FEASIBILITY STUDY REPORT
OPERABLE UNIT 2

Kerr-McGee Chemical Corp.—Navassa Superfund Site

Navassa, North Carolina
EPA ID #NCD980557805

Prepared for
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Trustee of the Multistate Environmental Response Trust

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ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
AUF	area use factor
BaP	benzo[*a*]pyrene
bgs	below ground surface
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	constituent of concern
COPC	constituent of potential concern
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
FS	feasibility study
GRA	general response action
HHRA	human health risk assessment
HI	hazard index
HMW	high molecular weight
HQ	hazard quotient
Integral	Integral Engineering, P.C.
Kerr-McGee	Kerr-McGee Chemical Corporation
Koc	organic carbon partitioning coefficient
LMW	low molecular weight
LOAEL	lowest-observed-adverse-effect level
Multistate Trust	Greenfield Environmental Multistate Trust LLC
NCDEQ	North Carolina Department of Environmental Quality
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance

OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PDI	pre-design investigation
pg/g	picograms per gram
PCP	pentachlorophenol
PRG	preliminary remediation goal
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
RSL	regional screening level
RTPO	remediation technology and process option
Site	Kerr-McGee Chemical Corp.—Navassa Superfund site
SRI	supplemental remedial investigation
SWAC	surface weighted average concentration
TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEQ	toxic equivalency
Tronox	Tronox, LLC
TRV	toxicity reference value

EXECUTIVE SUMMARY

Greenfield Environmental Multistate Trust LLC, not individually but solely in its representative capacity as Trustee of the Multistate Environmental Response Trust (Multistate Trust), has prepared this feasibility study (FS) report for Operable Unit 2 (OU2) of the Kerr-McGee Chemical Corp. – Navassa Superfund site, located in Navassa, North Carolina (U.S. Environmental Protection Agency [EPA] ID# NCD980557805]). OU2 encompasses approximately 15.6 acres in an area previously used to store treated and untreated wood. OU2 is located south of OU1, north of the Process Area, and west of the Eastern Upland Area. This FS report evaluates remedial alternatives for OU2 soils contaminated with polycyclic aromatic hydrocarbons (PAHs), measured as benzo[*a*]pyrene (BaP) toxic equivalency (TEQ) or summed as high molecular weight (HMW) PAHs, BaP, naphthalene, pentachlorophenol (PCP), and/or dioxins and furans, measured as 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) TEQ, at concentrations that pose an unacceptable risk to human health and the environment. The objective of the FS is to evaluate remedial alternatives for OU2 pursuant to the Comprehensive Environmental Response, Compensation and Liability Act and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300).

The majority of the former Kerr-McGee Chemical Corporation property is zoned for heavy industrial use, except for two former residential parcels located in the Eastern Upland Area that are zoned R-10 (Moderate Density Single Family Residential). Upon completion of the remedial action, the Multistate Trust intends to make OU2 available for community-supported redevelopment. The future zoning designation will be determined through the Town of Navassa's rezoning process. The Town of Navassa expressed a preference for flexibility to support a mix of potential land uses. As discussed below, the risk assessments found that the same parts of OU2 contribute to both unacceptable ecological risks and residential risks. Further, review of the soil data set for OU2 has shown that the North Carolina Department of Environmental Quality (NCDEQ) requirements for unrestricted use, as defined under North Carolina General Statute § 143B-279.9(d)(1), can be achieved in OU2. EPA and NCDEQ, in collaboration with the Multistate Trust, have decided to remediate OU2 to support residential use.

An extensive data set has been developed to characterize the nature and extent of contamination in OU2 soils over the course of multiple sampling investigations conducted from 2004 to 2021. The 15.6-acre area of OU2 was subdivided into 91 parcels of 0.25 acre or less to support evaluation of potential risks to a residential receptor as part of the 2021 OU2 human health risk assessment (2021 OU2 HHRA; Integral 2021a). The 2021 OU2 HHRA and 2021 OU2 HHRA Addendum (Integral 2021b) identified unacceptable risks (i.e., total excess lifetime cancer risk [ELCR] greater than 1.0×10^{-4} or noncancer risk hazard index [HI] greater than 1.0) to potential future residential receptors in OU2 soils, with PAHs (as BaP TEQ), BaP, naphthalene, PCP, and dioxins and furans (as TCDD TEQ) identified as the constituents of concern. The

ELCRs were less than 1.0×10^{-4} and the HIs less than 1.0 for all other receptors evaluated, indicating no unacceptable risk to commercial/industrial workers, construction workers, trespassers, recreational youth sports players, and site visitors/trail walkers. This FS identifies remedial action objectives (RAOs) to prevent potential unacceptable risk to future child and adult residents from long-term exposure through incidental ingestion of, dermal contact with, and/or inhalation of OU2 surface soils (up to 1 ft below ground surface [bgs]) and subsurface soils (1 to 2 ft bgs).

The ecological risk assessment (2021 OU2 ERA) (Ramboll 2021) evaluated potential risks associated with PAHs and dioxins and furans to a representative range of songbird and mammal receptors under a range of diet and home range scenarios. In addition, the ERA evaluated potential risks to soil invertebrates. The ERA identified hazard quotients greater than 1 for the American robin, American woodcock, and the short-tailed shrew due to HMW PAHs in OU2 soils—indicating potentially unacceptable risks. This FS identifies RAOs to prevent potential unacceptable risk to ecological receptors from long-term exposure to OU2 surface soils and through the food web. The highest concentrations of HMW PAHs (and thus the greatest contribution to ecological risk) are limited to a small number of OU2 parcels—several of which were identified as having unacceptable risk to a residential receptor. As a result, remediation of these parcels to address human health risks to a future resident will achieve the RAOs for ecological risks in OU2.

General response actions and remedial technologies and process options (RTPOs) evaluated in the FS are summarized in the table below. The RTPOs identified for OU2 soils were evaluated to identify those that are most viable to the specific conditions associated with OU2. Each RTPO was screened based on effectiveness, implementability, and relative cost to identify the RTPOs to be considered in the development of remedial alternatives. RTPOs shown in bold in the table below were retained for consideration in remedial alternatives development.

General Response Action	Description	Remedial Technology and Process Options (bold = retained)
No Action	No remedial action is taken and all contamination is left in place.	Institutional Controls
Monitoring	Measurement of contaminant concentrations over time to determine changes and trends in contaminant nature and extent.	**Construction Monitoring** **Long-Term Monitoring**
Containment/Isolation	Use of engineered barriers that prevent/limit contaminant migration and receptor contact with contamination, and/or prevent clean media from becoming contaminated.	**Cap/Cover**
Removal	Removal of contaminated media from their original location.	**Excavation**
Treatment	Use of *in situ* or *ex situ* technologies to chemically degrade and/or physically stabilize contaminants.	*In Situ* Stabilization *In Situ* Chemical Amendment *Ex Situ* Stabilization Land Farming Soil Washing
Disposal	Placement of contaminated media in a new, controlled location that eliminates potential exposure pathways between receptors and contaminated media.	**Onsite Reuse/Consolidation** **Offsite Landfill Disposal**

In collaboration with EPA and NCDEQ, the retained RTPOs were evaluated to develop the following remedial alternatives for OU2:

- Alternative 1: No Action—No action provides an assessment of the "as is" condition as a baseline for evaluating active remedial alternatives.
- Alternative 2: Removal and Offsite Disposal—This alternative includes the following main elements: excavation of contaminated OU2 soils, placement of clean backfill, and offsite disposal of excavated soils.
- Alternative 3: Removal, Onsite Reuse/Consolidation, and Offsite Disposal—This alternative includes the following main elements: excavation of contaminated OU2 soils, placement of clean backfill, onsite stockpiling for reuse/consolidation[1] of lower

[1] See Section 4.2.2.6.

concentration excavated soils in OU4, and offsite disposal of higher concentration excavated soils.

- Alternative 4: Cover and Institutional Controls—This alternative involves placement of a 1-ft-thick soil cover over contaminated OU2 soils and implementation of institutional controls to limit activity/use that could disturb the soil cover.

Each alternative was evaluated according to the remedy evaluation criteria specified by EPA and the NCP. To be eligible for selection as EPA's preferred alternative, the alternative must meet two threshold criteria: 1) overall protection of human health and the environment and 2) compliance with applicable or relevant and appropriate requirements. Five balancing criteria are then applied as a framework to assess tradeoffs among long-term effectiveness; short-term effectiveness; reduction in contaminant toxicity, mobility, or volume through treatment; implementability; and estimated cost of each alternative. The final two criteria address state and community acceptance. These are considered modifying criteria and are assessed by EPA, after the FS, based on consideration of state and public comment on EPA's proposed plan for remedial action.

The diagram below summarizes the results of the detailed evaluation of selected remedial alternatives presented in this FS.

LEGEND
- Excellent
- Good
- Fair
- Poor
- Very Poor

		EVALUATION CRITERIA							
		Threshold		Balancing					
		Protectiveness	Compliance with ARARs	Long-Term Effectiveness	Short-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume through Treatment	Implementability	Estimated Cost (millions)	***OVERALL RATING***
Alternative 1	No Action	Very Poor	Very Poor	Very Poor	Very Poor	NA	Excellent	$0.03	Very Poor
Alternative 2	Removal and Offsite Disposal	Excellent	Excellent	Excellent	Fair	NA	Excellent	$1.59	Excellent
Alternative 3	Removal, Onsite Reuse/ Consolidation, and Offsite Disposal	Excellent	Excellent	Good	Good	NA	Good	$1.46	Good
Alternative 4	Cover and Institutional Controls	Excellent	Excellent	Good	Excellent	NA	Poor	$1.11	Fair

Notes:
NA = not applicable. There are no principal threat wastes in OU2 and thus this criterion is not applicable

Alternative 1 (No Action) does not meet the threshold criteria and thus is not considered a viable alternative for OU2 soils. The remaining three alternatives all meet the threshold criteria.

Alternatives 2 and 3 rank similarly and higher than Alternatives 1 and 4 when considered across the five balancing criteria:

- **Long-term effectiveness**. Alternative 1 would not achieve the RAOs. Alternative 2 represents the highest level of long-term effectiveness and permanence because it would completely remove OU2 soils exceeding the preliminary remediation goals (PRGs) from the Site and minimize the potential for future remedy changes and long-term management.
- **Short-term effectiveness.** Alternative 1 would not achieve the RAOs. Alternatives 2 through 4 would involve the use of conventional construction techniques and would be effective immediately upon completion. The higher level of truck traffic associated with Alternative 2 presents a greater short-term risk and higher nuisance to workers and the community relative to Alternatives 3 and 4.
- **Implementability**. This criterion does not apply to Alternative 1 because no remedial actions would be implemented. Alternative 2 is easily implemented with conventional construction techniques. Alternative 3 also uses conventional construction techniques but may pose some challenges to implementation because reuse/consolidation of soils will be dependent on the OU4 remedy. Alternative 4 may pose challenges because it would require institutional controls and coordination with future property owners each time the property is sold or subdivided.
- **Reduction in contaminant toxicity, mobility, or volume through treatment.** This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment of hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at a site. There are no principal threat wastes in OU2, and this criterion does not apply.
- **Estimated cost.** Alternative 1 carries the lowest cost because no action is performed. Alternative 4 ranks higher than Alternatives 2 and 3 in a comparison of the estimated costs.

The modifying criteria are state and community acceptance. EPA will formally assess state acceptance and community acceptance after the proposed plan public comment period. This FS informally evaluates the modifying criteria of each alternative based on previous discussions with stakeholders. Alternative 2 ranks highest when considering the modifying criteria. Alternative 1 is not expected to be accepted by the regulatory agencies or the community because it does not address the unacceptable risks associated with OU2 soils. Alternatives 2 and 3 are likely to be acceptable to the State and the community because they would completely remove OU2 soils exceeding the PRGs from the Site. Alternative 3 may have a lower level of

State and community acceptance because this alternative would involve the placement of OU2 soils within OU4. Alternative 4 for OU2 has not been discussed with the community, and it is not clear how it would be perceived.

EPA will present the preferred alternative for OU2 in the proposed plan that is made available to the public and seek the public's input in accordance with the NCP at 40 CFR 300.430(f)(2). EPA will consider input from the public provided during public meetings and in written comments on EPA's proposed plan. The final selected remedy for OU2 will be documented in the record of decision issued by EPA.

1 INTRODUCTION

This report presents the feasibility study (FS) for Operable Unit 2 (OU2), which encompasses 15.6 acres of the Kerr-McGee Chemical Corp. – Navassa Superfund site, located in Navassa, North Carolina (U.S. Environmental Protection Agency [EPA] ID# NCD980557805]), referred to herein as "the Site." This report is being submitted by Integral Engineering, P.C. (Integral) on behalf of Greenfield Environmental Multistate Trust LLC, not individually but solely in its representative capacity as Trustee of the Multistate Environmental Response Trust (the Multistate Trust).

The Site operated as a creosote-based wood treating facility from 1936 to 1974. The Site location is shown on Figure 1-1. Figure 1-2 provides a Site overview showing the property boundary, Site operable units (OUs), Process Area, Pond Area, Wood Storage Areas, and other prominent features associated with former wood treatment operations. OU2 is located north of the Process Area, south of OU1, and west of the Eastern Upland Area in an area previously used to store treated and untreated wood.

A 1984 letter from Kerr-McGee Chemical Corporation (hereafter referred to as "Kerr-McGee") is the only documentation of the decommissioning of the former wood treating facility; there are no work plans, reports, photos, surveys, analytical results, or construction reports. Kerr-McGee reported that it dismantled and sold as scrap all equipment, treatment cylinders, buildings, and tanks. Kerr-McGee reforested the area by planting pine trees. At present, there are some building foundations at the Site. Although the aerial photos show extensive rail lines across the Site, the only intact railroad tracks at present are a 10- to 15-ft-long segment that is set into a concrete slab. No Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) response actions have been completed in OU2 to date.

Investigations from 2004 to 2018 indicated that soil, groundwater, and sediment at the Site were impacted by historical operations at the facility (EarthCon 2019a). Data collected for the Site remedial investigation (RI) (EarthCon 2019a) were incorporated into the analyses performed for the 2019 Site human health risk assessment (HHRA) and subsequent HHRA Addendum (EarthCon 2019b,c), which have been approved by EPA and the North Carolina Department of Environmental Quality (NCDEQ). Additional data were collected in 2020 and 2021 to provide sufficient data to evaluate potential risks in OU2 based on a range of land uses, including residential.

The 2019 HHRA and 2019 HHRA Addendum identified chemicals of interest (identified in those documents as "chemicals of potential concern") for the Site based on the Site operations history. The 2019 HHRA and 2019 HHRA Addendum identified polycyclic aromatic hydrocarbons (PAHs) and pentachlorophenol (PCP), chemicals associated with wood treatment, as chemicals of interest for OU2 soils. Groundwater underlying OU2 is not impacted based on three groundwater samples. During the planning for the 2020 field investigations, dioxins/furans were identified as chemicals of interest due to detections of PCP in soils and groundwater and the understanding that dioxins/furans can be an impurity in PCP solutions.

The revised data set for OU2 following the 2020 and 2021 field investigations was incorporated into the updated 2021 OU2 HHRA (Integral 2021a) and the 2021 OU2 ecological risk assessment (ERA) (Ramboll 2021), which were approved by EPA and NCDEQ on September 30, 2021. A 2021 OU2 HHRA Addendum (Integral 2021b) was prepared to present updated risk calculations for nine OU2 parcels based on follow-up sampling conducted in September/October 2021 as part of the OU2 pre-design investigation (PDI) (Integral 2021c,d). The 2021 OU2 HHRA Addendum was approved by EPA and NCDEQ on December 28, 2021. The 2021 OU2 HHRA and 2021 OU2 HHRA Addendum identified unacceptable risks (i.e., total excess lifetime cancer risk [ELCR] greater than 1.0×10^{-4} or noncancer risk hazard index [HI] greater than 1.0) to potential future residential receptors in OU2 soils (Integral 2021a,b) from the following compounds:

- PAHs (expressed as benzo[*a*]pyrene [BaP] toxic equivalency [TEQ])
- The individual PAHs BaP and naphthalene
- PCP
- Dioxins/furans (consisting of 17 dioxin and furan congeners, expressed as 2,3,7,8-tetrachlorodibenzo-*p*-dioxin [TCDD] concentrations, or "TCDD TEQ").

These chemicals were identified as constituents of concern (COCs) in the updated 2021 OU2 HHRA. The HHRA found no unacceptable risk to commercial/industrial workers, construction workers, trespassers, recreational youth sports players, and site visitors/trail walkers.

The 2021 OU2 ERA evaluated potential risks associated with PAHs and dioxins/furans in soils to a representative range of bird and mammal receptors under a range of diet and home range scenarios. In addition, the ERA evaluated potential risks associated with PAHs in OU2 soils to soil invertebrates. The ERA identified hazard quotients (HQs) greater than 1 for the American robin, American woodcock, and the short-tailed shrew due to high molecular weight (HMW) PAHs in OU2 soils, and for soil invertebrates due to HMW and low molecular weight (LMW) PAHs. The highest concentrations of HWM and LMW PAHs (and thus the greatest contribution to ecological risk) are limited to small areas of OU2—most of which were identified also as having unacceptable risk to a residential receptor.

1.1 PURPOSE

This FS identifies the remedial action objectives (RAOs) for OU2 soils contaminated by PAHs, PCP, and dioxins/furans, and develops and evaluates remedial alternatives to mitigate unacceptable risks posed to human health and the environment as a result of that contamination. The objective of the FS is to develop and evaluate remedial alternatives in support of the remedy selection process conducted pursuant to CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] 300). The FS follows the NCP and EPA guidance provided in the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (Interim Final)* (USEPA 1988).

1.2 REPORT ORGANIZATION

The FS report is organized as follows:

- Section 1: Introduction—purpose and organization of the FS report
- Section 2: Background—site description, conceptual site model, risk assessments, summary of study area property investigations, OU2 delineation, and identification of preliminary remediation areas and volumes
- Section 3: Remedial Action Objectives and Preliminary Remediation Goals—applicable or relevant and appropriate requirements (ARARs), preliminary remediation goals (PRGs), and the RAOs
- Section 4: Identification and Screening of Technologies—general response actions, and identification and screening of remediation technologies and process options (RTPOs)
- Section 5: Development and Screening of Remedial Alternatives—evaluation criteria and description of remedial alternatives
- Section 6: Comparative Analysis of Remedial Alternatives—threshold criteria, balancing criteria, and modifying criteria
- Section 7: References
- Appendix A: OU2 Remediation Area Extents and TCDD TEQ Concentration Data
- Appendix B: Detailed Cost Estimate for Remedial Alternatives.

2 BACKGROUND

This section presents a summary of background information, including a description of the Site and its history, the investigations completed to characterize OU2 soils, and the 2021 OU2 HHRA, 2021 OU2 HHRA Addendum, and 2021 OU2 ERA.

2.1 SITE DESCRIPTION AND HISTORY

The Site is located at 34°14’50.0” North latitude and 77°59’56.5” West longitude in Navassa, Brunswick County, North Carolina. The Site was an industrial wood treating facility operated by Kerr-McGee and its predecessors/successors from 1936 to 1974. Tronox, LLC (Tronox), a successor to Kerr-McGee, was the sole potentially responsible party. Following Tronox’s bankruptcy and pursuant to a 2011 Consent Decree and Environmental Settlement Agreement, the Multistate Trust is responsible for implementing all environmental actions at the Site consistent with its obligations to the beneficiaries of the Multistate Trust, EPA, National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, and NCDEQ (USEPA 2021).

Most of the Site consists of the property formerly owned and operated by Kerr-McGee (the “former Kerr-McGee facility”). The Site includes a former wood treating facility (about 70 acres) and an approximate 30-acre area of intertidal marsh (termed the “Southern Marsh”) situated to the south (Figure 1-2). The former wood treating facility is part of a larger property owned by the Multistate Trust. The Southern Marsh is owned by the State of North Carolina. The former wood treating facility is where most of the historical wood treatment operations occurred and is bounded to the north by Quality Drive and Pacon Manufacturing; to the west by Navassa Road; to the east by the Eastern Upland Area, Eastern Marsh, and the Brunswick River; and to the south by the Southern Marsh and Sturgeon Creek. Neither the Eastern Upland Area nor the Eastern Marsh are part of the Site (Figure 1-2 [USEPA 2021]).

The facility was in use for active operations—treating wood for utility poles, railroad ties, and pilings—between 1936 and 1974. The facility was operated by the Gulf States Creosoting Company from 1936 to 1958, when it was sold to American Creosoting. The facility was sold to Kerr-McGee in 1965. Kerr-McGee used pre-cut lumber as raw material in its facility operations. The wood was sized, classified, and stacked onsite for a period of 1 year to dry prior to treatment. After drying, the wood was pressure treated in one of two treatment cylinders using a creosote and oil solution. The creosote-treated wood was stored in the yard until final shipment to customers. Kerr-McGee stored the creosote solution in above-ground steel tanks contained within a dike. Wastewater generated by the facility was collected and discharged into three surface impoundments in series. The first two impoundments, the “wastewater ponds” (Figure 1-2), installed by Gulf States Creosoting Company, were used to settle the creosote preservative, which was reclaimed and reused in the production process. The effluent from the two impoundments was recycled to a condenser as make-up cooling water, with excess wastewater discharged to an evaporation pond installed by Kerr-McGee in 1971. The facility also maintained a fire water storage pond and a boiler water storage pond (Figure 1-2 [USEPA 2021]).

Kerr-McGee discontinued operations in 1974 and dismantled the facility in 1980, selling as scrap all equipment, treatment cylinders, buildings, and tanks; although some building foundations remain on the property today. Kerr-McGee also reforested the area by planting pine trees. In 1991, 92 acres of the property marsh land was transferred to the State of North Carolina (USEPA 2021).

As shown on Figure 1-2, the Site has been divided into five OUs:

- OU1, the northernmost 20.2 acres of the Site formerly used for wood storage
- OU2, the 15.6-acre area south of OU1 and north of the process area that was formerly used for wood storage
- OU3, the Southern Marsh, which consists of an approximately 30-acre area of intertidal marsh that borders the former facility boundary
- OU4, the approximately 36-acre area at the southern end of the former facility, which includes the former facility ponds area, process area, and an area that was used for wood storage
- OU5, the groundwater impacted by the former facility operations, including groundwater underlying the southern end of OU4, the northernmost edge of OU3, and the area immediately southwest of OU4.

For the purposes of risk evaluation, OU1 and OU2 were divided into parcels no larger than 0.25 acre, using Thiessen polygon methodology incorporating the historical soil sample locations with PAH data (Figure 2-1). In October 2019, EPA released a Proposed Plan proposing a "No Action" decision for OU1 based on the findings of the 2019 HHRA and 2019 HHRA Addendum and assuming commercial, industrial, and recreational (walking trail) land uses. At that time, OU1 was defined as a 21.6-acre area, and OU2 consisted of 13.9 acres (Figure 2-1). During the public comment period for the October 2019 Proposed Plan, the public and the local government expressed interest in residential land use for the proposed 21.6-acre OU1 and, on March 10, 2020, the Town Council provided a "Letter of Position" to the EPA stating that the Town Council would like to pursue redevelopment scenarios in OU1 that could include residential uses.

Based on this input from the Town of Navassa, EPA and NCDEQ decided to evaluate OU1 for unrestricted use and to evaluate OU2 based on a range of land uses. To support these evaluations, additional sampling was conducted in 2020 in OU1 and OU2. Based on the findings of the 2020 sampling, the OU1 and OU2 boundary was redefined, as shown in Figure 2-1, such that OU1 would be limited to land that requires no action to support residential use with no land use restrictions based on the Site-specific threshold approved by EPA and NCDEQ. The revised OU1 and OU2 areas encompass 20.2 and 15.6 acres, respectively. EPA released a new OU1 Proposed Plan on January 8, 2021, proposing no action for the revised OU1 area, and the record of decision (ROD) for OU1 was signed April 1, 2021 (USEPA 2021).

2.2 LAND USE

Land use in the Navassa area of Brunswick County is both rural residential and industrial. The residential areas are west of the Site and Navassa Road. Most of the land area to the north of the Site remains undeveloped and consists of industrial sites and undeveloped coastal forest or low-lying marsh. The majority of the former Kerr-McGee property is zoned for heavy industrial use, except for two former residential parcels located in the Eastern Upland Area that are zoned R-10 (Moderate Density Single Family Residential). The future zoning designation will be determined through the Town of Navassa's rezoning process. Upon completion of the remedial action, the Multistate Trust intends to make OU2 available for community-supported redevelopment by selling the property to a developer who may rezone the property under the Town's zoning process.

In August 2020, the Multistate Trust completed the sampling needed to evaluate residential risk across OU2 and OU1. In October 2020, the Town of Navassa requested that the risk assessment evaluate risks under commercial, professional services, and recreational land use scenarios. As detailed below, the OU2 sampling found that the same parts of OU2 contribute to both unacceptable ecological risks and residential risks. Further, review of the soil data set for OU2 has shown that NCDEQ's requirements for unrestricted use, as defined under North Carolina General Statute § 143B-279.9(d)(1), can be achieved in OU2. Based on the sampling and risk assessment results, EPA and NCDEQ, in collaboration with the Multistate Trust, have decided to remediate OU2 to support residential use, which would also allow the uses envisioned by the Town of Navassa.

2.3 SUMMARY OF INVESTIGATIONS TO CHARACTERIZE OU2

The Site RI included several investigations to characterize the nature and extent of contamination at the Site, including:

- ENSR/AECOM Phase 1 RI in 2006
- ENSR/AECOM Phase 2 RI in 2008
- EPA Residential Sampling in 2010
- AECOM Supplemental RI (SRI) in 2012
- CH2M Hill SRI conducted in 2015 and 2016
- EarthCon SRI conducted in 2016 and 2017

- EarthCon trench evaluation conducted in 2018
- EarthCon surface soil study conducted in August and December 2020
- Ramboll ecological uptake study conducted in June 2020
- EarthCon and Integral 2021 subsurface soil sampling conducted in May 2021
- EarthCon and Integral OU2 PDI conducted in September 2021
- EarthCon and Integral OU2 Eastern Upland Area soil sampling conducted in September 2021.

The 2020 and 2021 OU2 sampling was conducted to evaluate human health risks for the range of land uses suggested by the Town (including residential land use without restrictions); to evaluate ecological risks; and to evaluate the potential risks associated with dioxins/furans in soils. This included surface soil sampling and an ecological uptake study in 2020 (EarthCon 2020a; Integral 2021a; Ramboll 2021) and three soil sampling events in 2021 (Integral 2021c,d,e,f).

The June 2020 uptake study consisted of a field investigation for soil invertebrates and co-located soil samples (Ramboll 2021) to support the calculation of Site-specific uptake factors for PAHs and dioxins/furans from soils to invertebrates and, in turn, to provide a better understanding of potential ecological risk. The August and December 2020 soil sampling was designed to provide data to evaluate potential risks under a future residential land use scenario, with the understanding that such data would also help evaluate risks under other future land uses (Integral 2021a). The sampling design involved subdividing OU2 into 91 parcels of 0.25 acre or less—the size of a potential future residential parcel as specified by NCDEQ. The May 2021 subsurface sampling (Integral 2021e) was designed to identify the vertical extent of dioxin/furan contamination per NCDEQ guidelines for assessment and cleanup of contaminated sites for unrestricted use (NCDEQ 2020). Soil data were collected from OU2 in September/October 2021 as part of the OU2 PDI (Integral 2021c,d) to establish the final area and volume of soil to be remediated to address unacceptable risks to human health and the environment, and to determine if planned OU2 remedial activities need to extend past the current OU2 boundary. Samples were also collected from the area to the east of the OU2 boundary as part of the OU2 Eastern Upland study (Integral 2021f) to identify if dioxin/furan contamination extended past the OU2 boundary.

2.4 NATURE AND EXTENT OF CONTAMINATION

Soil data collection in OU2 prior to 2020 was largely focused on PAHs. These data were supplemented by additional soil data collection performed in 2020 and 2021 (Integral 2021d,e). PAH data were used to calculate the BaP TEQ concentration. Figure 2-2 presents BaP TEQ concentrations in surface soil (between 0 and 1 ft below ground surface (bgs)). Sample locations on Figure 2-2 are shaded based on how much they exceed the residential regional screening level (RSL) for BaP based on a target cancer risk level of 1×10^{-4} (or 1 in 10,000), which is 11 mg/kg. The samples exceeding the RSL are not clearly clustered in any specific portion of OU2, which has been attributed to the decommissioning of the facility. The historical aerial photo shows significant infrastructure in 1969. At present, the only remaining pieces of infrastructure in OU2 are building foundations. The parcels with the highest concentrations of the two individual PAHs identified as COCs, BaP and naphthalene, also exceed 11 mg/kg BaP TEQ. These are TB-16 and SS-117 for BaP and TB-16 and TB-16F for naphthalene. Similarly, the highest concentrations of HMW PAHs, which are the primary driver for ecological risk at the Site, are from parcels TB-16, TB-12, SS-117, and TB-16F.

Soil data collection in OU2 prior to 2020 was largely focused on PAHs. In July 2020, EPA, NCDEQ, and the Multistate Trust agreed to include analysis of soil samples for dioxins and furans (a common impurity associated with PCP) to ensure adequate characterization of these chemicals. Dioxins/furans were not identified as constituents of potential concern (COPCs) for Site soils in either the April 2019 HHRA or the August 2019 HHRA Addendum (EarthCon 2019b,c) as there were not soil data available for these chemicals at the time. Sampling in OU2 was performed in August and December 2020 for surface soils (0–1 ft bgs) (Integral 2021a) and in May 2021 for subsurface soils (1–2 ft and 2–3 ft bgs) (Integral 2021c). Additional dioxin/furan, PAH, and PCP data were collected in September 2021 in support of the OU2 PDI (Integral 2021d,e) and OU2 Eastern Upland study (Integral 2021f).

Dioxin/furan data were used to calculate the TCDD TEQ concentration. Figure 2-3 presents TCDD TEQ concentrations compared to an RSL of 50 picograms per gram (pg/g), which corresponds to a noncancer HI of 1 assuming residential use. Only five 0.25-acre parcels exceeded 50 pg/g, and none of the parcels with elevated concentrations of TCDD TEQ had BaP TEQ concentrations above 11 mg/kg. One OU2 PDI surface soil sample on the eastern boundary of parcel RISB05 exceeded 50 pg/g TCDD TEQ; as a result, the OU2 boundary was expanded 241 ft^2 to the east (less than 0.01 acre) to locations where soil sample results were less than 50 pg/g TCDD TEQ. An OU2 PDI surface soil sample was collected in the western portion of Parcel CS-56 to determine the horizontal extent of TCDD TEQ contamination within the parcel. This sample was below 50 pg/g TCDD TEQ. Impacts to soil from TCDD TEQ are not clustered in any one region of OU2 and are not correlated with detections of PCP, which was only detected in 11 of 228 soil samples collected from OU2.

Sampling indicates that impacts to OU2 soils are limited to the top 2 ft. This pattern of impacts to surficial soils in wood storage areas is common to wood treatment sites in general. Characterization of PAHs in soils prior to 2020 demonstrated that PAH impacts are limited to the top 1 ft of soil. Impacts to soil due to TCDD TEQ are not clustered in any one region of OU2 and are primarily limited to 0 to 1 ft bgs. The 2021 subsurface sampling event targeted the parcels where surface soil TCDD TEQ concentrations exceeded 50 pg/g (Figure 2-3). Subsurface samples were collected from the 1- to 2-ft bgs and 2- to 3-ft bgs depth increments. TCDD TEQ impacts to subsurface soil were only identified in the 1- to 2-ft bgs depth increment in four parcels (Figure 2-3).

2.5 CONTAMINANT FATE AND TRANSPORT

Sections 2.5.1 and 2.5.2 discuss the fate and transport of the OU2 COCs identified in the 2021 human health and ecological risk assessments (Integral 2021a; Ramboll 2021): PAHs, PCP, and dioxins/furans (consisting of 17 dioxin/furan congeners, expressed as TCDD TEQ). The results of the risk assessments are further discussed in Section 2.6.

2.5.1 OU2 COC Sources

Based on historical aerial photos, Kerr-McGee used OU2 for wood storage. PAH and PCP contamination in OU2 likely originated from the storage of treated wood products, decommissioned rail line timbers, buried creosote timbers, and/or transport from other portions of the Site by movement of personnel and vehicles. Because the facility decommissioning removed most of the surface features (i.e., buildings, rail lines, railroad timbers, etc.) and possibly moved or removed soil, it is not possible to confirm the original source of contamination.

The remainder of this section evaluates possible sources of the dioxins/furans detected in OU2 soils; compares OU2 results to background samples; and presents a fingerprint analysis to evaluate the origin of dioxins/furans. The Trust evaluated several lines of evidence to determine the possible sources of dioxins/furans, but as discussed below, the source of dioxins/furans in OU2 soils remains unclear and the fingerprint analysis suggests a mixture of PCP and urban sources.

Dioxins/furans are a common contaminant at wood treatment sites that used PCP as a treatment solution and can be formed as by-products during the production of PCP. However, there is no known record that PCP was used at the Site. Levels of dioxins/furans are not correlated with levels of PCP in Site soils. PCP was detected in 11 of the 228 samples from OU2 in which it was analyzed. When detected, PCP is generally not present at concentrations seen at other former PCP wood treating operations. PCP detections in OU2 soils are located along the former rail lines. Evidence of smoke plumes can be seen in historical aerial photographs taken during periods of active Site operations.

Dioxins/furans are also a common urban contaminant and are frequently detected in urban soils. Multiple sources can contribute dioxins/furans to the environment, including, but not limited to, incinerators (e.g., at waste disposal facilities, hospitals, and other public, private, and industrial facilities), industrial emissions (e.g., coking and sintering processes), open fires, domestic waste and leaf burning, domestic wood and coal combustion, vehicle emissions, and railways (e.g., PCP-treated ties, rail diesel equipment). These sources commonly contribute low levels of dioxins/furans to urban soils but can result in localized occurrence of higher concentrations depending on location-specific factors (e.g., soils collected from or adjacent to a burn site). The *Draft Dioxin/Furan Soil Background Technical Memorandum* (EarthCon 2020b) found that, while present, the concentrations of dioxins/furans in background soils collected in the Eastern Upland Area were lower than the levels detected in isolated areas of OU2. Based on these findings, the relatively elevated dioxins/furans in isolated portions of OU2 soils do not appear to be related to urban background.

Another tool for evaluating the origin of dioxins/furans is called principal component analysis, which compares the relative abundance of individual dioxin/furan congeners. For the purposes of the human health and ecological risk assessments, dioxins/furans are expressed as TCDD TEQ, which consists of a mixture of 17 dioxin/furan congeners. The relative abundance of the 17 congeners is reflective of the source of dioxins/furans (i.e., each source has a unique profile or "fingerprint"). As a result, fingerprint analyses, such as principal component analyses, can be a powerful tool for evaluating the origin of dioxins/furans detected in the environment. Principal component analysis was performed for the Site soil dioxin/furan congener data and plotted for comparison with literature-based TCDD TEQ congener profiles. In preparation for principal component analysis, Site soil dioxin/furan congener data were sample-normalized (as percent of total TCDD TEQ), natural log-transformed, and autoscaled. Data were categorized by Site OU or offsite location, sample depth, and comparison to the residential RSL, 50 pg/g. Figure 2-4 Panel A (upper-left hand corner) plots the literature-based (reference) TCDD TEQ congener profiles for TCDD TEQ associated with:

- PCP solutions and PCP in soils at a wood treatment facility in Mississippi
- Urban soils
- Backyard burn barrel.

The reference TCDD TEQ congener profiles associated with these sources each plot in a distinct area, as represented by different colored ovals. These ovals are carried into the subsequent plots for comparison with the Site soil results.

The results of the Site soils principal component analysis were broken out by the various assigned categories (e.g., Site versus offsite) and are presented on Figure 2-4 Panels B, C, and D. Figure 2-4 Panel B presents the profiles for Site TCDD TEQ surficial soil (0–1 ft bgs) and subsurface soil (1–2 or 2–3 ft bgs) samples, as categorized by OU, and Eastern Upland ("offsite") surface soil samples. Figure 2-4 Panels C and D present the TCDD TEQ profiles for soil samples with TCDD TEQ concentrations greater than and less than 50 pg/g, respectively. The TCDD TEQ profiles for the majority of Site soil samples and for the soil samples collected offsite in the Eastern Upland Area are consistent with the TCDD TEQ profile reported in literature for urban soils. However, the OU2 soil samples with greater than 50 pg/g TCDD TEQ (Panel C) plot between the literature-reported profiles for urban soils and PCP-sourced dioxins/furans. These results indicate that dioxins/furans in OU2 soils that exceed 50 pg/g TCDD TEQ are related to a mix of PCP and urban sources. While the principal component analysis provides insight into the possible origin of dioxins/furans in OU2 soils, the specific source remains unclear. Thus, the 2021 OU2 HHRA identified dioxins/furans as a COC in OU2 soils and dioxins/furans are included in the RAOs and PRGs.

Together, these lines of evidence do not support the hypothesis that dioxins/furans originated from PCP used in wood treating operations. Rather, dioxins/furans may have originated from PCP-treated wood brought onto the Site to be used to support rail lines or from localized burning activities at the Site.

2.5.2 OU2 COC Transport Mechanisms

During past Site operations, a variety of natural processes (e.g., storm runoff, wind-blown dust, infiltration) and anthropogenic processes (e.g., transport by movement of personnel and vehicles, facility decommissioning activities) likely contributed to the transport of COCs from the original source areas within OU2. Because the facility decommissioning removed most of the surface features (buildings, rail lines, railroad timbers, etc.) and possibly moved or removed soil, it is not possible to confirm the original source of contamination nor the specific transport mechanisms that contributed to the present day distribution of COCs in soils.

The remainder of this section focuses on the mechanisms that could potentially result in the transport of COCs in OU2 soils under present day conditions. The transport of OU2 COCs is driven by physicochemical characteristics and onsite activities. The OU2 COCs are characterized by moderate to very low solubility and low volatility, and high organic carbon partitioning coefficients (K_{oc}; Table 2-1). As a result, the COCs are often strongly associated with the particulate phase (soils, sediment) in the environment, and transport of these chemicals in the environment is often tied to particulate transport mechanisms.

The following bullets discuss potential migration of COCs from OU2 soils resulting from transport mechanisms that may occur under current site conditions and reasonably anticipated future land uses:

- **Leaching with Infiltrating Water.** COCs in unsaturated zone soils can be mobilized to groundwater as a result of dissolution into and downward transport via infiltrating groundwater. Due to their high K_{oc} values, PAHs, PCP, and dioxins/furans are expected to be strongly adsorbed to organic matter in soils, and the transport of these chemicals with infiltrating water is expected to be attenuated within shallow soil depths. Based on the lack of observed groundwater contamination, the PAHs, PCP, and dioxins/furans in OU2 soils do not appear to be leaching to groundwater. The 2021 OU2 HHRA (Integral 2021a) found no unacceptable risk due to groundwater in OU2. Groundwater monitoring has shown that PAH concentrations in groundwater beneath OU2 are below EPA’s tapwater RSLs.
- **Airborne Transport** (e.g., windblown dust, air emissions associated with burning, volatilization). Based on the nature and extent of soil contamination and the present Site conditions, there appears to be limited potential for airborne transport of COCs from OU2 soils. Inhalation of volatiles and particulates (i.e., outdoor dust) emitted from surface soil and present in outdoor air was evaluated by the 2021 OU2 HHRA and was not found to

pose an unacceptable risk in OU2 under current Site conditions or under the reasonably anticipated future land uses.

- **Stormwater Runoff.** Stormwater runoff could result in the erosion of Site soils with flowing stormwater, but there is minimal potential for this mechanism to result in transport of OU2 COCs under present Site conditions. There is minimal potential for stormwater runoff draining into the drainage swale along Navassa Road to transport contaminants offsite because the OU2 area that drains to the Navassa Road drainage does not contain COCs above levels acceptable for residential land use. Most of the stormwater runoff from OU2 drains to the east and ultimately flows into the marshes bordering the Brunswick River and Sturgeon Creek (Figure 2-5). Future site remedial actions will include best management practices (BMPs) to prevent soil erosion (contaminated or uncontaminated) and to prevent potentially contaminated stormwater from migrating offsite. EPA sampled the drainage swale on the east side of Navassa Road in 2010 and concluded that there are no unacceptable risks from exposure to soil in the ditches or residential yards along Navassa Road (USEPA 2010a,b).
- **Vehicular Traffic.** Following Kerr-McGee's planting of trees across the Site, traffic within OU2 is minimal and thus unlikely to be a significant present-day mechanism for contaminant transport. Future site remedial actions will include BMPs to prevent transport of OU2 COCs with fugitive dust and vehicle track out. Inhalation of particulates (i.e., outdoor dust) emitted from surface soil and present in outdoor air was evaluated by the 2021 OU2 HHRA and was not found to pose an unacceptable risk in OU2 under current Site conditions or under the reasonably anticipated future land uses, including potential exposure to construction workers.

2.6 RISK ASSESSMENT

This section summarizes the OU2 human health and ecological risk assessment efforts. The risk assessments quantify potential unacceptable risks to human and ecological receptors and identify the contaminants and exposure pathways that need to be addressed by the remedial action to protect human health and the environment.

2.6.1 Human Health Risk Assessment

Human health risks for OU2 were evaluated in the 2019 HHRA and 2019 HHRA Addendum (EarthCon 2019b,c). Additional data collection was performed in 2020 and 2021 to support risk management decisions and to evaluate potential risks associated with dioxins/furans in soils, and to support the 2021 OU2 HHRA and 2021 OU2 HHRA Addendum (Integral 2021a,b).

2.6.1.1 Site-Wide 2019 HHRA and 2019 HHRA Addendum

The 2019 HHRA documents the baseline health risks for current and future receptors using the data collected between 2003 and 2017. The 2019 HHRA did not evaluate risks to the currently defined OU2, but rather defined exposure areas based on historical site uses: Process Area, Pond Area, Treated Wood Storage Area, Untreated Wood Storage Area, Eastern Upland Area, West of Navassa Road, Southern Marsh, and Sturgeon Creek. As shown on Figure 1-2, OU2 includes portions of the Treated and Untreated Wood Storage Areas.

The 2019 HHRA evaluated risks from COPCs in groundwater, soil, sediment, and surface water:

- The 2019 HHRA concluded that, except for in the Pond and Process Areas, risks from Site soils are acceptable based on future commercial/industrial and recreational land uses—including in the Treated and Untreated Storage Areas in which OU2 is located.
- The 2019 HHRA found no unacceptable risks to construction workers due to exposure to PAHs and PCP in the Treated and Untreated Storage Areas surface and subsurface soils.
- The 2019 HHRA concluded that groundwater impacts are limited to areas in the southernmost portion of the Untreated Wood Storage Area adjacent to the Pond and Process Areas (Figure 1-2). Consequently, risk due to groundwater contamination was not estimated in the 2019 HHRA for the Treated Wood Storage Area and Untreated Wood Storage Area. No COPCs were detected in OU2 groundwater.
- The sediment and surface water pathways were not evaluated for the portions of the Treated Wood Storage Area and Untreated Wood Storage Area where OU2 is located because these media are not present there.

The 2019 HHRA Addendum was prepared in August 2019 to provide an updated evaluation of the potential risk and hazard to humans from Site-related contaminants present in soils in OU1 and OU2 considering new data collected at the Site in June 2019. The 2019 HHRA Addendum concluded that the overall risk from soil in OU1 and OU2 is acceptable for commercial, industrial, or recreational use. Risk was unacceptable for residential use for portions of OU2 due to PAHs in surface soils based on exceedance of the ELCR target risk of $1{\times}10^{-4}$.

Based on the 2019 HHRA and 2019 HHRA Addendum, EPA issued the October 2019 Proposed Plan for a no action decision for the northern portion of the Treated and Untreated Wood Storage Areas. In response to the October 2019 Proposed Plan the Navassa Town Council provided a "Letter of Position" to the EPA on March 10, 2020, clarifying the Town's position on reasonably anticipated land uses for OU1. Based on this input from the Town Council, EPA and NCDEQ, in collaboration with the Multistate Trust, decided to collect additional data to further characterize OU1 and OU2 to a level sufficient to assess a range of potential future land uses, including unrestricted (residential) land use and potential recreational uses (sports fields, nature trails) identified by the Town of Navassa that were not previously evaluated in the 2019 HHRA or 2019 HHRA Addendum.

2.6.1.2 2021 OU2 HHRA and 2021 OU2 HHRA Addendum

The Multistate Trust, in collaboration with EPA and NCDEQ, laid out the approach for evaluation of human health and ecological risk in OU2 in the *White Paper on Addressing Human Health and Ecological Risks from Exposures to Impacted Soils in OU2 and OU4* (Integral et al. 2021; hereafter referred to as the "Risk Strategy White Paper"). The approach incorporated the framework documented in the 2019 HHRA and 2019 HHRA Addendum, the approach for ecological risk assessment used by EPA for OU1 (USEPA 2020), as well as ongoing discussions between the Multistate Trust, EPA, and NCDEQ. The approaches presented in the Risk Strategy White Paper were used for evaluating human health risks and risks to the environment from exposures to PAHs, PCP, and dioxins/furans in OU2 surface soils.

The *OU2 Soil Sampling Results and Human Health Risk Assessment* (Integral 2021a; 2021 OU2 HHRA) presents the results of the August and December 2020 surface soil sample collection events, the May 2021 subsurface soil sample collection event, and a human health risk assessment for OU2 developed in accordance with the Risk Strategy White Paper (Integral et al. 2021). The 2021 OU2 HHRA evaluated risks to a range of potential human receptors: residents, commercial/industrial workers, construction workers, trespassers, youth sports players, and site visitors/trail walkers. The human health conceptual site exposure model for OU2 is presented in Figure 2-6.

The following steps were taken in the 2021 OU2 HHRA to evaluate human health risks from OU2 soils:

- ***COPC screening.*** To select surface soil COPCs, the maximum concentrations of detected chemicals were compared to EPA's RSLs for residential soils (USEPA 2021). The RSLs are based on a noncancer HQ of 0.1 and a cancer risk level of $1{\times}10^{-6}$.
- ***Identification of exposure areas.*** OU2 was divided into exposure units of different sizes dependent on the receptor being evaluated as follows:
  - Residents: exposure areas (parcels) no greater than 0.25 acre created by Thiessen polygon methodology.[2]
  - Commercial/industrial workers, construction workers, trespassers, and recreational youth sports players: exposure areas no greater than 2 acres.
  - Site visitor/trail walkers: exposure areas no greater than 6 acres.
- ***Calculation of exposure point concentration (EPCs)***. An EPC was calculated for each COPC in each exposure area.

[2] The northern 35.8 acres of the Site, comprising both OU1 and OU2, was divided into parcels no larger than 0.25 acre using Thiessen polygon methodology, incorporating the historical soil sample locations with PAH data.

- ***Calculation of ELCRs and noncancer HIs.*** Cumulative ELCRs and noncancer HIs were calculated for each receptor consistent with EPA guidance for risk assessment (USEPA 1989).

Unacceptable Risks

The 2021 OU2 HHRA identified a total of 19 parcels with an ELCR greater than 1.0×10^{-4} and/or a noncancer HI greater than 1.0 based on potential exposures to a future resident.[3] Because many parcels had less than eight discrete samples, the 2021 OU2 HHRA conservatively used the highest concentration discrete sample result as the EPC, which likely overestimates the potential risk. Where the estimated risk is very close to EPA's threshold for unacceptable risk, this assumption can be determinative. In 10 of the 19 parcels, the resulting estimated risk was within one significant digit of EPA's threshold for unacceptable risk; that is, the ELCR was less than or equal to 1.4×10^{-4} or the HI was less than 1.4. For these cases, the uncertainty in the estimated risk was resolved by additional sampling as part of the OU2 PDI (Integral 2021d). The 2021 OU2 HHRA Addendum (Integral 2021b) incorporated the PDI data and identified a total of 12 parcels with an ELCR greater than 1.0×10^{-4} and/or a noncancer HI greater than 1.0 based on potential exposures to a future resident. These parcels are presented in Table 2-2. Data collected during the OU2 PDI supported an expansion of the OU2 eastern boundary in parcel RISB05 and a refined delineation of the horizontal extent of TCDD TEQ contamination within Parcel CS-56. Figure 2-7 presents the area within each of the 12 parcels with unacceptable risks to a potential future resident.

COCs based on potential exposures to a future resident were identified for these 12 parcels as part of the 2021 OU2 HHRA and 2021 OU2 HHRA Addendum and are presented in Table 2-3. The highest potential risks to a future resident were estimated as an ELCR of 9.5×10^{-4} at parcel TB-16 and an HI of 5.7 at parcel SS-115. Site-specific remediation goals for each of these COCs were developed and are presented in Table 2-4.

No Unacceptable Risks

The 2021 OU2 HHRA found no unacceptable risks for nonresidential receptors (commercial/industrial workers; construction workers; trespassers; recreational youth sports players; and site visitors/trail walkers) in OU2. Because the 2021 OU2 HHRA calculated nonresidential ELCRs and noncancer HIs were less than 1.0×10^{-4} and 1.0, respectively, the nonresidential receptors were not evaluated in the 2021 OU2 HHRA Addendum.

The 2019 HHRA previously found no unacceptable risk to construction workers in the wood storage areas (including OU2) due to potential exposure to PAHs and PCP in subsurface soils.

[3] At the direction of NCDEQ, and consistent with EPA guidance (USEPA 2018), ELCRs and HIs in the HHRA were presented to two significant figures. Using one significant figure, a total of nine parcels would have an ELCR greater than 1.0×10^{-4} and/or a noncancer HI greater than 1.0 based on potential exposures to a future resident.

However, dioxins/furans were not evaluated in the 2019 HHRA because dioxin/furan data were not yet available. The 2021 OU2 HHRA presented a preliminary, conservative analysis using the maximum TCDD TEQ concentration in OU2 subsurface soils (i.e., 180 pg/g) and found no unacceptable risk to construction workers from exposure to TCDD TEQ in subsurface soils. Together, the 2019 HHRA and the 2021 OU2 HHRA identified no unacceptable risks for future construction workers.

2.6.2 Ecological Risk Assessment

The 2021 OU2 ERA (Ramboll 2021) was developed in accordance with the Risk Strategy White Paper (Integral et al. 2021), which builds on the approach used by EPA for OU1 (USEPA 2020). The 2021 OU2 ERA report presents the results of the June 2020 field event, calculates site-specific uptake equations, and estimates the potential for ecological risk to different receptor groups.

Two different land use scenarios were evaluated in the 2021 OU2 ERA: 1) the entire land surface is developed for residential, commercial/industrial, and/or recreational (sports field) use; and 2) the land is used for recreational nature trails and remains largely undisturbed:

- Future residential, commercial/industrial, and/or recreational (sports field) land uses would limit the quality and amount of wildlife habitat at OU2. As a result, the 2021 OU2 ERA focused on evaluating the potential for ecological risks to select offsite wildlife species that may forage at OU2 in the future. Songbirds were used as a representative receptor group for this scenario because they are prevalent in the area and have the potential to be highly exposed through their diet.
- The current habitat at OU2 would not be significantly disturbed under a future recreational nature trail land use. The evaluation of the potential for ecological risk included not just songbirds, but also mammals and soil invertebrates that may live and forage at OU2 under that scenario.

Figures 2-8 and 2-9 provide the ecological conceptual site exposure models for OU2.

The 2021 OU2 ERA used HQs to evaluate the potential for ecological risks to the wildlife receptors and soil invertebrates, as follows:

- The HQs for songbirds and mammals were calculated as the ratio of a daily dose estimated based on a food web model to the lowest-observed-adverse-effect level (LOAEL) toxicity reference values (TRVs) protective of birds and mammals. Receptor-specific LOAEL HQs were calculated for HMW PAHs, LMW PAHs, and for bird and mammal TCDD TEQs. A food web model was developed for each wildlife species to calculate total daily intakes (i.e., daily doses) based on species-specific exposure parameters and diet scenarios, and Site-specific EPCs for soil and food items. The food web model for the wildlife receptors incorporated site-specific uptake factors derived from the soil samples and co-located below-ground and above-ground soil invertebrates collected during the June 2020 PAH and dioxin and furan study.

- HQs for soil invertebrates at OU2 were calculated as the ratio of soil concentrations for HMW PAHs and LMW PAHs measured in each less than 0.25-acre parcel to the EPA PAH ecological soil screening levels for soil invertebrates. HQs above 1 may indicate a potential for ecological risk in terms of a drop in reproduction and growth in soil invertebrates.
- Exposure to dioxins/furans was not evaluated in soil invertebrates because they are insensitive to these chemicals because they lack the AhR-1 aryl hydrocarbon receptor required for high-affinity binding to occur. Therefore, invertebrates generally do not have a dioxin-induced toxic response.

The size of the exposure area for American woodcock and raccoon, both of which have large home ranges, was set at 15.6 acres, which represents the entire area of OU2. The size of the exposure area for American robin and shrew, both of which have much smaller home ranges, was set at 2 acres (i.e., a small fraction of the entire surface area of OU2). These 2-acre exposure areas were drawn around the locations with the highest soil concentrations. The EPCs for soil and food items needed for exposure modeling were estimated based on the OU2 data set, which included results of composite soil samples, or discrete soil samples collected from individual parcels.

The food web model for birds and mammals used a range of exposure scenarios, from conservative diets (i.e., diets that would lead to higher exposures than expected under representative Site conditions) to more realistic diets that better represent the mix of food sources a receptor might obtain from OU2.

The food web model for birds and mammals considered uptake of PAHs and dioxins/furans from soil to soil invertebrates based on the site-specific uptake factors derived from the June 2020 soil and soil invertebrate study. The total daily intakes estimated from the food web model were compared to the EPA TRVs to calculate HQs for the range of exposure scenarios evaluated in the OU2 ERA (i.e., various diets, area use factors [AUFs], different land uses).

A LOAEL HQ > 1 indicates a potential for ecological risk. However, as was applied at OU1, a higher LOAEL HQ (e.g., 2–4) may still be acceptable because 1) uncertainties in the risk estimates would tend to lower the potential for ecological risk if they were fully accounted for, and 2) all or a large portion of OU2 is expected to be redeveloped in the future.

The 2021 OU2 ERA calculated the following LOAEL HQs for birds and mammals:

- **LMW PAHs and TCDD TEQ:** The LOAEL HQs for LMW PAHs and TCDD TEQ were less than 1 for each bird and mammal receptor assessed in the food web modeling, whether based on a highly-exposed diet or the more realistic diet consisting of a mix of food sources. HQs in this range do not indicate a potential for ecological risk.

- **HMW PAHs:** The LOAEL HQs for HMW PAHs at OU2 varied based on wildlife receptor and diet considerations. The lower LOAEL HQs reflect a more realistic species-specific mixed diet, whereas the upper end of the range reflects a more conservative, highly-exposed diet (i.e., a diet comprised solely of below-ground invertebrates).
  - American robin: the LOAEL HQs varied between 7 and 20.
  - American woodcock: the LOAEL HQs varied between 3 and 6 when the entire food supply is obtained at OU2, but between 2 and 4 when the species-specific home range is included in the food web model.
  - Raccoon: the LOAEL HQs varied between 0.2 and 0.3 (i.e., no potential for ecological risk), regardless of diet or home range considerations.
  - Short-tailed shrew: the LOAEL HQs varied between 1 and 3.

The risk characterization for the soil invertebrates at OU2 yielded the following results:

- **HMW PAHs:** HQs were below 1 in 56 parcels, between 2 and 10 in 29 parcels, and equal to or exceeding 20 in 3 parcels (SS-117, TB-12, and TB-16).
- **LMW PAHs:** HQs were below 1 in 85 parcels and were 2, 8, and 20 in parcels TB-12, TB16-F, and TB-16, respectively.

2.6.3 Summary

The 2021 OU2 HHRA and 2021 OU2 HHRA Addendum identified unacceptable risks (i.e., ELCR greater than 1.0×10^{-4} or noncancer risk HI greater than 1.0) to potential future residential receptors in OU2 soils (Integral 2021a,b). The 2021 OU2 HHRA found no unacceptable risks for all other receptors evaluated, indicating no unacceptable risk to commercial/industrial workers, construction workers, trespassers, recreational youth sports players, and site visitors/trail walkers.

The 2021 OU2 ERA (Ramboll 2021) evaluated potential risks to birds, mammals, and soil invertebrates in OU2. The 2021 OU2 ERA identified LOAEL HQs above 1 for the American robin, American woodcock, and the short-tailed shrew due to HMW PAHs in OU2 soils—indicating a potential for unacceptable ecological risks. The highest LOAEL HQs were identified for the American robin—ranging from 7 to 20 for the four evaluated diet scenarios. The 2021 OU2 ERA also found LOAEL HQs above 1 for soil invertebrates in 36 percent of the OU2 parcels based on HMW PAHs, and 3 percent of the OU2 parcels based on LMW PAHs—suggesting that PAH concentrations may locally impact the availability of invertebrates as a food source in the food web.

The risk assessments showed that the portions of OU2 that pose unacceptable risks to human health and to ecological receptors have significant overlap. Therefore, the Multistate Trust prepared the December 2021 memorandum *Ecological Risk Reduction as a Result of Remediating OU2 Parcels* (Integral 2021g; OU2 Eco PRG memorandum), approved by EPA and NCDEQ on December 28,

2021. The OU2 Eco PRG memorandum estimates the range of ecological risks that would remain after completing a residential cleanup by calculating the decrease in HMW PAH surface weighted average concentrations (SWACs) and the corresponding decrease in risk to ecological receptors. The analysis estimated that after the OU2 remediation to protect human health is complete, the maximum 2-acre SWAC for HMW PAHs would be 22 mg/kg, and the resulting range of LOAEL HQs for the American robin would be 0.5 to 4.3 under the four evaluated diet scenarios. This range of HQs is consistent with the diet scenarios and HQs in OU1 where EPA's risk management decision was no action for ecological risks (USEPA 2020). Thus, a SWAC-based PRG of 22 mg/kg HMW PAHs or less over a 2-acre ecological exposure unit would result in a LOAEL HQ for the American robin of 4.3 or less under diet Scenario 1 and a LOAEL HQ of 2.4 or less under diet Scenario 3. As a result, remediation of the contaminated areas of OU2 will address both unacceptable ecological risks and unacceptable human health risks to a future resident.

2.7 REMEDIATION AREAS AND VOLUMES

This section provides an estimate of the areas and volumes of soils requiring remediation in OU2 to address unacceptable human health risks based on potential exposures to a future resident and to ecological receptors. The remediation areas and volumes were estimated based on the results of the 2021 OU2 HHRA and 2021 OU2 HHRA Addendum, the 2021 OU2 ERA, the OU2 RAOs, and the PRGs (Section 3).

This FS uses acreage and volume estimates to compare the relative costs of remedial alternatives, which is within EPA's expected range of accuracy at the FS stage. All remedial alternatives presented in this FS were evaluated using the same acreage and volume estimates, and the relative costs of the alternatives are comparable.

As discussed in Section 2.6.1, the 2021 OU2 HHRA and 2021 OU2 HHRA Addendum identified 12 parcels posing unacceptable human health risks based on potential exposures to a future resident (Table 2-2). Figures 2-10 and 2-11 present the horizontal and vertical extents of the OU2 remediation areas, with estimates for acres and volumes used for comparing remedial alternatives. The OU2 boundary has been expanded to the east adjacent to RISB05 to include remediation of an area on the former OU2 boundary with surficial soil exceeding 50 pg/g TCDD TEQ, resulting in an additional area of 0.01 acres (Figure 2-10). Appendix A contains detailed figures presenting TCDD TEQ concentrations used to define the vertical and horizontal extents for those parcels requiring excavation to 2 ft bgs. The remediation areas and volumes will be modified as appropriate based on field observations during the remedial action.

Remediation Area	1.6 acres
Remediation Volume, 0–1 ft bgs	2,526 cubic yards
Remediation Volume, 1–2 ft bgs	295 cubic yards
Total Remediation Volume	2,821 cubic yards

3 REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

This section presents the RAOs and the PRGs, which are based on the outcomes of the human health and the ecological risk assessments (Integral 2021a; Ramboll 2021). RAOs present a narrative statement of what the remedial action must achieve to protect human health and the environment. During the scoping of the FS, the Site team drafted the RAOs. All RAOs for OU2 are based on the 2021 OU2 HHRA, 2021 OU2 HHRA Addendum, and 2021 OU2 ERA and in consideration of ARARs identified by EPA and NCDEQ. The following RAOs have been identified for OU2:

- Prevent potential unacceptable risk to future child and adult residents from long-term exposure through incidental ingestion of, dermal contact with, and/or inhalation of surface soils (up to 1 ft bgs) with COC concentrations above the residential PRG for BaP TEQ or above the residential PRG for TCDD TEQ.
- Prevent potential unacceptable risk to future child and adult residents from long-term exposure through incidental ingestion of, dermal contact with, and/or inhalation of subsurface soils (1 to 2 ft bgs) with dioxin/furan concentrations above the residential PRG for TCDD TEQ should the subsurface soils be brought to the surface in the future.
- Prevent potential unacceptable risks to songbirds and small mammals due to exposure through the food chain, incidental ingestion of, or direct contact with surface soils (up to 1 ft bgs) with a SWAC of the sum of HMW PAHs above the ecological risk PRG across a 2-acre area.

The OU2 ARARs and PRGs are discussed in more detail below.

3.1 IDENTIFICATION OF THE ARARS

Based on the CERCLA Section 121(d)(2) requirements and the NCP at 40 CFR 300.430(e)(9)(iii)(B), the remedial alternatives developed in this FS are analyzed for compliance with ARARs. CERCLA remedial actions must comply with substantive requirements and standards under federal or more stringent state environmental laws and regulations that are identified as ARARs. For ease of identification, EPA has created three categories of ARARs: Chemical-, Location- and Action-Specific.

- Chemical-specific—Laws and regulatory requirements that establish health- or risk-based numerical concentration limits or assessment methodologies for chemical contaminants in environmental media
- Location-specific—Requirements that can restrict or limit response action based upon specific locations (e.g., wetlands, floodplains, historic places, or sensitive habitats)

- Action-specific—Requirements that set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants.

The Action-specific ARARs for all of the remedial alternatives are included in Table 3-1. There are no Location-specific or Chemical-specific ARARs for this Site.

3.2 PRELIMINARY REMEDIATION GOALS

PRGs for contaminated soil are typically risk-based concentrations because there are not many federal promulgated cleanup levels. PRGs are established for each COC that will achieve the RAOs for each medium and receptor. PRGs were developed for OU2 soils following EPA and NCDEQ review of the human health site-specific remediation goals presented in Table 2-4, and the analysis presented in the OU2 Eco PRG memorandum (Integral 2021g). Table 3-2 presents the PRGs for each COC.

As data are gathered during the risk assessments and FS, PRGs may be refined and eventually become the final contaminant-specific cleanup levels in a decision document such as a ROD. The proposed plan will seek public comment on the Preferred Alternative including the Site-specific cleanup levels. The final cleanup levels are selected in the ROD.

4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents the basis for identification, evaluation, and selection of RTPOs for consideration in the development of the remediation alternatives presented in Section 5.

4.1 GENERAL RESPONSE ACTIONS

A general response action (GRA) is a media-specific generic technology or administrative method for addressing contamination and achieving RAOs at CERCLA sites. GRAs applicable to contaminated OU2 soils were taken from remediation guidance documents (USEPA 1988) and are summarized below.

General Response Action	Description
No Action	No remedial action is taken and all contamination is left in place.
Institutional Controls	Administrative and/or legal methods that limit exposure of potential receptors to contaminated media.
Monitoring	Measurement of contaminant concentrations over time to determine changes and trends in contaminant nature and extent and to confirm remedy effectiveness.
Containment/Isolation	Engineered barriers that prevent/limit contaminant migration, receptor contact with contamination, and/or prevent clean media from becoming contaminated.
Removal	Removal of contaminated media from its original location.
Treatment	Use of *in situ* or *ex situ* technologies to chemically degrade and/or physically stabilize contaminants.
Disposal	Placement of contaminated media in a new, controlled location that eliminates potential exposure pathways between receptors and contaminated media.

4.1.1 No Action

No action is a baseline GRA scenario for the evaluation of alternative GRAs. No remedial action or monitoring would be performed under the no action GRA—providing a baseline assessment of the impact of the “as is” condition on potential receptors.

4.1.2 Institutional Controls

Institutional controls include administrative tools (e.g., zoning designations and governmental use restrictions) and legal instruments (e.g., restrictive covenants or negative easements) designed to protect human health by limiting potential exposure to contaminated media left in place at a site. Institutional controls can be used as the primary component of a remedial alternative or in combination with other RTPOs to minimize or prevent exposure to contaminated media left in place at a given site (USACE and USEPA 2000). The NCP emphasizes that institutional controls, such as land-use restrictions, are meant to supplement RTPOs during all phases of cleanup and may be a necessary component of the final remedy. Land use controls include institutional controls and informational tools such as warning signs and can require physical controls such as fences.

4.1.3 Monitoring

Monitoring provides the data necessary to determine if the remedial action has successfully achieved RAOs and cleanup standards. Monitoring involves media sampling and analysis of contaminant concentrations and other ancillary variables to track the progress and overall effect of a remedial action.

4.1.4 Containment/Isolation

Containment/isolation isolates COCs in soils from potential receptors and/or environmental media using a physical barrier, thereby breaking a potential exposure pathway. Contaminated soils are left in place under this GRA and thus containment/isolation is frequently used in combination with institutional controls and monitoring to ensure that the physical barrier remains intact and provides for long-term protection of human health and the environment.

4.1.5 Removal

Removal of soil contamination is typically accomplished through excavation. Removal of contaminated soil from a site immediately achieves RAOs and cleanup goals; however, full removal is not always achievable due to site-specific limitations (e.g., depth and/or extent of contamination, presence of adjacent structures, and presence of groundwater).

4.1.6 Treatment

Treatment involves the use of chemical, biological, and/or physical processes to cause the destruction or alteration of the contamination to a form that is less toxic and/or less mobile. Treatment can be achieved *in situ* (i.e., in place) or *ex situ* (i.e., aboveground following excavation). *Ex situ* treatment can be applied to excavated soils to support disposal of soils.

4.1.7 Disposal

Disposal is conducted in conjunction with any response action that generates remediation waste to ensure protective post-remedy management. Disposal involves the placement of contaminated media in a new, controlled location and includes offsite disposal at EPA-approved landfills consistent with the Off-site Rule in the NCP at 40 CFR 300.440, and/or onsite consolidation and beneficial reuse.

4.2 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

Each GRA described above (except no action) can involve one or more technology type. Remediation technologies refer to general categories of technology types. Process options refer to specific methods or types of equipment within each technology type. Specific RTPOs for the GRAs identified for the OU2 soils are summarized below.

General Response Action	Specific Remedial Technology and Process Options
Institutional Controls	Restrictive Covenants Easements Informational Devices
Monitoring	Construction Monitoring Long-Term Monitoring
Containment/Isolation	Cap/Cover
Removal	Excavation
Treatment	*In Situ* Stabilization *In Situ* Chemical Amendment *Ex Situ* Stabilization Land Farming Soil Washing
Disposal	Onsite Reuse/Consolidation Offsite Landfill Disposal

4.2.1 Criteria for Screening of Remedial Technologies and Process Options

The RTPOs for OU2 soils were evaluated to identify those most viable to site-specific conditions. Each RTPO was screened against the criteria described below:

- Effectiveness—This criterion considers 1) the potential effectiveness of RTPOs in handling the estimated areas or volumes of media and meeting the remediation goals identified in the remedial action objectives; 2) the potential impacts to human health and the environment during the construction and implementation phase; and 3) how proven and reliable the process is with respect to the contaminants and conditions at the site. Each RTPO was evaluated for effectiveness based on demonstrated success at similar sites/conditions.

- Implementability—This criterion considers the relative ease of implementing the RTPO and considers factors such as availability of the materials and services to implement the RTPO and the depth of contamination.
- Relative Estimated Cost—This criterion considers the estimated capital and operation and maintenance (O&M) costs to implement the RTPO. Estimated costs are AACE International Class 5 costs (AACE 2011). Class 5 estimates generate costs that can be used for the purposes of screening and FS. The cost estimates prepared for this FS were generated using a combination of available Site and vendor data, cost data from other sites and database sources, and professional judgment.

4.2.2 Identification, Screening, and Evaluation of Technologies

Figure 4-1 summarizes the results of the RTPO screening process, which is described for each GRA below.

4.2.2.1 Institutional Controls

Although institutional controls alone do not reduce the toxicity, mobility, or volume of contamination at a site, they can be conditionally effective at preventing exposure of human receptors to contaminated soils. Institutional controls screened as options for OU2 are as follows:

- Government Controls—Zoning restrictions or local ordinances
- Property Controls—Deed restrictions, easements, covenants
- Information Tools—Public notices, signage.

These institutional controls are typically used in combination with other RTPOs to achieve a remedy that is protective of human health and the environment. A common institutional control is a land use or deed restriction that specifies soil handling and management procedures following completion of the remedial action.

Institutional controls may be subject to administrative and legal challenges. Further, institutional controls that place restrictions on land use are likely to be viewed unfavorably by the potential future property owners, and the long-term maintenance of the institutional controls may be costly to ensure. Based on these considerations, institutional controls are not retained as a stand-alone RTPO but are retained for consideration as a potential supplement to other RTPOs in the development of OU2 remedial alternatives.

4.2.2.2 Monitoring

Monitoring involves collection of soil samples or other environmental data to evaluate the progress of remedial actions and to demonstrate that the remedial action has achieved the RAOs and cleanup goals. Monitoring is retained as an RTPO to be considered for inclusion as a component of all the remedial alternatives.

4.2.2.3 Containment/Isolation

Containment/isolation technologies isolate contaminants to prevent their migration and/or eliminate potential exposure pathways. For OU2 soils, this would involve the placement of a vegetated soil cover and/or low-permeability cap to isolate potential human and ecological receptors from contamination in soils. Cap/covers leave contamination in place and are not effective at reducing contaminant toxicity or volume. A cap or cover reduces potential contaminant mobility through stormwater or wind erosion, and, in the case of a low permeability cap, can reduce the potential leaching of soil contaminants to groundwater by limiting infiltration. Groundwater underlying OU2 is not contaminated, consistent with the inherently limited potential for PAHs and dioxins/furans transport via infiltrating water. Therefore, a low-permeability cap would have limited benefit to OU2 and is not retained for further consideration. Containment/isolation via a vegetated soil cover is retained for further consideration for development of remedial alternatives for OU2.

4.2.2.4 Removal

Removal is accomplished via excavation using conventional construction techniques and may include placing clean backfill in excavated areas as needed. Excavated soils would require disposal (Section 4.2.2.6).

Removal is highly effective at reducing/eliminating potential exposure to soil contamination. Because the depth of contamination of OU2 soils is relatively shallow and does not require excavation below the water table, conventional construction techniques and equipment can be employed and are readily implementable.

4.2.2.5 Treatment

Two *in situ* and three *ex situ* treatment RTPOs were identified and evaluated for OU2 soils.

- *In Situ* Stabilization—*In situ* stabilization involves the mixing of chemical reagents, such as cement, to create a solid "monolith" that isolates contaminated soils from potential exposure or migration. Stabilization has been shown to be effective at other wood treatment sites. *In situ* stabilization has several limitations as a RTPO for OU2. Most notably, the contamination would remain in place and institutional controls would be required to ensure that treated soils are maintained. Application of *in situ* stabilization to shallow soil contamination, such as in OU2, is uncommon due to the inefficiencies associated with mixing the reagents with the soils and the limited cost-benefits relative to conventional excavation and disposal. Finally, *in situ* stabilization would turn the treated soils into a solid monolith, which may not be compatible with potential future land uses (e.g., residential, recreational sports fields or nature trails). For these reasons, *in situ* stabilization is not retained for further consideration.

- *In Situ* Chemical Amendments—*In situ* chemical amendments involve the addition of specific chemical reagents to either degrade/destroy COCs or bind the COCs in soils and thereby reduce the toxicity, mobility, and volume of the contaminants. Application of *in situ* chemical amendments to shallow soil contamination, such as OU2, is uncommon due to the inefficiencies associated with mixing the reagents with the soils and the limited cost-benefits relative to conventional excavation and disposal. Chemical amendments have not been shown to be reliably effective for dioxins/furans. As a result, *in situ* chemical amendments are not retained for further consideration.
- *Ex Situ* Stabilization—*Ex situ* stabilization involves the mixing of chemical reagents, such as cement, with excavated soils to reduce COC mobility. Commonly, *ex situ* stabilization is used to reduce contaminant mobility in characteristically hazardous wastes (i.e., soils that fail toxicity characteristic leaching procedure testing) to allow for disposal in a Resource Conservation and Recovery Act (RCRA) Subtitle C or D landfill. Based on analytical results to date, OU2 soils are anticipated to not be considered RCRA toxicity characteristic hazardous; thus, *ex situ* stabilization is considered unnecessary and is not retained for further consideration.
- Land Farming—Land farming involves the placement of excavated soils in treatment cells to facilitate the physical (e.g., volatilization, photodegradation) and biological degradation of contaminants. Historically, land farming was commonly applied to treat soils at wood treatment sites, but with only modest effectiveness. Further, the technology would not be effective for dioxins/furans, as these compounds are not volatile and do not readily degrade. As a result, land farming is not retained for further consideration.
- Soil Washing—Soil washing involves contacting excavated contaminated soils with water to remove contaminants by dissolving or suspending them in the wash solution (often augmented with a surfactant or chelating agent to improve contaminant removal efficiency) or by concentrating them into a smaller volume of soil through separation. Soil washing would produce large volumes of wastewater that would need to be contained, treated, and disposed of. Further, because PAHs and dioxins/furans bind very strongly to soils, soil washing is likely to be inefficient and to have limited effectiveness. As a result, soil washing is not retained for further consideration.

4.2.2.6 Disposal

Following removal, contaminated soils require management and disposition in a controlled manner that prevents exposure that can lead to unacceptable risks to human health or the environment. Disposition can be accomplished by offsite disposal, onsite beneficial reuse/consolidation depending on the contaminant concentrations, or a combination depending on chemical concentrations in the excavated soil. Offsite disposal involves transport and placement of excavated soils in an EPA-approved offsite RCRA Subtitle C or D disposal facility (e.g., a landfill) for protective management that precludes exposure pathways. Offsite disposal of contaminated soils from Superfund sites must be disposed according to Section 121(d)(3) of CERCLA and 40 CFR 300.440 of the NCP, known as the "CERCLA Off-Site Rule." The purpose of the CERCLA Off-Site Rule is to prevent CERCLA wastes from creating future environmental problems when disposed. The CERCLA Off-Site Rule requires that wastes from a CERCLA cleanup may only be placed in a facility operating in compliance with Federal and State requirements, including RCRA. (https://www.epa.gov/superfund/site-rule-fact-sheet)

In consultation with EPA, the Multistate Trust will perform representative sampling to assess whether the soils to be excavated from OU2 remedial areas for disposal should be managed as a hazardous waste based on characteristics. Based on analytical results to date, excavated OU2 soils are anticipated not to be hazardous waste based on characteristics and thus suitable for disposal at a RCRA Subtitle D landfill.

Onsite dispensation of excavated OU2 soils would involve onsite reuse or consolidation of the soils within areas of OU4 designated for future industrial or commercial land uses. A final decision as to whether the OU2 soils that are stockpiled are utilized within OU4 or disposed offsite would be made in a future ROD for OU4. Excavated OU2 soils that have been determined to meet the applicable chemical acceptance criteria, as established by EPA and NCDEQ, and are not RCRA hazardous waste, would eventually be used as fill or cover in OU4 where the contaminated media do not pose a risk to human health and the environment, and where consolidation/reuse is approved by EPA. EPA approval would be required prior to placement of any OU2 soils on OU4. Soils that do not meet chemical acceptance criteria for reuse/consolidation would be transported for offsite disposal.

Onsite reuse/consolidation would involve future management of the soils within OU4 with soils that have similar levels of contamination (and are not considered RCRA hazardous waste) as part of the final OU4 remedy. Data collected for the OU2 soils show that a majority of the OU2 soil will meet the likely chemical acceptance criteria based on industrial, commercial, or construction worker exposures and can potentially be beneficially reused in the southern end of the process area of OU4 where the reasonably anticipated future land use is commercial/industrial. The concentrations of PAHs and PCP in OU2 parcels identified for potential remediation are similar to the concentrations in surface soils from this area of OU4. Therefore, placement of these OU2 soils in OU4 would not further degrade conditions or present unacceptable risk to human health provided 1) the land use in this portion of OU4 is not residential and 2) the soils are managed in a manner (such as seed/vegetated) to prevent any cross-media contamination from stormwater runoff or other transport mechanisms.

The TCDD TEQ concentrations in several of the OU2 parcels identified for potential remediation are elevated relative to the surface soils in the southern end of the OU4 process area. As a result, the soils from these parcels are not considered suitable for reuse/consolidation in OU4 and will be disposed offsite.

Onsite reuse/consolidation would require onsite stockpiling of the excavated OU2 soils in OU4 until the final remedy is approved for OU4. The soils would be stockpiled in an area of OU4 with soils having similar levels of contamination. The stockpiled soils would be protectively managed in accordance with applicable or relevant and appropriate RCRA regulations and guidance and in a manner that would be protective of human health and the environment and would not result in any cross-media transfer of contamination such as from stormwater runoff. Accordingly, the soils would need to be stockpiled in a manner that complies with relevant and appropriate RCRA staging pile requirements identified as ARARs until such time that the soils are managed as part of the final OU4 remedy.

All the disposal options described above have been retained for consideration in the development of remedial alternatives.

5 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

This section describes the remedial alternatives that were developed from the RTPOs that were retained during the screening process described in Section 4 and presents an analysis of each alternative based on the nine criteria defined under CERCLA. Each remedial alternative includes a combination of RTPOs and was developed to provide a range of options for achieving the RAOs. Figure 5-1 presents a matrix summarizing the RTPOs included in each remedial alternative. The alternatives are as follows:

- Alternative 1—No Action
- Alternative 2—Removal and Offsite Disposal
- Alternative 3—Removal, Onsite Reuse/Consolidation, and Offsite Disposal
- Alternative 4—Cover and Institutional Controls.

5.1 EVALUATION CRITERIA

The nine criteria defined under CERCLA for evaluation of remedial action alternatives fall into three categories—threshold criteria, primary balancing criteria, and modifying criteria.

- Each alternative must be capable of meeting the following two **threshold criteria**:
  - *Overall Protection of Human Health and the Environment*—Protectiveness of human health and the environment is based on an evaluation of each alternative's ability to meet the RAOs.
  - *Compliance with ARARs*—Each alternative is evaluated to determine how it complies with or can be modified to comply with federal and state ARARs.
- The comparative analysis of alternatives is then based on the following five **primary balancing criteria**:
  - *Long-Term Effectiveness and Permanence*—This criterion requires an evaluation of the potential long-term risks remaining after implementation of the remedy. Issues addressed for each alternative include the magnitude of long-term risks and the long-term reliability of the management controls. In addition to these considerations, sustainability was included as a secondary consideration in the comparative analysis of alternatives.
  - *Short-Term Effectiveness*—The evaluation of short-term effectiveness is based on the protectiveness of human health achieved during the construction and implementation phase of the remedial action. Key factors to be considered by this evaluation include

the time required for remedy implementation (construction duration) and the associated risks to local residents, site workers, and the community. Such issues include the duration and frequency of truck traffic through the community and associated risks (e.g., accidents) and nuisances (e.g., noise, emissions).

- *Reduction of Toxicity, Mobility, or Volume through Treatment*—This criterion addresses the preference under CERCLA for remedial alternatives that permanently and significantly reduce the mobility, toxicity, or volume of hazardous substances through treatment. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. (There are no principal threats within the scope of the OU2 action.)
- *Implementability*—The implementability of each alternative is evaluated based on its technical and administrative feasibility, and the availability of services and materials. Technical feasibility takes into consideration difficulties that may be encountered during construction and operation. Administrative feasibility factors include coordination with other offices and agencies, such as obtaining permits or approvals for various onsite and offsite activities.
- *Cost*—Evaluation of the cost of each alternative includes estimation of capital costs, O&M costs, and the net present worth based on a 30-year O&M period.[4] The net present worth cost provides a means of comparing the total costs of different alternatives with different O&M requirements and duration. All of the costs are presented in a format consistent with *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (USACE and USEPA 2000) and correspond to Level 5 costs (AACE 2011).

- After EPA issues its proposed plan for OU2, the following two **modifying criteria** will be considered in the ROD:
  - *State Acceptance*—State acceptance will be determined based on comments and input received during the FS review and approval process.
  - *Community Acceptance*—Community acceptance will be determined based on comments and input from the public presented to EPA during the proposed plan public comment period.

[4] A 7% discount rate was used to estimate potential future costs per communication from the Site Remedial Project Manager, Erik Spalvins, on August 24, 2021.

5.2 ALTERNATIVE 1—NO ACTION

The No Action Alternative is required under the NCP to provide a baseline scenario against which all other alternatives are compared. Under the No Action Alternative, no funds would be expended for remediation of OU2 soils. The minimum activities for the No Action Alternative include the mandatory 5-year reviews over the course of a 30-year period, resulting in a total of six 5-year reviews.

The following table presents an evaluation of the No Action Alternative relative to the CERCLA criteria.

Criterion	Analysis
Overall Protection of Human Health and the Environment	The No Action Alternative does not achieve the RAOs, does not mitigate the unacceptable risk represented by the exceedance of the PRGs, and does not eliminate or control exposure pathways. Therefore, the No Action Alternative is not deemed to be protective of human health or the environment.
Compliance with ARARs	This alternative will not meet the ARARs as detailed in Table 3-1.
Long-Term Effectiveness and Permanence	Long-term effectiveness is poor as the current level of contamination and associated risk is not projected to change substantially with time.
Reduction of Toxicity, Mobility, or Volume through Treatment	There are no principal threat wastes within the scope of the OU2 action. This alternative takes no action to reduce the toxicity, mobility, or volume of OU2 COCs. PAHs degrade slowly and dioxins/furans do not readily degrade in the environment. As a result, an extended time frame (decades) may be required before notable changes in concentrations occur due to natural attenuation.
Short-Term Effectiveness	This remedy is not expected to have any significant short-term effectiveness.
Implementability	The No Action Alternative is easily implemented.
Net Present Value Estimated Level 5 Cost (AACE 2011)	$32,000 (expected accuracy of +50 to −30 percent)

5.3 ALTERNATIVE 2—REMOVAL AND OFFSITE DISPOSAL

Alternative 2 includes the following elements:

- Excavation of OU2 surface soils (up to 2 ft bgs) with dioxin/furan concentrations and/or PAH concentrations that exceed the residential PRGs (Figure 2-8).
- Offsite disposal of excavated soils at an EPA-approved, RCRA Subtitle D or C landfill depending on waste characterization. In consultation with EPA, the Multistate Trust will perform representative sampling to assess whether the soils to be excavated from OU2 remedial areas for disposal should be managed as a hazardous waste based on

characteristics. Based on analytical results to date, excavated OU2 soils are anticipated not to be hazardous waste based on characteristics and thus suitable for disposal at a RCRA Subtitle D landfill.

- Placement and final grading of imported clean backfill material suitable for residential use in the excavated areas.
- No long-term O&M or post-remedy monitoring. Because this alternative involves removal of contaminated soils from OU2 to allow for unlimited use and unrestricted exposure, no monitoring will be required. Five-year reviews will not be required.
- A 1- to 3-month implementation time frame.

Removal of soils with concentrations exceeding the PRGs would be a highly effective and permanent remedy for OU2 soils and would meet all the CERCLA criteria, as summarized below.

Criteria	Analysis
Overall Protection of Human Health and the Environment	This alternative would achieve the RAOs and be protective of human health and the environment by removing soils that contain COCs at concentrations that exceed the PRGs.
Compliance with ARARs	This alternative can meet all ARARs as detailed in Table 3-1.
Long-Term Effectiveness and Permanence	This alternative would have a high degree of long-term effectiveness and permanence because the soils that contain COCs that exceed the PRGs would be removed from OU2 and protectively managed through landfill disposal.
Reduction of Toxicity, Mobility, or Volume through Treatment	There are no principal threat wastes within the scope of the OU2 action. This alternative would not result in a reduction of toxicity, mobility, or volume of OU2 COCs through treatment. However, this alternative would substantially reduce/eliminate the volume of contamination present in OU2. The contaminated soil would be moved to a RCRA Subtitle D or C landfill, where it would have limited potential mobility and where potential for exposure would be eliminated.
Short-Term Effectiveness	Short-term effectiveness is high. This alternative would be effective immediately upon completion of the remedial action; however, there is the potential for short-term exposure to workers and the community (e.g., due to dust, truck traffic) and for nuisance issues (e.g., noise, odors) during the active remediation construction period. Potential short-term impacts can be readily and effectively managed through well-established engineering controls.
Implementability	This alternative is implementable using well-established techniques and technologies and does not require specialized services or equipment. There are no known challenges to completing this alternative that cannot be addressed through proper engineering design and construction.
Net Present Value Estimated Level 5 Cost (AACE 2011)	$1,587,000 (expected accuracy of +50 to –30 percent)

5.4 ALTERNATIVE 3—REMOVAL, ONSITE REUSE/CONSOLIDATON, AND OFFSITE DISPOSAL

Alternative 3 includes the following elements:

- Excavation of OU2 surface soils (up to 2 ft bgs) with dioxin/furan concentrations and/or PAH concentrations that exceed the residential PRGs.
- Onsite reuse/consolidation and offsite disposal of excavated soils.
  - Excavated soils would be evaluated against contaminant concentration criteria established by EPA and NCDEQ for reuse/consolidation in OU4.
  - Excavated OU2 soils suitable for reuse/consolidation would be temporarily stockpiled in OU4 for use, as needed and appropriate, as backfill or cover as part of the OU4 remedy. The stockpiled soils would be managed in compliance with RCRA staging pile requirements that are identified as ARARs until the OU4 selected remedy is implemented.
  - OU2 soils that are unsuitable for onsite reuse/consolidation would be disposed of offsite at an EPA-approved, RCRA Subtitle D or C landfill, depending on waste characterization. In consultation with EPA, the Multistate Trust will perform representative sampling to assess whether the soils to be excavated from OU2 remedial areas for disposal should be managed as a hazardous waste based on characteristics. Based on analytical results to date, excavated OU2 soils are anticipated not to be hazardous waste based on characteristics and thus suitable for disposal at a RCRA Subtitle D landfill.
- Placement and final grading of imported clean backfill material suitable for residential use in the excavated areas.
- Regular inspections and five-year reviews would be required for OU2 soils that are stockpiled in a staging pile in OU4 until a final remedy is selected for OU4, which includes the stockpiled soils.
- A 1- to 3-month implementation time frame.

Removal of soils with concentrations exceeding the PRGs would be a highly effective and permanent remedy for OU2 soils and would meet all the CERCLA criteria, as summarized below.

Criteria	Analysis
Overall Protection of Human Health and the Environment	This alternative would achieve the RAOs and would be protective of human health and the environment by removing soils that contain COCs at concentrations that exceed the PRGs.
Compliance with ARARs	This alternative can meet all ARARs as detailed in Table 3-1.
Long-Term Effectiveness and Permanence	This alternative would have a high degree of long-term effectiveness and permanence because the soils that contain COCs that exceed the PRGs would be removed from OU2 and protectively managed during onsite reuse or landfill disposal.
Reduction of Toxicity, Mobility, or Volume through Treatment	There are no principal threat wastes within the scope of the OU2 action. This alternative would not result in a reduction of toxicity, mobility, or volume of OU2 COCs through treatment. However, this alternative would substantially reduce/eliminate the volume of contamination present at OU2. Contaminated soil would be moved to a RCRA Subtitle D landfill or be stockpiled on OU4 for onsite reuse, where it would have limited potential mobility and potential for exposure would be eliminated.
Short-Term Effectiveness	Short-term effectiveness is high. This alternative would be effective immediately upon completion of the remedial action; however, there is the potential for short-term exposure to workers and the community (e.g., due to dust, truck traffic) and for nuisance issues (e.g., odors) during the active remediation construction period. Potential short-term impacts can be readily and effectively managed through well-established engineering controls.
Implementability	This alternative is implementable using well-established techniques and technologies and does not require specialized services or equipment. There are no known challenges to completing this alternative that cannot be addressed through proper engineering design and construction.
Net Present Value Estimated Level 5 Cost (AACE 2011)	$1,455,000 (expected accuracy of +50 to –30 percent)

5.5 ALTERNATIVE 4—COVER AND INSTITUTIONAL CONTROLS

Alternative 4 includes the following elements:

- Placement of a 1-ft thick soil cover consisting of imported clean fill material suitable for residential use and appropriate vegetation.
- Routine monitoring of the vegetated soil cover integrity and maintenance, as required.
- Implementation of institutional controls to limit activity/use that could disturb the soil cover.
- A 1- to 2-month implementation time frame is anticipated for placement of the soil cover.
- Five-year reviews would be required indefinitely because contamination would be left in place above levels suitable for unrestricted use/unrestricted exposure.

Placement of a soil cover would be effective at eliminating direct exposure to OU2 soils and thus eliminating the associated unacceptable risks. However, institutional controls would be required because the contamination would be left in place and Alternative 4 would not meet NCDEQ's requirements for unrestricted use with no land-use restrictions, as defined under North Carolina General Statute § 143B-279.9(d)(1). The long-term effectiveness and permanence of the cover requires that the cap integrity be maintained. Further, a soil cover remedy would result in conditions that are likely to be viewed unfavorably by potential future property owners and would limit the future use of the property. As a result, a soil cover remedial alternative is unlikely to be acceptable to the community.

Criteria	Analysis
Overall Protection of Human Health and the Environment	This alternative would meet the RAOs and would be protective of human health and environment by isolating soils that contain COCs at concentrations that exceed the PRGs.
Compliance with ARARs	This alternative can meet all ARARs as detailed in Table 3-1.
Long-Term Effectiveness and Permanence	This alternative would have a moderate degree of long-term effectiveness and permanence because the soils that contain COCs that exceed the PRGs would remain in place—creating a potential for receptor exposure should the cover be disturbed.
Reduction of Toxicity, Mobility, or Volume through Treatment	There are no principal threat wastes within the scope of the OU2 action. This alternative would not result in a reduction of toxicity, mobility, or volume of OU2 COCs through treatment.
Short-Term Effectiveness	Short-term effectiveness is high. This alternative would be effective immediately upon completion of the remedial action; however, there is the potential for short-term exposure to workers and the community (e.g., due to dust, truck traffic) and for nuisance issues (e.g., odors) during the active remediation construction period. Potential short-term impacts can be readily and effectively managed through well-established engineering controls.
Implementability	This alternative is implementable using well-established techniques and technologies and does not require specialized services or equipment. There are no known challenges to completing this alternative that cannot be addressed through proper engineering design and construction.
Net Present Value Estimated Level 5 Cost (AACE 2011)	$1,107,000 (expected accuracy of +50 to –30 percent)

6 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

In this section, the five remedial alternatives identified for OU2 are comparatively analyzed against the nine CERCLA evaluation criteria. Table 6-1 summarizes the results of the comparative evaluation.

6.1 THRESHOLD CRITERIA

Alternative 1 (No Action) does not meet the threshold criteria (Table 6-1). The current condition of surface soils for a portion of the OU2 represents a potentially unacceptable risk and does not meet the RAOs. Without engineering controls and/or institutional controls there is a potential for exposure to PAHs and dioxins/furans in OU2 soils for current and future site users.

Alternatives 2 and 3 will effectively meet the threshold criteria by removing OU2 soils with COC concentrations above PRGs and replacing those soils with clean backfill. Under these alternatives, excavated soils would be transported offsite to a permitted RCRA landfill for disposal or stockpiled in OU4 for reuse/onsite consolidation as part of the OU4 final remedy. Alternatives 2 and 3 can meet identified ARARs.

Alternative 4 will meet the threshold criteria by isolating OU2 soils with COC concentrations above PRGs beneath a soil cover, thereby eliminating/limiting potential exposure. However, land-use controls in the form of deed restrictions and long-term monitoring would be required to ensure the cover integrity is maintained. Alternative 4 can meet identified ARARs.

6.2 BALANCING CRITERIA

Figure 6-1 presents a comparative analysis of the five remedial alternatives in terms of the balancing criteria. A relative ranking of the alternatives (i.e., excellent, good, fair, poor, or very poor) is provided for each balancing criterion, and an overall ranking across all the balancing criteria is also provided. The following sections discuss the active remedial alternative with respect to the balancing criteria.

6.2.1 Long-Term Effectiveness and Permanence

Alternative 1 would not alter the status quo and thus would not achieve the RAOs.

Alternatives 2 and 3 would meet the criteria of long-term effectiveness and permanence (Table 6-1) through removal of OU2 surface soils with COC concentrations above PRGs, followed by backfilling of the excavated areas with clean fill. Removal of soils containing COCs above PRGs from OU2 will prevent potential migration or receptor exposure. As a result, Alternatives 2 and 3 were both assigned a high ranking with respect to long-term effectiveness and permanence.

Alternatives 2 and 3 differ in the dispensation of the excavated OU2 soils. Under Alternative 2, all excavated soils would be transported offsite for disposal in an appropriately permitted RCRA landfill. This approach would be highly effective and permanent with a high degree of confidence because all OU2 soils exceeding the PRGs would be removed from the Site. No long-term management is required for OU2 under Alternative 2, and there is almost no likelihood of needing to adjust the OU2 remedy in the future.

Alternative 3 would involve eventual reuse/consolidation of OU2 soils that are suitable for use as backfill or cover on the southern end of the Process Area in OU4. OU2 soils that are unsuitable for reuse/consolidation in OU4 would be transported offsite for disposal in an appropriately permitted RCRA landfill.

Alternative 3 has somewhat lower long-term effectiveness and permanence than Alternative 2 because it would leave some OU2 contamination in OU4. While the OU2 soils would be managed in a protective manner and would not lead to unacceptable risk to human health or the environment, the stockpiled OU2 soils would require inspection and/or maintenance until soils are reused in OU4. Because the OU4 remedial investigation is underway and the OU4 remedy has not been selected, there is uncertainty in how the OU2 soils would be integrated into the OU4 remedy. If reuse/consolidation in OU4 is incompatible with the OU4 remedy, then the OU2 soils would require offsite disposal.

Alternative 4 would meet the criterion of long-term effectiveness and permanence through isolation of OU2 soils with COC concentrations above PRGs but would require inspection and maintenance of the soil cover and monitoring of restrictive covenants. As a result, Alternative 4 was assigned a lower ranking than Alternatives 2 and 3.

Sustainability was included as a secondary consideration in the comparative analysis alternatives. Physical impacts of sea level rise are not considered as a factor in the long-term effectiveness and permanence for the OU2 remedial alternatives because of the distance of OU2 from the 100-year floodplain and the elevation of OU2. The main considerations regarding sustainability are the use of fuel, emission of greenhouse gases, use of landfill space, and limitations on future use of OU2. Alternative 2 ranks lowest of the four alternatives with respect to long-term sustainability considerations, due to the transport of the soils to an offsite landfill and the use of landfill space. Alternative 3 is more sustainable than Alternative 2 because less soil is transported to a landfill, less soil would be imported for the OU4 remedy, less fuel would be used, and there would be fewer emissions. However, there is some uncertainty about the number of times soil would be moved onsite, and the remedy may need to be adjusted depending on the OU4 remedy. Alternative 4 has the lowest impacts related to fuel and emissions but would include limitations on the use of parts of OU2 that offset the benefit of not consuming landfill space.

6.2.2 Short-Term Effectiveness

Alternatives 2, 3, and 4 would involve the use of conventional construction techniques and would be effective immediately upon completion. The potential for short-term exposures to workers and the community will be readily addressed though proper design and execution of the remedial action, including use of well-established BMPs. Many of the potential short-term exposures associated with the implementation of remedial actions are related to the transport of backfill and contaminated soils. Some of the key factors related to these activities include, but are not limited to:

- Inherent hazards associated with the use of heavy machinery
- Potential to generate dusts, chemical vapors, and odors that, without proper controls, can represent a hazard or at least a nuisance to both workers and the adjacent community
- Truck traffic and associated risks (e.g., potential for truck-related accidents) and nuisance (e.g., emissions, traffic delays/disruption) posed to the community
- Noise associated with use of heavy machinery and truck traffic
- Potential for release of contaminants to the environment during handling and transport of excavated soils, and due to potential stormwater contact with excavated surfaces and stockpiles.

With well-established BMPs in place, risks associated with these factors would be effectively mitigated. Alternative 4 (cover and institutional controls) poses the least risks of Alternatives 2 through 4 because there is no excavation of contaminated soils. Alternative 2 was assigned the lowest relative ranking of these three alternatives because this alternative would involve considerably more offsite truck traffic and thus represents a higher risk to workers and the community, and a greater nuisance to the community.

Although the short-term potential risks associated with a remedial action do not exist under Alternative 1, leaving the surface soils containing COCs above PRGs in place on OU2 would not achieve the RAOs and thus would be ineffective at protecting human health and the environment both in the short- and long-term. Alternatives 2 through 4 would be immediately effective upon completion of the remedial action and would achieve the RAOs. Therefore, these alternatives rank higher than the Alternative 1.

6.2.3 Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion addresses the preference under CERCLA for remedial alternatives that permanently and significantly reduce the mobility, toxicity, or volume of hazardous substances through treatment. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. There are no principal threat wastes in OU2 and thus this criterion is not applicable.

6.2.4 Implementability

This criterion does not apply to Alternative 1 because no remedial actions would be implemented.

Alternatives 2 through 4 are straightforward to implement using readily available and highly reliable technologies and equipment, and specialists are not required. Alternative 3 requires stockpiling and coordination with the OU4 remedy, and thus poses some challenges to implementation. Alternative 4 would require institutional controls and coordination with future property owners each time the property is sold. As a result, Alternative 4 is more difficult to implement than Alternatives 2 and 3.

6.2.5 Estimated Costs

The breakdown of the estimated costs for the five alternatives is provided below. Detailed cost estimates (Level 5, AACE 2011) are provided in Appendix B.

Summary of Estimated Costs

Cost Category	Alternative 1 No Action	Alternative 2 Removal and Offsite Disposal	Alternative 3 Removal, Onsite Reuse/Consolidation, and Offsite Disposal	Alternative 4 Soil Cover and Institutional Controls
Direct Capital Costs	$0	$1,318,000	$1,166,000	$591,000
Indirect Capital Costs	$0	$269,000	$258,000	$316,000
Periodic Costs	$90,000	$0	$40,000	$510,000
Total (NPV)	$32,000	$1,587,000	$1,455,000	$1,107,000

6.2.6 Modifying Criteria

Alternative 1, No Action, is not expected to be accepted by the regulatory agencies or the community because it does not address the unacceptable risks associated with OU2 soils.

Alternatives 2 and 3 have been discussed in meetings with local stakeholders and are expected to be acceptable the community, local government, and to potential future property owners. Alternative 3 includes stockpiling and, ultimately, reuse/consolidation of OU2 soils on OU4 and may be less preferred by the community than Alternative 2.

Alternative 4 has not been discussed with the community for OU2, and it is not clear how it would be perceived. However, the community has expressed reservations about land-use controls in the past. Both deed restrictions and maintenance of the soil cover would require indefinite monitoring by stakeholders, EPA, and NCDEQ.

EPA will assess State acceptance and community acceptance after the proposed plan public comment period.

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EarthCon. 2019c. Human Health Risk Assessment Addendum, Kerr-McGee Chemical Corp-Navassa Superfund Site, Navassa, North Carolina. August.

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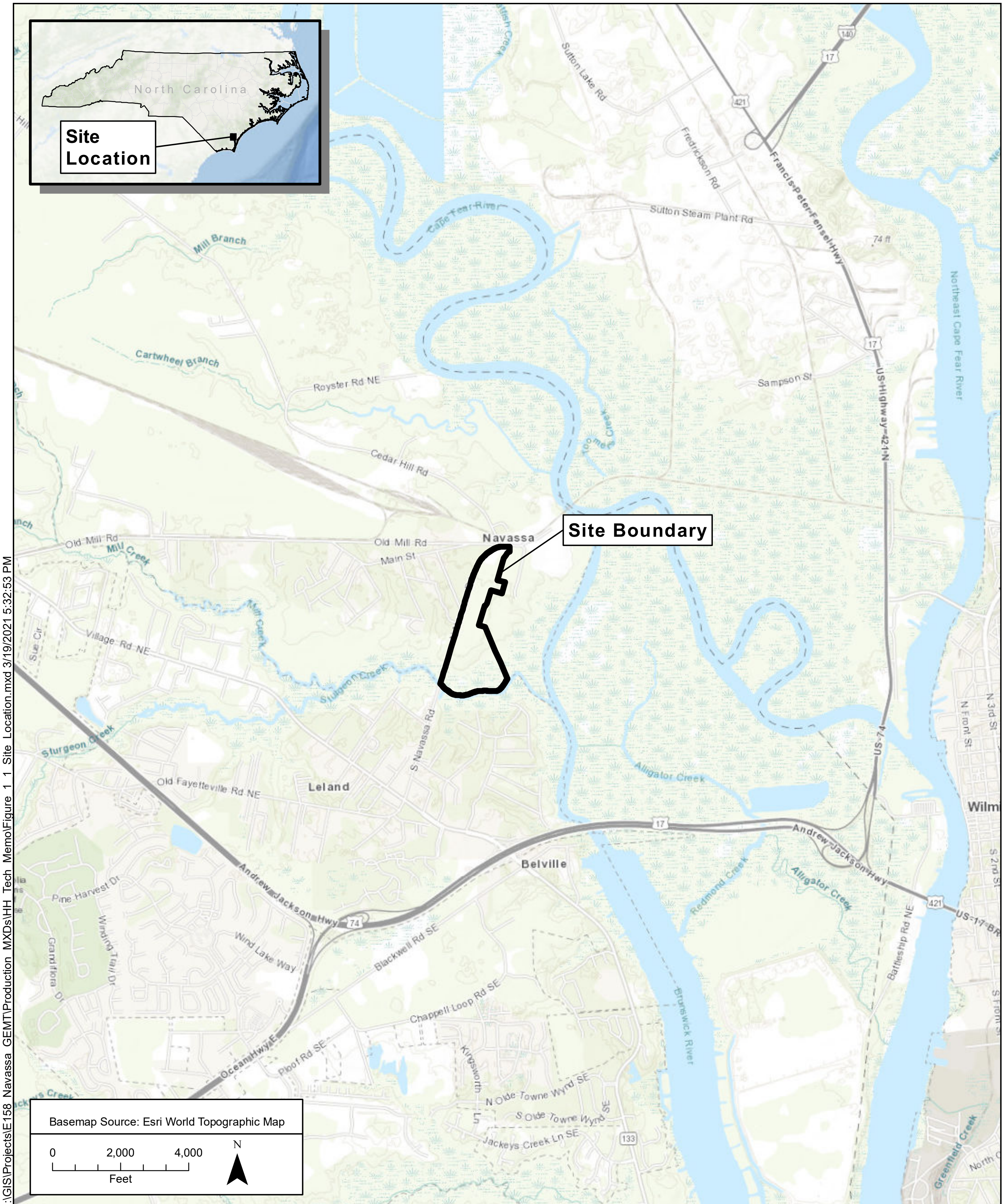
Figures

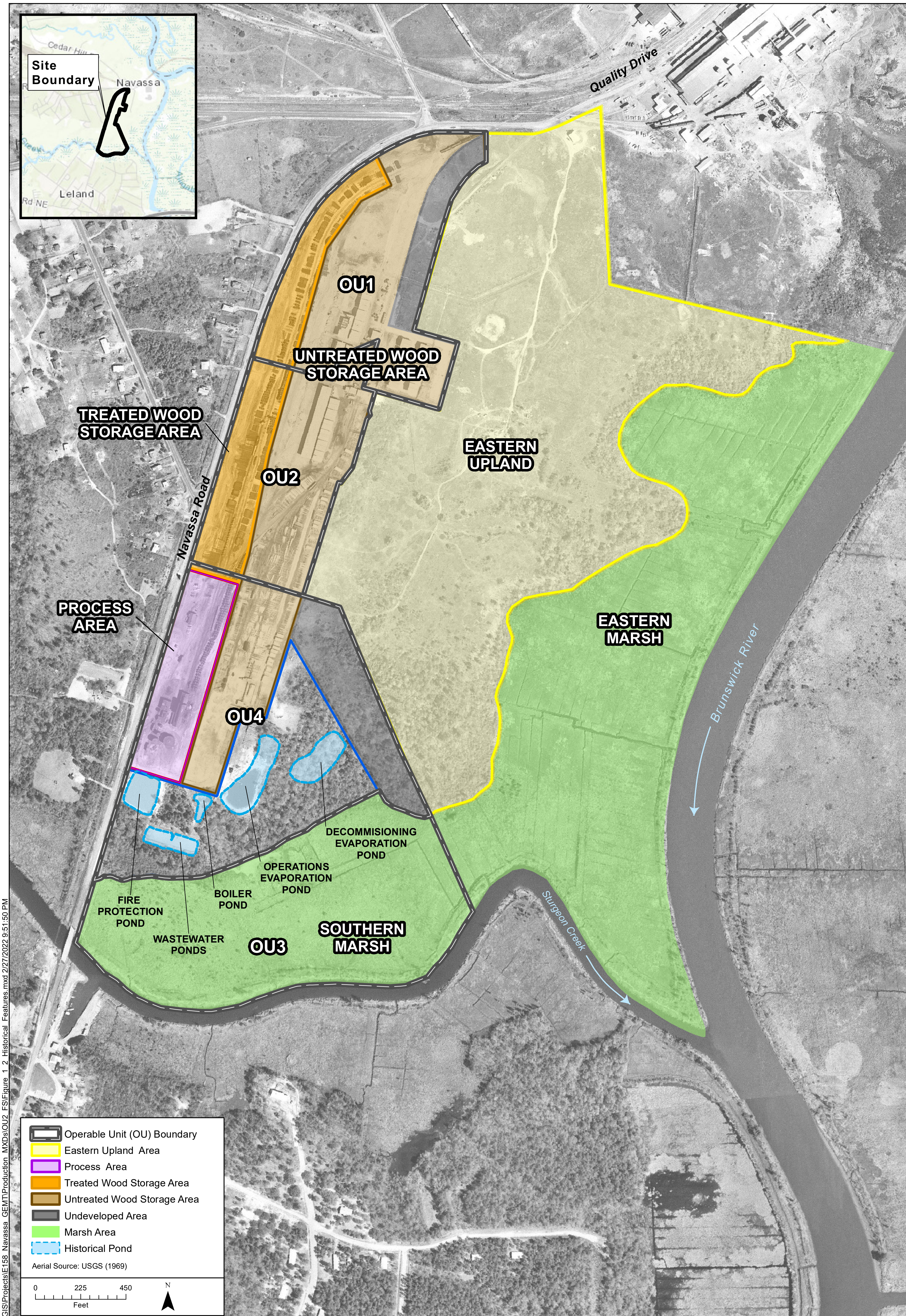


N:\GIS\Projects\E158 Navassa GEMT\Production MXDs\HH Tech Memo\Figure 1 1 Site Location.mxd 3/19/2021 5:32:53 PM

Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral engineering p.c.

Figure 1-1.
Site Location
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022



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Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental
Response Trust

Prepared by: integral engineering p.c.

Figure 1-2.
Historical Site Features
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022

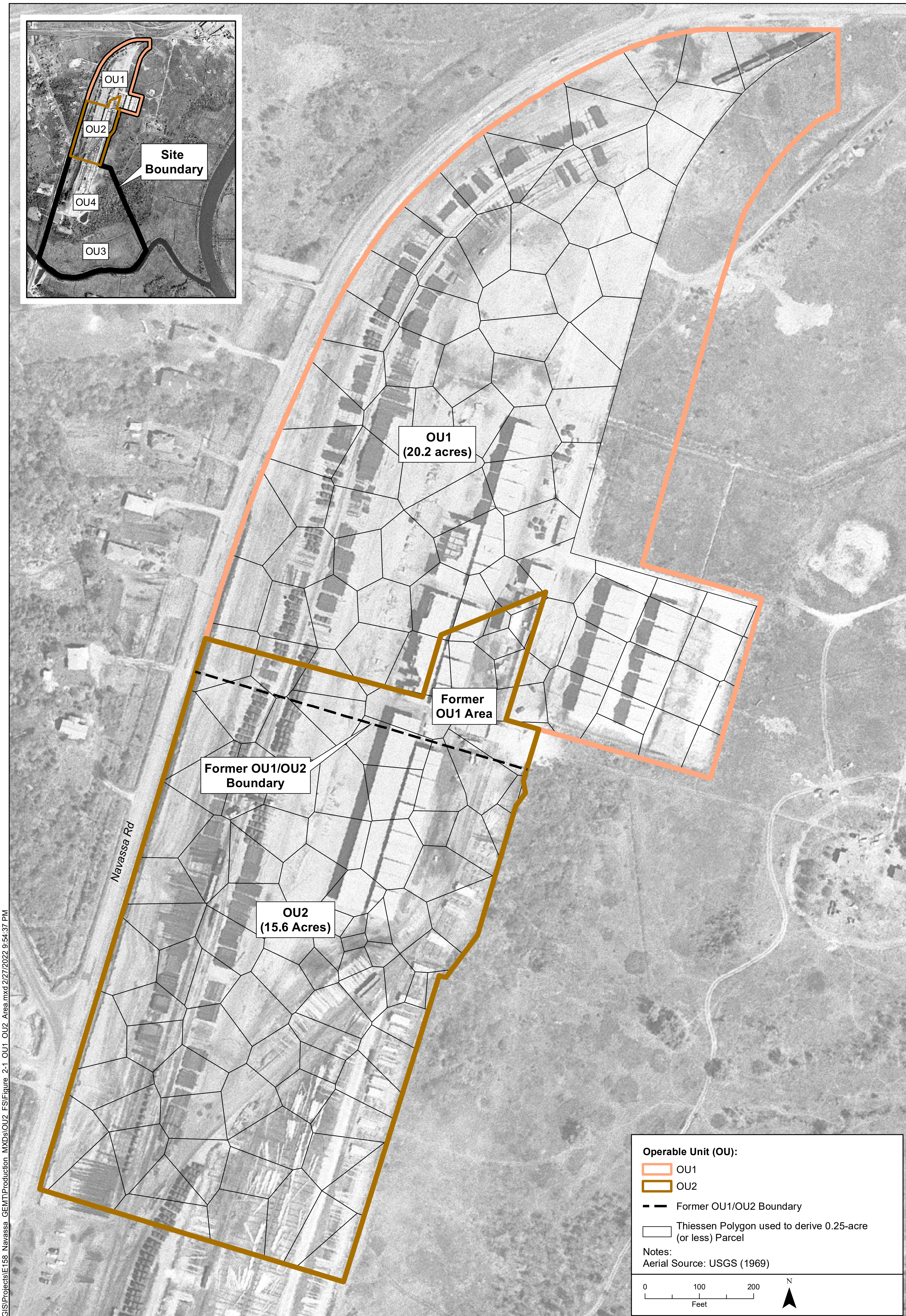

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Figure 2-1.
OU1/OU2 Area
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022

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Trustee of the Multistate Environmental Response Trust

Prepared by: integral engineering p.c.

Figure 2-2.
OU2 Surface Soil BaP TEQ Concentrations
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022

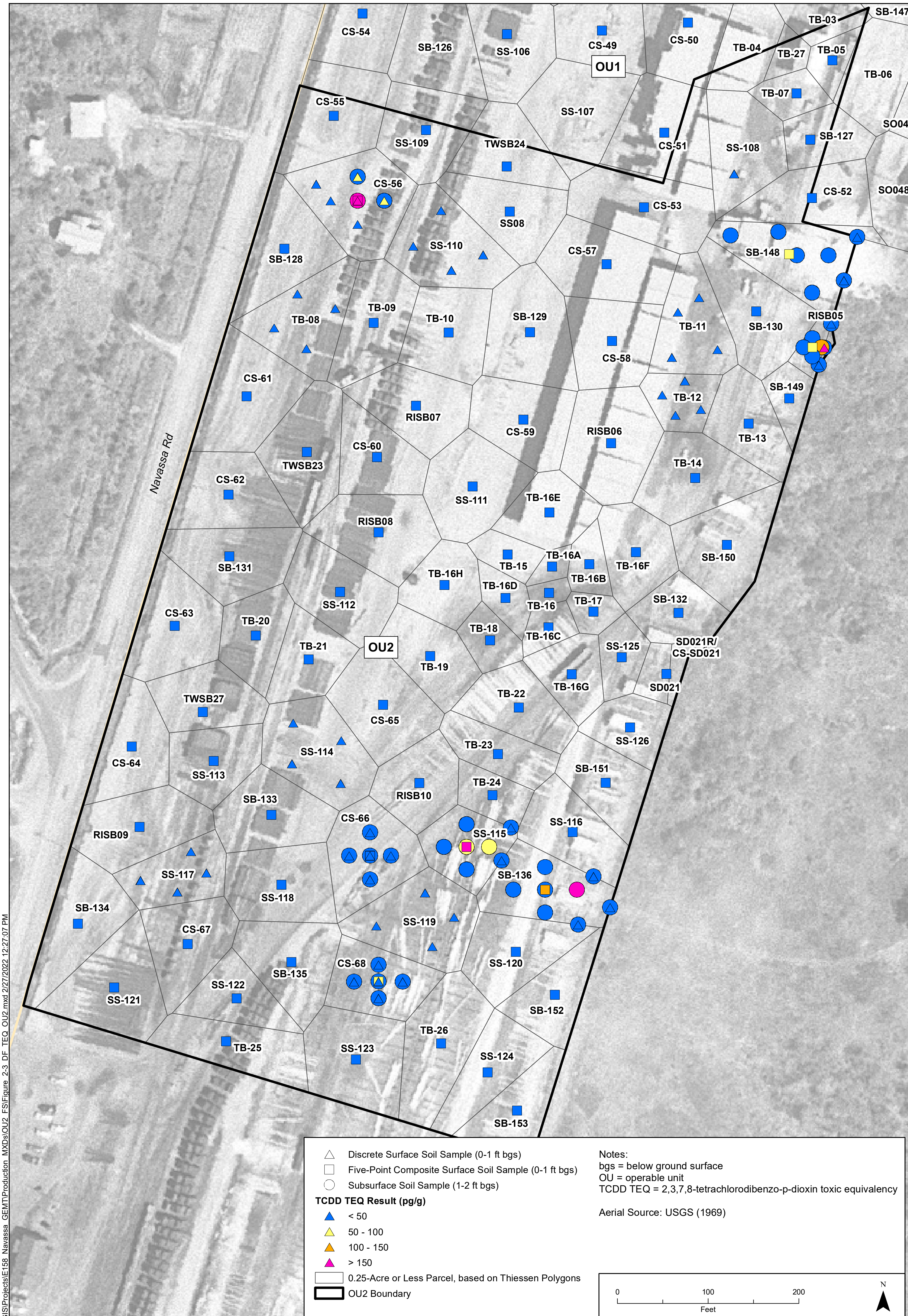

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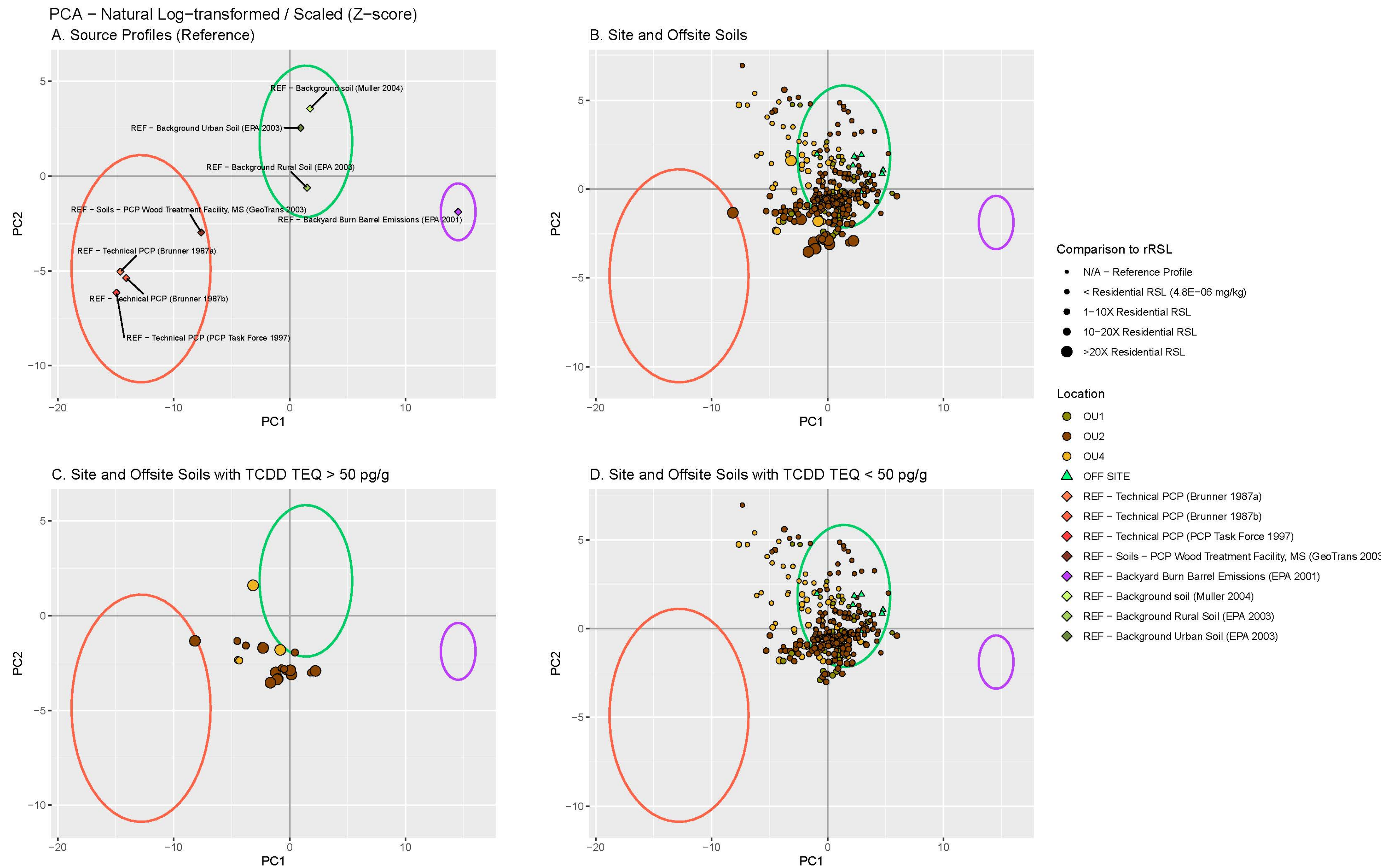
Figure 2-3.
OU2 Surface and Subsurface Soil TCDD TEQ Concentrations
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022



Notes:
Congener data were sample-normalized (percent of total TCDD TEQ), natural log-transformed, and autoscaled (z-scoring) prior to principal component analysis.
Ovals represent estimated source profile areas for visual purposes only.

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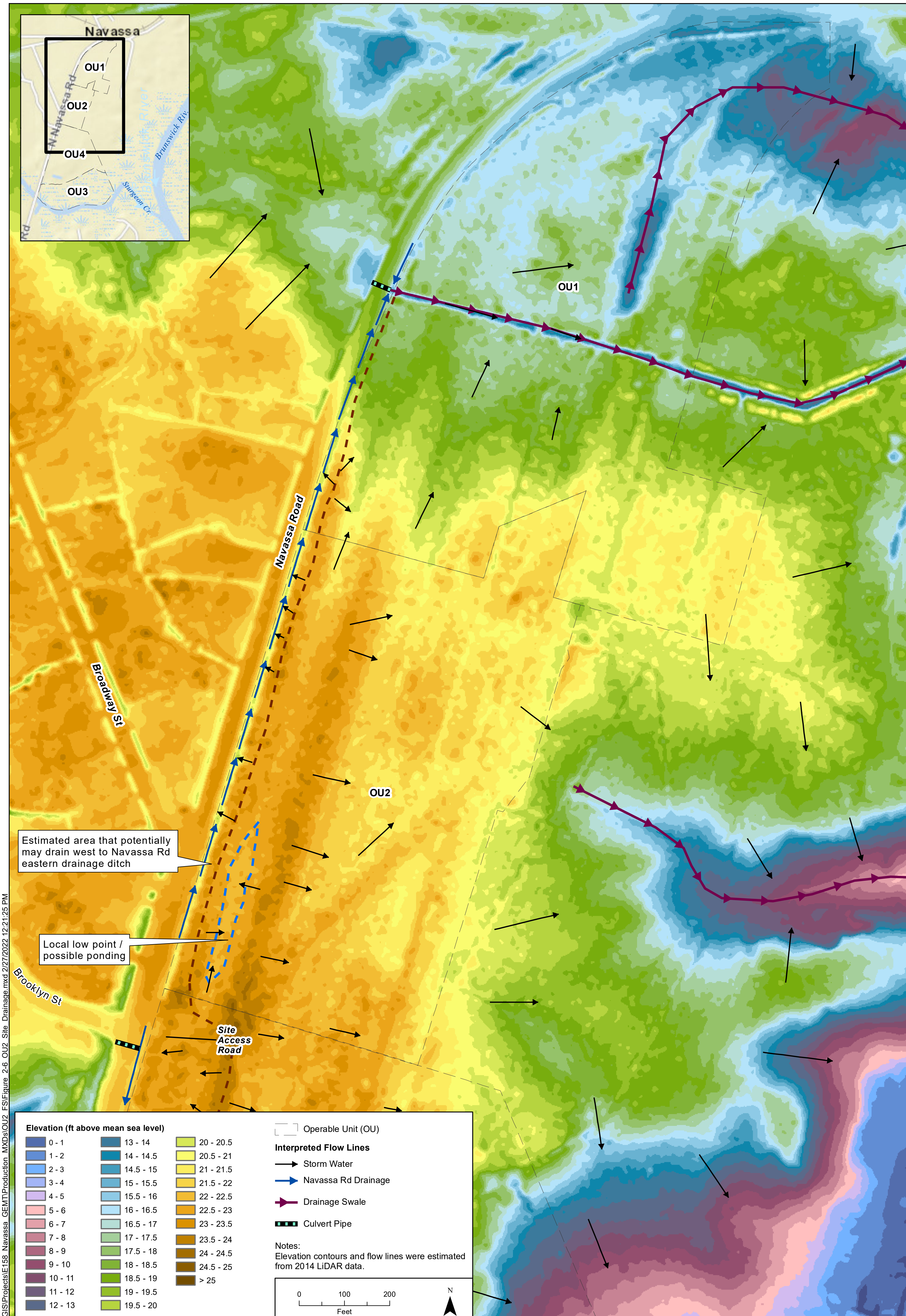
9/29/2021

Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral

Figure 2-4.
Principal Component Analysis of Dioxins and Furans in Surface and Subsurface Soils
Kerr-McGee Chemical Corp. – Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022



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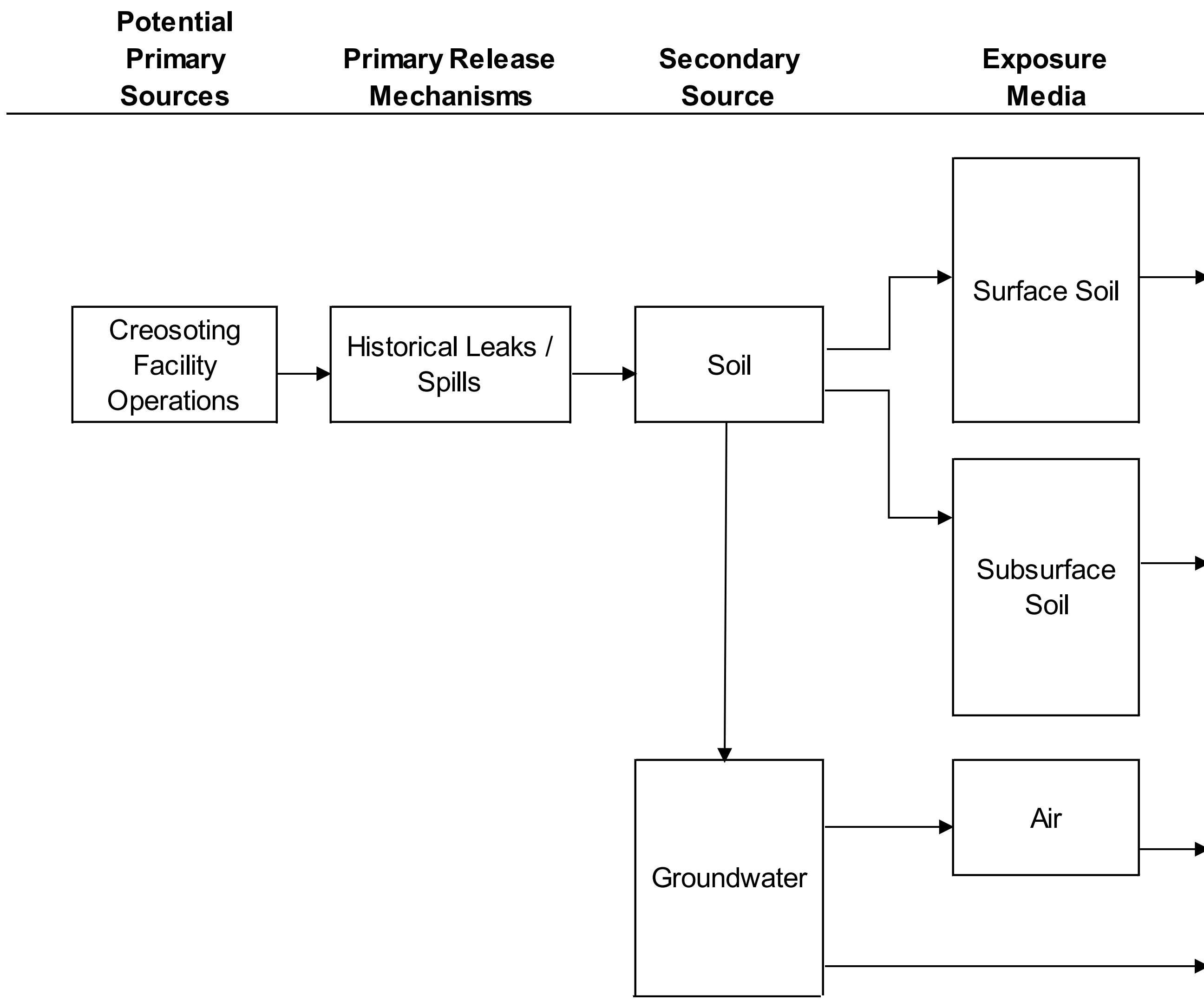
Trustee of the Multistate Environmental
Response Trust

Prepared by: integral

Figure 2-5.
OU1/OU2 Topography and Drainage
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022



Potentially Exposed Human Health Receptors

Exposure Media	Exposure Route	Future Resident	Future Commercial/ Industrial Worker	Future Construction Worker	Current/ Future Trespasser	Future Youth Sports Player	Future Site Visitor/ Trail Walker
Surface Soil	Incidental Ingestion	●	●	●	●	●	●
Surface Soil	Dermal Contact	●	●	●	●	●	●
Surface Soil	Inhalation (via Particulates and Volatiles)	●	●	●	●	●	●
Subsurface Soil	Incidental Ingestion	NA	NA	●	NA	NA	NA
Subsurface Soil	Dermal Contact	NA	NA	●	NA	NA	NA
Subsurface Soil	Inhalation (via Particulates and Volatiles)	NA	NA	●	NA	NA	NA
Air	Inhalation (via Vapor Intrusion)	o	o	NA	NA	NA	NA
Groundwater	Ingestion (as tap water)	o	o	NA	NA	o	o

Notes:

- ● Complete exposure route and quantitatively evaluated in the 2021 HHRA.
- o Exposure route potentially complete but qualitatively evaluated.
- NA Not applicable: receptor is not potentially exposed via this pathway.

6/15/2021

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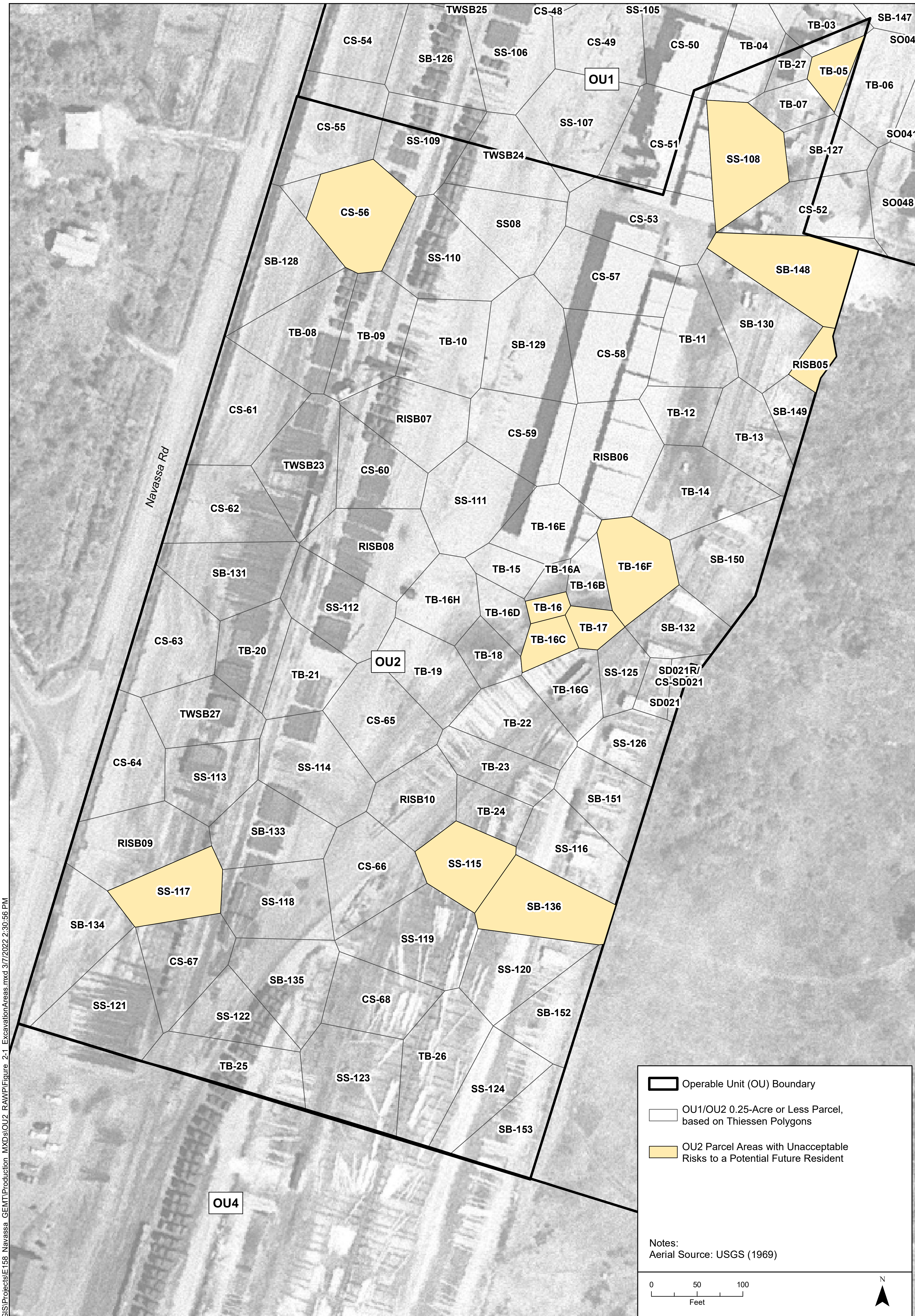
Trustee of the Multistate Environmental Response Trust

Prepared by: integral engineering p.c.

Figure 2-6.
OU2 Human Health Conceptual Site Exposure Model
Kerr-McGee Chemical Corp. – Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022



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Trustee of the Multistate Environmental Response Trust

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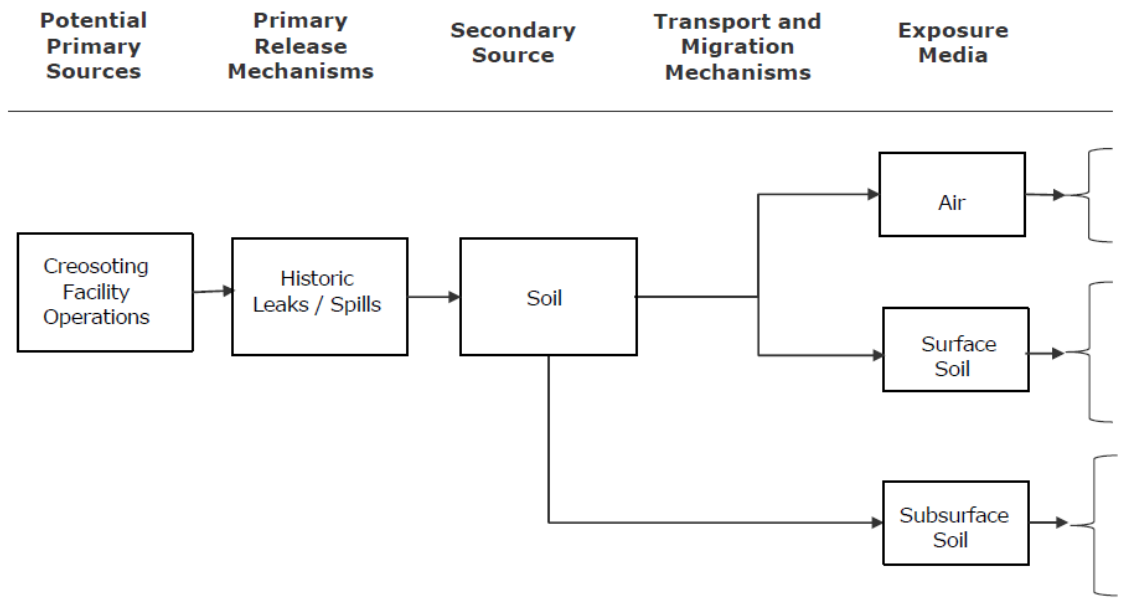
Figure 2-7.
OU2 Parcel Areas with Unacceptable Risks to a Potential Future Resident
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022



Exposure Route	Terrestrial Receptors: Off-site Birds
Inhalation of soil particles	I
Direct Contact	Y
Ingestion	Y
Direct Contact	N
Ingestion	N

Key:

Y The pathway is complete and is quantitatively evaluated in the environmental risk characterization

I The pathway is potentially complete but insignificant relative to other pathways, and is not evaluated further

N The pathway is not complete and is not evaluated

9/29/2021

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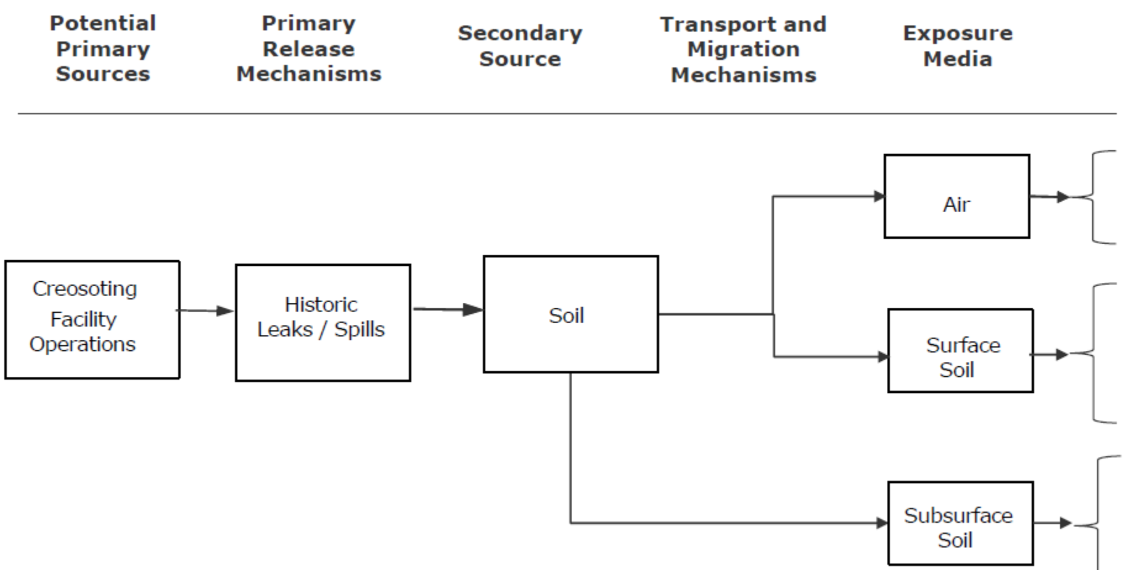
Trustee of the Multistate Environmental Response Trust

Prepared by: integral engineering p.c.

Figure 2-8.
OU2 Ecological Conceptual Site Exposure Model for Residential, Commercial/Industrial, and/or Sports Field Land Use
Kerr-McGee Chemical Corp. – Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022



Exposure Route (a)	Terrestrial Receptors		
	Invertebrates	Birds	Mammals
Inhalation of soil particles	I	I	I
Direct Contact	Y	Y	Y
Ingestion	Y	Y	Y
Direct Contact	N	N	Y
Ingestion	N	N	Y

Key:

Y The pathway is complete and is quantitatively evaluated in the environmental risk characterization

I The pathway is potentially complete but insignificant relative to other pathways, and is not evaluated further

N The pathway is not complete and is not evaluated

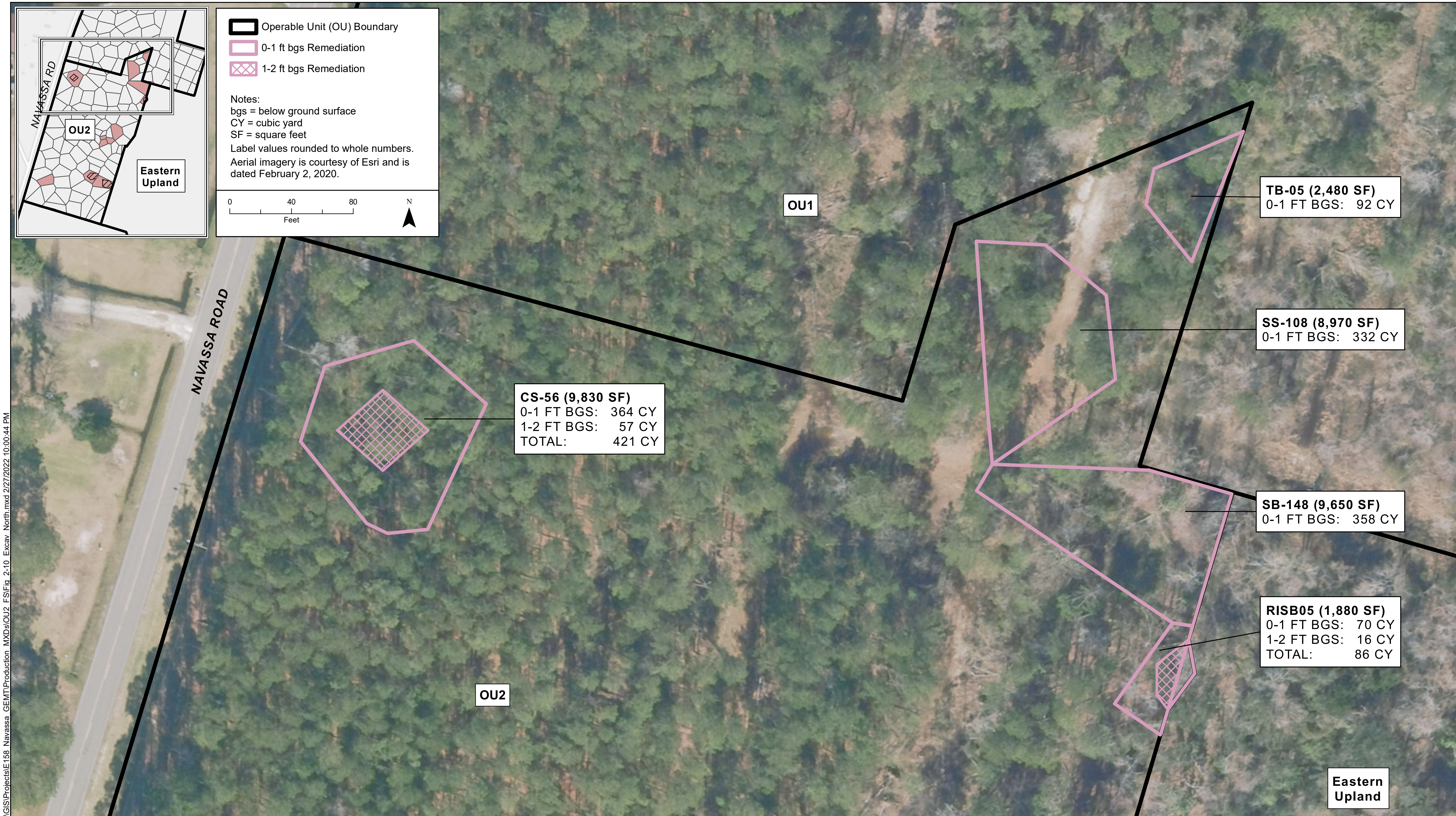
(a) For Exposure Route, "Direct Contact" and "Ingestion" includes direct contact, direct soil ingestion, and ingestion of prey that has been in contact with the media (soil) from the OU.

9/29/2021

Prepared for: Greenfield Environmental Trust, LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral engineering p.c.

Figure 2-9.
OU2 Ecological Conceptual Site Exposure Model for Hiking Trails and/or Other Natural Recreation Use Land Use
Kerr-McGee Chemical Corp. – Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022



N:\GIS\Projects\E158_Navassa_GEMT\Production_MXDs\OU2_FS\Fig_2-10_Excav_North.mxd 2/27/2022 10:00:44 PM

Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral

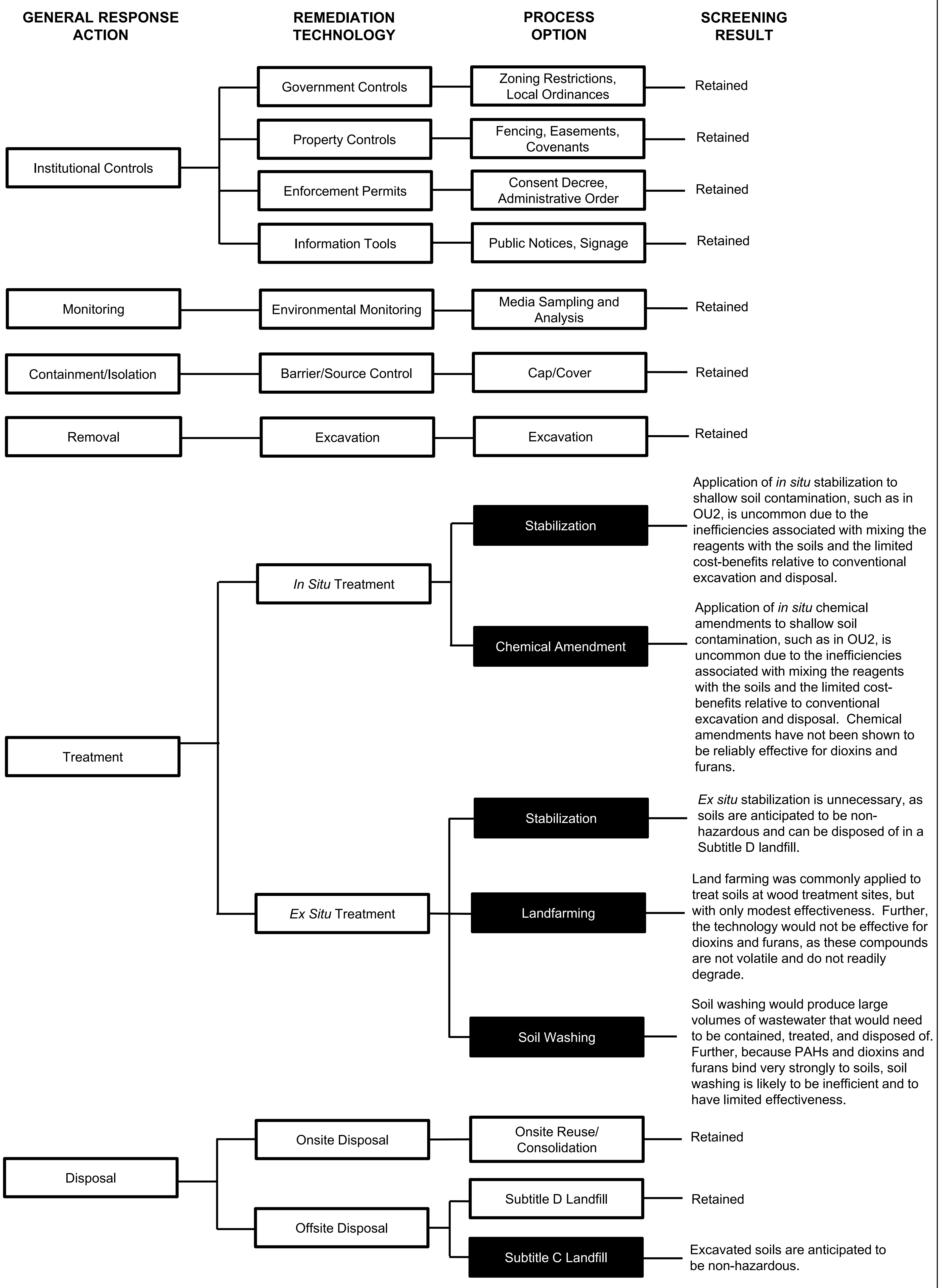
Figure 2-10.
OU2 Northern Parcel Remediation Areas
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022

N:\GIS\Projects\E158_Navassa_GEMT\Production_MXDs\OU2_FS\Fig_2-11_Excav_South.mxd 2/27/2022 10:05:09 PM

Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral

Figure 2-11.
OU2 Southern Parcel Remediation Areas
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022



Remediation Technology Retained
Remediation Technology Screened Out

Notes:
OU = operable unit
TCDD TEQ = 2,3,7,8-tetrachlorodibenzo-*p*-dioxin toxic equivalency

9/29/2021

Figure 4-1.
Identification and Screening of Remediation Technologies and Process Options
Kerr-McGee Chemical Corp. – Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022

Prepared for: Greenfield Environmental Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral

General Response Action			Alt 1	Alt 2	Alt 3	Alt 4
			No Action	Removal and Offsite Disposal	Removal, Onsite Reuse/ Consolidation and Offsite Disposal	Cover and Institutional Controls
Medium	Technology Type	Area or Volume[a]				
Soil	Institutional Controls	1.6 acres				X
	Environmental Monitoring	1.6 acres				X
	Excavation	1.6 acres 2,821 CY		X	X	
	Cap/Cover	1.6 acres				X
	Onsite Reuse/ Consolidation	2,821 CY			X	
	Subtitle D Landfill[b]	2,821 CY		X	X	

Notes:
[a] Areas and volumes are preliminary and are subject to change.
[b] It is anticipated that soils excavated from OU2 will be non-hazardous and can be disposed of in a Subtitle D landfill.

CY = cubic yards
TBD = to be determined

Prepared for: Greenfield Environmental Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral engineering p.c.

Figure 5-1.
Alternative Assembly Matrix
Kerr-McGee Chemical Corp. – Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022

LEGEND

- ● Excellent
- ◕ Good
- ◑ Fair
- ◔ Poor
- ○ Very Poor

		EVALUATION CRITERIA							
		Threshold		Balancing					
		Protectiveness	Compliance with ARARs	Long-Term Effectiveness	Short-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume through Treatment	Implementability	Estimated Cost (millions)	OVERALL RATING
Alternative 1	No Action	Very Poor	Very Poor	Very Poor	Very Poor	NA	Excellent	$0.03	Very Poor
Alternative 2	Removal and Offsite Disposal	Excellent	Excellent	Excellent	Fair	NA	Excellent	$1.59	Excellent
Alternative 3	Removal, Onsite Reuse/ Consolidation, and Offsite Disposal	Excellent	Excellent	Good	Good	NA	Good	$1.46	Good
Alternative 4	Cover and Institutional Controls	Excellent	Excellent	Good	Excellent	NA	Poor	$1.11	Fair

Notes:
NA = not applicable. There are no principal threat wastes in OU2 and thus this criterion is not applicable.

1/27/2022

Prepared for: Greenfield Environmental Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral engineering p.c.

Figure 6-1.
Summary of the Detailed Analysis of Remedial Alternatives
Kerr-McGee Chemical Corp. – Navassa Superfund Site
Navassa, North Carolina
Feasibility Study Report, OU2
April 2022

Tables

Table 2-1. Physical and Chemical Properties of OU2 COCs

Parameter Name	Koc (mL/g)	Henry's Constant (atm-m^3/mol)	Solubility (mg/L)
Select PAHs			
Benz[*a*]anthracene	1.4E+06[a]	1.16E-06[a]	5.70E-03[a]
Benzo[*a*]pyrene	5.9E+05[b]	1.55E-06[a]	1.20E-03[a]
Benzo[*b*]fluoranthene	5.50E+05[a]	1.19E-02[a]	1.40E-02[a]
Benzo[*k*]fluoranthene	6.45E+06 to 8.12E+07[c]	5.84E-07[c]	7.60E-04[c]
Chrysene	2.00E+05[a]	1.05E-06[a]	1.80E-03[a]
Dibenzo[*a,h*]anthracene	5.70E+5 to 4.80E+7[c]	1.40E-07[c]	2.49E-03[c]
Fluoranthene	5.5E+04[b]	6.46E-06[a]	2.06E-01[a]
Indeno[1,2,3-*cd*]pyrene	6.02E+05 to 6.60E+08[c]	3.48E-07[c]	1.90E-04[c]
Naphthalene	1.5E+03[b]	1.15E-03[a]	3.17E+01[a]
Pyrene	5.4E+04[b]	5.04E-06[a]	1.32E-01[a]
2-Methylnaphthalene	8,500[a]	3.20E-04[a]	2.46E+01[c]
1,1'-Biphenyl	1,700[a]	1.90E-04[a]	7.48E+00[c]
Phenols			
Pentachlorophenol	5.9E+02[b]	2.75E-06[a]	1.40E+01[a]
Dioxins and Furans			
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	2.5E+05[b]	3.20E-06[c]	2.00E-04[c]

Notes:

COC = chemical of concern

Koc = carbon-water partitioning coefficient

OU2 = Operable Unit 2

PAH = polycyclic aromatic hydrocarbon

Physical property data are from the following sources:

[a] J. Dragun, 1984, A Chemical Engineer's Guide to Groundwater Contamination

[b] USEPA. 2021. Chemical Specific Parameter Table, May 2021. Available at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

[c] Pubchem Open Chemistry Database, National Institutes of Health, pubchem.ncbi.nlm.nih.gov

Table 2-2. Summary of OU2 Parcels with ELCR Greater Than 1.0x10-4 and/or an HI Greater Than 1.0 under a Residential Use Scenario

Parcel	Total Excess Lifetime Cancer Risk	Total Noncancer HI (child)	Notes
CS-56	7.5x10-5	4.1	
RISB05	1.8x10-5	1.7	
SB-136	3.5x10-5	2.6	
SB-148	1.8x10-5	1.4	
SS-108	1.5x10-4	0.64	
SS-115	1.3x10-4	5.7	
SS-117	2.9x10-4	1.4	
TB-05	2.5x10-4	1.2	Parcel evaluated in OU2 HHRA Addendum; endpoint-specific HIs are less than 1.0
TB-16	9.5x10-4	4.7	
TB-16C	1.7x10-4	1.0	
TB-16F	1.3x10-4	0.88	
TB-17	1.6x10-4	0.77	Parcel evaluated in OU2 HHRA Addendum

Notes:

ELCR = excess lifetime cancer risk
HHRA = human health risk assessment
HI = hazard index
NCDEQ = North Carolina Department of Environmental Quality

At the direction of NCDEQ, ELCRs and HIs are presented to two significant figures. Total ELCR greater than $1.0x10^{-4}$ and/or total HI greater than 1.0 are shaded.

Risk calculations for parcels evaluated as part of this OU2 HHRA addendum are presented in Table 3-1. Table 3-10 of the 2021 OU2 HHRA presents the risk calculations for those parcels not evaluated as part of the OU2 HHRA Addendum.

Table 2-3. Constituents of Concern by Residential Parcel

	Endpoint		COPC ("X" if Identified as COC)								
Parcel	ELCR > 1.0x10-4	Endpoint-Specific Noncancer HI > 1.0	BaP TEQ	BaP	Fluoranthene	Naphthalene	PCP	Phenanthrene	Pyrene	TCDD TEQ	Notes
CS-56		X								X	
RISB05		X								X	
SB-136		X								X	
SB-148		X								X	
SS-108	X		X								
SS-115	X	X	X							X	
SS-117	X	X	X	X						X	
TB-05	X		X							X	Parcel with OU2 PDI data and evaluated in OU2 HHRA Addendum
TB-16	X	X	X	X		X	X			X	
TB-16C	X		X							X	
TB-16F	X		X			X				X	
TB-17	X		X							X	Parcel with OU2 PDI data and evaluated in OU2 HHRA Addendum

Notes:

BaP = benzo[*a*]pyrene
COC = constituent of concern
COPC = constituent of potential concern
ELCR = excess lifetime cancer risk
HHRA = human health risk assessment
HI = hazard index
PCP = pentachlorophenol
PDI = pre-design investigation
TCDD = 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEQ = toxic equivalency

Table 2-4. Range of Site-Specific Remediation Goals for Residential COCs

	Cancer Basis (mg/kg)			Child Noncancer Basis (mg/kg)			Adult Noncancer Basis (mg/kg)		
COC	1.0x10-6	1.0x10-5	1.0x10-4	0.10	1.0	3.0	0.10	1.0	3.0
BaP TEQ	0.11	1.1	11	NA	NA	NA	NA	NA	NA
BaP	NA	NA	NA	1.8	18	54	16	160	480
Naphthalene	1.7	17	170	9.5	95	290	10	100	310
Pentachlorophenol	1.0	10	100	25	250	740	200	2000	6100
TCDD TEQ	0.0000047	0.000047	0.00047	0.0000051	0.000051	0.00015	0.000051	0.00051	0.0015

Notes:

BaP = benzo[*a*]pyrene

COC = constituent of concern

NA = not applicable; endpoint not relevant for COC

TCDD = 2,3,7,8-tetrachlorodibenzo-*p* -dioxin

TEQ = toxic equivalency

Site-Specific Remediation Goals are presented to two significant figures.

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
General Construction Standards – All land–disturbing activities (i.e., excavation, trenching, grading etc.)			
Managing storm water runoff from land-disturbing activities	Shall install erosion and sedimentation control devices and practices sufficient to retain the sediment generated by the land-disturbing activity within the boundaries of the tract during construction.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-53) of more than 1 acre of land – **applicable**	N.C.G.S. Ch.113A-157(3) *Mandatory standards for land-disturbing activity*
	Shall plant or otherwise provide permanent ground cover sufficient to restrain erosion after completion of construction.		N.C.G.S. Ch.113A-157(3)
	The land-disturbing activity shall be conducted in accordance with the approved erosion and sedimentation control plan. *NOTE:* Plan which meets the objectives of 15A NCAC 4B.0106 would be included in the CERCLA Remedial Design or Remedial Action Work Plan		N.C.G.S. Ch.113A-157(5)
	Shall take all reasonable measures to protect all public and private property from damage caused by such activities.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52) of more than 1 acre of land – **applicable**	15A NCAC 4B.0105

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Managing storm water runoff from land-disturbing activities con't	Erosion and sedimentation control plan must address the following basic control objectives: (1) Identify areas subject to severe erosion, and off-site areas especially vulnerable to damage from erosion and sedimentation. (2) Limit the size of the area exposed at any one time. (3) Limit exposure to the shortest feasible time. (4) Control surface water run-off originating upgrade of exposed areas (5) Plan and conduct land-disturbing activity so as to prevent off-site sedimentation damage. (6) Include measures to control velocity of storm water runoff to the point of discharge.		15A NCAC 4B.0106
Managing storm water runoff from land-disturbing activities con't	Erosion and sedimentation control measures, structures, and devices shall be planned, designed, and constructed to provide protection from the run-off of 10 year storm.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52) of more than 1 acre of land – **applicable**	15A NCAC 4B.0108
	Shall conduct activity so that the post-construction velocity of the 10 year storm run-off in the receiving watercourse to the discharge point does not exceed the parameters provided in this Rule.		15A NCAC 4B.0109
	Shall install and maintain all temporary and permanent erosion and sedimentation control measures.		15A NCAC 4B.0113
Control of fugitive dust emissions	The owner/operator of a facility shall not cause fugitive dust emissions to cause or contribute to the substantive complaints or visible emissions.	Activities potentially generating fugitive dust as defined in 15A NCAC 02D .0540 (a)(2) – **relevant and appropriate**	15A NCAC 02D .0540

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Waste Characterization – Primary Wastes (contaminated soil and debris) and Secondary Wastes (contaminated PPE and equipment, etc.)			
Characterization of *solid waste* (all primary and secondary wastes)	Must determine if solid waste is a hazardous waste using the following method: • Should first determine if waste is excluded from regulation under 40 CFR § 261.4; and • Must then determine if waste is listed as a hazardous waste under subpart D 40 CFR part 261.	Generation of solid waste as defined in 40 CFR § 261.2 – **applicable**	40 CFR § 262.11(a) and (b) 15A NCAC 13A .0106, .107
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 CFR part 261 by either: (1) Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or according to an equivalent method approved by the Administrator under 40 CFR §260.21; or (2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.		40 CFR § 262.11(c) 15A NCAC 13A .0106
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste	Generation of solid waste which is determined to be hazardous – **applicable**	40 CFR § 262.11(d); 15A NCAC 13A .0106
Characterization of *hazardous waste* (all primary and secondary wastes)	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR 264 and 268.	Generation of RCRA-hazardous waste for storage, treatment or disposal – **applicable**	40 CFR § 264.13(a)(1) 15A NCAC 13A .0109

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Determinations for management of hazardous waste	Must determine if the hazardous waste has to be treated before land disposed. This is done by determining if the waste meets the treatment standards in 40 CFR § 268.40, § 268.45, or § 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. This determination can be made concurrently with the hazardous waste determination required in 40 CFR § 262.11.	Generation of RCRA hazardous waste for storage, treatment or disposal – **applicable**	40 CFR § 268.7(a)(1) 15A NCAC 13A .0106
	Must comply with the special requirements of 40 CFR § 268.9 in addition to any applicable requirements in 40 CFR § 268.7.	Generation of waste or soil that displays a hazardous characteristic of ignitability, corrosivity, reactivity, or toxicity for storage, treatment or disposal **– applicable**	40 CFR § 268.7(a)(1) 15A NCAC 13A .0112
	Must determine each EPA Hazardous Waste Number (waste code) applicable to the waste in order to determine the applicable treatment standards under 40 CFR 268 *et seq.* This determination may be made concurrently with the hazardous waste determination required in Sec. 262.11 of this chapter.	Generation of RCRA characteristic hazardous waste for storage, treatment or disposal – **applicable**	40 CFR § 268.9(a) 15A NCAC 13A .0112
	Must determine the underlying hazardous constituents [as defined in 40 CFR § 268.2(i)] in the characteristic waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non–wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal **– applicable**	40 CFR § 268.9(a) 15A NCAC 13A .0112

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Waste Storage – Primary Wastes (contaminated soil and debris) and Secondary Wastes (contaminated PPE and equipment, etc.)			
Storage of solid waste	All solid waste shall be stored in such a manner as to prevent the creation of a nuisance, insanitary conditions, or a potential public health hazard.	Generation of solid waste which is determined *not* to be hazardous – **relevant and appropriate**	15A NCAC 13B .0104(f)
	Containers for the storage of solid waste shall be maintained in such a manner as to prevent the creation of a nuisance or insanitary conditions. Containers that are broken or that otherwise fail to meet this Rule shall be replaced with acceptable containers.		15A NCAC 13B .0104(e)
Temporary Storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that: • waste is placed in containers that comply with 40 CFR 265.171–173; and	Accumulation of RCRA hazardous waste on site as defined in 40 CFR §260.10 – **applicable**	40 CFR § 262.34(a); 15A NCAC 13A .0107 40 CFR §262.34(a)(1)(i);
	• the date upon which accumulation begins is clearly marked and visible for inspection on each container; • container is marked with the words “hazardous waste”; or		40 CFR § 262.34(a)(2) and (3) 15A NCAC 13A .0107
	• container may be marked with other words that identify the contents.	Accumulation of 55 gal. or less of RCRA hazardous waste <u>or</u> one quart of acutely hazardous waste listed in §261.33(e) at or near any point of generation – **applicable**	40 CFR § 262.34(c)(1) 15A NCAC 13A .0107

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Use and management of hazardous waste in containers	If container is not in good condition (e.g. severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers – **applicable**	40 CFR § 265.171 15A NCAC 13A .0109
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 CFR § 265.172 15A NCAC 13A .0109
	Containers must be closed during storage, except when necessary to add/remove waste. Container must not be opened, handled and stored in a manner that may rupture the container or cause it to leak.		40 CFR § 265.173(a) and (b) 15A NCAC 13A .0109
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 CFR §264.175(b).	Storage of RCRA–hazardous waste in containers with *free liquids* **– applicable**	40 CFR §264.175(a) 15A NCAC 13A .0109
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA–hazardous waste in containers that *do not contain free liquids* (other than F020, F021, F022, F023, F026 and F027) **– applicable**	40 CFR § 264.175(c)(1) and (2) 15A NCAC 13A .0109

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Closure performance standard for RCRA container storage unit	Must close the facility (e.g., container storage unit) in a manner that: • Minimizes the need for further maintenance; • Controls minimizes or eliminates to the extent necessary to protect human health and the environment, post–closure escape of hazardous waste, hazardous constituents, leachate, contaminated run –off, or hazardous waste decomposition products to the ground or surface waters or the atmosphere; and • Complies with the closure requirements of subpart, but not limited to, the requirements of 40 CFR § 264.178 for containers.	Storage of RCRA hazardous waste in containers **– applicable**	40 CFR § 264.111 15A NCAC 13A .0109
Closure of RCRA container storage unit	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with40 CFR § 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter].	Storage of RCRA hazardous waste in containers in a unit with a containment system **– applicable**	40 CFR § 264.178 15A NCAC 13A .0109

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Temporary on–site storage of remediation waste in RCRA staging pile (e.g., excavated soils)	Must be located within the contiguous property under the control of the owner/operator where the wastes are to be managed in the staging pile originated. For purposes of this section, storage includes mixing, sizing, blending or other similar physical operations so long as intended to prepare the wastes for subsequent management or treatment.	Accumulation of ***solid non–flowing hazardous remediation waste*** (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 CFR § 260.10 **– relevant and appropriate**	40 CFR § 264.554(a)(1)
	Staging piles may be used to store hazardous remediation waste (or remediation waste otherwise subject to land disposal restrictions) based on approved standards and design criteria designated for that staging pile. *NOTE*: Design and standards of the staging pile should be included in CERCLA Remedial Design document approved or issued by EPA.		40 CFR § 264.554(b)
Performance criteria for RCRA staging pile	Staging pile must be designed to: • facilitate a reliable, effective and protective remedy; • must be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross–media transfer as necessary to protect human health and the environment (e.g. use of liners, covers, run–off/run–on controls).	Storage of remediation waste in a staging pile **– relevant and appropriate**	40 CFR § 264.554(d)(1)(i) and (ii)

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Design criteria for RCRA staging pile	In setting standards and design criteria must consider the following factors: • Length of time pile will be in operation; • Volumes of waste you intend to store in the pile; • Physical and chemical characteristics of the wastes to be stored in the unit; • Potential for releases from the unit; • Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and • Potential for human and environmental exposure to potential releases from the unit.	Storage of remediation waste in a staging pile **– relevant and appropriate**	40 CFR § 264.554(d)(2)(i) – (vi)
Operation of a RCRA staging pile	Must not place in the same staging pile unless you have complied with 40 CFR § 264.17(b).	Storage of ”incompatible” remediation waste (as defined in 40 CFR § 260.10) in staging pile – **relevant and appropriate**	40 CFR § 264.554(f)(1)
	Must separate the incompatible waste or materials, or protect them from one another by using a dike, berm, wall or other device.	Staging pile of remediation waste stored nearby to incompatible wastes or materials in containers, other piles, open tanks or land disposal units – **relevant and appropriate**	40 CFR § 264.554(f)(2)
	Must not pile remediation waste on same base where incompatible wastes or materials were previously piled unless you have sufficiently decontaminated the base to comply with 40 CFR 2§64.17(b).		40 CFR § 264.554(f)(3)

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Closure of RCRA staging pile of remediation waste	Must be closed within 180 days after the operating term by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate. Must decontaminate contaminated sub-soils in a manner that EPA determines will protect human and the environment.	Storage of remediation waste in staging pile in ***previously contaminated area*** – **relevant and appropriate**	40 CFR § 264.554(j)(1) and (2)
	Must be closed within 180 days after the operating term according to 40 CFR § 264.258(a) and § 264.111 or § 265.258(a) and § 265.111.	Storage of remediation waste in staging pile ***in uncontaminated area*** – **relevant and appropriate**	40 CFR § 264.554(k)
Operational limits of a RCRA staging pile	Must not operate for more than 2 years, except when an operating term extension under 40 CFR § 264.554(i) is granted. *NOTE:* Must measure the 2-year limit (or other operating term specified) from first time remediation waste placed in staging pile	Storage of remediation waste in a staging pile **– relevant and appropriate**	40 CFR § 264.554(d)(1)(iii)
	Must not use staging pile longer than the length of time designated by EPA in appropriate decision document.		40 CFR § 264.554(h)
Treatment/Disposal of Wastes – Primary (contaminated soil and debris) and Secondary Wastes (contaminated PPE or equipment)			
Disposal of solid waste	Shall ensure that waste is disposed of at a site or facility which is permitted to receive the waste.	Generation of solid waste intended for off-site disposal – **relevant and appropriate**	15A NCAC 13B .0106(b)
Disposal of RCRA–hazardous waste in a land–based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR § 268.40 before land disposal.	Land disposal, as defined in 40 CFR268.2, of restricted RCRA waste – **applicable**	40 CFR § 268.40(a) 15A NCAC 13A .0112

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
	All underlying hazardous constituents [as defined in 40 CFR § 268.2(i)] must meet the Universal Treatment Standards, found in 40 CFR § 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001 –D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well – **applicable**	40 CFR § 268.40(e) 15A NCAC 13A .0112
Disposal of RCRA–hazardous waste in a land–based unit	To determine whether a hazardous waste identified in this section exceeds the applicable treatment standards of 40 CFR § 268.40, the initial generator must test a sample of the waste extract or the entire waste, depending on whether the treatment standards are expressed as concentration in the waste extract or waste, or the generator may use knowledge of the waste. If the waste contains constituents (including UHCs in the characteristic wastes) in excess of the applicable UTS levels in 40 CFR § 268.48, the waste is prohibited from land disposal, and all requirements of part 268 are applicable, except as otherwise specified.	Land disposal of RCRA toxicity characteristic wastes (D004 –D011) that are newly identified (i.e., wastes, soil, or debris identified by the TCLP but not the Extraction Procedure) – **applicable**	40 CFR § 268.34(f) 15A NCAC 13A .0112
Disposal of RCRA–*hazardous waste soil* in a land–based unit	Must be treated according to the alternative treatment standards of 40 CFR § 268.49(c) or according to the UTSs [specified in 40 CFR § 268.48 Table UTS] applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 CFR § 268.2, of restricted hazardous *soils* **– applicable**	40 CFR § 268.49(b) 15A NCAC 13A .0112
Treatment of RCRA *hazardous waste soil*	Prior to land disposal, all "constituents subject to treatment" as defined in 40 CFR § 268.49(d) must be treated as follows:	Treatment of restricted hazardous waste soils –**applicable**	40 CFR § 268.49(c)(1)

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
	• **For non –metals** (except carbon disulfide, cyclohexanone, and methanol), treatment must achieve a 90 percent reduction in total constituent concentrations, except as provided in 40 CFR § 268.49(c)(1)(C) • **For metals** and carbon disulfide, cyclohexanone, and methanol), treatment must achieve a 90 percent reduction in total constituent concentrations as measured in leachate from the treated media (tested according to TCLP) <u>or</u> 90 percent reduction in total constituent concentrations (when a metal removal technology is used), except as provided in 40 CFR § 268.49(c)(1)(C) • When treatment of any constituent subject to treatment to a 90 percent reduction standard would result in a concentration less than 10 times the Universal Treatment Standard for that constituent, treatment to achieve constituent concentrations less than 10 times the universal treatment standard is not required. [Universal Treatment Standards are identified in 40 CFR § 268.48 Table UTS]		40 CFR § 268.49(c)(1)(A)-(C)
	In addition to the treatment requirement required by paragraph (c)(1) of this section, soils must be treated to eliminate these characteristics	Soils that exhibit the characteristic of ignitability, corrosivity or reactivity intended for land disposal – **applicable**	40 CFR § 268.49(c)(2)
	Provides methods on how to demonstrate compliance with the alternative treatment standards for contaminated soils that will be land disposed.	On-site treatment of restricted hazardous waste soils following alternative soil treatment of 40 CFR 268.49(c) – **To Be Considered**	*Guidance on Demonstrating Compliance with the LDR Alternative Soil Treatment Standards* [EPA 530 –R –02 –003, July 2002]

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Disposal of RCRA *hazardous waste debris* in a land–based unit (i.e., landfill)	Must be treated prior to land disposal as provided in 40 CFR § 268.45(a)(1)–(5) unless EPA determines under 40 CFR § 261.3(f)(2) that the debris no longer contaminated with hazardous waste or the debris is treated to the waste –specific treatment standard provided in 40 CFR § 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA–hazardous debris – **applicable**	40 CFR § 268.45(a)
Capping Soil in Place – (Landfill Final Closure and Post-closure Care)			
Solid Waste Landfill cover design and construction (capping soil contamination)	Shall install a cap system that is designed to minimize infiltration and erosion. The cap system shall be designed and constructed to: (C) Minimize erosion of the cap system and protect the low-permeability barrier from root penetration by use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.	Closure of a solid waste landfill (MSWLF) – **relevant and appropriate**	15A NCAC 13B .1627(c)(1)
	The Division may approve an alternative cap system if the owner or operator can adequately demonstrate the following: (B) The erosion layer will provide equivalent or improved protection as the erosion layer specified in Subparagraph (3) of this Paragraph. *NOTE:* In the event an alternative cover is sought, approval will be documented in a CERCLA decision document and NCDEQ concurrence obtained.	Closure of a solid waste landfill (MSWLF) – **relevant and appropriate**	15A NCAC 13B .1627(c)(2)
General post–closure care for closed Solid Waste Landfill	Maintaining the integrity and effectiveness of any cap system, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cap system.	Closure of a solid waste landfill (MSWLF) – **relevant and appropriate**	15A NCAC 13B .1627(d)(1)(A)

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Transportation of Wastes – Primary and Secondary			
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMTA and DOT HMR at 49 CFR §§ 171-180.	Any person who, under contract with an department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material **– applicable**	49 CFR § 171.1(c)
Transportation of hazardous waste *off site*	Must comply with the generator requirements of 40 CFR Sect. 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding and Sect. 262.40, 262.41(a) for record keeping requirements and Sect. 262.12 to obtain EPA ID number.	Preparation and initiation of shipment of RCRA hazardous waste off-site **– applicable**	40 CFR § 262.10(h) 15A NCAC 13A .0108
Transportation of hazardous waste *on–site*	The generator manifesting requirements of 40 CFR Sections 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR § 263.30 and § 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right–of–way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way – **applicable**	40 CFR § 262.20(f) 15A NCAC 13A .0108

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
Management of samples (i.e. contaminated soils and wastewaters)	Are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when: • The sample is being transported to a laboratory for the purpose of testing; • The sample is being transported back to the sample collector after testing; and • The sample collector ships samples to a laboratory in compliance with U.S.DOT, U.S. Postal Service, or any other applicable shipping requirements, including packing the sample so that it does not leak, spill or vaporize from its packaging.	Generation of samples of hazardous waste for purpose of conducting testing to determine its characteristics or composition – **applicable**	40 CFR § 261.4(d)(1)(i) and (ii) 15A NCAC 13A .0108 40 CFR § 261.4(d)(2) 15A NCAC 13A .0108
Institutional Controls			
Notice of Contaminated Site	Prepare and certify by professional land surveyor a survey plat which identifies contaminated areas which shall be entitled "NOTICE OF CONTAMINATED SITE". Notice shall include a legal description of the site that would be sufficient as a description in an instrument of conveyance and meet the requirements of N.C.G.S. 47-30 for maps and plans.	Contaminated site subject to current or future use restrictions included in a remedial action plan as provided in N.C.G.S. 143B-279.9(a) – **TBC**	N.C.G.S. 143B-279.10(a)
	The Survey plat shall identify: • the location and dimensions of any disposal areas and areas of potential environmental concern with respect to permanently surveyed benchmarks; • the type location, and quantity of contamination known to exist on the site; and • any use restriction on the current or future use of the site.		N.C.G.S. 143B-279.10(a)(1)-(3)

Table 3-1. Action Specific Applicable or Relevant and Appropriate Requirements

Action-Specific ARARs			
Action	**Requirements**	**Prerequisite**	**Citation(s)**
	Notice (survey plat) shall be filed in the register of deeds office in the county which the site is located in the grantor index under the name of the owner.		N.C.G.S. 143B-279.10(b) and (c)
	The deed or other instrument of transfer shall contain in the description section, in no smaller type than used in the body of the deed or instrument, a statement that the property is a contaminated site and reference by book and page to the recordation of the Notice.	Contaminated site subject to current or future use restrictions as provided in N.C.G.S. 143B-279.9(a) that is to sold, leased, conveyed or transferred – **TBC**	N.C.G.S. 143B-279.10(e)

Notes:
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act of 1972
DOT = U.S. Department of Transportation
EPA = U.S. Environmental Protection Agency
HMR = Hazardous Materials Regulations
HMTA = Hazardous Materials Transportation Act
MSWF = Municipal solid waste landfill
NCAC = *North Carolina Administrative Code*
N.C.G.S. = North Carolina General Statutes
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery Act of 1976
SWDS = Solid waste Disposal Site
TBC = to be considered
U.S. = United States
UTS = Universal Treatment Standard

Table 3-2. Soil PRGs

Risk Assessment	COC	PRG	Units	Basis
Human Health	BaP TEQ	1.1	mg/kg	Cancer, ELCR = 1.0x10-5
Human Health	BaP	18	mg/kg	Noncancer, HI = 1
Human Health	Naphthalene	17	mg/kg	Cancer, ELCR = 1.0x10-5
Human Health	Pentachlorophenol	10	mg/kg	Cancer, ELCR = 1.0x10-5
Human Health	TCDD TEQ	50	pg/g	Noncancer, HI = 1
Ecological	HMW PAHs	22	mg/kg	2-acre SWAC

Notes:
BaP = benzo[*a*]pyrene
COC = constituent of concern
ELCR = excess lifetime cancer risk
HI = hazard index
HMW PAH = high molecular weight polycyclic aromatic hydrocarbon
PRG = preliminary remediation goal
SWAC = surface weighted area concentration
TCDD = 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEQ = toxic equivalency

Table 6-1. Detailed Analysis of Remedial Alternatives

CERCLA Evaluation Criteria	Alt 1 No Action	Alt 2 Removal and Offsite Disposal	Alt 3 Removal, Onsite Reuse/Consolidation, and Offsite Disposal	Alt 4 Cover and Institutional Controls
Threshold Criteria				
Protective of Human Health and the Environment	Unacceptable risk to potential future resident or ecological receptor	√	√	√
Complies with ARARs	NA	√	√	√
Long-Term Effectiveness				
Magnitude of residual risks				
What is magnitude of remaining risk?	Unacceptable risk to potential future resident or ecological receptor	No unacceptable remaining risk	No unacceptable remaining risk	No unacceptable remaining risk
Will a 5-year review be required?	Yes	No	May be required	Yes
Adequacy and Reliability of Controls				
Likelihood to meet performance specifications	NA	High	High	High
Type and degree of long term management required	NA	None	Low. Inspection/maintenance of stockpiled OU2 soils and BMP until soils are reused/consolidation within OU4 as part of the OU4 remedy.	Low. Cover inspection and maintenance, monitoring of restrictive covenants.
Likelihood of need for future remedy replacement	NA	NA	Some potential that reuse/consolidation in OU4 is determined to be incompatible with the OU4 remedy and the OU2 soils would require alternative disposal.	Low
Degree in the confidence in controls	NA	High	High	Moderate. Challenges to placing, maintaining and enforcing long-term land use restrictions.
Reduction of Toxicity, Mobility, or Volume through Treatment				
Reduction of Toxicity, Mobility, or Volume through Treatment	NA	Remedial alternative does not involve treatment. There are no PTWs in OU2 and thus the NCP expectation of the use of treatment to the extent practicable does not apply.	Remedial alternative does not involve treatment. There are no PTWs in OU2 and thus the NCP expectation of the use of treatment to the extent practicable does not apply.	Remedial alternative does not involve treatment. There are no PTWs in OU2 and thus the NCP expectation of the use of treatment to the extent practicable does not apply.
Short-Term Effectiveness				
What are the risks to the community during remedial actions that must be addressed?	NA	Greatest of Alts 2-4. Risk to community due to increased truck traffic (accident, air emissions) due to offsite disposal and backfill import.	Less than Alt 2. Risk to community due to increased truck traffic (accident, air emissions) due to offsite disposal and backfill import.	Least of Alts 2-4. Risk to community due to increased truck traffic (accident, air emissions) due to import of cover material.
What are the risks to the workers that must be addressed?	NA	Risk due to use of heavy machinery and exposure to nuisance dust, etc.	Risk due to use of heavy machinery and exposure to dust, etc.	Least risk of Alts 2-4 (no excavation, limited disturbance of contaminated soil)
What environmental impacts are expected with the construction and implementation of the impacts alternative?	NA	Potential for nuisance dust and odor generation during excavation. Need for water management. Appropriate SWPPP controls needed.	Potential for dust and odor generation during excavation. Need for water management. Appropriate SWPPP controls needed.	Some potential for dust and odor generation, but less than Alts 2-4 because this alternative does not include excavation. Need for water management. Appropriate SWPPP controls needed.
How long until protection against the threats being addressed by the specific action is achieved?	NA	Immediate upon remedial action (1-3 months)	Immediate upon remedial action (1-3 months)	Immediate upon cover placement (1-2 months)

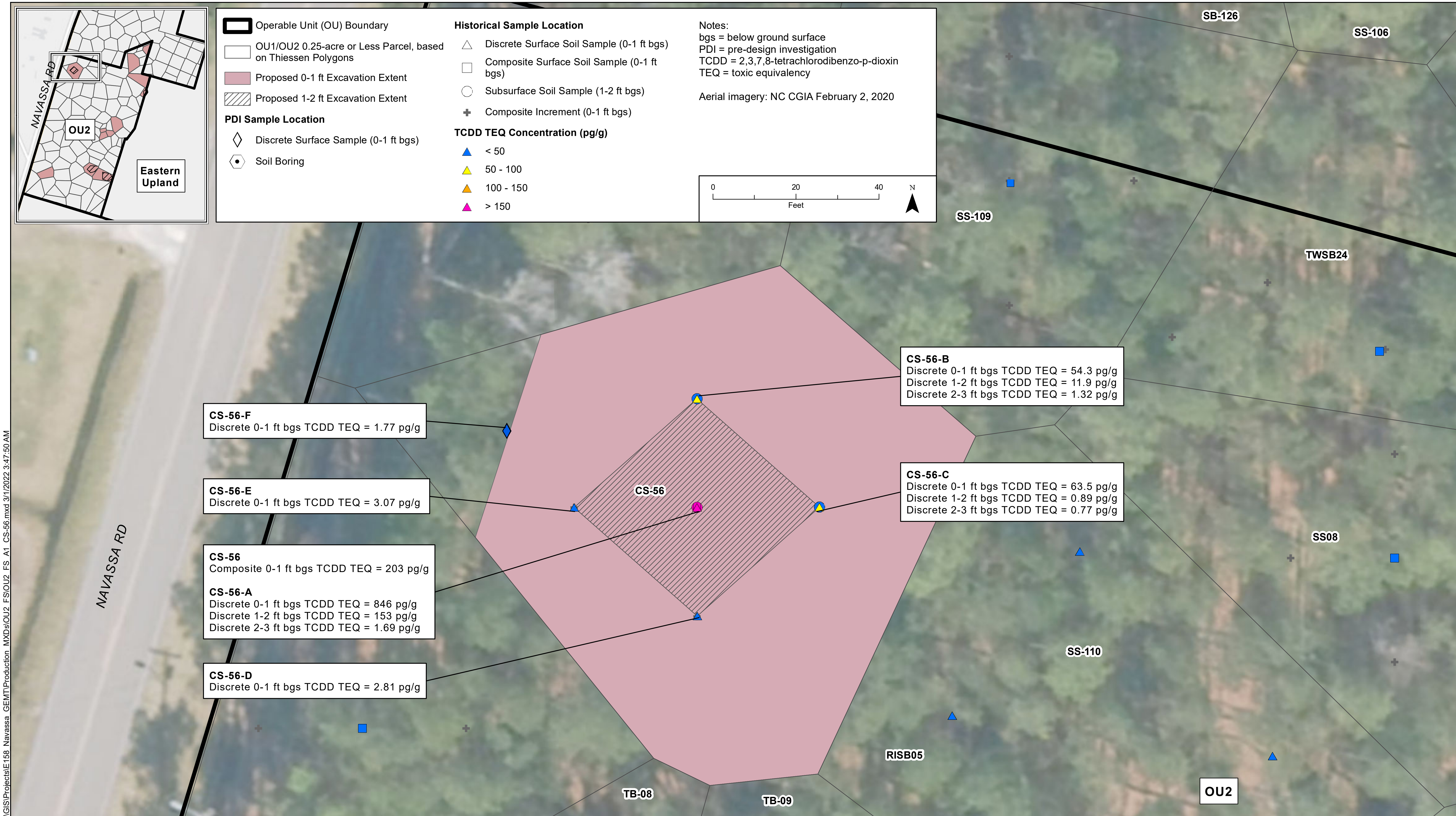
Table 6-1. Detailed Analysis of Remedial Alternatives

CERCLA Evaluation Criteria	Alt 1 No Action	Alt 2 Removal and Offsite Disposal	Alt 3 Removal, Onsite Reuse/Consolidation, and Offsite Disposal	Alt 4 Cover and Institutional Controls
Implementability				
Ability to construct and operate the technology	NA	Readily constructed	Readily constructed	Readily constructed
Reliability of technology	NA	High	High	High
Ease of undertaking additional remedial action	NA	High	High	High
Monitoring considerations	NA	No monitoring required	Low. Inspection/maintenance of stockpiled OU2 soils and BMP until soils are reused/consolidation within OU4 as part of the OU4 remedy.	Requires simple cover inspections
Administrative feasibility	NA	No significant challenges known	Onsite reuse and consolidation requires stockpiling and coordination with OU4 remedy	Would not allow for unrestricted use. Placement, maintenance, and enforcement of land use controls would be highly challenging.
Availability of services and materials	NA	Widely available	Widely available	Widely available
Availability of treatment, storage capacity, and disposal services	NA	Disposal services available	Disposal services available	NA
Availability of equipment and specialists	NA	Uses conventional construction equipment. Specialists not required.	Uses conventional construction equipment. Specialists not required.	Uses conventional construction equipment. Specialists not required.
Availability of prospective technologies	NA	Widely available	Widely available	Widely available
Cost				
Capital Costs	NA	Highest capital cost of Alts 2-4	Intermediate capital costs between Alts 2 and 4	Least capital costs of Alts 2-4, but high administrative costs associated with establishing ICs.
O&M Costs	NA	NA	Short-term costs associated with inspection of stockpiles and maintenance of BMPs until OU4 remedy is completed.	Long-term costs for inspection and maintenance of cap and for maintenance of ICs.
State Acceptance				
State Acceptance	Would not be acceptable	Anticipated to be acceptable	Anticipated to be acceptable	Would not be acceptable for unrestricted use.
Community Acceptance				
Community Acceptance	Unlikely to be acceptable	Anticipated to be acceptable	Anticipated to be acceptable, but may not be as preferred as Alt 2	Anticipated to be least likely to be acceptable

Notes:
- ARAR = applicable or relevant and appropriate requirement
- BMP = best management practice
- CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
- IC = institutional control
- NA = not applicable
- NCP = National Contingency Plan
- OU = operable unit
- PTW = Principal Threat Waste
- SWPPP = stormwater pollution prevention plan

Appendix A

OU2 Remediation Area Extents and TCDD TEQ Concentration Data



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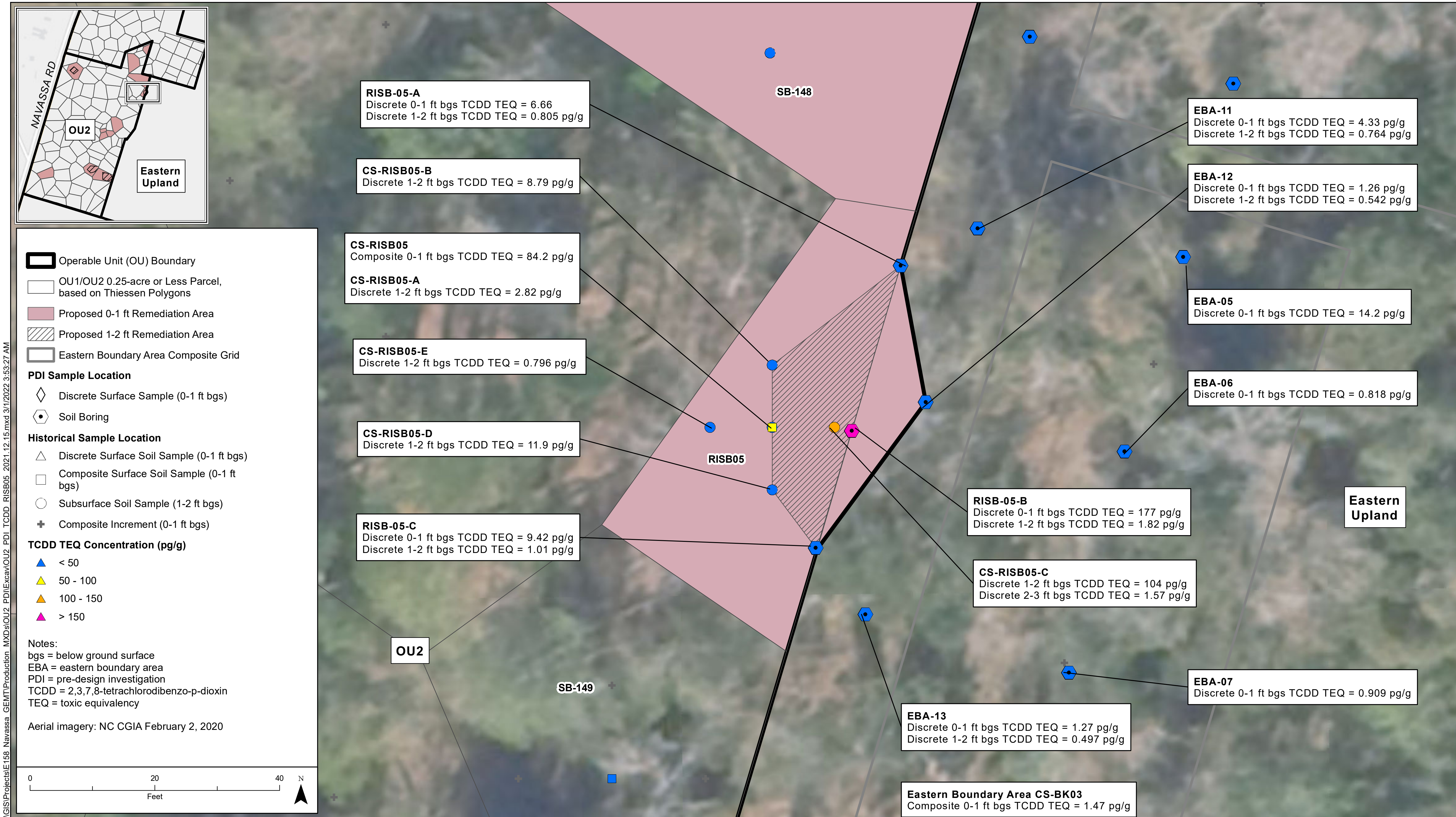
Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral

Figure A1.
Proposed OU2 Excavation Extents and TCDD TEQ Concentrations - Parcel CS-56
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022



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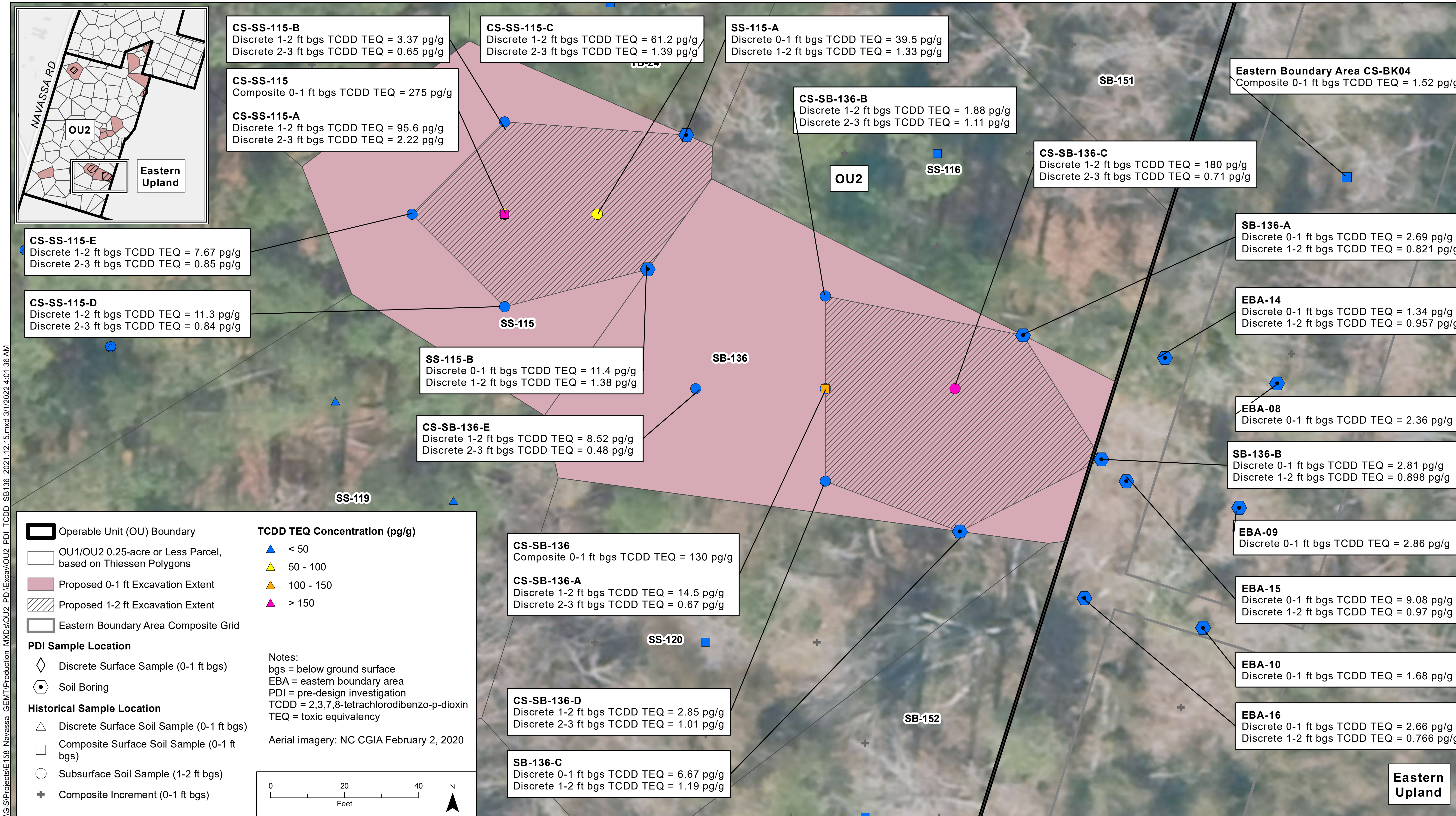
Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral

Figure A2.
Proposed OU2 Excavation Extents and TCDD TEQ Concentrations - Parcel RISB05
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022



Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral

Figure A3.
Proposed OU2 Remediation Areas and TCDD TEQ Concentrations - Parcels SS-115 and SB-136
Kerr-McGee Chemical Corp. - Navassa Superfund Site
Navassa, North Carolina
Feasibility Study, OU2
April 2022

Appendix B

Detailed Cost Estimate for Remedial Alternatives

Table B1. OU2 Feasibility Study Cost Estimate (Level 5, AACE 2011)

Item	Description	Unit	Unit Cost ($)[a]	**Alternative 1** No Action		**Alternative 2** Removal and Offsite Disposal		**Alternative 3** Removal, Onsite Reuse/Consolidation, and Offsite Disposal		**Alternative 4** Cover and Institutional Controls		Key Assumptions
				Quantity[b]	Total Cost ($)[c]	Quantity[b]	Total Cost ($)[c]	Quantity[b]	Total Cost ($)[c]	Quantity[b]	Total Cost ($)[c]	
DIRECT CAPITAL COSTS												
1	Mobilization & Demobilization	LS	$ 54,000	-	$ -	1.0	$ 54,000	1.0	$ 54,000	1.0	$ 54,000	1
2	Contractor Plans and Submittals	LS	$ 37,000	-	$ -	1.0	$ 37,000	1.0	$ 37,000	1.0	$ 37,000	2
3	Construction Management and Construction Quality Control	MO	$ 57,000	-	$ -	2.1	$ 117,000	2.1	$ 117,000	1.0	$ 57,000	3
4	Site Access and Traffic Control	MO	$ 12,000	-	$ -	2.1	$ 25,000	2.1	$ 25,000	1.0	$ 12,000	4
5	Surveying and Field Engineering	LS	$ 28,000	-	$ -	1.0	$ 28,000	1.0	$ 28,000	1.0	$ 28,000	5
6	Construction Pollution Prevention Control	MO	varies	-	$ -	2.1	$ 124,000	2.1	$ 134,000	1.0	$ 61,000	6
7	Removal Activities											
	Site Preparation – Tree Removal	AC	$ 22,000	-	$ -	2.2	$ 51,000	2.4	$ 57,000	2.2	$ 47,000	7
	Soil Excavation	TN	$ 21	-	$ -	4,514	$ 97,000	4,514	$ 97,000	-	$ -	8
	Soil Transport and Disposal	CY	$ 104	-	$ -	2,932	$ 306,000	1,710	$ 178,000	-	$ -	9
	Water Disposal	MO	$ 6,800	-	$ -	2.1	$ 14,000	2.1	$ 14,000	1.0	$ 6,000	
	Backfill and Grading	CY	$ 23	-	$ -	1,994	$ 50,000	1,994	$ 50,000	-	$ -	10
	REMOVAL SUBTOTAL						$ 518,000		$ 396,000		$ 53,000	
8	Soil Cover	CY	$ 41	-	$ -	-	$ -	-	$ -	1,617	$ 69,000	11
9	Site Restoration – Topsoil and seeding	SY	$ 8	-	$ -	7,578	$ 61,000	7,578	$ 61,000	7,578	$ 61,000	
	Construction Subtotal				**$ -**		**$ 964,000**		**$ 852,000**		**$ 432,000**	
	Contingency	%	30%		**$ -**		**$ 289,000**		**$ 256,000**		**$ 130,000**	
	Tax	%	6.75%		**$ -**		**$ 65,000**		**$ 58,000**		**$ 29,000**	12
	TOTAL DIRECT CAPITAL COSTS				**$ -**		**$ 1,318,000**		**$ 1,166,000**		**$ 591,000**	
INDIRECT COSTS												
1	Project Management	%	4-5%	-	$ -	4%	$ 50,000	4%	$ 44,000	5%	$ 28,000	13
2	Construction Quality Assurance	MO	$ 70,000	-	$ -	2.1	$ 144,000	2.1	$ 144,000	1.0	$ 70,000	14
3	Institutional Controls	LS	varies	-	$ -	-	$ -	-	$ -	-	$ 165,000	15
4	Remedial Design and Work Plan	%	3%	-	$ -	-	$ 40,000	-	$ 35,000	-	$ 18,000	
5	Completion Report	LS	$ 35,000	-	$ -	-	$ 35,000	-	$ 35,000	-	$ 35,000	
	TOTAL INDIRECT COSTS				**$ -**		**$ 269,000**		**$ 258,000**		**$ 316,000**	
PERIODIC COSTS												
1	Update Institutional Controls Plan	YR	$ 20,000	-	$ -	-	$ -	-	$ -	6	120,000	16
2	O&M	YR	varies	-	$ -	-	$ -	5	$ 25,000	30	300,000	17
3	Five Year Reviews	YR	$ 15,000	6	$ 90,000	-	$ -	1	$ 15,000	6	90,000	18
	TOTAL PERIODIC COSTS				**$ 90,000**		**$ -**		**$ 40,000**		**$ 510,000**	
TOTAL NET PRESENT VALUE					**$ 32,000**		**$ 1,587,000**		**$ 1,455,000**		**$ 1,107,000**	19

Table B1. OU2 Feasibility Study Cost Estimate (Level 5, AACE 2011)

Notes:

AACE = Association for the Advancement of Cost Engineering
AC = acre
bgs = below ground surface
CY = cubic yard
LS = lump sum
MO = month
O&M = operation and maintenance
OU = operable unit
SY = square yard
TN = ton
YR = year

[a] All material unit rates include costs for purchase, loading, and delivery of materials to the site, along with quality control sampling, overhead, and profit.
[b] All quantities are estimates, which may be refined.
[c] Total costs are rounded to the nearest $1,000.

Key Assumptions:

1 Mobilization and demobilization based on recent project experience, including Kerr-McGee Chemical Corp – Columbus Superfund site, Columbus, MS OU-1 construction costs.
2 Plans and submittals based on previous project experience. Includes construction quality control plan, excavation and material handling plan, construction sequencing plan and schedule, soil erosion and sediment control plan, health and safety plan.
3 Monthly construction management and quality control cost based on approximately 1 to 3 months to complete soil removal alternatives and approximately 0.5 to 1.5 months to complete cover alternative.
4 Includes provisions for flagger, traffic cones, and signage.
5 Assumes approximately two surveys completed per week and includes documentation and reporting.
6 Includes provisions for site stormwater best management practices, spill control measures, and equipment decontamination areas. Provisions vary for each alternative. Includes best management practices for stockpiles (Alternative 3).
7 Includes forester subcontractor for tree harvesting plan along with tree removal and grubbing for parcels, haul road, and stockpiles (Alternative 3).
8 Includes excavation and loading of soil and debris.
9 Assumes material will be transported to a non-hazardous waste landfill.
10 Includes imported backfill materials from an approved offsite source, placement, compaction and grading. Assumes backfill compaction factor of 1.28.
11 Soil cover includes 6 inches of backfill and 6 inches of topsoil. Assumes compaction factor of 1.28.
12 Assumed Brunswick County tax of 6.75% to cover tax required for purchase of material by contractor.
13 Includes planning, reporting, community relations, contract administration, and legal services outside of institutional controls.
14 Includes review of submittals, design modifications, construction observation or oversight, confirmation sampling, documentation of quality control/quality assurance.
15 Includes preparation of institutional control plans and associated agency and legal coordination, including NCDEQ fees and legal fees that may occur during property sale.
16 Institutional control plans will be updated every 5 years for 30 years for Alternative 4.
17 Stockpiled soils (Alternative 3) will be maintained for 5 years until used with a separate OU. The Alternative 4 soil cover will be maintained for 30 years.
18 Assumes review will be conducted every 5 years for 5 years under Alternative 3 (until stockpiled soils are used for separate OU) and every 5 years for for 30 years under Alternative 1 and Alternative 4.
19 Net present value based on 7% discount rate for a 30 year duration.