ingestion
Receptor Age: **Adult**

Intake Equation:
CDI=CT x IF
Intake Factor Equation:
IF=IR-T x EF x ED x ET x 1/BW x 1/AT

Parameter Code	Parameter Definition	Units	VRP Default Value	Rationale/ Reference	User Defined Value	Rationale/ Reference
CDI	Chronic Daily Intake	mg/kg-day				
CT	Chemical Concentration in Tis	mg/kg				
IR-t	Ingestion Rate of Tissue	kg/day	0	No fish ingestion		
EF	Exposure Frequency	days/year	120	VAP Support Doc		
ED	Exposure Duration	years	1	VAP Support Doc		
FI	Fraction Ingested		1	DEQ		
BW	Body Weight	kg	70	VAP Support Doc		
AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989		
AT-N	Averaging Time (Non-Cancer	days	365	EPA, 1989		
IF-C	Intake Factor (Cancer)	1/day	0.00E+00	calculated		
IF-N	Intake Factor (Non-Cancer)	1/day	0.00E+00	calculated		

DEQ= VRP Staff Professional Judgement
EPA, 1989= Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. EPA/540/1-89/002.
EPA, 1991= Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-03
EPA, 1997 Exposure Factors handbook
EPA, 2011= EPA Exposure Factors Handbook: 2011 Edition

Revised 8/5/14 Chemical of Potential Concern	Cancer Classification	Surface Water Concentration ug/L	Exposure Point Concentration (Oral) (CW) mg/L	Bioconcentration Factor	Exposure Point Concentration Tissue CT mg/kg	Chronic Daily Intake (Cancer) (CDIc) mg/kg-day	Oral Cancer Slope Factor CSFo 1/(mg/kg-day)	Cancer Risk (CDIc*CSFi) unitless	Chronic Daily Intake (Non-Cancer) (CDIn) mg/kg-day	Oral Reference Dose (chronic) RfDo mg/kg-day	Oral Reference Dose (subchronic) RfDo mg/kg-day	Hazard Quotient (CDIn/RfDi) unitless	Total Cancer Risk	Total Hazard Quotient
TAL Inorganics														
Arsenic	A	9.88E+01	9.88E-02		0.00E+00		1.50E+00			3.00E-04	3.00E-04		1.65E-07	2.57E-02
Barium	D	3.74E+02	3.74E-01		0.00E+00					2.00E-01	2.00E-01		0.00E+00	1.46E-04
Cadmium (water)	B1	2.10E+00	2.10E-03		0.00E+00					1.00E-03	1.00E-03		0.00E+00	1.64E-04
Chromium	A	1.54E+02	1.54E-01		0.00E+00		5.00E-01			1.50E+00	1.50E+00		0.00E+00	1.12E-05
Cobalt		1.99E+01	1.99E-02		0.00E+00					3.00E-04	3.00E-03		0.00E+00	3.94E-03
Copper	D	1.85E+02	1.85E-01		0.00E+00					4.00E-02	1.00E-02		0.00E+00	3.61E-04
Manganese (nonfood)	D	1.18E+03	1.18E+00		0.00E+00					2.40E-02	2.40E-02		0.00E+00	4.04E-02
Mercury	D	6.30E-03	6.30E-06		0.00E+00								0.00E+00	0.00E+00
Nickel	A	1.05E+02	1.05E-01		0.00E+00					2.00E-02	2.00E-02		0.00E+00	2.79E-04
Silver	D	1.15E+01	1.15E-02		0.00E+00					5.00E-03	5.00E-03		0.00E+00	1.51E-04
Vanadium		4.88E+01	4.88E-02		0.00E+00					5.00E-03	1.00E-02		0.00E+00	6.10E-04
Zinc	D	6.95E+02	6.95E-01		0.00E+00					3.00E-01	3.00E-01		0.00E+00	1.52E-04

TABLE 3.16

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site Name

Medium:	Surface Water
Exposure Medium:	Surface Water
Receptor Population:	**Commercial Worker**
Exposure Route:	Dermal
Receptor Age:	**Adult**
Swimming possible?	**n**
	Y = Yes
	N = No

Intake Equation:
DAD = DAevent x IF
Intake Factor Equation:
IF=EV x SA x EF x ED x 1/BW x 1/AT

To calculate DAevent, see Guidance, Equations 3-10 to 3-12

Parameter Code	Parameter Definition	Units	VRP Default Value	Rationale/ Reference	User Defined Value	Rationale/ Reference
DAD	Dermally Absorbed Dose	mg/kg-day				
DAevent	Absorbed dose per event	mg/cm^2-event	Chemical specific	EPA, 1992		
EV	Event frequency	events/day	1	EPA, 1992		
SA	Skin Surface Area Availab for Contact	cm2	3,300 (1)	VAP Support Document		
EF	Exposure Frequency	days/years	60	Property-Specific		
ED	Exposure Duration	years	25	VAP Support Document		
BW	Body Weight	kg	70	VAP Support Document		
AT-C	Averaging Time (Cancer)	days	25,550	70 yr (lifetime) x 365		
AT-N	Averaging Time (Non-cance	days	9,125	ED x 365 days/year		
IF-C	Intake Factor (Cancer)	event-cm^2/kg-day	2.77E+00	calculated		
IF-N	Intake Factor (Non-cancer)	event-cm^2/kg-day	7.75E+00	calculated		

DEQ= VRP Staff Professional Judgement

EPA, 1989= Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. EPA /540/1-89/002.

EPA, 1991= Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-03

EPA, 1992= Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment. EPA /600/8-91/011B.

EPA, 2001= RAGS Part E

EPA, 2011= EPA Exposure Factors Handbook: 2011 Edition

(1) Assumes feet and legs are exposed during wading.

(2) Assumes wading takes place 5 days per week, 9 months (approximately 39 weeks) per year.

(3) Assumes wading takes place 6 days per month, 4 months per year.

Revised 8/5/14

Chemical of Potential Concern	Cancer Classification	Surface Water Concentration ug/L	Exposure Point Concentration (Dermal) (CW) mg/cm3	Dermally Absorbed Dose (Cancer) (DADc) mg/kg-day	Adjusted Dermal Cancer Slope Factor CSFd 1/(mg/kg-day)	Cancer Risk (DADc*CSFd) unitless	Dermally Absorbed Dose (Non-Cancer) (DADn) mg/kg-day	Adjusted Dermal Reference Dose (chronic) RfDd mg/kg-day	Adjusted Dermal Reference Dose (subchronic) RfDd mg/kg-day
Arsenic	A	98.8	9.88E-05	5.47E-07	1.50E+00	8.20E-07	1.53E-06	3.00E-04	3.00E-04
Barium	D	374	3.74E-04				5.80E-06	2.00E-01	2.00E-01
Cadmium (water)		2.1	2.10E-06				3.25E-08	1.00E-03	1.00E-03
Chromium	D	154	1.54E-04				4.77E-06	1.50E+00	1.50E+00
Cobalt		20	1.99E-05				1.23E-07	3.00E-04	3.00E-03
Copper	D	185	1.85E-04				2.87E-06	4.00E-02	1.00E-02
Manganese (nonfood)	D	1180	1.18E-03				1.83E-05	9.60E-04	9.60E-04
Mercury	D	0.0063	6.30E-09						
Nickel		105	1.05E-04				3.25E-07	2.00E-02	2.00E-02
Silver	D	12	1.15E-05				1.07E-07	5.00E-03	5.00E-03
Vanadium		49	4.88E-05				7.56E-07	1.00E-02	1.00E-02
Zinc	D	695	6.95E-04				6.46E-06	3.00E-01	3.00E-01

Chemical of Potential Concern	Hazard Quotient (DADn/RfDd) unitless	Absorbed Dose per Event (DAevent) mg/cm2-event	Permeability Coefficient Kp cm/hr	Lag Time Per Event tau hr/event	Time To Reach Steady-State t* hour	Permeability Ratio B	Exposure Tim (ET) hours/day	Fraction Absorbed FA
Arsenic	5.10E-03	1.98E-07	1.00E-03				2	
Barium	2.90E-05	7.48E-07	1.00E-03				2	
Cadmium (water)	3.25E-05	4.20E-09	1.00E-03				2	
Chromium	3.18E-06	6.16E-07	2.00E-03				2	
Cobalt	4.11E-04	1.59E-08	4.00E-04				2	
Copper	7.17E-05	3.70E-07	1.00E-03				2	
Manganese (nonfood)	1.91E-02	2.36E-06	1.00E-03				2	
Mercury		1.26E-11	1.00E-03				2	
Nickel	1.63E-05	4.20E-08	2.00E-04				2	
Silver	2.14E-05	1.38E-08	6.00E-04				2	
Vanadium	7.56E-05	9.76E-08	1.00E-03				2	
Zinc	2.15E-05	8.34E-07	6.00E-04				2	

TABLE 3.17

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site Name

Medium:	Surface Water
Exposure Medium:	Surface Water
Receptor Population:	**Recreational**
Exposure Route:	Ingestion
Receptor Age:	**Adult**
	A = Adult
	C = Child
Swimming possible?	**n**
	Y = Yes
	N = No

Intake Equation:
CDI=CW x IF
Intake Factor Equation:
IF=IR-W x EF x ED x ET x 1/BW x 1/AT

Parameter Code	Parameter Definition	Units	VRP Default Value	Rationale/ Reference	User Defined Value	Rationale/ Reference
CDI	Chronic Daily Intake	mg/kg-day				
CW	Chemical Concentration in Water	mg/L				
IR-W	Ingestion Rate of Water	liters/hour	0.005	EPA, 1989		
EF	Exposure Frequency	days/year	60	DEQ (1)		
ED	Exposure Duration	years	25	EPA, 1991		
ET	Exposure Time	hours	2	DEQ		
BW	Body Weight	kg	70	EPA, 2011		
AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989		
AT-N	Averaging Time (Non-Cancer)	days	9,125	EPA, 1989		
IF-C	Intake Factor (Cancer)	liters/kg-day	8.39E-06	calculated		
IF-N	Intake Factor (Non-Cancer)	liters/kg-day	2.35E-05	calculated		

DEQ= VRP Staff Professional Judgement

EPA, 1989= Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. EPA/540/1-89/002.

EPA, 1991= Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-03

EPA, 2011= EPA Exposure Factors Handbook: 2011 Edition

(1) Assumes swimming or wading takes place 5 days per week, 9 months (approximately 39 weeks) per year.

(2) Assumes swimming or wading takes place 6 days per month, 4 months per year.

Revised 8/5/14

Chemical of Potential Concern	Cancer Classification	Surface Water Concentration ug/L	Exposure Point Concentration (Oral) (CW) mg/L	Chronic Daily Intake (Cancer) (CDIc) mg/kg-day	Oral Cancer Slope Factor CSFo 1/(mg/kg-day)	Cancer Risk (CDIc*CSFo) unitless	Chronic Daily Intake (Non-Cancer) (CDIn) mg/kg-day	Oral Reference Dose (chronic) RfDo mg/kg-day	Oral Reference Dose (subchronic) RfDo mg/kg-day	Hazard Quotient (CDIn/RfDo) unitless
Arsenic	A	9.88E+01	9.88E-02	8.29E-07	1.50E+00	1.24E-06	2.32E-06	3.00E-04	3.00E-04	7.73E-03
Barium	D	3.74E+02	3.74E-01				8.78E-06	2.00E-01	2.00E-01	4.39E-05
Cadmium (water)		2.10E+00	2.10E-03				4.93E-08	1.00E-03	1.00E-03	4.93E-05
Chromium	D	1.54E+02	1.54E-01				3.62E-06	1.50E+00	1.50E+00	2.41E-06
Cobalt		1.99E+01	1.99E-02				4.67E-07	3.00E-04	3.00E-03	1.56E-03
Copper	D	1.85E+02	1.85E-01				4.34E-06	4.00E-02	1.00E-02	1.09E-04
Manganese (nonfood)	D	1.18E+03	1.18E+00				2.77E-05	2.40E-02	2.40E-02	1.15E-03
Mercury	D	6.30E-03	6.30E-06							
Nickel		1.05E+02	1.05E-01				2.47E-06	2.00E-02	2.00E-02	1.23E-04
Silver	D	1.15E+01	1.15E-02				2.70E-07	5.00E-03	5.00E-03	5.40E-05
Vanadium		4.88E+01	4.88E-02				1.15E-06	5.00E-03	1.00E-02	2.29E-04
Zinc	D	6.95E+02	6.95E-01				1.63E-05	3.00E-01	3.00E-01	5.44E-05

TABLE 3.18

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site Name

Medium:	Surface Water
Exposure Medium:	Fish Tissue
Exposure Route:	Ingestion
Receptor Age:	**Adult**

Intake Equation:
CDI=CT x IF
Intake Factor Equation:
IF=IR-T x EF x ED x ET x 1/BW x 1/AT

Parameter Code	Parameter Definition	Units	VRP Default Value	Rationale/ Reference	User Defined Value	Rationale/ Reference
CDI	Chronic Daily Intake	mg/kg-day				
CT	Chemical Concentration in Tissue	mg/kg				
IR-t	Ingestion Rate of Tissue	kg/day	0	No fish ingestion		
EF	Exposure Frequency	days/year	350	EPA, 1989		
ED	Exposure Duration	years	25	EPA, 1991		
FI	Fraction Ingested		1	DEQ		
BW	Body Weight	kg	70	EPA, 2011		
AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989		
AT-N	Averaging Time (Non-Cancer)	days	9,125	EPA, 1989		
IF-C	Intake Factor (Cancer)	1/day	0.00E+00	calculated		
IF-N	Intake Factor (Non-Cancer)	1/day	0.00E+00	calculated		

DEQ=	VRP Staff Professional Judgement
EPA, 1989=	Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. EPA/540/1-89/002.
EPA, 1991=	Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-03
EPA, 1997	Exposure Factors handbook
EPA, 2011=	EPA Exposure Factors Handbook: 2011 Edition

Revised 8/5/14 Chemical of Potential Concern	Cancer Classification	Surface Water Concentration ug/L	Exposure Point Concentration (Oral) (CW) mg/L	Bioconcentration Factor	Exposure Point Concentration Tissue CT mg/kg	Chronic Daily Intake (Cancer) (CDIc) mg/kg-day	Oral Cancer Slope Factor CSFo 1/(mg/kg-day)	Cancer Risk (CDIc*CSFi) unitless	Chronic Daily Intake (Non-Cancer) (CDIn) mg/kg-day	Oral Reference Dose (chronic) RfDo mg/kg-day	Oral Reference Dose (subchronic) RfDo mg/kg-day	Hazard Quotient (CDIn/RfDi) unitless	Total Cancer Risk	Total Hazard Quotient
Arsenic	A	9.88E+01	9.88E-02		0.00E+00		1.50E+00			3.00E-04	3.00E-04		2.06E-06	1.28E-02
Barium	D	3.74E+02	3.74E-01		0.00E+00					2.00E-01	2.00E-01		0.00E+00	7.29E-05
Cadmium (water)	B1	2.10E+00	2.10E-03		0.00E+00					1.00E-03	1.00E-03		0.00E+00	8.19E-05
Chromium	D	1.54E+02	1.54E-01		0.00E+00		5.00E-01			1.50E+00	1.50E+00		0.00E+00	5.59E-06
Cobalt		1.99E+01	1.99E-02		0.00E+00					3.00E-04	3.00E-03		0.00E+00	1.97E-03
Copper	D	1.85E+02	1.85E-01		0.00E+00					4.00E-02	1.00E-02		0.00E+00	1.80E-04
Manganese (nonfood)	D	1.18E+03	1.18E+00		0.00E+00					2.40E-02	2.40E-02		0.00E+00	2.02E-02
Mercury	D	6.30E-03	6.30E-06		0.00E+00								0.00E+00	0.00E+00
Nickel	A	1.05E+02	1.05E-01		0.00E+00					2.00E-02	2.00E-02		0.00E+00	1.40E-04
Silver	D	1.15E+01	1.15E-02		0.00E+00					5.00E-03	5.00E-03		0.00E+00	7.54E-05
Vanadium		4.88E+01	4.88E-02		0.00E+00					5.00E-03	1.00E-02		0.00E+00	3.05E-04
Zinc	D	6.95E+02	6.95E-01		0.00E+00					3.00E-01	3.00E-01		0.00E+00	7.59E-05

APPENDIX G

Derivation of Direct Contact Groundwater Standard for Lead

LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	400
Lead in Water (ug/l)	2070
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	3.4	8.8	11.5	15.7	19.2	-43	278
BLOOD Pb, CHILD	135.9	351.8	458.8	624.3	765.6	-18497	-18329
BLOOD Pb, PICA CHILD	138.7	359.1	468.3	637.2	781.4	-9286	-9202
BLOOD Pb, OCCUPATIONA	3.0	7.7	10.0	13.6	16.7	-57	402

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		2.1	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	3300	
Soil adherence	ug/cm^2	300	200
Dermal uptake constant	(ug/dl)/(ug/da	0.0001	
Soil ingestion	mg/day	200	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/da	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/da	0.08	0.19
Water ingestion	l/day	0.02	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	720.0	

Click here for REFERENCES

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.6E-4	0.07	2%	6.8E-5	0.03	1%
Soil Ingestion	3.5E-3	1.41	41%	2.5E-3	1.01	34%
Inhalation, bkgrnd		0.05	1%		0.03	1%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		1.66	49%		1.66	56%
Food Ingestion, bkgrnd		0.23	7%		0.23	8%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.02	0%		0.02	0%
Soil Ingestion	7.0E-3	2.82	2%	1.4E-2	5.63	4%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		132.48	97%		132.48	96%
Food Ingestion, bkgrnd		0.54	0%		0.54	0%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

EDWARD J. PFAU | Principal Scientist and Senior Risk Assessor

HULL
Environment / Energy / Infrastructure

EDUCATION:
- Master of Science, Wright State University, Biology
- Bachelor of Science, University of Dayton, Biology

TRAINING/SEMINARS:
- U.S. EPA Introduction to Ground Water Investigations
- U.S EPA Risk Assessment Guidance for Superfund
- U.S EPA Treatment Technologies for Superfund
- U.S EPA Ecological Risk Assessment
- Chemical Mixtures Guidance Workshop (U.S. EPA/ORD/NCEA)
- Benchmark Dose Modeling Workshop (U.S. EPA/ORD/NCEA)

PROFESSIONAL AFFILIATIONS:
- Society of Environmental Toxicology and Chemistry
- North American Lake Management Society
- Society for Risk Analysis

PUBLICATIONS:
- "Bounding Analysis of Drinking Water Health Risks from a Spill of Hydraulic Fracturing Flowback Water", by Rish, W., and Pfau, E. (2018). *Risk Analysis* **38**(4):724-754
- "Managing risks of noncancer health effects at hazardous waste sites: A case study using the Reference Concentration (RfC) of trichloroethylene (TCE)", by Dourson, M.L., Gadagbui, B.K., Thompson, R.B., Pfau, E.J., and Lowe, J. (2016). *Regulatory Toxicology and Pharmacology* **80**: 125-133.

Years with Hull: 18
Other: 10 (including 7 years at Ohio EPA)

Ed has over 25 years of experience in environmental toxicology and environmental risk assessment. He prepares and reviews human health and ecological risk assessments for brownfields, hazardous waste management units, Superfund sites, and other sites where hazardous substances or petroleum pose a potential or known environmental or regulatory concern. Ed conducts environmental fate and eco-toxicological evaluations as part of chemical safety assessments prepared to meet chemical registration requirements in the European Union. He also works with public water systems to assist in the assessment of human health concerns, such as harmful algal blooms in water supplies and lead in drinking water distribution systems.

Ed's expertise includes:

Environmental Risk Assessment
- Conducts human health and ecological risk evaluations for sites in five states, under CERCLA, RCRA, TSCA and various state programs.
- Has acted as lead or contributing author of more than 30 Property-Specific Risk Assessments, each of which supported a Voluntary Action Program No Further Action letter that had received a Covenant Not to Sue from the Ohio EPA.
- Prepares environmental fate and eco-toxicological evaluations for chemical safety assessments conducted under the requirements of the REACH regulations for chemical registration and evaluation in the European Union.

Rule Guidance and Development
- Alliance for Risk Assessment, *Trichloroethylene (TCE) Risk Assessment Guidance for Contaminated Sites.* Uncredited co-author. 16 April 2013. https://www.tera.org/Alliance%20for%20Risk/TCE2018/ARA_TCE2018a.htm
- Principal author of *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures*, and various Voluntary Action Program Technical Guidance Compendium documents, Ohio EPA, 1996 – 2001.

Expert Testimony
- Immel v. Petron, Ross County Common Pleas Court, Chillicothe, Ohio, July 29, 2015. Expert testimony regarding fuel oil release and indoor air quality.

Selected project experience:

Human Health Risk Assessment
- Residential Redevelopment of Former Vacuum Pump Manufacturing Facility, RCRA Corrective Action | Stark County, Ohio
- Former Wood Treatment Facility, Voluntary Action Program Risk Assessment | Toledo, Ohio
- Former Automotive Components Manufacturing Facility, Voluntary Action Risk Assessment| Dayton, Ohio
- Former Printing Facility and Uniform Cleaning Facility, Voluntary Action Risk Assessment | Columbus, Franklin County, Ohio

- Mixed-Use Redevelopment of Former Paper Manufacturing Facilities, Voluntary Action Risk Assessment | Sandusky, Ohio

Ecological Risk Assessment

- Cement Kiln Dust Landfill, Ohio EPA Remedial Response | Human Health and Ecological Risk Assessment and Focused Feasibility Study | Fairborn, Ohio
- Lime Fill Material Landfills (Landfills containing Fly ash from combusted coal, limestone fines, hydrated lime and precipitated calcium sulfate), Ohio EPA Solid Waste | Human Health and Ecological Risk Assessment | Huron Township, Ohio
- Wastewater and settling lagoons from grinding and polishing waste | Glass manufacturing facility | Superfund Human Health and Ecological risk assessments | LaSalle County, Illinois

Environmental Remediation and Closure

- Former Paper Sludge Disposal Dump, Self-Implementing Cleanup and Risk-based Closure Plan under Region V TSCA | Moraine, Ohio
- Former Shoe Manufacturing Facility, Source Control-Ground Water Interim Action | Ohio EPA Remedial Response | Ripley, Ohio
- Active Chemical Manufacturing Facility, RCRA Corrective Action under Ohio EPA | Scioto County, Ohio
- Former Wood Treatment Facility, Ohio EPA Voluntary Action Program No Further Action Letter | Wayne County, Ohio

Regulatory and Third-Party Review

- Reviewed numerous Property-specific risk assessments submitted in support of No Further Action Letters, as Voluntary Action Program Toxicologist and Lead Technical Worker, Ohio Environmental Protection Agency, 1995-2001
- Third-party review of assessment and remediation of an unregulated captive landfill containing incineration waste and infectious waste at a community hospital | Central Ohio
- Third-party review of environmental assessment of the off-site vapor intrusion potential of chlorinated solvents at a former manufacturing facility | Columbus, Ohio
- Third-party review of Conceptual Site Model, Work Plans and Human Health and Ecological Risk Assessments of coal combustion residuals at fossil fuel plant under state environmental orders | Confidential location

Eco-toxicology and Chemical Hazard Assessment

- Ecological toxicity and environmental fate assessments for more than sixty substances under European Union REACH program | Various chemical manufacturers in Austria, Belgium, Czech Republic, Germany, United Kingdom and United States.
- Coordination of laboratory testing for aquatic and terrestrial eco-toxicological environmental fate and physico-chemical endpoints of more than ten substances.
- Evaluation of chemical residuals in superphosphate fertilizer, Regulatory inquiry by Government of India | Chemical manufacturer, India.
- Evaluation of perfluorocarbon substance used as a filter coating, due diligence inquiry | Industrial filter manufacturer, United States.

- Evaluation of ecological hazard posed by partitioning of an anti-cancer pharmaceutical in surface water and sediments.

Lectures, Presentations, and Publications

- "A Decision Matrix of Risk Management Options Based on the Non-cancer Safety Range for TCE", a presentation at the American Institute of Professional Geologists, Ohio Section, Vapor Intrusion Short Course, Delaware, Ohio, 11 October 2018.
- "Multi-Agency Partnerships and Cooperation: One Smart Way to Manage Algal Toxins in a Drinking Water Source through Mitigation and Treatment." Co-presenter with Fernanda Craig (Muskingum Watershed Conservancy District) at the AGWA Smart Water Conference, University of Akron, 31 May 2018.
- "The Challenge of HABs in a Drinking Water Source Creates Opportunity for Multi-Agency Cooperation." Co-presenter with John Watkins and Fernanda Craig (Muskingum Watershed Conservancy District) at the Water Management Association of Ohio 46th Annual Conference, Voices for Water, Worthington, Ohio, 2 November 2017.
- "A Framework for Using the Reference Concentration for TCE as a Basis for Action Levels and Remedial Objectives", a presentation as part of the TCE Panel at Vapor Intrusion: The Conference II – Legal, Technical and Regulatory Perspectives, Association of Environmental and Engineering Geologists conference, Charlotte, NC, 5 October 2017.
- "Non-cancer Risk Assessment Workshop." One-day workshop on the principles of non-cancer assessment, the development of toxicity values for non-cancer endpoints, the derivation of screening levels and action levels from the toxicity criteria, focusing on trichloroethylene, tetrachloroethylene and xylene as examples and case studies, co-presenter with Andrew Maier (University of Cincinnati) and Rod Thompson (Indiana University-Purdue University Indianapolis) for the Indiana Department of Environmental Management, Indianapolis, Indiana, 26 September 2017.
- "From the Fire into the (non-stick) Frying Pan: Some Background Information for Public Water Systems on Perfluoroalkyl Substances and the Drinking Water Health Advisories for PFOA and PFOS." Toledo Metropolitan Area Council of Governments (TMACOG) Public Water Supply Committee, Toledo, OH, 7 September 2017.
- "Using the Non-cancer Safety Range to Develop Risk Management Options and Action Levels for TCE", co-presenter with Michael Dourson, University of Cincinnati Risk Science Center and Rod Thompson, Indiana University-Purdue University Indianapolis, at the Midwestern States Environmental Consultants Assn. conference, Innovative Sampling Strategies and Regulatory Insights in Vapor Intrusion", Indianapolis, IN, 4 May 2017. Available at: https://www.tera.org/Alliance%20for%20Risk/TCE2018/ARA_TCE2018a.htm
- "Determining a Safety Range of the Reference Concentration (RfC) for Trichloroethylene: A Useful Tool in Addressing the Uncertainty Associated with the Assessment of Non-cancer Health Effects at Vapor

Intrusion Sites", co-presentation with John Lowe, CH2M, at the Air and Waste Management conference, "Vapor Intrusion, Remediation and Site Closure: Balancing Technical Defensibility, Risk, Sustainability and Costs", San Diego, California, 7-8 December 2016.

- "Feasibility Considerations of Shoreside Ballast Water Management for Lakers", co-presentation with Travis Smith at the Great Lakes Commission conference, Great Lakes and St. Lawrence Ballast Water Workshop Detroit, Michigan, 16-17 November 2016.
- "First Flowback: A Review of EPA's External Review Draft Report of the Impact of Hydraulic Fracturing on Drinking Water Resources", presentation at The Shale Exchange: Shale Challenges and technical Solutions", sponsored by the Gas Technology Institute, at the University of Pittsburgh, Pittsburgh, PA, 20 October 2015.
- "TCE Vapor Intrusion: Making Sense of Conflicting Exposure Standards in Indoor Air", co-presentation with Chris Walker, VanKley and Walker, Ohio State Bar Association Environment, Energy and Resources Law Seminar, 25 April 2015.
- "Assessment of Drinking Water Risks from a Hypothetical Marcellus Shale Flowback Water Spill", poster at the National Groundwater Association Workshop, "Groundwater Quality and Unconventional Gas Development: is There a Connection?", Carnegie Mellon University, Pittsburgh, PA, 13-14 November 2014. Abstract available at: https://ngwa.confex.com/ngwa/gqhf14/webprogram/Paper10112.html
- "Non-cancer Hazard Range as a Tool to Aid Risk Management Decisions at TCE-Contaminated Sites", presenter on behalf of co-authors Bernard Gadagbui (TERA), David Gillay (Barnes & Thornburg), John Lowe (CH2M-Hill) and Rod Thompson (Risk Options, LLC), at the Vapor Intrusion, Remediation and Site Closure Conference, Air and Waste Management Association, Cherry Hill, NJ, 10 September 2014. Available: https://www.tera.org/Alliance%20for%20Risk/TCE2018/ARA_TCE2018a.htm
- "Case Study: Practical Guidance on the Development of a Non-cancer Hazard Range", co-presenter with Rod Thompson (Alliance for Site Closure), Beyond Science and Decisions: From Problem Formulation to Dose-response", Workshop VIII, Texas Commission on Environmental Quality, Austin, TX, 21-22 May 2014. Available at: https://www.tera.org/Alliance%20for%20Risk/TCE2018/ARA_TCE2018a.htm
- "Practical Guidance for Contaminated Sites: Trichloroethylene (TCE) Risk Assessment Case Study", Moderator for Alliance for Risk Assessment Webinar, 4 November 2013. Available at: https://www.tera.org/Alliance%20for%20Risk/TCE2018/ARA_TCE2018a.htm

KATHY SHEARER | Senior Scientist

HULL
Environment / Energy / Infrastructure

Kathy is a Senior Scientist with experience in environmental risk assessment within the environmental consulting field. She prepares and reviews human health and ecological risk assessments for Superfund sites, hazardous waste management units, brownfields, and other sites where hazardous substances or petroleum related chemicals pose a potential or known environmental or regulatory concern. Her experience also includes data compilation, data auditing, data evaluation, summary statistics, field sampling/biological surveys, sediment toxicity, and preparation of technical dossiers to comply with the requirements of the European Union REACH program.

Kathy's expertise includes:

Human Health and Ecological Risk Assessment

- Served as a senior reviewer and administrative project manager/risk assessor for RIFS Scoping Level and Baseline Level Risk Assessments and Focused Feasibility Study Risk Assessments (human health and ecological) for numerous Operable Units.
- Prepared and reviewed numerous risk assessments at former industrial, underground storage tank (UST), and petroleum sites in Ohio and Pennsylvania for the Ohio EPA Voluntary Action Program, Ohio BUSTR and Pennsylvania Act 2 programs.
- Prepared numerous risk evaluations for brine spills from produced water and flowback releases at Oil and Gas Well Pad sites in the Marcellus and Utica Shale formations in Pennsylvania and Ohio.
- Prepared a risk evaluation for agricultural receptors for a well control event in Texas.
- Served as an ecological risk assessor at sites in many states, under CERCLA, RCRA and various state programs.
- Prepared technical dossiers in the IUCLID database for environmental fate and ecotoxicological endpoints for chemical registration under the European Union REACH program.
- Data evaluation and statistical analysis to support a Natural Resource Damage Assessment (NRDA).

Field Sampling/Biological Surveys/Sediment Toxicity

- Participated in a field sampling program to evaluate water quality of the Tuscarawas River using the Sediment Triad Evaluation methodology.
- Prepared a chromium bioavailability report for potentially impacted sediments at a former Ferroalloy production facility in South Carolina.

Selected project experience:

- Former Chemical Manufacturing Facility | Human Health and Ecological Risk Assessment | Painesville, Ohio
- Cement Kiln Dust Landfill | Human Health and Ecological Risk Assessment | Fairborn, Ohio
- Lime Fill Material Landfills (Landfills containing Fly ash from combusted coal, limestone fines, hydrated lime and precipitated calcium sulfate) | Human Health and Ecological Risk Assessment | Huron Township, Ohio
- Former Paperboard Plant Captive Landfill | Non-Hazardous Constituents Compliance Report, Ecological Risk Assessment | Rittman, Ohio
- Ecological Risk Assessment | 3,000-acre RCRA Site | Barberton, Ohio
- Ecological Risk Assessment | Marine Estuary RCRA Site | Lake Charles, Louisiana

EDUCATION:

- Master of Science, Biology, John Carroll University, 1994
- Bachelor of Science, Biology, John Carroll University, 1992

TRAINING:

- Society of Environmental Toxicology and Chemistry (SETAC), Short Course: Multivariate Analysis of Ecotoxicological Data. Charlotte, North Carolina (1998)
- SETAC, Short Course: Environmental organic and inorganic chemistry: The nature and fate of common site contaminants. San Francisco, California, (1997)
- Duke University, Workshop: New advances in ecological risk assessment, Durham, North Carolina, (1997)
- SETAC, Short Course: Population and community ecology: Environmental toxicology and risk assessment. Washington D.C. (1996)
- American Heart Association CPR/AED and First Aid Certification (through October 2021)
- Smith DriverDirect On Road Defensive Driving Certification (March 2014)
- OSHA 1910.120, 8-Hour Hazardous Waste Operations Refresher Training (1996-2020)
- OSHA 1910.120, 40-Hour Hazardous Waste Operations Training (1995)

AFFILIATIONS:

- Women's Energy Network (WEN) – Appalachia Chapter Member, 2017-Present
- Society of Environmental Toxicology and Chemistry (SETAC), 1996-2000, 2020

Years with Hull: 20
Other:
ChemRisk Scientist: 5 years;
Cleveland Metroparks, Lorain County MetroParks Part-time Naturalist: 7 years.

SARAH M. EWING | Senior Scientist

HULL
Environment / Energy / Infrastructur

EDUCATION:
- Master of Science in Environmental Toxicology, The Ohio State University, 2008
- Bachelor of Science in Biology, John Carroll University 2001

TRAINING:
- "Theories and Practices in Toxicology and Risk Assessment", 36th Annual Conference (April 2002)
- SEVIEW fate and transport modeling training seminar (September 2002)
- OSHA 1910.120 40-hr Hazardous Waste Operations Training Course (2001)
- Annual Refreshers for OSHA Safety & Hazardous Waste (2002- 2020)
- First Aid and CPR Training (2002-2005)
- SETAC North America 27th Annual Meeting, Montreal QC, 2006
- Ohio Valley Chapter SETAC 23rd Annual Meeting Indianapolis, IN (2006)
- ODOT OES Categorical Exclusion Training Class November 2010

AFFILIATIONS:
- The Society of Environmental Toxicology and Chemistry (SETAC), 2006-2010
- The Ohio Valley Chapter SETAC, 2006-2010

Years with Hull: 19
Other: The Ohio State University, Graduate Teacher's Assistant 2 years

Sarah Ewing conducts human health risk assessments for a variety of regulatory programs. She has assisted in the preparation and review of over twenty No Further Action (NFA) Letters and associated documents through the Ohio Voluntary Action Program (VAP). She is involved in data management, data analysis, data compilation, data auditing, and data evaluation. She has also worked on National Environmental Policy Act (NEPA) documents including categorical exclusions and environmental assessments. She has prepared multiple risk-based documents and data reviews under both the Bureau of Underground Storage Tank Regulations (BUSTR) and Resource Conservation and Recovery Act (RCRA) programs. Sarah also has professional experience in the field of environmental toxicology, including ecological risk assessments, field sampling/biological surveys and bioassays.

<u>Sarah's expertise includes:</u>

Human Health Risk Assessments
- Completes risk assessments for properties by managing, modeling, and evaluating data concerning toxicity and other potential hazards and risks
- Reviews and completes risk-based reports for various regulatory programs (i.e., work plans, sampling plans, risk assessments, Operation & Maintenance Plans, Risk Mitigation Plans, soil management plans)
- Assisted in the planning and preparation of over 20 Ohio VAP risk assessments and associated NFA Letters
- Assists in the completion of proposals and sampling plans for a variety of Ohio BUSTR petroleum sites and Ohio VAP projects, including technical review of data and information gathered by third parties

Ecological Risk Assessments
- Compiles, analyzes, and evaluates data concerning toxicity and other potential hazards
- Conducts air flow and BIOSCREEN fate and transport modeling
- Completes feasibility studies and ecological risk reports

<u>Selected project experience:</u>
- Career Technical High School: Property-Specific Risk Assessment and VAP NFA Letter | Cleveland, Ohio
- Active Chemical Manufacturing Facility: Property-Specific Risk Assessments and VAP NFA Letters, and RCRA Closure Documents | Cleveland, Ohio
- 3.699-Acre Former Shipyard Property: Property-Specific Risk Assessment and VAP NFA Letter | Cleveland, Ohio
- Multiple Portions of Former Rubber Manufacturing Facility: Property-Specific Risk Assessments and VAP NFA Letters | Akron, Ohio
- Environmental Assessment: Telecommunications Network | Bradley, Monroe, Hamblen, Washington, Sullivan, Putnam, and Anderson Counties, Tennessee
- Environmental Assessment: Stream Channel Restoration (in progress) | Brecksville, Ohio
- Former Automotive Component Manufacturing Facilities: Technical Review and RCRA Project Support | Dayton, Ohio and Kettering, Ohio
- Park District Trail Alignment: Preliminary Risk Evaluations | Cleveland, Ohio
- Redevelopment of Former Chemical Manufacturing Facility: Human Health and Ecological Risk Assessments | Painesville, Ohio

DESIGNATED CONTACT: Vendor appoints the individual identified in this Section as the Contract Administrator and the initial point of contact for matters relating to this Contract.

Dominick Anselmo

(Name, Title)

Sr. Project Mangaer

(Printed Name and Title)

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danselmo@hullinc.com

(email address)

CERTIFICATION AND SIGNATURE: By signing below, or submitting documentation through wvOASIS, I certify that I have reviewed this Solicitation in its entirety; that I understand the requirements, terms and conditions, and other information contained herein; that this bid, offer or proposal constitutes an offer to the State that cannot be unilaterally withdrawn; that the product or service proposed meets the mandatory requirements contained in the Solicitation for that product or service, unless otherwise stated herein; that the Vendor accepts the terms and conditions contained in the Solicitation, unless otherwise stated herein; that I am submitting this bid, offer or proposal for review and consideration; that I am authorized by the vendor to execute and submit this bid, offer, or proposal, or any documents related thereto on vendor's behalf; that I am authorized to bind the vendor in a contractual relationship; and that to the best of my knowledge, the vendor has properly registered with any State agency that may require registration.

Hull & Associates LLC

(Company)

David B. Mustafaga

(Authorized Signature) (Representative Name, Title)

David B. Mustafaga VP Environmental

(Printed Name and Title of Authorized Representative)

7/29/20

(Date)

614-793-8777

(Phone Number) (Fax Number)