Prepared for
Nevada Environmental Response Trust

Project Number
1690025040-003

Prepared by
Ramboll
Emeryville, California

Date
December 5, 2022

BASELINE HEALTH RISK ASSESSMENT WORK PLAN FOR OU-3, REVISION 1

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE HENDERSON, NEVADA

RAMBOLL

Baseline Health Risk Assessment Work Plan for OU-3, Revision 1

Nevada Environmental Response Trust Site
(Former Tronox LLC Site)
Henderson, Nevada

Nevada Environmental Response Trust (NERT) Representative Certification
I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the system(s) or those directly responsible for gathering the information or preparing the document, or the immediate supervisor of such person(s), the information submitted and provided herein is, to the best of my knowledge and belief, true, accurate, and complete in all material respects.

Office of the Nevada Environmental Response Trust

Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Signature: _____

Name: Andrew W. Steinberg, not individually, but solely in his representative capacity as Vice President of the Nevada Environmental Response Trust Trustee

Title: Solely as Vice President and not individually

Company: Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Date: 12-5-22

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Responsible Certified Environmental Manager (CEM) for this project
I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and, to the best of my knowledge, comply with all applicable federal, state and local statutes, regulations and ordinances.

Kimberly Kuwabara

12-05-2022

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Date

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Date **December 5, 2022**
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ACRONYMS AND ABBREVIATIONS

AOC	Administrative Order on Consent
AMPAC	American Pacific Corporation
amsl	above mean sea level
AP Area	Ammonium Perchlorate manufacturing area
AWF	Athens Road Well Field
BCL	basic comparison level
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHRA	Baseline Health Risk Assessment
Birding Ponds	Henderson Bird Viewing Preserve
BMI	Black Mountain Industrial
BRC	Basic Remediation Company, LLC
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
COH	City of Henderson
COPC	chemical of potential concern
CSF	cancer slope factor
CSM	conceptual site model
DUE	data usability evaluation
DVSR	data validation summary report
EDD	electronic data deliverable
EMD	EMD Acquisitions LLC
ENSR	ENSR Corporation
ENVIRON	Environ International Corporation
EPC	exposure point concentration
Exponent	Exponent, Inc.
°F	degrees Fahrenheit
FBRs	fluidized bed reactors
ft	feet

GWETS	Groundwater Extraction and Treatment System
GWMP	groundwater monitoring program
HRA	health risk assessment
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
ITRC	Interstate Technology & Regulatory Council
IUR	inhalation unit risk
IWF	Interceptor Well Field
IX	ion exchange
kg	Kilogram
L	Liter
LOU	Letter of Understanding
LVWCC	Las Vegas Wash Coordination Committee
µg	microgram
m^3	cubic meter
mg	milligram
mol	mole
mph	miles per hour
NCP	National Contingency Plan
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
NFA	No Further Action
Northgate	Northgate Environmental Management, Inc.
NPDES	National Pollutant Discharge Elimination System
OEHHA	Office of Environmental Health Hazard Assessment
Olin	Olin Chlor-Alkali Products
OSSM	Olin, Stauffer, Syngenta, and Montrose
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
OU-1	Operable Unit 1
OU-2	Operable Unit 2
OU-3	Operable Unit 3

PEF	particulate emission factor
PEPCON	Pacific Engineering and Production Company of Nevada
Q/C	site-specific dispersion factor
QAPP	Quality Assurance Project Plan
Ramboll	Ramboll US Consulting, Inc.
Ramboll Environ	Ramboll Environ US Corporation
RAO	Remedial Action Objective
RfC	reference concentration
RfD	noncancer oral reference dose
RI/FS	Remedial Investigation and Feasibility Study
RIB	rapid infiltration basin
RME	Reasonable Maximum Exposure
RSL	regional screening level
Site	Nevada Environmental Response Trust Site
SNWA	Southern Nevada Water Authority
SWF	Seep Well Field
TDS	total dissolved solids
Wash	Las Vegas Wash
Wetlands Park	Clark County Wetlands Park
TIMET	Titanium Metals Corporation of America
TOC	total organic carbon
Tronox	Tronox, LLC
Trust	Nevada Environmental Response Trust
UCL	upper confidence level
UMCf	Upper Muddy Creek formation
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WRF	Water Reclamation Facility

1. INTRODUCTION

This Baseline Health Risk Assessment (BHRA) Work Plan, Revision 1 ("BHRA Work Plan") has been prepared by Ramboll US Consulting, Inc. (Ramboll) on behalf of the Nevada Environmental Response Trust (NERT or the Trust) for Operable Unit 3 (OU-3). The initial version of the OU-3 BHRA Work Plan was submitted to NDEP on February 28, 2022 (Ramboll 2022a); NDEP comments were provided on May 6, 2022. A meeting with NDEP and its consultants to discuss the NDEP comments on the work plan was held on June 3, 2022, and revised NDEP comments, which supersede the comments dated May 6, 2022, were provided on June 29, 2022. As requested by NDEP, an annotated response to comments has been provided alongside this revised BHRA Work Plan.

OU-3 is located approximately 2.5 miles north-northeast (downgradient) of the NERT Site (also referred to as Operable Unit 1 [OU-1] or the Site) in the NERT Remedial Investigation (RI) Study Area in Henderson, Nevada (Figures 1-1 and 1-2). The OU-3 BHRA will be conducted as part of the *Remedial Investigation and Feasibility Study* (RI/FS). The BHRA described in this BHRA Work Plan will be implemented as part of the RI/FS and will be conducted following the risk assessment framework and methodology recommended by NDEP (2020a) and the United States Environmental Protection Agency (USEPA) (USEPA 1989, 2002, 2004a, 2004b, 2009, 2015, 2017a, and 2022a). Results of the BHRA will identify potential chemical exposures and corresponding human health risks within OU-3 from contaminants that may have originated from the NERT Site.

NERT is implementing a RI consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The NERT RI Study Area occupies approximately 5,200 acres (8.1 square miles) within the City of Henderson (COH) and Clark County, Nevada (Figure 1-1). The southern-most portion of the NERT RI Study Area is located within a portion of the Black Mountain Industrial (BMI) Complex. The NERT RI Study Area extends north towards the Las Vegas Wash (the "Wash") and east towards Lake Mead Parkway, as depicted in Figures 1-2 and 1-3. The BMI Complex was initially developed for industrial purposes in the early 1940s and continues to house several industrial manufacturing operations. As depicted in Figure 1-3, the NERT RI Study Area collectively consists of four study areas. These are the NERT Site Study Area,[1] the NERT Off-Site Study Area, the Downgradient Study Area, and the Eastside Study Area (comprised of the Eastside Sub-Area and the Northeast Sub-Area).

The NERT RI Study Area has been divided into three Operable Units (OUs). OU-1 is approximately 346 acres, is located in the southeast portion of the Las Vegas Valley, and includes the NERT Site. OU-2 is approximately 2,645 acres and is located immediately north of OU-1 and extends to the east; it comprises the southern portion of the NERT Off-Site Study Area and the entire Eastside Sub-Area. OU-3 is approximately 2,200 acres (Figure 1-1) and is downgradient (north) of OU-1 and OU-2. OU-3 encompasses the Downgradient

[1] Prior to May 2020, OU-1 and the NERT Site were exchangeable terms, both referring to property owned by NERT. Since May 2020, the NERT Site excludes the three parcels (former Sale Parcels C, D, and H) which are no longer owned by NERT, while OU-1 still refers to the same area as before, consisting of the NERT Site and Sale Parcels C, D, and H.

Study Area, the Northeast Sub-Area and the northern portion of the NERT Off-Site Study Area (Figure 1-3).

The layout, key features, and properties within OU-3, including the Wash and its weir systems, are shown in Figure 1-4. The Wash is a perennial stream carrying treated municipal and industrial wastewater (including treated groundwater), storm water, urban runoff, and discharge from shallow groundwater in the Las Vegas Valley into Lake Mead.

Within the Eastside Sub-Area (the portion of OU-2 located east of Pabco Road), chemicals of potential concern (COPCs) are administratively limited to perchlorate and chlorate impacts to the subsurface. While hexavalent chromium and other potential contaminants may be present in soil and groundwater within the Eastside Sub-Area, consistent with the approved NERT Phase 3 RI Work Plan, NERT's investigations within the Eastside Sub-Area were limited to the investigation of perchlorate and chlorate impacts to the subsurface. Consistent with the *Settlement Agreement and Administrative Order on Consent: BMI Common Areas, Phase 3* (NDEP 2006), known as AOC3, the potential presence of hexavalent chromium and other potential contaminants in groundwater within the Eastside Sub-Area will be addressed separately by Basic Remediation Company, LLC (BRC), if required by NDEP, under the oversight and direction of NDEP. As demonstrated in the particle tracking presented in Phase 3 RI Modification No. 8, groundwater within the portion of OU-3 east of Pabco Road is hydraulically downgradient of the Eastside Sub-Area. As such, COPCs in groundwater within the portion of OU-3 east of Pabco Road would originate from releases in OU-2 east of Pabco Road. Therefore, consistent with AOC3, the Phase 3 RI Work Plan, and the particle tracking presented in Phase 3 RI Modification No 8, the COPCs in OU-3 east of Pabco Road are limited to perchlorate and chlorate.

In 1997, perchlorate, later shown to originate from the NERT Site and the former American Pacific Corporation (AMPAC) site, was detected in the Wash and the Colorado River (Nevada Division of Environmental Protection [NDEP] 2011). In early 1999, the Southern Nevada Water Authority (SNWA) discovered a perchlorate-impacted surface water seep discharging into the Wash. Subsequent to discovery of the seep, Kerr-McGee and NDEP entered into a Consent Agreement (NDEP 1999) which identified steps to be taken by Kerr-McGee to mitigate discharge of the perchlorate-impacted seep to the Wash. In 1999, a temporary groundwater treatment system for the removal of perchlorate originating from OU-1 was constructed near the Wash. In 2001, an AOC was issued by NDEP, which defined additional perchlorate removal requirements (NDEP 2001). In response to the AOC, Kerr-McGee designed and installed the Seep Well Field (the SWF) that began operating in 2002. Extracted water from the SWF and the seep collection system were pumped back to the Kerr-McGee facility (now OU-1), treated on-site, and then discharged to the Wash under a National Pollutant Discharge Elimination System (NPDES) permit. NERT continues to operate the SWF and discharges treated groundwater to the Wash under this permit today. Currently, extracted water from the SWF is treated either in the fluidized bed reactors (FBRs) located on the NERT Site or in an ion exchange (IX) system located near the SWF, which was brought online in February 2017 (Ramboll 2021a).

Performing the OU-3 BHRA is one step of the CERCLA process. The results and conclusions from the BHRA will be evaluated in the upcoming Feasibility Study (FS) to determine if remediation is necessary in OU-3 to satisfy the Remedial Action Objectives (RAOs). The

RAOs were established within the approved Phase 3 RI Work Plan (Ramboll Environ 2017a) and presented in the RI Report for OU-1 and OU-2 (Ramboll 2021a). The RAOs focus on achieving the Trust's overarching objective of protecting the Wash and downstream interests over a long-term time frame (i.e., greater than five years). A RI Report for OU-3 is under preparation.

As noted in the *Remedial Investigation and Feasibility Study Work Plan* ("RI/FS Work Plan", ENVIRON 2014a), businesses and residences located within or downgradient of the Site are connected to a municipal water supply. Based on the available information, groundwater is not currently used as a source of drinking water and given the high concentrations of total dissolved solids (TDS),[2] is not anticipated to be used in the future as a drinking water source in the NERT RI Study Area. Therefore, groundwater consumption is not considered a complete pathway and will not be evaluated in this BHRA.

Separate BHRA reports were prepared for OU-1 and OU-2. The BHRAs for OU-1 (Ramboll 2021b and 2022b) address the potential health risks associated with the vapor intrusion pathway for volatile organic compounds (VOCs) released from soil gas and groundwater as well as direct contact with surface soil in OU-1. The BHRA for OU-2 (Ramboll 2021c) addresses the potential health risks associated with the vapor intrusion pathway for VOCs released from soil gas and groundwater in the NERT Off-Site Study Area in OU-2 located west of Pabco Road. Revision 2 of the OU-1 Soil BHRA Report (Ramboll 2022b) was submitted to NDEP on May 6, 2022, and approved by NDEP on June 2, 2022. NDEP comments on the OU-1 Soil Gas and Groundwater BHRA Report (Ramboll 2021b) were received on March 9, 2022; the annotated response to the NDEP comment letter on this report was submitted to NDEP on June 24; NDEP's responses on the annotated response to comment letter were received on November 3, 2022; the revised report and annotated response to the NDEP comment letter is currently under preparation. NDEP comments on the OU-2 Soil Gas and Groundwater BHRA Report (Ramboll 2021c) were received on October 13, 2022; the revised report and annotated response to the NDEP comment letter is currently under preparation.

This BHRA Work Plan has the following objectives:

- Review and summarize information on background and the environmental setting for OU-3.
- Describe current and completed field investigations and NDEP-approved planned sampling events for OU-3.
- Describe the sources and types of data that will be considered in the BHRA and the methodology for conducting the data usability evaluation (DUE) for the BHRA data set for OU-3.
- Develop the conceptual site model (CSM) to characterize potential exposures to human receptors in OU-3. The CSM will include the identification of the preliminary COPCs and define receptor populations and their exposure pathways.

[2] TDS concentrations exceed the drinking water standard in most areas throughout the Las Vegas Valley. https://www.lasvegasgmp.com/wells-groundwater/facts/index.html

- Describe the methodology for performing the BHRA.

1.1 Scope of BHRA

The NERT Site (OU-1) has been the subject of extensive environmental investigations since the 1970s. In 2010, prior to the inception of NERT and thus NERT's ownership of the Site, Northgate Environmental Management, Inc. (Northgate) and Exponent, Inc. (Exponent) prepared an HRA Work Plan ("the 2010 HRA Work Plan") that described the risk assessment methodology for evaluating soil and soil gas exposure pathways in future HRAs to be prepared for the NERT Site (Northgate and Exponent 2010). The 2010 HRA Work Plan was approved by NDEP on March 16, 2010 (NDEP 2010a).

In 2014, a new BHRA Work Plan ("the 2014 BHRA Work Plan") was prepared by the Trust (ENVIRON 2014b) as part of the RI/FS Work Plan (ENVIRON 2014a). The 2014 BHRA Work Plan, as well as the RI/FS Work Plan, addressed the NERT Site (OU-1) and an area of impacted groundwater directly downgradient of the NERT Site (collectively, the original "RI Study Area"). The 2014 BHRA Work Plan incorporated relevant elements of the 2010 HRA Work Plan, updated background information at the Site, and presented preliminary summary statistics for the soil and soil gas data sets representative of current conditions and available for the BHRA. The 2014 BHRA Work Plan was submitted to NDEP on February 28, 2014 and approved by NDEP on May 20, 2014. In addition, the CSM, which had been completed by ENSR Corporation (ENSR 2005), was significantly revised in the 2014 BHRA Work Plan to identify additional transport pathways, evaluate off-site populations in the downgradient portions of the RI Study Area (not previously included in the 2010 HRA Work Plan) and consider soil removal actions that had been completed between 2010 and 2013. During the development of the Phase 2 RI, NDEP determined that the NERT RI Study Area needed to be expanded to include the Downgradient Study Area in 2016, and the scope of investigation was memorialized in a series of work plans prepared by AECOM under contract to NDEP in late 2015 and early 2016 (AECOM 2015, 2016a, 2016b). In 2017, the RI Study Area was expanded again and divided into three OUs via the *RI/FS Work Plan Addendum, Phase 3 RI, Revision 1* ("Phase 3 RI Work Plan", Ramboll Environ US Corporation [Ramboll Environ] 2017a).

A portion of OU-3, referred to as the "Open Space Sub-Area" as identified in Figure 1-4, will not be evaluated in this BHRA. The Open Space Sub-Area is subject to AOC3 (NDEP 2006) which obligated BRC to conduct an HRA in this area. To support a request for a no further action (NFA) determination for this area for anticipated future development of a park as part of the Cadence development, an HRA was conducted by BRC in late 2014 (BRC 2014) separate and apart from the in-progress NERT RI. Based on the HRA conducted by BRC, NDEP issued a NFA determination for this sub-area for both direct contact with soil to a depth of 7 feet (ft) below ground surface (bgs) and vapor intrusion assuming no future residential development will occur in these areas (NDEP 2015a and BRC 2015, Figure 1-5).

The OU-3 BHRA will focus on potential health risks associated with COPCs migrating from OU-1 to OU-3 via impacted groundwater. As previously indicated, Pabco Road, within OU-3 serves as a demarcation with respect to NERT's obligations. As such, and to characterize exposures due to different COPCs, impacted environmental media, land uses, and potentially exposed populations, the OU-3 BHRA Study Area includes two portions: 1) the

area in OU-3 west of Pabco Road (excluding the Open Space Sub-Area), and 2) the area in OU-3 east of Pabco Road (Figure 1-4).

Given the complex history of the BMI Complex and the various responsible parties currently implementing soil and groundwater remedial activities, NERT is only responsible for addressing those contaminants originating at the NERT Site and determined to have migrated from OU-1 through groundwater in OU-2 and into OU-3. In addition, as discussed in the Phase 3 RI Work Plan (Ramboll Environ 2017a) and the RI Report for OU-1 and OU-2 (Ramboll 2021a), the potential risks associated with the vapor intrusion pathway from soil gas and groundwater is only being evaluated west of Pabco Road since NERT is only responsible for evaluating perchlorate and chlorate (which are not volatile organic compounds) in the environment east of Pabco Road. Contaminants released to the environment and present within OU-3 east of Pabco Road other than perchlorate and chlorate are outside the scope of this BHRA. Furthermore, if contaminants were identified in soil or groundwater within OU-1 but were determined not to have migrated off-site, they were excluded as COPCs from OU-2 (Ramboll 2021a). The initial COPCs to be evaluated in this OU-3 BHRA Work Plan are limited to those that were identified as COPCs in groundwater for OU-2, as discussed in Section 3.1. The initial COPCs for groundwater, soil gas, soil, surface water, and sediment located west of Pabco Road are further assessed in Section 6.1 by performing a health risk-based screening analysis to determine the preliminary COPC list to be evaluated in this OU-3 BHRA.

1.2 Work Plan Organization

The remainder of this work plan is organized as follows:

- Section 2 – Overview: provides an overview of the NERT Site and surrounding area including OU-3, and discusses the background, climate, and geologic and hydrogeological setting of the NERT Site and surrounding area.
- Section 3 – Identification of Impacted Environmental Media and Initial COPCs: discusses the potential chemical sources at the Site, describes the chemical transport from OU-1 to OU-3, identifies the potentially impacted environmental media in OU-3, and presents the initial COPCs to be evaluated in this work plan.
- Section 4 – Environmental Investigations: summarizes the existing environmental investigations for soil gas, groundwater, soil, surface water, and sediment conducted within OU-3. This section also discusses additional soil gas sampling conducted in OU-3 west of Pabco Road as requested by NDEP in the June 29, 2022 comment letter (NDEP 2022).
- Section 5 – BHRA Data Set and DUE: describes the sources and types of data that will be considered in the BHRA, as well as the DUE process.
- Section 6 – Risk Assessment Methodology: presents the methodology for each of the four steps of the risk assessment that will be used in the BHRA, i.e., 1) identification of preliminary COPCs, 2) exposure assessment, 3) toxicity assessment, and 4) risk characterization.
- Section 7 – Summary: provides a summary of this OU-3 BHRA Work Plan.
- Section 8 – Schedule: provides the proposed schedule for implementing the BHRA.

- Section 9 – References: lists the references cited in this work plan.

Supporting tables, figures, and appendices follow the text of the work plan.

2. OVERVIEW

The following sections provide an overview of the background, climate, and geologic and hydrogeological setting at the NERT Site and surrounding area, including in OU-3.

2.1 Background

The 346-acre NERT Site is located approximately 13 miles southeast of the City of Las Vegas in an unincorporated area of Clark County, Nevada, within Sections 12 and 13 of Township 22 S, Range 62 E (Figures 1-1 and 1-2). The NERT Site is situated within the BMI Complex, which consists of several facilities that are owned and/or operated by various entities and is surrounded by the COH, Nevada. Tronox, LLC (Tronox), leased approximately 113 acres within the NERT Site from February 2011 to August 2018, on which it initially operated a chemical manufacturing business. In August 2018, Tronox's Henderson operations were purchased by EMD Acquisitions LLC (EMD), and EMD assumed the lease with the Trust, which is continuing similar manufacturing operations at the Site.

The BMI Complex, including the NERT Site, has a long, complex ownership and operational history. The BMI complex was first developed by the United States government in 1942 as a magnesium plant to support World War II operations. Following the war, the NERT Site continued to be the location of industrial activities, including production of perchlorate, boron, and manganese compounds. Former industrial and waste management activities conducted at the NERT Site, as well as those conducted within the adjacent BMI Complex (Figure 1-2), resulted in contamination of environmental media, including soil, groundwater, and surface water in the NERT RI Study Area. Most of the former BMI Common Areas located within OU-2 and OU-3 are currently vacant, although residential construction is underway as part of the Cadence master planned community development. In addition, construction of sports facilities and parks within the Open Space Sub-Area in OU-3 as part of the Cadence development is currently underway (LandWell 2019).

The NERT RI Study Area was originally defined in 2012 and was limited to the NERT Site (the "NERT Site Study Area") and the area of impacted groundwater immediately downgradient ("NERT Off-Site Study Area"), as shown on Figure 1-3. In 2015 and 2016, the NERT RI Study Area was expanded to include the Downgradient Study Area which parallels the Wash. In 2017, the NERT RI Study Area was again expanded to include the area formerly known as the BMI Common Areas to the northeast of the NERT Site ("the Eastside Study Area") which had potentially been impacted by contaminants migrating from the NERT Site. Currently, the NERT RI Study Area collectively consists of four study areas: 1) the NERT Site Study Area;[3] 2) the NERT Off-Site Study Area (established in 2012 as the original NERT RI Study Area); 3) the Downgradient Study Area (added in 2015); and 4) the Eastside Study Area (added in 2016 and comprised of the Eastside Sub-Area and the Northeast Sub-Area) (Figure 1-3). In 2017, the NERT RI

[3] The original "NERT Site Study Area" was established as part of the initial NERT RI/FS Work Plan in 2012 where it was referred to as simply the "NERT Site." The NERT Site Study Area is identical to the OU-1 area, includes Sale Parcels C, D, and H, no longer owned by the Trust, and refers to the property owned by the Trust after February 14, 2011 and prior to May 8, 2020.

Study Area was divided into three OUs for the purposes of investigation and determination of future remedial action, as discussed in the Phase 3 RI Work Plan (Ramboll Environ 2017a) and the RI Report for OU-1 and OU-2 (Ramboll 2021a).

As shown in Figure 1-3, OU-3 encompasses the Downgradient Study Area, the Northeast Sub-Area and the northern portion of the NERT Off-Site Study Area. The southern border of OU-3 is generally in the vicinity of Galleria Drive and also forms the northern boundary of OU-2. It is bordered to the west by the COH Bird Viewing Preserve (Birding Ponds) and undeveloped land, to the east by East Galleria Drive, and to the north by an approximately 3.5-mile stretch of undeveloped land just north of the Wash.

As shown in Figure 1-4, the west side of OU-3 contains a portion of the Birding Ponds and the COH Water Reclamation Facility (WRF). The northern rapid infiltration basins (RIBs), which were formerly used by the COH for infiltration of treated municipal wastewater, are located further east. The Tuscany residential community, the Weston Hills neighborhood, and the Chimera Golf Course are located in the eastern portion of OU-3, as well as mostly vacant areas with sparse vegetation north of the Tuscany community, a portion of which served as a former COH landfill (now closed) (Figure 1-3). The Wash is located downgradient (north) of each of these features.

2.2 Climate

The climate of the Las Vegas Valley is arid with mild winters and dry, hot summers. Average annual precipitation, as measured in Las Vegas between 1980 to 2020, was 4.20 inches (National Oceanic and Atmospheric Administration 2021). Precipitation generally occurs during two periods, December through March and July through September. Winter storms generally produce low intensity rainfall over a large area. Summer storms generally produce high intensity rainfall over a smaller area for a short duration, and account for most of the documented floods in the Las Vegas area. Winds frequently blow from the south or northwest at a mean velocity of approximately nine miles per hour (mph); however, velocities in excess of 50 mph are not atypical when weather fronts move through the area. During these windy events, dust, sand, and soil at the ground surface can become airborne and may travel several miles. Temperatures can rise to 120 degrees Fahrenheit (°F) in the summer, and the average relative humidity is approximately 20% (Schevenell 1996). The mean annual evaporation from lake and reservoir surfaces ranges from 60 to 82 inches per year (Shevenell 1996).

2.3 Geologic and Hydrogeological Setting

The NERT RI Study Area is located within the Las Vegas Valley, which occupies a topographic and structural basin trending northwest-southeast and extending approximately 55 miles from near Indian Springs in the north to Railroad Pass in the south. The Las Vegas Valley is bounded by the Las Vegas Range, Sheep Range, and Desert Range to the north; by Frenchman and Sunrise Mountains to the east; by the McCullough Range and River Mountains to the south and southeast; and by the Spring Mountains to the west. The mountain ranges bounding the east, north, and west sides of the Las Vegas Valley consist primarily of Paleozoic and Mesozoic sedimentary rocks (limestones, sandstones, siltstones, and fanglomerates), whereas the mountains on the

south and southeast consist primarily of Tertiary volcanic rocks (basalt, rhyolite, andesite, and related rock types) that overlie Precambrian metamorphic and granitic basement (ENSR 2007, Ramboll 2021a).

Within the Las Vegas Valley, eroded Tertiary and Quaternary sedimentary and volcanic rocks comprise the unconsolidated basin deposits, which can be over 5,000 ft thick (Plume 1989). The Las Vegas Valley floor consists of fluvial, paludal (swamp), playa, and lacustrine deposits surrounded by more steeply sloping alluvial fan aprons derived from erosion of the surrounding mountains. Generally, the deposits grade finer with increasing distance from their source and with decreasing elevation. The structure within the Quaternary and Tertiary-aged basin fill is characterized by a series of generally north-south trending fault scarps (Ramboll 2021a).

OU-3 is located primarily on these Quaternary alluvial deposits (Qal) that slope north toward the Wash. The alluvium consists of a reddish-brown, heterogeneous mixture of well-graded sand and gravel with lesser amounts of silt, clay, and caliche. Clasts within the alluvium are primarily composed of volcanic material. Boulders and cobbles are common. Due to the mode of deposition, no distinct beds or units are continuous over the area. The thickness of the alluvial deposits within OU-3 can range up to approximately 65 ft where paleochannels are encountered but generally occur at an average thickness of 30 to 50 ft. Within OU-3, topographic elevations range from 1,467 to 1,690 ft above mean sea level (amsl). The topographic surface in OU-3 slopes down at a gradient of approximately 0.01 ft/ft to the Wash. East of Pabco road, the surface slopes more steeply at a gradient of approximately 0.3 ft/ft. The depth to groundwater decreases significantly, moving from south to north, approaching the Wash. The depth to groundwater ranges from approximately 50 ft bgs in the southern portion of OU-3 to approximately 2 ft bgs in the north.

A major feature of the alluvial deposits is the stream-deposited sands and gravels that were laid down within paleochannels eroded into the surface of the underlying Muddy Creek Formation during infrequent flood runoff periods. These deposits, which are present within OU-3, vary in thickness and are generally linear. These generally uniform sand and gravel deposits exhibit higher hydraulic conductivity than the adjacent, well-graded deposits. In general, these paleochannels trend northeast and represent significant transport pathways as discussed in the CSM in the RI Report for OU-1 and OU-2 (Ramboll 2021a).

Las Vegas Valley is drained by the Wash, a 12-mile-long channel located approximately 2.6 miles north of OU-1, which flows into Lake Mead. Accounting for approximately 2% on average of the water in Lake Mead since 2002,[4] the water flowing through the Wash consists of urban runoff, shallow groundwater, storm water, and treated wastewater from the Clark County Sanitation District, the COH, the City of Las Vegas, and treated discharge from NERT, Titanium Metals Corporation of America (TIMET), and AMPAC.

[4] https://www.nps.gov/lake/learn/nature/overview-of-lake mead.htm#:~:text=The%20annual%20inflow,in%20the%201980s..htm

Prior to the development of Las Vegas Valley, the Wash was primarily an ephemeral stream incapable of supporting perennial emergent wetlands. From the 1950s to the 1970s, rapid urban development in the Las Vegas Valley resulted in increased storm water, urban runoff, and treated wastewater discharges that resulted in the establishment of extensive wetland areas along the Wash. By the 1980s, increasing base flows and periodic flood flows in the Wash contributed to extensive erosion, as well as loss of wetlands, loss of property, damage to infrastructure, excessive sediment transport to Lake Mead, and water quality degradation (Las Vegas Wash Coordination Committee [LVWCC] 2000). Currently, the flow is perennial and composed almost entirely of effluent from wastewater treatment plants.

To address the erosional issues that arose, beginning in approximately 2000, a series of restoration measures were implemented in the Wash. These measures included the construction of 21 weirs[5] for the purposes of erosion control, wetland restoration, and revegetation (LVWCC 2008). All 21 weir construction projects were completed by 2018 (LVWCC 2018) (Figure 1-4).

Additional details on the regional and local geology and hydrogeology within the NERT RI Study Area, including information on the water-bearing zones, is provided in the RI Report for OU-1 and OU-2 (Ramboll 2021a) and the Phase 3 RI Work Plan (Ramboll Environ 2017a), and will be discussed in more detail within the forthcoming RI Report for OU-3.

[5] Ten weirs are within the extent of the OU-3 boundary.

3. IDENTIFICATION OF IMPACTED ENVIRONMENTAL MEDIA AND INITIAL COPCS

This work plan presents the framework through which human health risks will be evaluated. The evaluation of human health risks posed by contamination of environmental media requires the development of a site-specific CSM, which identifies the chemical sources, COPCs, release and transport mechanisms, and potentially impacted environmental media present at an area of interest (in this case, OU-3). The CSM also identifies exposure populations and pathways relevant to the assessment of health risks. Though the OU-3 RI is still in progress, sufficient data exists and such data was used to prepare the CSM for the BHRA presented in this work plan. This section summarizes the chemical sources, release and transport mechanisms, the potentially impacted environmental media to include in the evaluation of the OU-3 BHRA, and initial identified COPCs for evaluation in this work plan. The initial COPCs presented in this section are further evaluated through a health risk-based screening analysis to determine the preliminary COPCs to include in the BHRA in Section 6.1; the exposure populations and pathways are identified and discussed in detail in the exposure assessment provided in Section 6.2.

3.1 Potential Chemical Sources

As discussed in the NERT RI/FS Work Plan (ENVIRON 2014a), the *Technical Memorandum Remedial Investigation Data Evaluation* ("RI Data Evaluation Technical Memorandum", Ramboll Environ 2016a) and the RI Report for OU-1 and OU-2 (Ramboll 2021a), characterization of sources of groundwater contamination and transport pathways from sources in OU-1, though OU-2, and to the Wash were conducted as part of the RI for OU-1 and OU-2. Sources of groundwater contamination in OU-3 that are included in this work plan are those associated with releases from operations at the NERT Site (OU-1) and the former BMI Common Areas (primarily within the eastern portion of OU-2), where wastewater from OU-1 (and adjacent BMI Complex facilities) migrated to OU-2 and ultimately infiltrated into the ground via the BMI Ponds. These sources have resulted in a groundwater plume of perchlorate and other chemicals (further detailed in Section 3.5) extending from OU-1 to OU-3. Vadose zone soils within OU-1 and OU-2 are expected to be ongoing sources of constituent migration to groundwater that may then migrate to OU-3 and ultimately to the Wash via the groundwater pathway. However, as previously discussed, and consistent with the Phase 3 RI Work Plan (Ramboll Environ 2017a) and the RI Report for OU-1 and OU-2 (Ramboll 2021a), NERT is only responsible for evaluating and remediating perchlorate and chlorate east of Pabco Road.

Other sources of groundwater contamination within the NERT RI Study Area originated from neighboring properties within the BMI Complex, including from the Olin Chlor-Alkali Products (Olin), Stauffer, Syngenta, and Montrose (OSSM) site (located west of OU-1) and the TIMET property (located to the east of OU-1). Notably, there is a VOC plume from the OSSM site trespassing onto OU-1 (Ramboll 2021a). The Beta Ditch, which was an unlined west-east trending ditch that traversed OU-1, conveyed co-mingled process wastewater from a number of BMI Complex parties to the Upper BMI Ponds within the BMI Common Areas (primarily within OU-2). Additional information regarding the transport of constituents via the Beta Ditch is provided in the RI Report for OU-1 and

OU-2 (Ramboll 2021a). In addition, the BMI Corrective Action Management Unit [BMI CAMU], a lined, 52-acre landfill, received wastes from a number of BMI Complex parties. Historical features within the boundaries of the CAMU include the BMI Landfill which received wastes from facilities within the BMI Complex between 1943 and 1980. See Figure 1-2 for the location of the OSSM, TIMET, and BMI CAMU properties.

An additional source of perchlorate in groundwater is the former AMPAC site which was operated by AMPAC from 1982 to 1988 and the Pacific Engineering and Production Company of Nevada (PEPCON) from 1958 to 1982. AMPAC and PEPCON produced perchlorates at a plant located approximately 1.5 miles west of the BMI Complex (see Figure 1-2). As part of the perchlorate production process, chlorate was also generated as a byproduct. The facility experienced a catastrophic explosion in 1988. The perchlorate and chlorate groundwater plume associated with the former AMPAC facility is generally located to the west of the NERT plume. Perchlorate from the AMPAC plume also discharges to the Wash in OU-3 (Ramboll 2021a).

3.2 Chemical Transport

As discussed in the NERT RI/FS Work Plan (ENVIRON 2014a), the RI Data Evaluation Technical Memorandum (Ramboll Environ 2016a), and the RI Report for OU-1 and OU-2 (Ramboll 2021a), process wastewater containing various chemical byproducts was generated by industrial operations within OU-1 and the surrounding BMI Complex (as shown in Figure 3-1). This process wastewater was accumulated on-site and also migrated to off-site ponds via the Beta Ditch. The Beta Ditch, which was unlined and constructed circa 1941 or 1942, received a variety of wastes from process operations, storm water, and non-contact cooling water within the BMI Complex (including the NERT Site) until the 1970s when discharges to the beta ditch ceased.

3.3 Groundwater Extraction and Treatment System

As discussed in detail in the RI/FS Work Plan (ENVIRON 2014a) and the RI Report for OU-1 and OU-2 (Ramboll 2021a), the current NERT Groundwater Extraction and Treatment System (GWETS) was designed as a removal action that targets the core groundwater plumes of perchlorate and hexavalent chromium that originate within OU-1 and migrated into the portions of OU-2 and OU-3 west of Pabco Road. Groundwater investigation, removal, and monitoring has been conducted at the NERT Site and downgradient of the NERT Site within the NERT Off-Site Study Area since the mid-1970s. Treatment of hexavalent chromium in groundwater began in 1987, and treatment of perchlorate in groundwater began in 1999.

The current NERT GWETS includes three groundwater extraction well fields, including the Interceptor Well Field (IWF), the Athens Road Well Field (AWF), and the SWF, as well as eight Ammonium Perchlorate manufacturing area (AP Area) extraction wells located approximately 300 ft south of the IWF just west of the former AP-5 Pond. The extraction well locations are shown on Figure 3-3. The IWF, which currently contains 30 active extraction wells, coupled with the on-site barrier wall and the eight AP area extraction wells, provide capture of the highest concentrations of perchlorate and chromium and significantly reduces the amount of perchlorate and chromium in downgradient groundwater.

The off-site AWF, located in OU-2 approximately 8,200 ft downgradient of the IWF, consists of eight active extraction wells[6] and captures moderate concentrations of both perchlorate and chromium (in comparison to groundwater captured by the IWF), but operates at higher extraction rates than the IWF, resulting in significant contributions to overall perchlorate mass removal from the environment and mitigation of perchlorate migration in groundwater. The SWF, located in close proximity to the Wash, includes nine extraction wells[7] and operates at the highest extraction rate of the three well fields, but captures groundwater containing significantly lower perchlorate concentrations.

As reported in the *2020 Annual Groundwater Monitoring and GWETS Performance Report* (Ramboll 2021d), the GWETS captures all groundwater currently migrating from OU-1. As a result, there is no longer any discharge to the Wash from the groundwater plumes originating from OU-1, with the exception of perchlorate diffusing upwards from the UMCf north of the SWF.

The trends in average perchlorate and hexavalent chromium concentrations in the extraction well fields between 2004 and 2019 have decreased during this time period. The persistence of contamination in shallow groundwater is affected by the continued upward migration due to matrix diffusion and upward flow, in which slow upward migration from the saturated UMCf causes concentrations in the higher permeability alluvium to remain above regulatory levels for extended periods of time.

In contrast, the perchlorate plume located in OU-2 and OU-3 east of Pabco Road is mostly outside of the capture zone of the GWETS and therefore will migrate to the Wash. This uncontrolled discharge to the Wash in OU-3 will be discussed in the forthcoming OU-3 RI Report. It is assumed that the NERT GWETS will remain in operation largely as-is until the final remedy is selected.

3.4 Potentially Impacted Environmental Media

As discussed in Sections 3.1 and 3.2, site-related chemicals migrate via groundwater into OU-3 and some discharge into the Wash. Contaminated groundwater discharging into the Wash may impact bank soil, surface water, and sediment. Groundwater may also impact surface soil due to seepage near the former seep area. The environmental media that have been potentially impacted by the chemicals present in OU-3 that may have migrated from OU-1 are summarized below:

- Direct contact with groundwater (for certain worker receptors) could occur in OU-3 at locations where depth to groundwater is shallow.[8]

[6] There are a total of 14 extraction wells, eight extraction wells actively pumping at any given time and six buddy extraction wells.

[7] Extraction wells PC-99R2 and PC-99R3 are separate wells but share a pump for extraction from both wells and are therefore considered to be one extraction well.

[8] It is assumed that construction activities could occur at or near the WRF and direct contact with groundwater could occur in a 10-ft construction trench where groundwater is shallow near the WRF. Construction is not expected near the Wash; however, it is assumed a utility/maintenance worker could dig a 5-foot trench in this area. All groundwater locations shallower than or approximately 10 feet bgs were used to evaluate these two worker scenarios.

- Human receptors could also be exposed to VOCs migrating from shallow groundwater (less than 60 ft bgs) and soil gas to indoor air, outdoor air, or air within a utility trench or construction trench (trench air).[9]
- Maintenance/utility workers and recreational users may potentially be exposed to soils that could have been contaminated by shallow groundwater near the former seep area or in bank soil.
- While direct contact with sediment and surface water within Wetlands Park is prohibited, it is assumed that adolescent trespassers (between 7-18 years old)[10] in the Wetlands Park may disregard Park rules and encounter surface water and sediment through dermal contact and inhalation of resuspended bank soil particulates.

Environmental media that will be addressed in the OU-3 BHRA are detailed in Table 3-1 and summarized as follows:

- East of Pabco Road – shallow groundwater within 10 ft of the ground surface bgs near the Wash, bank soil, surface water, and sediment.
- West of Pabco Road (excluding the Open Space Sub-Area) – shallow groundwater within 60 ft of the ground surface, bank soil, surface water, and sediment, soil from the former seep area, and soil gas.

The details of the CSM including specific exposure populations and pathways are discussed in Section 6.2.

3.5 Initial COPC Selection

As discussed in the RI Report for OU-1 and OU-2 (Ramboll 2021a), NERT is only responsible for those constituents in OU-2 and OU-3 that have migrated from the NERT Site. As such, the COPCs identified within OU-2 and OU-3 west of Pabco Road are limited to those constituents that are present in soil and groundwater within OU-1 and which have migrated off-site through groundwater. In addition, the COPCs in OU-2 east of Pabco Road are administratively limited to perchlorate and chlorate. Based on this, the initial COPCs to be evaluated in this work plan are described below:

- OU-3 West of Pabco Road (including the northern portion of the NERT Off-Site Study Area and the Downgradient Study Area west of Pabco Road, excluding the Open Space Sub-Area):

[9] The exposures associated with inhalation of VOCs migrating from surface water to outdoor air for the recreational users or adolescent trespassers near the Wash are expected to be low due to low exposure time for the recreational users or adolescent trespasser and high mixing rate in outdoor air. Therefore, the health risks associated with this pathway will not be quantitatively evaluated but qualitatively discussed in the uncertainty section of the OU-3 BHRA.

[10] An adolescent trespasser was evaluated based on the recommendation of NDEP in an email from Weiquan Dong on July 21, 2022.

  - All groundwater COPCs identified for OU-2 in the RI Report for OU-1 and OU-2 (Ramboll 2021a) and detected in OU-3 are included as the initial COPCs for groundwater in OU-3 west of Pabco Road.[11]
  - All volatile OU-2 groundwater COPCs that were detected in soil gas in OU-3 west of Pabco Road are included as the initial COPCs for soil gas in OU-3 west of Pabco Road.
  - In the recent Phase 3 RI sampling (as described in Section 4.3), no VOCs were detected in soil, so they are not included as COPCs for soil in OU-3 west of Pabco Road. All non-volatile OU-2 groundwater COPCs that were detected in 0-10 ft bgs in bank soil near the Wash and soils near the seep well field in OU-3 west of Pabco Road are included as the initial COPCs for soil in OU-3 west of Pabco Road.
  - For surface water, all OU-2 groundwater COPCs that were detected in surface water in OU-3 west of Pabco Road are included as initial COPCs for surface water for this area.
  - For sediment, all OU-2 groundwater COPCs that were detected in sediment in OU-3 west of Pabco Road are included as initial COPCs for sediment for this area.

- OU-3 East of Pabco Road (including the Northeast Sub-Area and the Downgradient Study Area east of Pabco Road):
  - The non-volatile groundwater COPCs identified for the portion of OU-2 east of Pabco Road are administratively limited to perchlorate and chlorate (Ramboll 2021a). As all groundwater in the eastern portion of OU-3 is downgradient of the eastern portion of OU-2, perchlorate and chlorate are added as the COPCs for groundwater and soil. Since perchlorate and chlorate were also both detected in surface water east of Pabco Road, they are added as the initial COPCs for surface water as well. Perchlorate was not detected in sediment, so chlorate is the only initial COPC east of Pabco Road.[12]
  - The potential risks associated with the vapor intrusion pathway from soil gas and groundwater is not being evaluated by NERT east of Pabco Road since NERT is only responsible for evaluating the nature and extent of perchlorate and chlorate (which are not volatile organic compounds) in this area. Therefore, there are no NERT COPCs for soil gas in OU-3 east of Pabco Road.

In addition, as discussed in the RI Report for OU-1 and OU-2 (Ramboll 2021a), a detailed analysis of hexavalent chromium to total chromium ratios was performed as part of the 2016 Groundwater Monitoring Optimization Plan (Ramboll Environ 2016b). The analysis found that the concentration of total chromium is generally equal to the

[11] If speciated hexavalent chromium data was not available and only total chromium was analyzed for a groundwater sample, then total chromium is conservatively evaluated as hexavalent chromium.

[12] As noted in Section 6.1.4, perchlorate and chlorate are the only COPCs identified in surface water in OU-3 west of Pabco Road that are also detected in surface water in OU-3 east of Pabco Road.

concentration of hexavalent chromium within the NERT groundwater plume. With NDEP approval, hexavalent chromium was eliminated from NERT's on-going groundwater monitoring program in 2016. Therefore, total chromium and hexavalent chromium are not regarded as separate COPCs in groundwater and interpretations of the lateral and vertical extent of chromium in groundwater will primarily rely on total chromium data (rather than hexavalent chromium data).

Hexavalent chromium was not detected in any soil, surface water, or sediment samples in OU-3.[13] Therefore, for these media, if speciated chromium data is not available for a sample and only total chromium was analyzed, total chromium is evaluated as trivalent chromium.

The initial COPCs identified to be evaluated in this work plan are as shown in Table 3-1 and in the data sets in Appendices A through E for each medium listed above. The initial COPCs evaluated in this work plan for groundwater, soil, soil gas, surface water, and sediment are further assessed in Section 6.1 of this work plan by performing a health risk-based screening analysis to determine the preliminary COPC list to be evaluated in the OU-3 BHRA.

[13] For soil and sediment samples included in the BHRA data set for OU-3, all samples that were analyzed for total chromium were also analyzed for hexavalent chromium. For surface water samples included in the BHRA data set for OU-3, approximately 75% of the samples that were analyzed for total chromium were also analyzed for hexavalent chromium. Hexavalent chromium was not detected in the soil, sediment, or surface water BHRA data set for OU-3 indicating that chromium in these media is predominately trivalent chromium.

4. ENVIRONMENTAL INVESTIGATIONS

The BHRA for OU-3 will rely on data collected throughout multiple investigations (both completed and in progress) during the time period from 2015 to 2022, which have been determined to be most representative of current conditions and relevant to the BHRA. The environmental investigation data to be included in the BHRA data set for OU-3 is summarized in Table 4-1 and discussed in detail below.

4.1 Soil Gas Investigations

A soil gas and groundwater investigation was implemented in OU-3 west of Pabco Road to provide additional information necessary for the BHRA risk evaluation as part of NERT's Phase 3 RI. The investigation was developed by considering VOC data from groundwater sampling conducted in OU-3 since 2015 as part of the Phase 1 RI, Phase 2 RI, and the NERT groundwater monitoring and GWETS performance reporting program. The scope of work for this investigation was detailed in the *Phase 3 RI Modification No. 7 Technical Memorandum* (Ramboll 2019a), which was submitted to NDEP on May 17, 2019, and approved by NDEP on May 31, 2019. This soil gas sampling event was conducted in the first and second quarters of 2020 and included the installation and sampling of multi-level soil gas sampling probes at 17 locations (RISG-35 through RISG-51) limited to OU-3 west of Pabco Road. Of the 17 locations, five are located in the Open Space Sub-Area and will not be included in the OU-3 BHRA. Therefore, only 12 of the 17 soil gas probe locations sampled during the Phase 3 RI Modification No. 7 investigation are to be included in this BHRA (RISG-35 through RISG-40, RISG-42 through RISG-45, RISG-50, and RISG-51). The 12 locations are shown on Figure 4-1.[14]

Two soil gas probes were installed at most locations, with one at 5 ft bgs and the other at between 10 and 15 ft bgs. In some cases, groundwater was encountered above 10 ft bgs, or refusal was encountered due to the presence of caliche, preventing the installation of the deep soil gas probes. At two soil gas sampling locations, RISG-35 and RISG-40, deeper soil gas probes were not installed due to the presence of shallow groundwater and shallow refusal, respectively. Soil gas samples were collected from each soil gas probe and analyzed for VOCs between February and May 2020.

In addition, to perform more representative vapor intrusion modeling, samples were collected in multiple locations and tested for soil physical properties as part of the Phase 3 RI Modification No. 7 sampling (Ramboll 2019a). These included soil classification (grain size distribution/Atterberg Limits), total organic carbon (TOC), bulk density, water content, and total porosity at 5 ft bgs and 10-15 ft bgs in nine locations, as well as at 5 ft bgs only in three locations.

Soil gas sample results from this investigation will be incorporated into the forthcoming RI Report for OU-3 and are summarized in the associated Data Validation Summary

[14] Soil gas probes RISG-41, RISG-46, RISG-47, RISG-48, and RISG-49 are located within the Open Space Sub-Area but will not be used in the risk assessment since this area has already received a NFA for vapor intrusion.

Report (DVSR) which was submitted to NDEP on May 12, 2021 and approved by NDEP on June 24, 2021 (Ramboll 2021e).[15]

Additionally, NDEP's comments provided on June 29, 2022 on the initial version of this BHRA Work Plan indicated that the existing soil gas data collected for chloroform as part of Phase 3 RI Modification No. 7 in the OU-3 area west of Pabco Road and north of Galleria Drive may not be adequate to assess risk and may not represent a worst case or Reasonable Maximum Exposure (RME) condition. Therefore, additional soil gas samples outside of the Open Space Sub-Area were collected to characterize the concentrations of VOCs in soil gas in the vicinity of the chloroform plume in groundwater west of Pabco Road and north of Galleria Drive. The scope of work for this investigation was detailed in the *Phase 3 RI Modification No. 15 Technical Memorandum* (Ramboll 2022c), which was submitted to NDEP on August 2, 2022, and approved by NDEP on August 9, 2022. Sampling was conducted at 5 and 15 ft bgs at two new soil gas probe locations (RISG-91 and RISG-92) and at 10 existing soil gas probe locations (RISG-35, RISG-36, RISG-37, RISG-38, RISG-39, RISG-40, RISG-42, RISG-43, RISG-44, and RISG-45) that were previously installed as part of Phase 3 RI Modification 7 and are south of the Open Space Area, as shown in Figure 4-1.

These analytical results for the soil gas samples collected as discussed above, along with relevant shallow groundwater sample results (see discussion in Section 4.2) obtained from samples collected from monitoring wells in OU-3 west of Pabco Road (excluding the Open Space Sub-Area), will be used in the BHRA for OU-3 to evaluate potential health risk due to vapor migration from the subsurface to indoor air, outdoor air, or trench air.

4.2 Groundwater Investigations

The following sections describe the groundwater investigations conducted in OU-3 that provide relevant data for the initial COPCs, as identified in Section 3.5 and Table 3-1.

Depth to groundwater in the NERT RI Study Area decreases significantly from the south (within OU-1) to the north (within OU-3) with the depth to groundwater ranging from as shallow as 2 ft bgs in the northern portion of OU-3 to deeper than 50 ft bgs in the southern portion of OU-3. Direct contact with groundwater for certain worker receptors could occur in OU-3 at locations where the depth to groundwater is shallow. In OU-3 west of Pabco Road, exposures due to inhalation of groundwater vapors migrating from subsurface to indoor air, outdoor air, or trench air could also occur and will be evaluated in this BHRA using groundwater VOC data collected from monitoring wells with a top of well screen shallower than 60 ft bgs. Specifically, the relevant groundwater data that will be used in the BHRA include the following:

- Groundwater data for the VOCs on the list of initial COPCs as discussed in Section 3.5 and shown in Table 3-1, which were collected from 2015 to 2022 from shallow groundwater monitoring wells which have a top of well screen shallower

[15] Although NDEP approved the submittal, NDEP provided comments for the administrative record in their June 24, 2021 approval letter (NDEP 2021a). A revised DVSR was submitted to NDEP on June 29, 2021 in response to the comments for the administrative record (Ramboll 2021j).

than 60 ft bgs in OU-3 west of Pabco Road (excluding the Open Space Sub-Area) (see Table 4-2a), will be used for evaluating vapor intrusion west of Pabco Road.

- Groundwater data for non-volatile chemicals on the list of initial COPCs as discussed in Section 3.5 and shown in Table 3-1 collected from 2015 to 2022 from shallow groundwater monitoring wells with the minimum depths to groundwater shallower than or at approximately 10 ft bgs in OU-3 west of Pabco Road (excluding the Open Space Sub-Area) (see Table 4-2b) will be used for evaluating direct contact with shallow groundwater west of Pabco Road.
- Groundwater data for chlorate and perchlorate collected from 2015 to 2022 from shallow groundwater monitoring wells with the minimum depths to groundwater shallower than or at approximately 10 ft bgs in OU-3 east of Pabco Road (see Table 4-2b) will be used for evaluating direct contact with shallow groundwater east of Pabco Road.

Wells meeting the criteria described above were further reviewed to evaluate their applicability for use in the OU-3 BHRA. Wells with the minimum depths to groundwater shallower than or at approximately 10 ft bgs are excluded if their top screen depths are significantly (30 ft or more) deeper than the depths to groundwater and if there are nearby well(s) with available data that have shallower top screen depths that are considered more representative of shallow groundwater conditions in OU-3.

The level of data validation and the sampling purposes for groundwater data collected in OU-3 were evaluated according to the Quality Assurance Project Plans (QAPPs) in place at the time of sampling (Environ 2014c; Ramboll Environ 2017b; Ramboll 2019b, 2020a, and 2021f). Accordingly, only groundwater data that were collected to support risk assessment and risk decision making and for which the data validation meets the requirement of Stage 2A for groundwater are included in the BHRA data set for OU-3. The Phase 1, 2, and 3 RI investigations that are representative of the current conditions and relevant to the BHRA are summarized in Sections 4.2.1, 4.2.2, and 4.2.3, respectively. In addition to the RI, data collected during other groundwater investigations are relevant to the BHRA. These include the Downgradient Study Area investigations, the Groundwater Monitoring and GWETS Performance Reporting Program investigations and the SWF flow quantification investigation. These additional investigations are summarized in Sections 4.2.4 through 4.2.6, respectively. The shallow groundwater monitoring wells that will be evaluated in the BHRA are summarized in Tables 4-2a and 4-2b and shown in Figures 4-1 (west of Pabco Road) and 4-2 (east of Pabco Road).

4.2.1 Phase 1 RI

Phase 1 field investigations represent NERT's first RI data collection effort and were conducted between October 2014 and May 2015. Per the RI/FS Work Plan (ENVIRON 2014a), the purpose of the Phase 1 RI was to determine the nature and extent of COPCs in soil and groundwater at the NERT Site Study Area (OU-1) and in the NERT Off-Site Study Area (including what is now parts of OU-2 and OU-3). The Phase 1 RI for groundwater included new on-site and off-site monitoring well installations, collection of grab groundwater samples, performing slug tests, and sampling of existing groundwater

monitoring wells. As part of the Phase 1 RI, chlorate, perchlorate, hexavalent chromium, and total chromium data were collected in OU-3.

The results of the Phase 1 RI were summarized in the RI Data Evaluation Technical Memorandum (Ramboll Environ 2016a). Data gaps to be addressed in the Phase 2 RI Data Gap Investigation (Phase 2 RI) were identified in the same submittal. Analytical results for groundwater samples collected during the Phase 1 RI were presented in a DVSR (Ramboll 2018a) that was submitted to NDEP on June 22, 2018 and approved by NDEP on August 14, 2018.

Groundwater samples were not collected for VOC analyses during the Phase 1 RI. For non-volatile COPCs in groundwater (see Section 3.5 and Table 3-1), exposures could occur through direct contact at locations where the depth to groundwater is shallower. Therefore, analytical results for non-volatile initial COPCs in groundwater from monitoring wells with depths to groundwater shallower than, or approximately equal to, 10 ft bgs will be included in the BHRA data set for wells in OU-3 west of Pabco Road (excluding the Open Space Sub-Area). Phase 1 analytical data for chlorate and perchlorate for OU-3 wells located east of Pabco Road will also be included in the BHRA data set for OU-3.

4.2.2 Phase 2 RI

In accordance with the RI Data Evaluation Technical Memorandum (Ramboll Environ 2016a), the Trust implemented a second phase of remedial investigation (Phase 2 RI) and 15 Phase 2 RI Modifications from January 2017 to November 2018. Field work was conducted both at the NERT Site (OU-1) and within the NERT Off-Site Study Area (including what is now parts of OU-2 and OU-3). The primary purpose of the Phase 2 RI was to obtain data to understand the nature and extent of impacts to soil and groundwater and also to address additional data gaps identified during the Phase 1 RI.

The Phase 2 RI in the NERT Off-Site Study Area in OU-3 included the installation and sampling of new monitoring wells to provide the information necessary to further characterize the lateral and vertical extent of COPCs in groundwater within the alluvium and underlying UMCf. Analytical results for groundwater samples collected during the Phase 2 RI in OU-3 between October and November 2017 are presented in a DVSR submitted to NDEP on May 31, 2019 and approved by NDEP on June 3, 2019 (Ramboll 2019c). Analytical results for groundwater samples collected between May and November 2018 during the Phase 2 RI in OU-3 are included in a DVSR submitted to NDEP on February 14, 2020 and approved by NDEP on April 9, 2020 (Ramboll 2020b).

Direct contact with groundwater may occur in OU-3 at locations where depth to groundwater is shallower. Therefore, analytical results for non-volatile COPCs in groundwater (see Section 3.5 and Table 3-1) from monitoring wells with depths to groundwater shallower than or approximately equal to 10 ft bgs will be included in the BHRA data set for wells in OU-3 west of Pabco Road (excluding the Open Space Sub-Area). Phase 2 analytical data for chlorate and perchlorate for OU-3 wells located east of Pabco Road also will be included in the BHRA data set for OU-3.

In addition, potential human receptors may be exposed to vapors migrating from shallow groundwater to indoor, outdoor, or trench air in OU-3 west of Pabco Road (excluding the Open Space Sub-Area). Hence, groundwater data for the VOCs on the initial COPC list (see Section 3.5 and Table 3-1) for groundwater collected during the Phase 2 RI from monitoring wells with top of the well screens shallower than 60 ft bgs will be included in the BHRA data set for OU-3 west of Pabco Road (excluding the Open Space Sub-Area).

4.2.3 Phase 3 RI

As discussed in the Phase 3 RI Work Plan (Ramboll Environ 2017a), the Trust implemented a third phase of the remedial investigation (Phase 3 RI), including 15 Phase 3 RI modifications. The Phase 3 RI began in November 2017 and was completed in 2022.[16] The RI Report for OU-1 and OU-2 (Ramboll 2021a) provides details regarding the 12 Phase 3 RI scope modifications that were approved by NDEP as of July 2021. In addition, Phase 3 RI Modification No. 13 was submitted to NDEP on August 25, 2021 and approved by NDEP on September 1, 2021 (Ramboll 2021g), and Phase 3 RI Modification No. 14 was submitted to NDEP on December 3, 2021 and approved by NDEP on December 8, 2021 (Ramboll 2021h). This investigation incorporates additional analytes into the comprehensive groundwater sampling program described in Modification Nos. 8, 11, and 12 (Ramboll 2020c, 2020d, 2021i).

The Phase 3 RI Work Plan provided details regarding the establishment of the Eastside Study Area (including the Eastside Sub-Area in OU-2 and the Northeast Sub-Area in OU-3) located immediately east of the NERT Site and NERT Off-Site Study Area. The Phase 3 investigation was designed to determine the extent of groundwater contamination for chemicals migrating from the NERT Site to the Eastside Study Area, to obtain data to support risk assessments and future feasibility study evaluations to address impacts to groundwater, and to assist in the selection of the final remedy in the Eastside Study Area. As discussed in detail in Section 1 of this OU-3 BHRA Work Plan and the Phase 3 RI Work Plan, COPCs are administratively limited to perchlorate and chlorate in the Eastside Study Area. All monitoring wells sampled in OU-3 under the initial scope of the Phase 3 RI are located east of Pabco Road. Only one of these wells, MW-1, located on the Chimera Golf Course, has a depth to groundwater shallower than or at approximately 10 ft bgs. Groundwater data for perchlorate and chlorate collected from well MW-1 in April 2018 as part of the Phase 3 RI will be included in the BHRA data set for OU-3.

To supplement data previously obtained during the RI and the Groundwater Monitoring and GWETS Performance Reporting Program, the BHRA data set for OU-3 will also include analytical data from groundwater samples collected at three wells in OU-3 west of Pabco Road (excluding the Open Space Sub-Area) in March 2020 (PC-200, PC-201, and PZ-2S), performed as part of the approved Phase 3 RI Modification No. 7 (Ramboll 2019a). The data set will also include the groundwater sampling results from the approved Phase 3 RI Modification Nos. 8, 11, 12, and 13 (Ramboll 2020c, 2020d, 2021g, and 2021i). Phase 3 RI Modification No. 14 (Ramboll 2021h) wells are all located east of Pabco Road and are deeper than 10 ft bgs. Therefore, the groundwater data collected

[16] The Phase 3 RI groundwater samples were collected between 2018 and 2022 in OU-3.

during the Modification No. 14 sampling event will not be included in the BHRA data set for OU-3.

Groundwater analytical results collected in April 2018 as part of initial scope of the Phase 3 RI (Ramboll Environ 2017a) were included in a DVSR submitted to NDEP on September 26, 2019 and approved by NDEP on October 28, 2019 (Ramboll 2019d). Groundwater analytical results collected in March 2020 as part of the approved Phase 3 RI Modification No. 7 (Ramboll 2019a) were included in a DVSR submitted to NDEP on May 12, 2021 and approved by NDEP on June 24, 2021 (Ramboll 2021e).[17]

Direct contact with groundwater may occur in OU-3 at locations where depth to groundwater is shallower. Therefore, analytical results for non-volatile COPCs in groundwater (see Section 3.5 and Table 3-1) from monitoring wells with depths to groundwater shallower than or approximately equal to 10 ft bgs will be included in the BHRA data set for wells in OU-3 west of Pabco Road (excluding the Open Space Sub-Area). Phase 3 analytical data for chlorate and perchlorate for OU-3 wells located east of Pabco Road also will be included in the BHRA data set.

Potential human receptors may also be exposed to vapors migrating from shallow groundwater to indoor, outdoor, or trench air in OU-3 west of Pabco Road. Therefore, groundwater data for the VOCs on the initial COPC list (see Section 3.5 and Table 3-1) for groundwater collected during the Phase 3 RI from monitoring wells with top of the well screens shallower than 60 ft bgs will be included in the BHRA data set for OU-3 west of Pabco Road (excluding the Open Space Sub-Area).

4.2.4 Downgradient Study Area Investigation

In addition to the RI activities described above, additional groundwater data were collected at the direction of NDEP that are relevant to the BHRA. Specifically, additional groundwater sampling was conducted in the Downgradient Study Area by AECOM (AECOM 2016a), the results of which will be incorporated by NERT into the forthcoming RI Report for OU-3.

The objective of the Downgradient Study Area investigation was to identify subsurface pathways through which perchlorate-impacted groundwater is entering the Wash. Three rounds of groundwater sampling in the Downgradient Study Area were conducted by AECOM in April and May 2016, July 2018, and June and July 2019. A total of 84 monitoring wells were sampled during these three rounds of sampling. Samples were analyzed for general chemistry parameters and metals.

The 2016 sampling effort and the associated DVSR for the analytical results are presented in the *Groundwater Sampling Technical Memorandum, Revision 1* (AECOM 2017). The 2018 sampling effort and the associated DVSR for the analytical results are presented in the *Groundwater Data Gap Investigation Technical Memorandum – Phase I, final draft* (AECOM 2019a). The 2019 sampling effort and the associated DVSR for the

[17] Although NDEP approved the submittal, NDEP provided comments for the administrative record in their June 24, 2021 approval letter (NDEP 2021a). A revised DVSR was submitted to NDEP on June 29, 2021 in response to the comments for the administrative record (Ramboll 2021j).

analytical results are presented in the *Gap Investigation – Phase II Groundwater Quality Assessment* (AECOM 2019b).

A total of 15 wells (7 wells located in OU-3 west of Pabco Road and 8 wells located in OU-3 east of Pabco Road) sampled during these three sampling events are shallower than or at approximately 10 ft bgs. The groundwater samples collected during the Downgradient Study Area investigation (implemented by NDEP) were not analyzed for VOCs. Direct contact with groundwater may occur in OU-3 at locations where depth to groundwater is shallower. Groundwater data collected from monitoring wells with depths to groundwater shallower than or at approximately 10 ft bgs for the non-volatile initial COPCs (see Section 3.5 and Table 3-1) for OU-3 west of Pabco Road (excluding the Open Space Sub-Area) and for chlorate and perchlorate in OU-3 east of Pabco Road during the 2016, 2018 and 2019 Downgradient Study Area investigations will be conservatively included in the BHRA data set for OU-3.

4.2.5 Groundwater Monitoring and GWETS Performance Reporting Program

The 2015 *Annual Remedial Performance Report for Chromium and Perchlorate* (Ramboll Environ 2015) detailed the results of groundwater sampling for chlorate, nitrate, perchlorate and chromium from the second half of 2014 through the first half of 2015. This report was submitted to NDEP on October 30, 2015 and approved on December 30, 2015. The analytical results for groundwater samples collected in the first half of 2015 were presented in a DVSR submitted to NDEP on February 12, 2016 (Ramboll Environ 2016c), which was approved by NDEP on March 31, 2016.

As directed by NDEP, VOCs were added to NERT's GWMP in 2016 (Ramboll Environ 2016b). The 2016 *Annual Remedial Performance Report for Chromium and Perchlorate* (Ramboll Environ 2016d) detailed the results of groundwater sampling from the second half of 2015 through the first half of 2016. The report was submitted to NDEP on October 31, 2016 and approved by NDEP on December 6, 2016. The results associated with VOC analyses of groundwater samples collected in OU-3 were reported in subsequent Annual Remedial Performance Reports submitted in 2017 (Ramboll Environ 2017c) and 2018 (Ramboll 2018b). DVSRs were submitted with each Annual Remedial Performance Report.

Comprehensive groundwater sampling for general chemistry (i.e., chlorate, nitrate, and perchlorate), metals (e.g., boron and chromium), and VOCs has been conducted on a semi-annual (for the non-volatile chemicals, usually in May and November every year) or annual basis (for VOCs, usually in May every year) as part of the groundwater monitoring program since 2017. The results of groundwater sampling conducted in 2017 through 2021 under this program were presented in the *Annual Remedial Performance Report for Chromium and Perchlorate for 2017* (Ramboll Environ 2017c), 2018 (Ramboll 2018b), 2019 (Ramboll 2019e), the *Annual Groundwater Monitoring and GWETS Performance Report, July 2019 - June 2020* (Ramboll 2021d), *the Annual Groundwater Monitoring and GWETS Performance Report July 2020 through June 2021* (Ramboll 2022d), and the *Semi-Annual Groundwater Monitoring and GWETS Performance Memorandum for July 2021 through December 2021* (Ramboll 2022e), respectively. The results of groundwater sampling conducted in 2022 under this program will be presented in the *2022 Annual Groundwater Monitoring and GWETS*

Performance Report, which is anticipated to be submitted to the NDEP in the first quarter of 2023.

Analytical results from 24 monitoring wells with the top of the well screen less than 60 ft bgs that were sampled during the February 2016 – July 2022 Groundwater Monitoring and GWETS Performance Reporting Program sampling events in OU-3 (excluding the Open Space Sub-Area) will be included in the BHRA. Among these wells, seven wells are located east of Pabco Road with depth to groundwater shallower than or at approximately 10 ft bgs; 17 wells are located west of Pabco Road and 14 of the 17 are shallower than or at approximately 10 ft bgs. VOCs, general chemistry, and metals were analyzed for these groundwater samples.

Direct contact with groundwater may occur in OU-3 at locations where depth to groundwater is shallower. Therefore, groundwater analytical data for the non-volatile initial COPCs (see Section 3.5 and Table 3-1) from monitoring wells with depths to groundwater shallower than or approximately equal to 10 ft bgs for OU-3 west of Pabco Road (excluding the Open Space Sub-Area) will be included in the BHRA data set for OU-3. Chlorate and perchlorate for groundwater samples collected from OU-3 wells east of Pabco Road during the Groundwater Monitoring and GWETS Performance Reporting Program sampling between 2016 and 2022 will be conservatively included in the BHRA data set for OU-3 to evaluate this scenario.

In addition, potential human receptors may be exposed to vapors migrating from shallow groundwater to indoor, outdoor, or trench air in OU-3 west of Pabco Road. Hence, groundwater data for the VOCs on the initial COPC list (see Section 3.5 and Table 3-1) for groundwater collected during the Groundwater Monitoring and GWETS Performance Reporting Program sampling between 2016 and 2022 from monitoring wells with top of the well screens shallower than 60 ft bgs will be included in the BHRA data set for OU-3 west of Pabco Road (excluding the Open Space Sub-Area).

4.2.6 Seep Well Field Flow Quantification

The SWF is one of three primary extraction well fields comprising the GWETS operated by the Trust for the NERT Site. The SWF is located in OU-3 west of Pabco Road approximately 2.3 miles downgradient from the NERT Site boundary. Water extracted by the SWF is currently pumped to an FBR biological treatment plant at the NERT Site or an IX treatment system near the SWF designed to treat perchlorate prior to discharge to the Wash. Two surface water bodies are located near the SWF: the Birding Ponds, which are approximately 3,000 ft hydraulically upgradient of the SWF, and the Wash, which is approximately 1,300 ft hydraulically downgradient of the SWF.

As described in the *Seep Well Field Flow Quantification Technical Memorandum* (Ramboll Environ 2016e), groundwater samples were collected from February 8, 2016 to February 19, 2016 from nine SWF extraction wells and five SWF-area monitoring wells in OU-3 as part of the effort to respond to a request from NDEP to quantify the relative contributions of three sources of water (i.e., the Wash, the Birding Ponds, and groundwater from other sources) to the SWF. The data collected during this investigation supplements the ongoing NERT Site RI to address a previously identified data gap. Samples were analyzed for general chemistry and metals including the non-

volatile chemicals on the initial COPC list (see Section 3.5 and Table 3-1). The data were reported in the 2016 Annual Report DVSR (Ramboll 2018c). Only one monitoring well (PC-97) sampled in this investigation has a depth to groundwater shallower than 10 ft bgs. Therefore, only groundwater data for the non-volatile initial COPCs (see Section 3.5 and Table 3-1) from PC-97 will be included in the BHRA data set for OU-3 to evaluate the potential exposures through direct contact with shallow groundwater. The applicable groundwater results from the groundwater investigations summarized in this Section will also be incorporated into the forthcoming RI Report for OU-3.

4.3 Soil Investigations

There are currently two areas where groundwater can surface in OU-3 and potentially impact soils: seepage to bank soil at the Las Vegas Wash and seepage to soil in the former seep area. This section describes the soil investigations that have been conducted at these two locations to date that provide relevant soil data for use in the BHRA in OU-3.

As part of the Phase 2 RI and outlined in the *2016 RI Data Evaluation Technical Memorandum* (Ramboll Environ 2016a), soil data was collected for evaluation of white salt deposits for potential perchlorate contamination observed in shallow soil within a low-lying area surrounding the former seep capture sump near the Wash in OU-3 west of Pabco Road during the Phase 2 RI in October 2017. Soil sampling was conducted at 10 locations in the vicinity of the SWF (SWF-01 through SWF-10). One surface soil sample (0-0.5 ft bgs) and one shallow subsurface soil sample (0.5 to 1.0 ft bgs) were collected at each location (See Figure 4-3) and were analyzed for perchlorate. At the time of sample collection, the seep capture area had recently been covered by a thick layer of soil produced during the construction of the diversion channel associated with the Sunrise Mountain Weir project conducted by the SNWA. These soil data for perchlorate are reported in the revised DVSR for soil and groundwater Phase 2 RI sampling for July through November 2017 (Ramboll 2019f) submitted to NDEP on May 29, 2019 and approved by NDEP on June 3, 2019. These soil data will be included in the BHRA data set for OU-3 to evaluate potential exposures to soil in the former seep area for the recreational users and maintenance/utility workers.

As described in the *Phase 3 RI Modification. No. 13* (Ramboll 2021g) submitted to NDEP on August 25, 2021 and approved by NDEP on September 1, 2021, due to limited chemical data available in the former seep area located in OU-3 west of Pabco Road, additional soil data within the 0-10 ft bgs depth interval were necessary for evaluating potential human exposures in this area. As part of this RI Modification, a total of ten additional soil samples (including one field duplicate) were collected in 2021 from three depth intervals (0 ft, 5 ft, and 9.5 ft bgs) at one new boring location (pilot boring PC-205) and the two well locations (PC-205A and PC-205B; see Figure 4-3)previously specified in Modification No. 11 (Ramboll 2020d). It should be noted that the current ground surface is now approximately 3 ft above the former seep due to regrading that SNWA completed during the construction of the Sunrise Mountain Weir. These soil samples were analyzed for perchlorate, chlorate, nitrate, nitrite, arsenic, boron, chromium, magnesium, manganese, and VOCs. These soil data are included in the BHRA data set for OU-3 (Appendix C) to evaluate potential exposures to soil in the

former seep area west of Pabco Road for the recreational users and maintenance/utility workers.

As described in the approved Baseline Ecological Risk Assessment (BERA) Field Sampling Plan for OU-3, Revision 1 (Ramboll 2019g), the soil investigation included collection of bank soil samples from low-lying areas between 0 and 3 ft bgs at eight locations along the southern bank of the Wash (one location in OU-3 west of Pabco Road and the other seven locations east of Pabco Road), as well as from three locations near the former seep area that had been graded and covered with soil from weir construction activities in OU-3 west of Pabco Road. In addition, five slightly deeper soil samples (at approximately 0.5 ft bgs), including one field duplicate sample, were collected from a subset (i.e., four) of the bank soil sampling locations, all located in OU-3 east of Pabco Road. These soil samples were collected to provide a greater understanding of the magnitude and extent of impacts to bank soils and soil in the former seep area. The soil data collected during this investigation will be utilized to support the evaluations of potential risks to both terrestrial receptors and human recreational users. The bank soil data collected along the Wash will also be used to evaluate the potential risks to adolescent trespassers. These samples were analyzed for perchlorate, chlorate, chloroform, total chromium, and hexavalent chromium. Soil sample locations are shown in Figure 4-3. These soil data are reported in the DVSR for the BERA field sampling and *Phase 3 RI Modification No. 7* submitted to NDEP on May 12, 2021 and approved by NDEP on June 24, 2021 (Ramboll 2021e).[18] Bank soil data for chlorate and perchlorate from OU-3 east of Pabco Road during the BERA sampling, and the soil data for all detected initial COPCs for soil (see Section 3.5 and Table 3-1) near the Wash and the former seep area (as shown in Figure 4-3) from OU-3 west of Pabco Road will be included in the BHRA data set for OU-3 to evaluate potential exposures to soil for the recreational users, maintenance/utility workers, or adolescent trespassers.

4.4 Surface Water Investigations

The following sections provide information regarding the surface water investigations conducted in OU-3 that provide relevant data for the selection of initial COPCs for surface water, as identified in Section 3.5.

As discussed in Section 3.4, while direct contact with surface water within Wetlands Park are prohibited, some adolescent trespassers in the Wetlands Park may disregard Park rules and encounter surface water through dermal contact. The exposure due to dermal contact with surface water near the Wash will be evaluated in this BHRA using surface water data collected from the Wash.

The level of data validation and the sampling purposes for surface water data in OU-3 were evaluated according to the QAPPs in place at the time of sampling (Environ 2014c; Ramboll Environ 2017b; Ramboll 2019b, 2020a, and Ramboll 2021f). Accordingly, only surface water data that were collected to support risk assessment and risk decision making and for which the data validation meets the requirement of Stage 2A for surface

[18] Although NDEP approved the submittal, NDEP provided comments for the administrative record in their June 24, 2021 approval letter (NDEP 2021a). A revised DVSR was submitted to NDEP on June 29, 2021 in response to the comments for the administrative record (Ramboll 2021j).

water are included in the BHRA data set for OU-3. The Phase 3 RI investigations that are representative of the current conditions and relevant to the BHRA are summarized in Sections 4.4.1. In addition to the RI, a few other surface water investigations are also relevant to the BHRA, including the Downgradient Study Area investigations conducted by NDEP, the Groundwater Monitoring and GWETS Performance Reporting Program investigations, SWF flow quantification investigation, and the 2019 BERA field sampling. The results obtained from these additional investigations are summarized in Sections 4.4.2 through 4.4.5, respectively.

4.4.1 Phase 3 RI

As part of the RI in OU-3, high frequency surface water samples in the Wash were collected as part of approved Phase 3 RI Modification No. 10 (Ramboll 2020e). The purpose of the sampling was to better characterize the temporal variation in mass loading of perchlorate in the Wash resulting from discharge of groundwater into surface water within OU-3. This was one of the recommended areas of additional investigation from the Downgradient Study Area Investigation (AECOM 2019c). Two separate sampling events with one event in the summer (in August 2021) and one event in the winter (in February 2022) were conducted at eight key locations within the Wash in OU-3 (as shown in Figures 4-4a and 4-4b). Surface water analytical results collected between August 2021 and February 2022 as part of the approved Phase 3 RI Modification No. 10 (Ramboll 2020e) were included in a DVSR submitted to NDEP on August 5, 2022, and NDEP comments were received on November 9, 2022[19] (Ramboll 2022f).

Surface water data for the initial surface water COPCs (see Section 3.5 and Table 3-1) for OU-3 west of Pabco Road and for chlorate and perchlorate for OU-3 east of Pabco Road during the Phase 3 RI will be included in the BHRA data set for OU-3.

4.4.2 Downgradient Study Area Investigation

In addition to the RI activities described above, additional surface water data were collected at the direction of NDEP as part of the Downgradient Study Area investigations that are relevant to the BHRA. Specifically, additional surface water sampling was conducted in the Downgradient Study Area by AECOM (AECOM 2016b), the results of which will be incorporated by NERT into the forthcoming RI Report for OU-3. The objective of the Downgradient Study Area investigations for surface water was to identify subsurface pathways downgradient and cross-gradient of the NERT RI Study Area through which perchlorate-impacted groundwater is entering the Wash (AECOM 2016b). A total of 21 historical surface water sampling locations identified by NDEP were sampled in this investigation. Three rounds of surface water sampling in the Downgradient Study Area were conducted by AECOM in May 2016, December 2016 - February 2017, and May 2018. Samples were analyzed for general chemistry and metals.

[19] Electronic data deliverable (EDD) for Phase 3 RI Modification No. 10 was approved by NDEP on September 16, 2022, and the Revision 2 of the DVSR is under preparation to address NDEP's comments received on November 9, 2022.

The surface water analytical results collected in the three rounds of surface water sampling in the Downgradient Study Area investigations were included in *Data Gap Investigation – Phase II Groundwater Quality Assessment* (AECOM 2019b). Surface water data for the initial surface water COPCs (see Section 3.5 and Table 3-1) for OU-3 west of Pabco Road and for chlorate and perchlorate for OU-3 east of Pabco Road during the Downgradient Study Area investigations for surface water will be included in the BHRA data set for OU-3.

4.4.3 GWETS Performance Reporting Program

Surface water sampling in the Wash has been conducted for many years as part of the annual and semiannual GWETS performance reporting. Beginning in July 2017, the sampling program was expanded to include more locations in the Wash. Samples are collected monthly and analyzed for perchlorate, chlorate, and TDS. The results of surface water sampling conducted from July 2017 through December 2021 under this program were presented in the GWETS performance reports covering that period (Ramboll Environ 2017c; Ramboll 2018b, 2019e, 2021d, 2021k, 2022d, and 2022f). The results of surface water sampling conducted in the first half of 2022 under this program will be presented in the *2022 Annual Groundwater Monitoring and GWETS Performance Report*, which is anticipated to be submitted to the NDEP in the first quarter of 2023. Surface water data for chlorate and perchlorate collected as part of the GWETS performance reporting program will be included in the BHRA data set for OU-3.

4.4.4 Seep Well Field Flow Quantification

The SWF is one of three primary extraction well fields comprising the GWETS operated by the Trust for the NERT Site. Two surface water bodies are located near the SWF: the Birding Ponds, which are approximately 3,000 ft hydraulically upgradient of the SWF, and the Wash, which is approximately 1,300 ft hydraulically downgradient of the SWF. As described in the *Seep Well Field Flow Quantification Technical Memorandum* (Ramboll Environ 2016e), 10 surface water sample locations were sampled in February 2016 in OU-3 as part of the effort to respond to a request from NDEP to quantify the relative contributions of three sources of water (i.e., the Wash, the Birding Ponds, and groundwater from other sources) to the SWF. The data collected during this investigation supplements the ongoing NERT Site RI to address a previously identified data gap. Results from one surface water sampling location (BP_09/2016) located near the Birding Ponds are excluded from the surface water BHRA data set for OU-3 since there are no expected exposures to surface water in this area. All samples were analyzed for general chemistry and metals including the non-volatile chemicals on the initial COPC list as identified in Section 3.5 (Table 3-1). The surface water sampling results were reported in the 2016 Annual Report DVSR (Ramboll 2018c). The surface water data for the initial surface water COPCs (see Section 3.5 and Table 3-1) for OU-3 west of Pabco Road and for chlorate and perchlorate for OU-3 east of Pabco Road during the Downgradient Study Area investigations for surface water will be included in the BHRA data set for OU-3.

4.4.5 BERA Field Sampling

As described in the approved BERA Field Sampling Plan for OU-3, Revision 1 (Ramboll 2019g), the supplemental investigation to support both the ecological risk assessment

and human health risk assessment included collection of surface water samples from 23 sampling locations along both the northern and southern bank of the Wash (seven locations in OU-3 west of Pabco Road and the other 16 locations east of Pabco Road near the Wash, as shown in Figures 4-4a and 4-4b, respectively). These surface water samples were collected to understand the magnitude and extent of impacts in surface water from the contaminated groundwater discharging into the Wash. The surface water data collected during this investigation will be utilized to support the evaluations of potential risks to both terrestrial receptors and adolescent trespassers. Results from one surface water sampling location located near the Birding Ponds (BERA_BP9-S) are excluded from the surface water BHRA data set for OU-3 since there are no expected exposures to surface water in this area. These samples were analyzed for perchlorate, chlorate, chloroform, total chromium, and hexavalent chromium. These surface water data are reported in the DVSR for the BERA field sampling and *Phase 3 RI Modification No. 7* submitted to NDEP on May 12, 2021 and approved by NDEP on June 24, 2021 (Ramboll 2021e).[20] Surface water data for chlorate and perchlorate from OU-3 east of Pabco Road and the surface water data for all initial COPCs for surface water from OU-3 west of Pabco Road (see Section 3.5 and Table 3-1) will be included in the BHRA data set for OU-3.

4.5 Sediment Investigations

This section describes the sediment investigations that have been conducted to date that provide relevant sediment data for use in the BHRA in OU-3.

As described in the approved BERA Field Sampling Plan for OU-3, Revision 1 (Ramboll 2019g), the supplemental investigation to support both the ecological risk assessment and human health risk assessment included collection of sediment samples from 21 sampling locations between 0 and 0.5 ft bgs along both the northern and southern bank of the Wash. These include six locations in OU-3 west Pabco Road and 15 locations east of Pabco Road near the Wash, as shown in Figures 4-4a and 4-4b, respectively. Results from one sediment sampling location located near the Birding Ponds west of Pabco Road (BERA_BP9-S) are excluded from the sediment BHRA data set for OU-3 since there are no expected exposures to sediment in this area. These sediment samples were collected to provide greater understanding of the magnitude and extent of impacts in sediment from the contaminated groundwater discharging into the Wash. The sediment data collected in this investigation will be utilized to support the evaluations of potential risks to both terrestrial receptors and adolescent trespassers. These samples were analyzed for perchlorate, chlorate, chloroform, total chromium, and hexavalent chromium. These sediment data are reported in the DVSR for the BERA field sampling and *Phase 3 RI Modification No. 7* submitted to NDEP on May 12, 2021 and approved by NDEP on June 24, 2021 (Ramboll 2021e).[21] Sediment data for chlorate and perchlorate from OU-3 east of Pabco Road and the sediment data for all initial COPCs for sediment from OU-3

[20] Although NDEP approved the submittal, NDEP provided comments for the administrative record in their June 24, 2021 approval letter (NDEP 2021a). A revised DVSR was submitted to NDEP on June 29, 2021 in response to the comments for the administrative record (Ramboll 2021j).

[21] Although NDEP approved the submittal, NDEP provided comments for the administrative record in their June 24, 2021 approval letter (NDEP 2021a). A revised DVSR was submitted to NDEP on June 29, 2021 in response to the comments for the administrative record (Ramboll 2021j).

west of Pabco Road (see Section 3.5 and Table 3-1) will be included in the BHRA data set for OU-3.

5. BHRA DATA SET AND DATA USABILITY EVALUATION

This section describes the sources and types of data that will be considered in the BHRA for OU-3 as well as the DUE process. As part of the data collection and evaluation for the BHRA, relevant data have been gathered from various investigations in OU-3 as described in Section 4. For the BHRA data set, the first component of the DUE focuses on the quality of each individual data point to ensure that only data of appropriate quality to meet the specific objectives of the DUE will be used in the BHRA. The second component of the DUE, data analysis, focuses on the data set as a whole. The sources of BHRA data are described in Section 5.1, the DUE is discussed in Section 5.2, and the data analysis is discussed in Section 5.3.

5.1 BHRA Data Set

5.1.1 Soil Gas

The soil gas BHRA data set for OU-3 comprises the analytical results that are representative of current conditions within OU-3 west of Pabco Road. Specifically, the data set includes data for VOCs collected at the 12 soil gas sampling locations in OU-3 west of Pabco Road, as described in the approved *Phase 3 RI Modification No. 7* (Ramboll 2019a), as well as 2 additional soil gas sampling locations as described in the approved *Phase 3 RI Modification No. 15* (Ramboll 2022c), summarized in detail in Section 4.1 and shown on Figure 4-1.

Soil gas sample results from this investigation are summarized in the associated DVSR which was submitted to NDEP on May 12, 2021 and approved by NDEP on June 24, 2021 (Ramboll 2021e).[22] Soil gas sample results from 2022 sampling (*Phase 3 RI Modification No. 15)* will be summarized in a future DVSR to be submitted to NDEP. Soil gas sample results from this investigation, along with relevant shallow groundwater sample results as discussed in Section 4.2, will be used in the BHRA for OU-3 west of Pabco Road to evaluate potential health risk from vapor migration from the subsurface to indoor air, outdoor air, or trench air. The preliminary soil gas BHRA data set for OU-3 and sample list for OU-3 west of Pabco Road are presented in Appendix A (Tables A-1 and A-2, respectively). As discussed in Section 3 of this work plan, soil gas from east of Pabco Road will not be evaluated in this BHRA.

5.1.2 Groundwater

The shallow groundwater BHRA data set for OU-3 comprises the analytical results that are representative of current conditions within OU-3. The data set will be generated from groundwater VOC data collected at shallow monitoring wells (with top of well screen less than 60 ft bgs) for the evaluation of vapor intrusion, and for VOC and non-volatile COPC (Table 3-1) data from groundwater samples collected at monitoring wells with depth to groundwater shallower than or at approximately 10 ft bgs in OU-3 west of Pabco Road (excluding the Open Space Sub-Area) for the evaluation of direct contact,

[22] Although NDEP approved the submittal, NDEP provided comments for the administrative record in their June 24, 2021 approval letter (NDEP 2021a). A revised DVSR was submitted to NDEP on June 29, 2021 in response to the comments for the administrative record (Ramboll 2021j).

and chlorate and perchlorate groundwater data from groundwater samples collected at monitoring wells with depth to groundwater within this depth interval in OU-3 east of Pabco Road for the evaluation of direct contact.[23] These data sets were gathered as part of the following groundwater investigations completed between 2015 and 2022:

- 2015 Phase 1 RI; [24]
- 2017-2018 Phase 2 RI;
- 2018-2022 Phase 3 RI, including data collected as part of Phase 3 RI Modification Nos. 1, 2, 6, 7, and sampling programs in progress as specified in Phase 3 RI Modification Nos. 8, 11, 12, and 13;
- 2015-2022 Groundwater Monitoring and GWETS Performance Reporting Program;
- 2016-2019 Downgradient Study Area Investigations; and
- 2016 Seep Well Field Investigation.

The preliminary shallow groundwater BHRA data set and sample list for OU-3 are presented in Appendix B (Tables B-1 and B-2, respectively).[25] The existing shallow groundwater sample locations that will be evaluated in the BHRA for OU-3 (as discussed in Section 4.2) are shown in Tables 4-2a and 4-2b and Figures 4-1 and 4-2 for OU-3 west of Pabco Road and OU-3 east of Pabco Road, respectively. Data from samples collected in 2022 that are not yet validated will be included in the BHRA once validated, but these samples are currently not included in the BHRA data set for OU-3 (Appendix B).

5.1.3 Soil

The major migration pathway from OU-1 to the Wash is through groundwater. Potential current locations where groundwater may surface and remain in soils within OU-3 include the banks of the Wash and in the former seep area located west of Pabco Road (see Figure 4.3). No other locations of groundwater seeping up through soil in OU-3 have been identified. Soil data to be included in the BHRA data set for OU-3 in the forthcoming BHRA Report for OU-3 include the following:

- Bank Soil: soil data collected and analyzed as described in the *BERA Field Sampling Plan* (Appendix A in Ramboll 2019g). The soil data collected during this

[23] See discussion in Section 4.2, wells meeting these criteria are excluded if top screen depth is significantly deeper than the nearby shallow well(s) (more representative of shallow groundwater conditions in this area) that have available data for use in the BHRA.

[24] The Phase 1 RI started in 2014 but the groundwater sampling was conducted in 2015.

[25] The original groundwater data set contained values for four related analytes: "Nitrate (as NO3)", "Nitrate (as N)", "Nitrate Nitrite as N", and "Nitrite as N", with many individual samples having values for several of these analytes. Values for "Nitrate (as NO3)" were converted to "Nitrate (as N)" for comparison against relevant screening values. Samples with available values for "Nitrate Nitrite as N" also included results for both "Nitrate (as N)" and "Nitrite (as N)"; since there is a significantly larger data set for Nitrate than Nitrite, and all Nitrite values are not detected, the combined "Nitrate Nitrite as N" results are not evaluated. Therefore, the current BHRA data set in Appendix B only includes data for "Nitrate (as N)" (since Nitrite was not detected, it is not on the initial COPC list [see Section 3.5 and Table 3-1] and therefore not in the data set).

sampling event includes data for chloroform[26], chlorate, perchlorate, hexavalent chromium, and total chromium at four surface soil (0-0.5 ft bgs) sampling locations (one location from the southern banks of the Wash and three locations near the former seep area) west of Pabco Road. For OU-3 east of Pabco Road, soil data includes chlorate and perchlorate collected from the southern bank of the Wash from seven surface soil (0-0.5 ft bgs) sampling locations and a subset (i.e., four) sub-surface soil (0.5-3 ft bgs) sampling locations.

- Phase 2 RI soil sampling near the former seep area: soil data collected and analyzed, as outlined in the *2016 RI Data Evaluation Technical Memorandum* (Ramboll Environ 2016a), from two intervals (0 ft and 2 ft bgs) at ten soil sampling locations near the former seep area; only perchlorate was analyzed during this sampling event.
- Phase 3 RI soil sampling near the former seep area: soil data from three depth intervals (0 ft, 5 ft, and 9.5 ft bgs) at three soil sampling locations near the former seep area and analyzed for the initial soil COPCs (see Table 3-1) as described in the *Phase 3 RI Modification. No. 13* (Ramboll 2021g).

The soil sample locations in OU-3 included in the BHRA data set for OU-3 are shown in Figure 4-3. The preliminary soil BHRA data set and sample list for OU-3 are presented in Appendix C (Tables C-1 and C-2, respectively).

5.1.4 Surface Water

Surface water data to be included in the OU-3 BHRA data set in the forthcoming BHRA Report for OU-3 include the following:

- 2018-2022 Phase 3 RI, including data collected as part of the original Phase 3 RI scope and Phase 3 RI Modification No. 10;
- 2017-2022 Groundwater Monitoring and GWETS Performance Reporting Program;
- 2016-2018 Downgradient Study Area Investigations;
- 2016 Seep Well Field Investigation; and
- 2019 BERA Field Sampling.

The surface water sample locations included in the BHRA data set for OU-3 are shown in Figures 4-4a (west of Pabco Road) and 4-4b (east of Pabco Road). The preliminary surface water BHRA data set and sample list for OU-3 are presented in Appendix D (Tables D-1 and D-2, respectively).[27] Data from samples collected in 2022 that are not

[26] However, chloroform was not detected in soil in OU-3 and is not included as an initial COPC - see Section 3.5 and Table 3-1.

[27] The original surface water data set contained duplicate values for "Nitrate (as NO_3)" for several samples, as well as some "Nitrate (as N)" samples labeled as just "Nitrate" (which were re-labeled as needed). Values for "Nitrate (as N)" were used when available, and values for "Nitrate (as NO_3)" were converted to "Nitrate (as N)" for comparison against relevant screening values as needed. Therefore, the current BHRA data set in Appendix D only includes data for "Nitrate (as N)".

yet validated will be included in the BHRA once validated, but these samples are currently not included in the surface water BHRA data set for OU-3 (Appendix D).

5.1.5 Sediment

Sediment data to be included in the OU-3 BHRA data set in the forthcoming BHRA Report for OU-3 include the sediment data collected and analyzed as described in the *BERA Field Sampling Plan* (Appendix A in Ramboll 2019g). The sediment data collected during this sampling event includes data for chloroform, chlorate, perchlorate, hexavalent chromium, and total chromium[28] at 20 surface sediment (0-0.5 ft bgs) sampling locations from both the southern banks and the northern banks of the Wash. For OU-3 east of Pabco Road, sediment data includes chlorate and perchlorate collected from fifteen sediment sampling locations in the Wash. For OU-3 west of Pabco Road, sediment data includes chromium, chlorate, and perchlorate from five sediment sampling locations.

The sediment sample locations included in the BHRA data set for OU-3 are shown in Figures 4-4a (west of Pabco Road) and 4-4b (east of Pabco Road). The preliminary sediment BHRA data set and sample list for OU-3 are presented in Appendix E (Tables E-1 and E-2, respectively).

5.2 Data Usability Evaluation

The primary objective of the DUE is to identify appropriate data for use in the BHRA. The DUE will be conducted in accordance with NDEP's *Supplemental Guidance for Assessing Data Usability for Environmental Investigations at the Black Mountain Industrial (BMI) Facility in Henderson, NV* (NDEP 2010b), which is based on the USEPA *Guidance for Data Usability in Risk Assessment* (Parts A and B) (USEPA 1992a, b). This methodology has been used in the previous HRA evaluations for the *Interim Report: Identification of COPCs and Decision Units for OU-1 Soils, Revision 1* (Ramboll Environ 2017d) and for the sale parcels C, D, G (Ramboll Environ 2017e), F (Ramboll Environ 2017f), and H (Ramboll 2018d) that have been approved by NDEP. The USEPA data usability guidance identifies the following data quality criteria for evaluating the usability of site investigation data in the risk assessment process:

- Criterion I – Reports to Risk Assessor;
- Criterion II – Documentation;
- Criterion III – Data Sources;

[28] However, chromium VI and perchlorate were not detected in sediment in OU-3 and are not included as initial COPCs - see Section 3.5 and Table 3-1.

- Criterion IV – Analytical Methods and Detection Limits;[29]
- Criterion V – Data Review; and
- Criterion VI – Data Quality Indicators.

5.3 Data Analysis

As described in NDEP guidance (NDEP 2010b), the purpose of the data analysis step is to "use simple exploratory data analysis to compare data to the expectations of the CSM to determine if the data adequately represent the source terms and exposure areas or evaluation areas." The following types of data analyses will be included in the forthcoming OU-3 BHRA report:

- Summary statistics for soil gas, shallow groundwater, soil, sediment, and surface water data;
- Background evaluation for metals in soil compared to BRC/TIMET regional background concentrations[30] as well as for COPCs in bank soil compared to upgradient reference area concentrations, specified in the approved BERA Field Sampling Plan (Appendix A in Ramboll 2019g);
- Spatial distribution of COPC concentrations in all media;
- Plots for temporal trends of COPC concentrations in soil gas, groundwater, and surface water;[31]
- Plots for chloroform concentrations in co-located soil gas and groundwater samples; and
- Results from the exploratory data analysis will be used to compare the data included in the OU-3 BHRA to the expectations of the CSM.

[29] Regarding treatment of non-detects, all results used in the BHRA will be classified as non-detects based on the sample quantitation limit (SQL). The quantitation limit column in the datasets in Appendices A-E contains the SQL. The reporting detection limit (RDL) column contains the practical quantitation limit (PQL). No results are classified as non-detects based on the RDL/PQL. All results presented in the report_numeric column for non-detects are equal to the values in the quantitation_limit column (the SQL). For analytes where the detection frequency is less than 100%, the SQLs from the BHRA data set will be compared to risk-based screening levels to confirm that they are sufficiently low for risk characterization. Chemicals with SQLs above risk-based screening levels will be summarized in DUE tables and discussed in both the DUE and Uncertainty Analysis sections of the BHRA.

[30] The comparison of metal concentrations in bank soil within the OU-3 BERA data set to background concentrations will be conducted using the existing background data sets presented in the BRC/TIMET regional background data set (BRC and TIMET 2007). Specifically, as recommended by Neptune (2017), the 95 McCullough samples collected as part of the BRC/TIMET background study will be used in the background evaluation as OU-3 is located north of the NERT Site and north of the McCullough Range on alluvial soils generated from McCullough Range substrate. Since statistical analysis showed no significant difference in background data across different depth intervals up to 10 ft bgs and to ensure adequate sample size, the background data from 0-10 ft bgs will be compared to the OU-3 BERA bank soil data collected from 0 to 3 ft bgs.

[31] Only one round of sediment sampling was conducted in OU-3 during the BERA field investigation; therefore, temporal trend analysis for sediment data will not be performed in the BHRA.

6. RISK ASSESSMENT METHODOLOGY

The following sections describe the methodology for evaluating potential health risks associated with populations that are potentially exposed to COPCs within OU-3. Consistent with recommended procedures outlined in the USEPA's *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual* (Part A) (USEPA 1989), the BHRA will include the following elements:

- Identification of COPCs;
- Exposure assessment;
- Toxicity assessment; and
- Risk characterization.

In addition, the approach for an uncertainty analysis and the approach for a data quality assessment are also discussed in this section.

The BHRA for OU-3 will be based on the approach described in the NDEP-approved 2014 BHRA Work Plan (ENVIRON 2014b). The BHRA will follow the procedures outlined in the USEPA's *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual* (Part A) (USEPA 1989). Other guidance documents that will be consulted in preparing the BHRA include:

- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA 2002a);
- *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual* (Part E, Supplemental Guidance for Dermal Risk Assessment), Final (USEPA 2004a);
- *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildin*gs (USEPA 2004b);
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual* (Part F, Supplemental Guidance for Inhalation Risk Assessment) (USEPA 2009);
- *Office of Solid Waste and Emergency Response (OSWER) Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA 2015);
- *Documentation for EPA's Implementation of the Johnson and Ettinger Model to Evaluate Site Specific Vapor Intrusion into Buildings, Version 6.0* (USEPA 2017a);
- *Regional Screening Levels (RSLs) – User's Guide* (USEPA 2022a);
- *Technical and Regulatory Guidance, Vapor Intrusion Pathway: A Practical Guideline* (Interstate Technology & Regulatory Council [ITRC] 2007); and
- *User's Guide and Background Technical Document for the Nevada Division of Environmental Projection (NDEP) Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas* (NDEP 2020a).

6.1 Identification of Preliminary COPCs

As discussed in Section 3.5 of this work plan, the initial COPCs to be evaluated in this work plan are limited to the chemicals present in OU-3 that have migrated from OU-1 through groundwater underneath OU-2 and into OU-3, as shown in Table 3-1.

In the following sections, the initial COPCs for soil gas, shallow groundwater, soil, surface water, and sediment (see Section 3.5 and Table 3-1) are further evaluated using their respective health-risk based screening levels to determine those constituents that exceed certain criteria indicating that they should be retained as either preliminary soil gas or groundwater COPCs to evaluate in the BHRA. The results of this health-based screening for each exposure medium (i.e., soil gas, groundwater, soil, surface water, and sediment) are presented in Appendix F and summarized in Table 6-1, which presents the preliminary COPC list.

6.1.1 Preliminary Soil Gas COPCs

In this section, the soil gas BHRA data set for OU-3 from Phase 3 RI Modification No. 7 sampling in OU-3 west of Pabco Road (see details in Sections 4.1 and 5.1.1) are evaluated to identify those constituents that will be retained as the preliminary COPCs in the risk assessment for soil gas west of Pabco Road in OU-3. The most conservative risk-based target concentrations (RBTCs) for soil gas at 5 ft bgs and 10-15 ft bgs, respectively, developed for residents, commercial workers, and construction workers in the OU-2 BHRA (Ramboll 2021c), were compared with the soil gas BHRA data set for OU-3. The soil gas RBTCs and the results of the soil gas COPC screening evaluation are presented in Appendix F in Tables F-1 (5 ft bgs) and F-2 (10-15 ft bgs). As shown in Table 6-1, chloroform is the only VOC that was detected in soil gas at concentrations exceeding its respective RBTCs at both 5 ft bgs and 10-15 ft bgs intervals and therefore is the only VOC that is retained as a preliminary COPC for soil gas to include in the risk assessment for OU-3.

6.1.2 Preliminary Shallow Groundwater COPCs

In this section, the preliminary shallow groundwater BHRA data set for OU-3 (see details in Sections 4.2 and 5.1.2) is evaluated to identify those constituents that will be retained as the preliminary COPCs in the risk assessment for shallow groundwater in OU-3. The groundwater screening levels (GWSLs) developed in the RI Report for OU-1 and OU-2 (Ramboll 2021a, Appendix G.2) were compared with the preliminary shallow groundwater BHRA data set for OU-3 for the non-volatile initial COPCs (see Section 3.5 and Table 3-1) from wells with depth to groundwater shallower than or at approximately 10 ft bgs. For the volatile initial COPCs (see Section 3.5 and Table 3-1), the preliminary shallow groundwater BHRA data set for OU-3 from wells with the top of the well screen <60 ft bgs in OU-3 west of Pabco Road was compared with the minimum of the GWSLs and the most conservative groundwater RBTCs for the vapor intrusion pathway for residents, commercial workers, and construction workers developed in the OU-2 BHRA (Ramboll 2021c). The groundwater GWSLs, RBTCs and the results of the groundwater COPC screening evaluation are presented in Table F-3 for wells with depth to groundwater shallower than or at approximately 10 ft bgs and Table F-4 for wells with depth to groundwater deeper than 10 ft bgs, respectively.

The preliminary shallow groundwater COPCs to include in the BHRA are summarized below and shown in Table 6-1:

West of Pabco Road

- Three inorganics (i.e., chlorate, nitrate, and perchlorate), three metals (i.e., arsenic, chromium,[32] and magnesium), and four VOCs (i.e., chloroform, 1,1-dichloroethane, 1,4-dioxane, and 1,2,3-trichloropropane) are detected at concentrations exceeding their respective health risk-based screening level in groundwater shallower than or at approximately 10 ft bgs.
- Four VOCs (i.e., carbon tetrachloride, chloroform, 1,4-dioxane, and 1,2,3-trichloropropane) are detected at concentrations exceeding their respective health risk-based screening level in groundwater deeper than 10 ft bgs in OU-3.

East of Pabco Road

- Chlorate and perchlorate are detected at concentrations exceeding their respective health risk-based screening level in groundwater shallower than or at approximately 10 ft bgs.

Therefore, these chemicals were retained as preliminary COPCs for shallow groundwater to include in the risk assessment for OU-3.

6.1.3 Preliminary Soil COPCs

In this section, the preliminary soil BHRA data set for OU-3 (see details in Sections 4.3 and 5.1.3) is evaluated to identify those constituents that will be retained as the preliminary COPCs in the risk assessment for soil in OU-3. Residential soil BCLs (NDEP 2020a) were compared to the preliminary soil BHRA data set for OU-3 based on the initial soil COPCs (see Table 3-1) from the bank soil sample locations near the Wash and the former seep area between 0-10 ft bgs, expect for arsenic for which the maximum BRC/TIMET background level (BRC and TIMET 2007; Ramboll 2021k) was used. The selected soil screening levels and the results of the soil COPC screening evaluation are presented in Table F-5. The preliminary soil COPCs to include in the BHRA are summarized below and shown in Table 6-1:

West of Pabco Road

- Arsenic was identified as the only preliminary COPC for soil in OU-3 in this area.

East of Pabco Road

- no preliminary COPCs were identified for soil in OU-3 in this area.

[32] Chromium VI exceeded its health-risk screening level, but chromium (total) did not. However, a detailed analysis of hexavalent chromium to total chromium ratios was performed as part of the *2016 Groundwater Monitoring Optimization Plan* (Ramboll Environ 2016b). The analysis found that the concentration of total chromium is generally equal to the concentration of hexavalent chromium within the NERT groundwater plume. With NDEP approval, hexavalent chromium was eliminated from NERT's on-going groundwater monitoring program in 2016. Therefore, total chromium and hexavalent chromium are not regarded as separate COPCs and interpretations of the lateral and vertical extent of chromium in groundwater will primarily rely on total chromium data (rather than hexavalent chromium data).

Therefore, arsenic is retained as the only preliminary COPCs for soil to include in the risk assessment for OU-3 west of Pabco Road.

6.1.4 Preliminary Surface Water COPCs

In this section, the preliminary surface water BHRA data set for OU-3 (see details in Sections 4.3 and 5.1.3) is evaluated to identify those constituents that will be retained as the preliminary COPCs in the risk assessment for surface water in OU-3. The surface water screening levels selected in this analysis are based on the residential water BCLs from NDEP's 2020 BCL table (NDEP 2020a); they were compared with the preliminary surface water BHRA data set for OU-3 for the initial COPCs for surface water (see Section 3.5 and Table 3-1) collected from the surface water sample locations near the Wash as shown in Figures 4-4a and 4-4b. The selected surface water screening levels and the results of the surface water COPC screening evaluation are presented in Table F-6.

The preliminary surface water COPCs to include in the BHRA are summarized below and shown in Table 6-1:

West of Pabco Road

- One metal (arsenic) and three inorganic compounds (chlorate, nitrate, and perchlorate) were identified as the preliminary COPCs for surface water in this area.

East of Pabco Road

- Chlorate and perchlorate were identified as the preliminary COPCs for surface water in this area.[33]

Therefore, these chemicals are retained as the preliminary COPCs for surface water to include in the risk assessment for OU-3.

6.1.5 Preliminary Sediment COPCs

In this section, the preliminary sediment BHRA data set for OU-3 (see details in Sections 4.5 and 5.1.5) is evaluated to identify those constituents that will be retained as the preliminary COPCs in the risk assessment for sediment in OU-3. The soil screening levels developed in the RI Report for OU-1 and OU-2 (Ramboll 2021a, Appendix G.1) were compared with the preliminary sediment BHRA data set for OU-3 for the initial COPCs for sediment (see Section 3.5 and Table 3-1) from the sediment sample locations near the Wash. The selected sediment screening levels and the results of the sediment COPC screening evaluation are presented in Table F-7. As shown in Table 6-1, no preliminary COPCs were identified for sediment in OU-3.

In addition, the spatial distribution of COPCs will be evaluated using continuous concentration bubble plots and/or color range maps to identify potential areas with higher COPC concentrations as recommended by NDEP (NDEP 2021b).

[33] Perchlorate and chlorate are the only COPCs identified in surface water in OU-3 west of Pabco Road that are also detected in surface water in OU-3 east of Pabco Road.

6.2 Exposure Assessment

The exposure assessment analyzes contaminant releases and the physical setting, identifies exposed populations and exposure pathways, and estimates exposure concentrations and chemical intakes for the identified pathways. The exposure assessment includes a discussion of the potential exposure populations and human exposure pathways within the CSM, fate and transport modeling, and exposure assumptions and calculations, as discussed in the following sections.

6.2.1 CSM

To evaluate the human health risks posed by a site, it is necessary to identify the populations that may potentially be exposed to the chemicals present and to determine the pathways by which these exposures may occur. Due to the fact that NERT's COPCs are administratively limited to chlorate and perchlorate east of Pabco Road, separate CSMs have been developed for the portions of OU-3 located west of Pabco Road and east of Pabco Road. Specifically, the two CSMs address the specific COPCs, impacted environmental media, land uses and potentially exposed populations that are present in these two areas. The CSMs outline information relevant to conducting the exposure assessment by 1) evaluating potential chemical sources and releases (described above in Section 3.1), 2) identifying populations that could potentially be exposed to chemicals present in OU-3 that have originated from OU-1, and 3) identifying exposure pathways and routes through which human exposure might occur. The CSM is an important tool in guiding site characterization, evaluating data quality in the context of potential risks to exposure populations, and developing exposure scenarios.

The CSMs for OU-3 west of Pabco Road and OU-3 east of Pabco Road are presented in Figures 6-1 and 6-2, respectively. The potential chemical sources, release mechanisms and the impacted environmental media are discussed in detail in Section 3. Both CSMs consider the fact that businesses and residences located within or downgradient of the NERT Site are connected to a municipal water supply. Groundwater has therefore been determined to not currently be used as a drinking water source, and given the high concentrations of TDS, it is not anticipated to be used in the future as a drinking water source in OU-3. Therefore, groundwater consumption is not considered a complete pathway and will not be evaluated in this BHRA.

The potentially exposed populations and associated exposure pathways and routes are discussed below.

CSM for OU-3 West of Pabco Road

The preliminary COPCs are transported in groundwater to OU-3 and some discharge into the Wash. The current and future land use in OU-3 west of Pabco Road is mixed commercial/light industrial and recreational use. There is no existing or planned residential development in this area. Accordingly, the potentially exposed populations identified for evaluation in the BHRA for this area include the following: indoor commercial/industrial workers; outdoor commercial/industrial workers; construction workers at the WRF; maintenance/utility workers; recreational users and adolescent trespassers.

Exposure populations identified above may be exposed to volatile COPCs migrating from shallow groundwater and soil gas to indoor or outdoor air. In addition, maintenance/utility workers that perform maintenance, utility, or landscaping activities could encounter shallow groundwater while working in a 5-ft utility trench in the saturated zone at locations with shallow groundwater (wet trench scenario) and shallow soils which could have been potentially contaminated by groundwater in the former seep well field area. The average depth to groundwater is greater than 25 ft bgs at the WRF located in the southern portion of OU-3. During a short period of maintenance on the WRF effluent pipe in late 2021, the WRF effluent was largely diverted to the infiltration ponds located east of the Birding Ponds causing groundwater levels to rise to less than 10 ft of the ground surface in a few wells located northwest of the WRF. Since this was a temporary condition, chronic exposure due to direct contact to shallow groundwater in this area is not anticipated. The construction workers who may conduct short-term excavation activities at the WRF are conservatively assumed to encounter shallow groundwater while conducting construction activities in a 10-ft construction trench. Therefore, the direct contact with groundwater pathway for the construction workers will be evaluated in this BHRA.

The Wash, and the area immediately surrounding the Wash within OU-3, fall within the Clark County Wetlands Park. At the Wetlands Park in OU-3 west of Pabco Road, recreational users may be exposed to volatile preliminary COPCs migrating from shallow groundwater and soil gas to outdoor air. In addition, the recreational users may be exposed to COPCs in bank soil through inhalation of airborne soil particulates. While fishing, drinking/touching water from the Wash, swimming, wading, and boating are prohibited in the Wetlands Park (water in the park is not intended for human contact),[34] the adolescent trespassers (between 7-18 years old) in the Wetlands Park may disregard Park rules and encounter surface water and sediment through dermal contact and be exposed to bank soil through inhalation of airborne soil particulates. As such, these pathways will be quantitatively evaluated under an adolescent trespasser scenario in the BHRA. Because there are no volatile preliminary COPCs identified in the BHRA soil data set (see Section 6.1.3), the inhalation of airborne vapors of VOCs emitted from soil to ambient air pathway will not be quantitatively evaluated in the BHRA. In addition, because no preliminary COPCs were identified in the health-based screening for sediment in OU-3 west of Pabco Road sediment will not be evaluated in the western portion of OU-3 in the BHRA.

Based on the source and release mechanisms presented in the CSM for OU-3 west of Pabco Road, the following exposure pathways are identified for quantitative evaluation in the BHRA for each potential exposure population that may be present in this area:

- Indoor commercial/industrial workers
    - Inhalation of vapors from volatile COPCs migrating from soil gas/shallow groundwater to indoor air at locations where long-term indoor exposures could occur (i.e., in buildings in the WRF).
- Outdoor commercial/industrial workers

[34] See the Wetlands Park rules at: https://www.clarkcountynv.gov/government/departments/parks___recreation/wetlands_park/park_rules_and_faqs.php

  - Inhalation of vapors from volatile COPCs migrating from soil gas/shallow groundwater to outdoor air at locations where long-term outdoor exposures could occur (i.e., outside the buildings in the WRF).

- Construction workers
  - Inhalation of vapors from volatile COPCs migrating from soil gas/groundwater to trench air in a 10-ft dry construction trench in the unsaturated zone and in a 10-ft wet construction trench in the saturated zone in the WRF.
- Maintenance/utility workers
  - Direct contact (incidental ingestion and dermal contact) with groundwater in a 5-ft wet utility trench in the saturated zone in areas with shallow groundwater (wet trench scenario).
  - Inhalation of vapors from volatile COPCs migrating from soil gas/groundwater to trench air in a 5-ft utility trench in the saturated zone in areas with shallow groundwater (wet trench scenario).
  - Inhalation of vapors from volatile COPCs migrating from soil gas/groundwater to trench air in a 5-ft dry utility trench in areas with depths to groundwater deeper than 5 ft bgs (dry trench scenario).
  - Direct contact (incidental ingestion and dermal contact) with and inhalation of airborne particulates from shallow soil near the former seep area.
- Recreational Users
  - Inhalation of vapors from volatile COPCs migrating from soil gas/shallow groundwater to outdoor air.
  - Direct contact (incidental ingestion and dermal contact) and inhalation of airborne particulates from surface soil near the former seep area.
  - Inhalation of airborne volatile COPCs and particulates from bank soil.
- Adolescent Trespassers
  - Inhalation of airborne particulates from surface bank soil near the Wash.
  - Dermal contact with surface water in the Wash.

CSM for OU-3 East of Pabco Road

As discussed in Section 3.1, the preliminary COPCs are transported in groundwater to OU-3 and then some discharge to the Wash. The current and future land uses in OU-3 east of Pabco Road include vacant land in the northern RIBs area zoned for commercial/industrial land use, vacant land north of the Chimera Golf Course zoned for public or semi-public land use, a school, the Wetlands Park, and residential communities (Weston Hills Community and Tuscany Community). As discussed previously, COPCs in this area are administratively limited to perchlorate and chlorate. Therefore, for the portion of OU-3 east of Pabco Road, the exposures to VOCs in soil gas and shallow groundwater through the vapor intrusion pathway will not be evaluated and only direct contact to perchlorate and chlorate in groundwater shallower than 10 ft bgs will be evaluated in the BHRA.

One of the potentially exposed populations identified in this area are maintenance/utility workers that perform excavation (e.g., landscaping or utility) activities and may encounter shallow groundwater in a 5-ft utility trench in the saturated zone at locations with shallow groundwater (wet trench scenario). Recreational users at the Wetlands Park who may be exposed to perchlorate or chlorate in bank soil through inhalation of airborne soil particulates are also considered to be a potentially exposed population.

Similar to the portion of OU-3 west of Pabco Road, at the Wetlands Park in OU-3 east of Pabco Road potential exposures through direct contact with bank soil, surface water, or sediment are not expected to occur for a regular recreator in this area.[35] However, some adolescent trespassers (between 7-18 years old) in the Wetlands Park may disregard Park rules and encounter surface water and sediment through dermal contact and be exposed to bank soil through inhalation of airborne soil particulates. As such, these pathways will be quantitatively evaluated under an adolescent trespasser scenario in the BHRA. Because there are no volatile preliminary COPCs for OU-3 east of Pabco Road, the inhalation of airborne vapors of VOCs emitted from soil to ambient air pathway will not be quantitatively evaluated in the BHRA. In addition, because chlorate and perchlorate were not identified as a preliminary COPC in the health-based screening for soil or sediment in OU-3 east of Pabco Road, no evaluation of soil or sediment will be conducted in the eastern portion of OU-3 in the BHRA.

Based on the source and release mechanisms presented in the CSM for OU-3 east of Pabco Road, the following exposure pathways are identified for quantitative evaluation in the BHRA for maintenance/utility workers in this area:

- Maintenance/utility workers
    - Direct contact (incidental ingestion and dermal contact) with groundwater in a 5-ft wet utility trench in the saturated zone in areas with depths to groundwater shallower than 5 ft bgs (wet trench scenario).
- Adolescent Trespassers
    - Dermal contact with surface water.

6.2.2 Fate and Transport Modeling

Concentrations of volatile preliminary COPCs in shallow groundwater, soil gas, and soil will be used to estimate indoor, outdoor, or trench air concentrations at exposure points for workers and recreational users in OU-3 west of Pabco Road. The migration of volatile preliminary COPCs detected in soil gas (sourced from groundwater), groundwater, or soil in OU-3 west of Pabco Road will be quantified in the BHRA through media-specific intermedia transfer factors. When the transfer factor is multiplied by the source concentration of VOC in soil gas (in micrograms per cubic meter [µg/m^3]), groundwater (in micrograms per liter [µg/L]), or soil (in micrograms per kilogram [µg/kg]), the product is the predicted steady-state concentration in indoor, outdoor, or trench air (in µg/m^3), which represents the

[35] See the Wetlands Park rules at: https://www.clarkcountynv.gov/government/departments/parks___recreation/wetlands_park/park_rules_and_faqs.php

exposure point concentration (EPC) in the air to which a receptor (i.e., a member of a potentially exposed population) is exposed over an assumed duration of exposure.

In general, we use the term "transfer factor" to refer to transport from either soil, soil gas, or groundwater to air in lieu of the term "attenuation factor", which is applicable to only transport from soil gas to air (i.e., within the same medium). For soil gas, the transfer factor is equal to the attenuation factor, but we use the term "transfer factor" for consistency. For groundwater, the transfer factor is the product of a partitioning factor (from groundwater to soil gas) and an attenuation factor (from soil gas to air). For soil, the transfer factor is the combination of partitioning from soil and transport of chemicals through the subsurface to outdoor air. However, the partitioning portion is not as easily separable from the transport portion as it is in groundwater. The soil transfer factor is the ratio of the average air concentration over the exposure period to the initial soil concentration at the source.

Vapor intrusion for the residential exposures will not be evaluated in this BHRA since there are no existing or planned residential homes in OU-3 west of Pabco Road. For populations in OU-3 west of Pabco Road, transfer factors will be developed for the following scenarios:

- Transport of soil gas from 5 ft bgs and 10-15 ft bgs into a commercial/industrial slab-on-grade building in the commercial/industrial area in the southern portion of OU-3 west of Pabco Road;
- Transport of soil gas from 5 ft bgs and 10-15 ft bgs to outdoor air for an outdoor commercial/industrial worker scenario in the commercial/industrial area in the WRF in the southern portion of OU-3 west of Pabco Road;
- Transport of soil gas from 5 ft bgs and 10-15 ft bgs to outdoor air for a recreational user scenario;
- Transport of soil gas from 5 ft below the bottom or beside the walls of a trench into a 5-ft utility trench and a 10-ft construction trench in the unsaturated zone for a dry trench scenario;
- Transport of groundwater vapor from 20 ft bgs into a commercial/industrial slab-on-grade building in the commercial/industrial area in the southern portion of OU-3 west of Pabco Road;
- Transport of groundwater vapor from 20 ft bgs to outdoor air for an outdoor commercial/industrial worker scenario in the commercial/industrial area in the southern portion of OU-3 west of Pabco Road;
- Transport of groundwater from 20 ft bgs and 10 ft bgs to outdoor air for a recreational user scenario;
- Transport of groundwater vapor from 20 ft bgs into a 10-ft construction trench at the Henderson WRF and from 20 ft bgs and 10 ft bgs into a 5-ft utility trench in the unsaturated zone for a dry trench scenario;
- Transport of groundwater vapor into a 5-ft utility trench and a 10-ft construction trench in the saturated zone for a wet trench scenario;

The intermedia transfer factors for groundwater and soil gas will be estimated using the screening-level model described by Johnson and Ettinger (1991); this model was developed to predict vapor migration into buildings using a combination of diffusion and advection. Specifically, Version 6.0 of the spreadsheet implementation developed by the USEPA will be used (USEPA 2017b). While the Johnson and Ettinger model was originally developed to predict vapor intrusion into buildings using a combination of diffusion and advection, it is easily adapted to predict vapor intrusion into outdoor air or trench air. The intermedia transfer factors for soil will be estimated using the Jury model as described in USEPA (2002b). This model is conservative because it assumes that the chemical source has infinite mass and does not include other attenuation processes that typically would reduce the amount of vapor migration, such as biodegradation, leaching from infiltration, and lateral diffusion.

The calculation of transfer factors will be based on parameters describing the properties of volatile COPCs identified for the OU-3 BHRA, the vadose zone, the surface barrier, and the air dispersion zone. The physical/chemical properties that will be used in these calculations are presented in Table 6-2. Based on guidance from USEPA (2022a), only chemicals that easily volatize will be included in the evaluation of vapor migration. These include chemicals with a Henry's Law constant of greater than 1×10^{-5} atmosphere-cubic meter per mole (atm-m^3/mol) or a vapor pressure of greater than 1 millimeter of mercury (mm Hg). In general, priority is given to the most recent physical/chemical data as well as the most relevant data for a site located in Nevada. As such, the hierarchy for selecting physical/chemical properties is:

1. NDEP values from the BCL tables (NDEP 2020a);
2. USEPA values from the Johnson and Ettinger model (USEPA 2017a);
3. USEPA values from the regional screening level (RSL) tables (USEPA 2022b); and
4. USEPA values from EPISuite (USEPA 2012).

Soil physical property data were collected from three locations in OU-3 west of Pabco Road during the Phase 2 RI.[36] Additional soil physical property data were collected in OU-3 west of Pabco Road as part of the Phase 3 RI Modification No. 7 (Ramboll 2019a). Samples were collected at 5 ft bgs and 10-15 ft bgs intervals from the 16 soil gas sampling locations during Phase 3 RI Modification No. 7 sampling and analyzed for soil physical properties, including soil classification (grain size distribution/Atterberg Limits), TOC, bulk density, water content, and total porosity. The soil physical property data collected during the Phase 2 RI and the Phase 3 RI will be used in the site-specific fate and transport modeling for the OU-3 BHRA.

Depth to groundwater in OU-3 was determined by evaluating both current and historic groundwater elevations for non-artesian shallow wells within OU-3 west of Pabco Road. Depth to groundwater ranges from approximately 2 ft bgs to deeper than 50 ft bgs, with the depth to water in the majority of wells between 20 and 50 ft bgs. For initial screening,

[36] Soil classification (grain size distribution/Atterberg Limits) and total organic carbon have previously been collected at PC-172 (co-located with RISG-4, at 13.5 ft bgs), PC-167 (co-located with RISG-7, at 11.0 ft bgs) and PC-166 (co-located with RISG-9, at 11.5 ft bgs) during the Phase 2 RI.

depths of groundwater of 20 ft bgs and 10 ft bgs will be selected for modeling vapors from volatile COPCs migrating from groundwater to indoor, outdoor, and trench air in the OU-3 BHRA.

A conservative default commercial/industrial building will be assumed for an indoor air scenario with a building with an enclosed floor space area of approximately 16,146 square ft (or 1,500 square meters) and a vapor flow rate of 337.5 L/minute into the building (USEPA 2017a). A default air exchange rate of 1.5 air changes per hour for a commercial/industrial building and a default building height of 10 ft will be assumed (USEPA 2017a). Taken together, these assumptions will likely overestimate risks for most, if not all, receptors.

When modeling the above-ground outdoor air scenario, the site-specific dispersion factor (Q/C) model described in the *Soil Screening Users Guidance* (USEPA 2002a) will be used. For the trench scenario, a box model will be used to simulate dispersion. The construction trench dimensions are assumed to be 10 ft deep, 20 ft long, and 5 ft wide; the utility trench dimensions are assumed to be 5 ft deep, 10 ft long, and 5 ft wide. For this box model, the air flow through the trench will be controlled by a site-specific windspeed that is reduced by a factor of 10 to ensure it would be conservative where the breathing zone may be a few ft bgs. Additionally, VOCs will be assumed to be emitted from all trench walls in addition to the base of the trench.

Exposure to COPCs bound to airborne particulates for the maintenance/utility workers and recreational users in OU-3 will be evaluated using USEPA's particulate emission factor (PEF) approach (USEPA 2002). The PEF relates COPC concentrations in bank soil to the COPC concentrations in airborne soil/dust particles, and it will be estimated based on emissions from wind erosion of bank soil. The Q/C used in the calculations is based on information for Las Vegas, Nevada, as presented in Appendix E of USEPA (2002). The calculation of a PEF is also a function of the areal extent of site surface contamination, which is assumed to be a default source area of 0.5 acres. Depth to the top and base of the soil contamination will be assumed based on conservative, worst-case assumptions. It will be assumed that the soil could be contaminated with VOCs from 1 cm bgs extending down to the water table.

6.2.3 Exposure Assumptions and Calculations

The magnitude of exposure for any given receptor is a function of the amount of chemical in the exposure medium (e.g., air, groundwater, soil), and the frequency, intensity, and duration of contact with that medium. In order to quantify exposures, an upper-bound estimate of the theoretical intake is developed for each of the potentially exposed human populations via each of the exposure pathways identified in the CSM. The exposure dose for an ingestion or dermal pathway is calculated by multiplying the EPC in the exposure medium by the intake factor. For inhalation exposures, the air EPC adjusted by the intake factor, rather than exposure dose, is used as the basis for estimating inhalation risks based on *Risk Assessment Guidance for Superfund, Part F, Supplemental Guidance for Inhalation Risk Assessment* (USEPA 2009). For carcinogens, the intake factor averaged over a 70-year lifetime will be used in the risk characterization, while for non-carcinogens, the intake factor averaged over the exposure period will be used (USEPA 1989).

As shown in Table 6-3, exposure assumptions recommended by NDEP (2020a) will be used for indoor and outdoor commercial/industrial workers. Per a comment from NDEP (NDEP

2017, General Comment #3) on the 2016 HRA for Parcels C, D, F, G and H (Ramboll Environ 2016f), a construction worker dry trench scenario will be evaluated, assuming that the construction workers could be exposed to vapors migrating from soil gas and groundwater to air in a construction trench when conducting excavation activities for four hours per day, 30 days per year for one year.

Vapor Inhalation

The intake factor for inhalation of vapors migrating from soil gas, groundwater or soil to air, or inhalation of particulates from soil will be calculated using the following equation (USEPA 2009):

$$IF_{inh} = \frac{ET \times EF \times ED}{AT \times CF}$$

where:

IF_{inh}	=	Intake Factor for air inhalation (unitless)
ET	=	Exposure Time (hour/day)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
AT	=	Averaging Time (day)
CF	=	Conversion Factor (hour/day)

Groundwater Ingestion

For maintenance/utility workers who may directly contact shallow groundwater during maintenance, utility, or landscaping activities, an additional potential exposure pathway is the incidental ingestion of shallow groundwater. The intake factor for groundwater ingestion will be calculated using the following equation (USEPA 1989):

$$IF_{ing} = \frac{IR_{gw} \times EF \times ED}{BW \times AT}$$

where:

IF_{ing}	=	Intake Factor for groundwater ingestion (liter [L] of groundwater/kilogram [kg] body weight-day)
IR_{gw}	=	Groundwater Ingestion Rate (L of groundwater/day)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (day)

Groundwater and Surface Water Dermal Contact

The maintenance/utility workers can also be exposed through dermal contact with shallow groundwater. The adolescent trespassers can be exposed through dermal contact with

surface water in the Wash. The dermal absorbed unit dose from direct contact with shallow groundwater or surface water will be estimated using the following equations (USEPA 2004a):

For organic compounds:

$$\text{If } t_{event} \leq t^*, \text{then: } DA_{event} = 2FA \times K_p \times \sqrt{\frac{6\tau_{event} \times t_{event}}{\pi}}$$

$$\text{If } t_{event} > t^*, \text{then: } DA_{event} = FA \times K_p \times \left[\frac{t_{event}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

$$B = K_p \times \frac{\sqrt{MW}}{2.6}$$

$$\tau_{event} = 0.105 \times 10^{(0.0056 * MW)}$$

$$\text{If } B \leq 0.6, \text{then } t^* = 2.4 \times \tau_{event}$$

$$\text{If } B > 0.6, \text{then } t^* = 6 \times \tau_{event} \times (b - \sqrt{b^2 - c^2})$$

$$b = \frac{2 \times (1+B)^2}{\pi} - c$$

$$c = \frac{1 + 3 \times B + 3 \times B^2}{3 \times (1+B)}$$

For inorganic compounds:

$$DA_{event} = K_p \times t_{event}$$

where:

t_{event}	=	Event Duration (hour/event)
t^*	=	Time to reach steady-state (hour/event)
DA_{event}	=	Absorbed dose per event per concentration (cm/event)
FA	=	Fraction absorbed water (unitless)
K_p	=	Dermal permeability coefficient of compound in water (cm/hour)
T_{event}	=	Lag time per event (hour/event)
B	=	Dimensionless ratio of the permeability coefficient of a compound through the coefficient of a compound through stratum corneum relative to its permeability coefficient across the viable epidermis (unitless)

MW	=	Molecular weight (gram [g]/mole [mol])
b, c	=	Correlation coefficients

Chemical-specific parameters used in the above equations to calculate the dermal absorbed unit dose are given in Table 6-2.

The intake factor for dermal contact with water was calculated using the following equation (USEPA 2004a):

$$\mathrm{IF_{derm}} = \frac{\mathrm{EV} \times \mathrm{SA_w} \times \mathrm{EF} \times \mathrm{ED}}{\mathrm{BW} \times \mathrm{AT}}$$

where:

IF_{derm}	=	Intake Factor for dermal contact with water (cm^2-event/kg body weight-day)
EV	=	Event Frequency (event/day)
SA_w	=	Skin Surface Area for water contact (cm^2)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (day)

Soil Ingestion

The intake factor for soil ingestion was calculated using the following equation (USEPA 1989):

$$IF_{soil.ing} = \frac{IR_S \times EF \times ED \times CF}{BW \times AT}$$

where:

$IF_{soil.ing}$	=	Intake Factor for soil ingestion (kg of soil/kg body weight-day)
IR_s	=	Soil Ingestion Rate (mg of soil/day)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (day)
CF	=	Conversion Factor (kg of soil/mg of soil)

Soil and Sediment Dermal Contact

The intake factor for dermal contact with soil or sediment was calculated using the following equation (USEPA 2004a):

$$IF_{s.derm} = \frac{AF \times SA_s \times EF \times ED \times CF}{BW \times AT}$$

where:

$IF_{s.derm}$	=	Intake Factor for dermal contact with soil or sediment (kg of soil/kg body weight-day)
AF	=	Adherence Factor (mg of soil/square centimeter [cm^2])
SA_s	=	Skin Surface Area for soil or sediment contact (cm^2/day)
EF	=	Exposure Frequency (day/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (day)
CF	=	Conversion Factor (kg /mg)

6.3 Toxicity Assessment

The purpose of a toxicity assessment is to present the weight-of-evidence regarding the potential for a chemical to cause adverse effects in exposed individuals. It also quantitatively characterizes, where possible, the relationship between exposure to a chemical and the increased likelihood and/or severity of adverse effects (i.e., the dose-response assessment).

Oral cancer slope factors (CSFs), which are expressed in units of milligram per kilogram per day $(mg/kg\text{-}day)^{-1}$, and inhalation unit risks (IURs), which are expressed in units of $(\mu g/m^3)^{-1}$, are chemical-specific and experimentally derived potency values that are used to calculate the risk of cancer resulting from exposure to potentially carcinogenic chemicals. Noncancer oral reference doses (RfDs), which are expressed in units of mg/kg-day, and inhalation reference concentrations (RfCs), which are expressed in units of $\mu g/m^3$, are experimentally derived levels not expected to cause adverse health effects that are used to quantify the extent of toxic effects other than cancer due to exposure to chemicals.

For the preliminary COPCs identified in Section 6.1, an initial list of chronic toxicity values will be developed based on the values used by NDEP for the derivation of the 2020 BCLs (NDEP 2020a). For most chemicals in the BCL table, NDEP selected toxicity values from the USEPA's Integrated Risk Information System (IRIS). For chemicals not included in IRIS, NDEP relied on other sources for toxicity values. During implementation of the BHRA, the chronic toxicity values from the 2020 BCL table will be checked against the identified source to confirm that the most current values are being used. Toxicity values for total chromium are not available from the 2020 BCL table (NDEP 2020a), IRIS (USEPA 2022c), or the USEPA RSL table (USEPA 2022b). As discussed in Section 3.5, with NDEP approval,

hexavalent chromium was eliminated from NERT's on-going groundwater monitoring program in 2016. Therefore, total chromium and hexavalent chromium are not regarded as separate COPCs and interpretations of the lateral and vertical extent of chromium in groundwater will primarily rely on total chromium data (rather than hexavalent chromium data). If hexavalent chromium data was not available and only total chromium was analyzed for a groundwater sample then total chromium is conservatively evaluated as hexavalent chromium.

Hexavalent chromium was not detected in any soil, surface water, or sediment samples in OU-3. Therefore, for these media, if hexavalent chromium data was not available and only total chromium was analyzed for a sample then total chromium is evaluated as trivalent chromium.

For construction workers who are assumed to be present at OU-3 for one year, subchronic toxicity values will be used whenever available for the evaluation of adverse noncancer effects, in accordance with recommendations by USEPA (USEPA 2022a) during implementation of the BHRA. The subchronic toxicity values recommended by USEPA (2022b) were selected to use in the BHRA for the preliminary COPCs.

Specific dermal route toxicity values have not yet been developed for any chemicals. Consistent with NDEP and USEPA guidance, potential health effects associated with dermal exposure will be calculated using the oral toxicity values.

Route-to-route extrapolation were not applied, which is consistent with the updated BCL Guidance (NDEP 2020a) and *Risk Assessment Guidance for Superfund, Part F, Supplemental Guidance for Inhalation Risk Assessment* (USEPA 2009).

In addition, for each carcinogenic COPC, the USEPA weight-of-evidence classification were identified.

The chronic and subchronic toxicity values for the preliminary COPCs (as shown in Table 6-1) are presented in Table 6-4.

6.4 Risk Characterization

Risk characterization represents the final step in the risk assessment process. In this step, the results of exposure and toxicity assessments are integrated into quantitative or qualitative estimates of potential health risks. In each exposure medium (i.e., soil gas, groundwater, and soil), potential excess lifetime cancer risks and noncancer adverse health effects for each COPC will be characterized separately.

The National Contingency Plan (NCP) (40 CFR § 300) is cited as the basis for the target risk range by NDEP (2020a). According to NDEP (2020a), the acceptability of any calculated incremental cancer risk is generally evaluated relative to the target risk range of 10^{-6} to 10^{-4} described in the NCP. According to the NCP and NDEP (2020a), non-carcinogenic chemicals should not be present at levels expected to cause adverse health effects (i.e., a hazard index [HI] greater than one).

It should be noted that the cancer risk and noncancer hazard to be estimated in the BHRA do not represent absolute estimates in OU-3, since generic and conservative assumptions will be used that are likely to overestimate actual exposures and calculated risks. Exceedance of the target cancer risk range of 10^{-6} to 10^{-4} or the target noncancer HI of one does not indicate that adverse impacts to human health are occurring or will occur, but rather suggests that further evaluation may be warranted.

6.4.1 Assessment of Cancer Risks

The excess lifetime cancer risk is estimated as the upper-bound incremental probability of an individual developing cancer over a lifetime (i.e., 70 years) as a result of exposure to a potential carcinogen at a given concentration. The equation used to calculate cancer risk due to exposure via inhalation of vapors migrating from soil gas or shallow groundwater to air is as follows:

$$Cancer\ Risk = EPC_{air} \times IF_{inh} \times IUR$$

where:

EPC_{air}	=	Exposure Point Concentration in air (µg/m^3)
IF_{inh}	=	Inhalation Intake Factor (unitless)
IUR	=	Inhalation Unit Risk (µg/m^3)$^{-1}$

The equation used to calculate cancer risk due to exposure via incidental ingestion of groundwater is as follows:

$$Cancer\ Risk = EPC_{water} \times IF_{ing} \times CSF_{oral} \times CF$$

where:

EPC_{water}	=	Groundwater Exposure Point Concentration (µg/L)
IF_{ing}	=	Intake Factor for groundwater ingestion (L of groundwater/kg body weight-day)
CSF_{oral}	=	Oral Cancer Slope Factor (mg/kg body weight-day)$^{-1}$
CF	=	Conversion Factor (µg/mg)

The equation to calculate cancer risk due to dermal contact with groundwater or surface water is as follows:

$$Cancer\ Risk = EPC_{water} \times IF_{derm\_c} \times \frac{\frac{DA_{event}}{CF_1}}{GIABS} \times CSF_{oral} \times CF_2$$

where:

EPC_{water}	=	Water Exposure Point Concentration (µg/L)
IF_{derm_c}	=	Intake Factor for dermal contact with water, cancer (cm^2-event/kg body weight-day)

DA_{event}	=	Absorbed dose per event per concentration (cm/event)
CF_1	=	Conversion Factor (cm^3/L)
GIABS	=	Fraction of contaminant absorbed in gastrointestinal tract (unitless)
CSF_{oral}	=	Oral Cancer Slope Factor $(mg/kg\ body\ weight\text{-}day)^{-1}$
CF_2	=	Conversion Factor (mg/µg)

The equation used to calculate cancer risk for exposure via incidental soil ingestion, dermal contact, and inhalation of airborne soil particulates and vapor is as follows:

$$Cancer\ Risk = EPC_{soil} \times (IF_{soil.ing} \times RBA_{oral} + IF_{soil.derm} \times ABS) \times CSF_{oral} + EPC_{air} \times IF_{inh} \times IUR$$

where:

EPC_{soil}	=	Soil Exposure Point Concentration (mg/kg)
$IF_{soil.ing}$	=	Intake Factor for soil ingestion (kg of soil/kg body weight-day)
RBA_{oral}	=	Relative Bioavailability for oral ingestion (unitless)
$IF_{soil.derm}$	=	Intake Factor for dermal contact with soil (kg of soil/kg body weight-day)
ABS	=	Soil Absorption Factor (unitless)
CSF_{oral}	=	Oral Cancer Slope Factor $(mg/kg\ body\ weight\text{-}day)^{-1}$
EPC_{air}	=	Air Exposure Point Concentration ($\mu g/m^3$)
IF_{inh}	=	Intake Factor for air inhalation (unitless)
IUR	=	Inhalation Unit Risk $(\mu g/m^3)^{-1}$

Soil absorption factors (ABS) used in the risk calculation are presented in Table 6-4. The soil EPCs will be based on 95% upper confidence levels (UCLs) calculated using the approach recommended by NDEP (NDEP 2020b).

The equation used to calculate cancer risk for exposure via dermal contact with sediment is as follows:

$$Cancer\ Risk = EPC_{sed} \times IF_{sed.derm} \times ABS \times CSF_{oral}$$

where:

EPC_{sed}	=	Sediment Exposure Point Concentration (mg/kg)
$IF_{sed.derm}$	=	Intake Factor for dermal contact with sediment (kg of sediment/kg body weight-day)

ABS = Sediment Absorption Factor (unitless)

CSF_{oral} = Oral Cancer Slope Factor (mg/kg body weight-day)$^{-1}$

Sediment absorption factors (ABS) used in the risk calculation are presented in Table 6-4. The sediment EPCs will be based on 95% upper confidence levels (UCLs) calculated using the approach recommended by NDEP (NDEP 2020b).

The excess lifetime cancer risk will be calculated for each carcinogenic COPC at each individual soil gas, groundwater, soil, sediment and surface water sample location. Also, the estimated excess lifetime cancer risk for each identified carcinogenic COPC will be conservatively summed, regardless of the type of cancer, to estimate the total cancer risk for an exposed individual at each location.

6.4.2 Assessment of Noncancer Health Effects

The likelihood of noncancer adverse effects is quantified by the development of a hazard quotient (HQ). The HQ represents the ratio of the estimated exposure to a non-carcinogen at a given concentration to a value that is believed not to produce noncancer adverse health effects. The equation used to calculate the noncancer HQ due to exposure via inhalation of VOCs migrating from soil gas or groundwater is as follows:

$$HQ = \frac{EPC_{air} \times IF_{inh}}{RfC_{inh}}$$

where:

HQ = Hazard Quotient

EPC_{air} = Exposure Point Concentration in air (µg/m^3)

IF_{inh} = Inhalation Intake Factor (unitless)

RfC_{inh} = Inhalation Reference Concentration (µg/m^3)

The equation used to calculate noncancer HQ due to exposure via incidental ingestion of groundwater is as follows:

$$HQ = \frac{EPC_{water} \times IF_{ing} \times RBA_{oral} \times CF}{RfD_{oral}}$$

where:

HQ = Hazard Quotient

EPC_{water} = Water Exposure Point Concentration (µg/L)

IF_{ing} = Intake Factor for water (L of groundwater/kg body weight-day)

RBA_{oral} = Relative Bioavailability for oral ingestion (unitless)

CF = Conversion Factor (mg/µg)

RfD_{oral} = Oral Reference Dose mg/kg body weight-day

The equation to calculate noncancer HQ due to dermal contact with groundwater or surface water is as follows:

$$HQ = \frac{EPC_{water} \times IF_{derm\_c} \times \frac{\frac{DA_{event}}{CF_1}}{GIABS} \times CF_2}{RfD_{oral}}$$

where:

HQ = Hazard Quotient

EPC_{water} = Water Exposure Point Concentration (µg/L)

IF_{derm_c} = Intake Factor for dermal contact with water, cancer (cm^2-event/kg body weight-day)

DA_{event} = Absorbed dose per event per concentration (cm/event)

CF_1 = Conversion Factor (cm^3/L)

GIABS = Fraction of contaminant absorbed in gastrointestinal tract (unitless)

CF_2 = Conversion Factor (mg/µg)

RfD_{oral} = Oral Reference Dose (mg/kg body weight-day)

The equation used to calculate the noncancer HQ for exposure via incidental soil ingestion, dermal contact, and inhalation of airborne soil particulates and vapor is as follows:

$$HQ = EPC_{soil} \times (IF_{soil.ing} \times RBA_{oral} + IF_{soil.derm} \times ABS)/RfD_{oral} + EPC_{air} \times IF_{inh}/RfC_{inh}$$

where:

HQ = Hazard Quotient

EPC_{soil} = Soil Exposure Point Concentration (mg/kg)

$IF_{soil.ing}$ = Intake Factor for soil ingestion (kg of soil/kg body weight-day)

RBA_{oral} = Relative Bioavailability for oral ingestion (unitless)

$IF_{soil.derm}$ = Intake Factor for dermal contact with soil (kg of soil/kg body weight-day)

ABS = Soil Absorption Factor (unitless)

RfD_{oral} = Oral Reference Dose (mg/kg body weight-day)

EPC_{air} = Air Exposure Point Concentration (µg/m^3)

IF_{inh} = Intake Factor for air inhalation (unitless)

RfC_{inh} = Inhalation Reference Concentration (µg/m^3)

Soil absorption factors (ABS) used in the risk calculation are presented in Table 6-4. The soil EPCs will be based on 95% UCLs calculated using the approach recommended by NDEP (NDEP 2020b).

The equation used to calculate the noncancer HQ for exposure via dermal contact with sediment is as follows:

$$HQ = (EPC_{sed} \times IF_{soil.derm} \times ABS)/RfD_{oral}$$

where:

HQ = Hazard Quotient

EPC_{sed} = Sediment Exposure Point Concentration (mg/kg)

$IF_{sed.derm}$ = Intake Factor for dermal contact with sediment (kg of sediment/kg body weight-day)

ABS = Sediment Absorption Factor (unitless)

RfD_{oral} = Oral Reference Dose (mg/kg body weight-day)

Sediment absorption factors (ABS) used in the risk calculation are presented in Table 6-4. The sediment EPCs will be based on 95% UCLs calculated using the approach recommended by NDEP (NDEP 2020b).

The noncancer HQ will be calculated for each COPC at each individual soil gas, groundwater, soil, sediment and surface water sample location. The estimated noncancer HQ for each COPC will be conservatively summed, regardless of the target organ, to estimate the total noncancer HI for an exposed individual at each location.

6.5 Uncertainty Analysis

The process of risk assessment has inherent uncertainties associated with the calculations and assumptions used in the BHRA resulting from lack of knowledge and variability of site conditions, fate and transport modeling, and chemical toxicity and exposure. The approach used in the BHRA is health-protective and tends to overestimate potential exposure, resulting in estimated cancer risks and noncancer hazard levels that are likely to overestimate the actual risks or hazards experienced by the potentially exposed populations. These uncertainties are generally difficult to quantify. A qualitative discussion of key uncertainties associated with the available data and the methodology will be presented in the forthcoming BHRA.

6.6 Data Quality Assessment

Data quality assessment is an analysis that will be performed as part of the risk assessment after the risk characterization is complete to determine whether enough data have been collected to support the risk-based decisions that are recommended by the risk assessment. Sample size calculations will be conducted based on the methodology for maximum

detected concentrations, which will be conceptualized as a statistical test of the proportion of the samples that are associated with an unacceptable risk. The data quality assessment will be presented in the forthcoming BHRA.

7. SUMMARY

The BHRA for OU-3 will be based on the approach described in the NDEP-approved 2014 BHRA Work Plan (ENVIRON 2014b) and methodology recommended by NDEP (NDEP 2020a) and USEPA (1989, 2002a, 2004a, 2004b, 2009, 2015, 2017a, and 2022a). The OU-3 BHRA will focus on potential health risks associated with COPCs migrating from OU-1 to OU-3 via impacted groundwater. Consistent with the Phase 3 RI Work Plan (Ramboll Environ 2017a) approved by NDEP on November 8, 2017 and the RI Report for OU-1 and OU-2 (Ramboll 2021a), Pabco Road serves as a demarcation of two differing sets of obligations for the Trust. Accordingly, the OU-3 BHRA Study Area includes two portions: 1) the area in OU-3 west of Pabco Road (excluding the Open Space Sub-Area), and 2) the area in OU-3 east of Pabco Road. NDEP has already issued a NFA determination for the Open Space Sub-Area for both direct contact with soil to a depth of 7 ft bgs and vapor intrusion assuming no future residential development will occur in these areas (NDEP 2015a and BRC 2015).

The area in OU-3 west of Pabco Road contains a portion of the Birding Ponds and the COH WRF. The northern RIBs, which were formerly used by the COH for infiltration of treated municipal wastewater, are located further east. The Tuscany residential community, the Weston Hills neighborhood, and the Chimera Golf Course are located in the area of OU-3 east of Pabco Road, as well as mostly vacant areas with sparse vegetation north of the Tuscany community, a portion of which served as a former COH landfill (now closed). The Wash is located downgradient (north) of each of these features. The Wash, and the area immediately surrounding the Wash within OU-3 fall within the Clark County Wetlands Park.

Las Vegas Valley is drained by the Wash, a 12-mile-long channel located approximately 2.6 miles north of OU-1, which flows into Lake Mead. Accounting for less than 2% on average of the water in Lake Mead, the water flowing through the Wash consists of urban runoff, shallow groundwater, storm water, and treated wastewater from the Clark County Sanitation District, the COH, the City of Las Vegas, and treated discharge from NERT, TIMET, and AMPAC.

As discussed in this work plan, NERT is only responsible for evaluating perchlorate and chlorate in the portion of OU-3 east of Pabco Road. Therefore, chlorate and perchlorate were identified as the only COPCs for groundwater shallower than or at approximately 10 ft bgs l in OU-3 east of Pabco Road. Potentially exposed populations for shallow groundwater would include maintenance/utility workers digging a utility trench in areas of shallow groundwater. Soil gas will not be evaluated in the BHRA for OU-3 east of Pabco Road as perchlorate and chlorate are not volatile compounds. Potentially exposed populations for shallow bank soil would include recreational users who may be exposed to non-volatile COPCs in bank soil through inhalation of airborne soil particulates. As fishing, drinking/touching water from the Wash, swimming, wading, and boating are prohibited in the Wetlands Park (water in the park is not intended for human contact),[37] exposures through direct contact with the bank soil, surface water, and sediment in the Wash are not

[37] See the Wetlands Park rules at:
https://www.clarkcountynv.gov/government/departments/parks___recreation/wetlands_park/park_rules_and_faqs.php

expected to occur on a regular basis for recreational users. However, some adolescent trespassers in the Wetlands Park may disregard Park rules and encounter bank soils, surface water, and sediment. Because neither chlorate nor perchlorate was identified as a preliminary COPC in the health-based screening for soil or sediment in OU-3 east of Pabco Road, soil and sediment will not be evaluated in the eastern portion of OU-3 in the BHRA.

A health risk-based screening assessment was performed to determine the preliminary COPCs for soil gas, groundwater, soil, surface water, and sediment to be evaluated in the BHRA for OU-3 west of Pabco Road (excluding the Open Space Area). The preliminary COPCs are summarized below:

- Chloroform was identified as the only preliminary COPC in soil gas in this area.
- Four VOCs (carbon tetrachloride, chloroform, 1,4-dioxane, and 1,2,3-trichloropropane) were identified as the preliminary COPCs in groundwater deeper than 10 ft bgs in this area.
- Three metals (arsenic, chromium, and magnesium), three inorganic compounds (chlorate, nitrate, and perchlorate), and four VOCs (chloroform, 1,1-dichloroethane, 1,4-dioxane, and 1,2,3-trichloropropane) were identified as the preliminary COPCs in groundwater shallower than or at approximately 10 ft bgs in this area.
- Arsenic was identified as the only preliminary COPC for soil in this area.
- One metal (arsenic) and three inorganic compounds (chlorate, nitrate, and perchlorate) were identified as the preliminary COPCs in surface water in this area.
- No preliminary COPCs were identified for sediment in OU-3 in this area.

Potentially exposed populations in the area west of Pabco Road would include:

- Indoor commercial/industrial workers: inhalation of vapors migrating from soil gas/shallow groundwater to indoor air at locations where long-term indoor exposures could occur (i.e., in buildings in the WRF).
- Outdoor commercial/industrial workers: inhalation of vapors migrating from soil gas/shallow groundwater to outdoor air at locations where long-term outdoor exposures could occur (i.e., outside the buildings in the WRF).
- Construction workers: inhalation of vapors migrating from soil gas/groundwater to trench air in a 10-ft dry construction trench in the unsaturated zone and in a 10-ft wet construction trench in the saturated zone within or near the WRF.
- Maintenance/utility workers:
    - Direct contact (incidental ingestion and dermal contact) with groundwater in a utility trench in the saturated zone in areas with shallow groundwater.
    - Inhalation of vapors migrating from soil gas/groundwater into a utility trench in the saturated zone in areas with shallow groundwater.
    - Direct contact (incidental ingestion and dermal contact) with and inhalation of airborne particulates from shallow soil near the former seep area.

- Recreational Users:
    - Inhalation of vapors migrating from soil gas/shallow groundwater to outdoor air.
    - Direct contact (incidental ingestion and dermal contact) and inhalation of airborne particulates from surface soil near the former seep area.
    - Inhalation of airborne particulates from bank soil.
- Adolescent Trespassers:
    - Inhalation of airborne particulates from surface bank soil near the Wash.
    - Dermal contact with surface water in the Wash.

Similar to the area in OU-3 east of Pabco Road, exposures through direct contact with bank soil, surface water, and sediment in the Wash are not expected to occur on a regular basis for recreational users. In addition, exposures associated with inhalation of VOCs migrating from surface water to outdoor air for the recreational users or adolescent trespassers near the Wash are expected to be low due to low exposure time for the recreational users and high mixing rate in outdoor air. These pathways will not be quantitatively evaluated but qualitatively discussed in the uncertainty section of the BHRA.

The BHRA for OU-3 will rely on environmental investigation data collected from 2016 to 2021, which are identified to be relevant to support this BHRA. The BHRA will use soil gas, groundwater, soil, surface water, and sediment data collected previously. The BHRA will include the following elements: DUE of the BHRA data set for OU-3 based on the preliminary COPCs identified in this work plan, identification of the final COPCs for OU-3, exposure assessment, toxicity assessment, and risk characterization. In addition, the BHRA will include an uncertainty analysis and a data quality assessment.

8. SCHEDULE

The implementation of the BHRA will begin following NDEP approval of this BHRA Work Plan. As described in this work plan, the BHRA data set for OU-3 will include existing data, described in Section 4. The OU-3 BHRA report is anticipated to be submitted to NDEP six months following submittal of the RI Report for OU-3.

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TABLES

TABLE 3-1. Initial COPCs to Evaluate in the OU-3 BHRA Work Plan
Nevada Environmental Response Trust Site
Henderson, Nevada

Matrix	Chemical Group	Chemical [1]	OU-3 West of Pabco Road (including the NERT Off-Site Study Area and the Downgradient Study Area West of Pabco Road, excluding the Open Space Sub-Area)	OU-3 East of Pabco Road (including the Northeast Sub-Area and the Downgradient Study Area East of Pabco Road) [2]
Shallow Groundwater [2,3]	General Chemistry	Chlorate	X	X
		Nitrate	X	--
		Perchlorate	X	X
	Metals	Arsenic	X	--
		Boron	X	--
		Chromium (total)	X	--
		Chromium VI	X	--
		Magnesium	X	--
		Manganese	X	--
	VOCs	Benzene	X	--
		Bromodichloromethane	X	--
		Carbon tetrachloride	X	--
		Chloroform	X	--
		1,1-Dichloroethane	X	--
		1,4-Dioxane	X	--
		Tetrachloroethene	X	--
		1,2,3-Trichloropropane	X	--
Soil [2,4,5]	General Chemistry	Chlorate	X	X
		Nitrate	X	--
		Perchlorate	X	X
	Metals	Arsenic	X	--
		Boron	X	--
		Chromium (total)	X	--
		Magnesium	X	--
		Manganese	X	--
Soil Gas [2,6]	VOCs	Benzene	X	--
		Bromodichloromethane	X	--
		Carbon tetrachloride	X	--
		Chlorobenzene	X	--
		Chloroform	X	--
		1,1-Dichloroethane	X	--
		1,4-Dioxane	X	--
		Tetrachloroethene	X	--
Surface Water [2,7]	General Chemistry	Chlorate	X	X
		Nitrate	X	--
		Perchlorate	X	X
	Metals	Arsenic	X	--
		Boron	X	--
		Chromium (total)	X	--
		Magnesium	X	--
		Manganese	X	--
	VOCs	Chloroform	X	--
Sediment [2,7]	General Chemistry	Chlorate	X	X
	Metals	Chromium (total)	X	--
	VOCs	Chloroform	X	--

Notes:

-- = Not evaluated for the indicated area and medium in the proposed BHRA.
bgs = below ground surface
BHRA = Baseline health risk assessment
COPC = Chemical of potential concern
ft = feet
NERT = Nevada Environmental Response Trust
OU = Operable unit
RI = Remedial Investigation
VOC = Volatile organic compound

X = Initial COPCs identified for each medium in indicated area

[1] These chemicals are further evaluated using health risk-based screening levels to determine whether they will be retained as the preliminary COPCs to include in the OU-3 BHRA (see Section 6.1 and Table 6-1).

[2] The COPCs in OU-3 east of Pabco Road are administratively limited to chlorate and perchlorate. Therefore, these two chemicals (which are not volatile organic compounds) are the only initial COPCs identified for shallow groundwater, soil, and surface water in OU-3 east of Pabco Road. For sediment, only chlorate was detected and is listed as an initial COPC. There are no COPCs for soil gas in this area.

[3] All groundwater COPCs identified for OU-2 (Ramboll 2021a) and detected in OU-3 are included as the initial COPCs for groundwater in OU-3 west of Pabco Road.

[4] All detected non-volatile OU-2 groundwater COPCs are included as the initial COPCs for soil in OU-3 west of Pabco Road. No volatile (VOCs) on the OU-2 groundwater COPC list were detected in any of the selected soil samples for the BHRA collected during the recent Phase 3 RI sampling (Ramboll 2021b) in OU-3 west of Pabco Road.

[5] Only the bank soil data collected near Las Vegas Wash and the 0-10 ft soil data from the former seep area are incuded.

[6] All volatile OU-2 groundwater COPCs (Ramboll 2021a) that were detected in soil gas in OU-3 west of Pabco Road are included as the initial COPCs for soil gas in OU-3 west of Pabco Road, and any additional VOCs detected in the upcoming soil gas sampling from Phase 3 RI Modification No. 15 (Ramboll 2022) will also be included as initial soil gas COPCs.

[7] All OU-2 groundwater COPCs detected in surface water and sediment in OU-3 west of Pabco Road are included as initial COPCs for that area.

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TABLE 4-1. Summary of Environmental Investigation Data to Include in the OU-3 BHRA
Nevada Environmental Response Trust Site
Henderson, Nevada

Matrix	Investigation Name	Task Code	Years	Chemical Groups			Notes
				General Chemistry	Metals	VOCs	
Shallow Groundwater	RI Phase1	RI Phase1	2015	X	X		Wells with groundwater levels <10 ft bgs are included. Only perchlorate and chlorate data are included for the wells east of Pabco Road.
	RI Phase2	RI Phase2	2017-2018	X	X	X	For the VOCs on the initial COPC list (Table 3-1), wells with top screen depths shallower than 60 ft bgs west of Pabco Road are included; for the non-volatile initial COPCs, only wells with groundwater levels <10 ft bgs are included. No wells meeting inclusion criteria are east of Pabco Road.
	RI Phase 3	RI Phase3	2018-2022	X	X	X	For the VOCs on the initial COPC list, wells with top screen depths shallower than 60 ft bgs west of Pabco Road are included; for the non-volatile initial COPCs, only wells with groundwater levels <10 ft bgs are included. Only perchlorate and chlorate data are included for the wells east of Pabco Road.
	Annual Groundwater Monitoring	GWM GWM16q1 GWM16q2 GWM16q3 Weir 2016	2015-2022	X	X	X	For the VOCs on the initial COPC list, wells with top screen depths shallower than 60 ft bgs west of Pabco Road are included; for the non-volatile initial COPCs, only wells with groundwater levels <10 ft bgs are included. Only perchlorate and chlorate data are included for the wells east of Pabco Road.
	NDEP Downgradient Study Area Investigation	AECOM_Round1 AECOM_Round3 AECOM_Round4	2016-2019	X	X		Wells with groundwater levels <10 ft bgs are included. Only perchlorate and chlorate data are included for the wells east of Pabco Road.
	Seep Well Field Investigation	SWF 2016	2016	X	X		Only one well with groundwater levels <10 ft bgs west of Pabco Road is included.
Soil	Baseline Ecological Risk Assessment Sampling Program	BERA_OU3	2019-2020	X	X	X	Eighteen samples at 11 locations at depths of 0 ft, 0.5 ft, 1 ft, or 2 ft bgs. Sampling was limited to five analytes; general chemistry analytes include chlorate and perchlorate, metal analytes include chromium (total) and chromium VI, and VOC analytes include chloroform (however, chloroform was not detected in soil in OU-3 and is not included as an initial COPC - see Table 3-1). Only perchlorate and chlorate data are included for the samples east of Pabco Road.
	RI Phase 2	RI Phase2	2017	X			Twenty samples at 10 locations, including two samples at each location at depth intervals 0.5 and 1.5 ft bgs; perchlorate is the only chemical evaluated.
	RI Phase 3	RI Phase3	2021	X	X	X	Ten soil samples at three depth intervals (0 ft, 5 ft, and 9.5 ft bgs) at three locations in the seep field west of Pabco Road.
Soil Gas	RI Phase 3	RI Phase3	2020 - 2022			X	Twenty-three samples at 12 locations at depths of 5 and 10 to 15 ft bgs in 2020. Additional sampling is in process at two new soil gas probe locations (5 and 15 ft bgs) and at 10 existing locations - refer to Phase 3 RI Modification No. 15 (Ramboll 2022) for details.
Surface Water	Baseline Ecological Risk Assessment Sampling Program	BERA_OU3	2019 - 2022	X	X	X	Only perchlorate and chlorate data are included for the wells east of Pabco Road.
	RI Phase 3	RI Phase3 RI Phase3 Mod10	2018 - 2022	X			Surface water sampling was limited to perchlorate and chlorate.
	Annual Groundwater Monitoring	GWM	2017 - 2022	X			Surface water sampling was limited to perchlorate and chlorate.

TABLE 4-1. Summary of Environmental Investigation Data to Include in the OU-3 BHRA
Nevada Environmental Response Trust Site
Henderson, Nevada

Matrix	Investigation Name	Task Code	Years	Chemical Groups			Notes
				General Chemistry	Metals	VOCs	
Surface Water	NDEP Downgradient Study Area Investigation	AECOM_Round1 AECOM_Round2_Discrete AECOM_Round2_Transect AECOM_Round2_USGS AECOM_Round 3	2016 - 2018	X	X		Only perchlorate and chlorate data are included for the wells east of Pabco Road.
	Seep Well Field Investigation	SWF 2016	2016	X	X		Only perchlorate and chlorate data are included for the samples east of Pabco Road.
Sediment	Baseline Ecological Risk Assessment Sampling Program	BERA_OU3	2019 - 2020	X	X	X	Twenty-four samples at 20 locations. For the samples east of Pabco Road, only chlorate data are included (perchlorate was not detected in sediment and is not an initial COPC, see Table 3-1).

Notes:

bgs = below ground surface

BHRA = Baseline health risk assessment

COPC = Chemical of potential concern

ft = feet

NDEP = Nevada Division of Environmental Protection

OU = Operable Unit

RI = Remedial Investigation

VOC = Volatile organic compound

Sources:

Ramboll. 2021. Phase 3 RI Modification No. 13, Nevada Environmental Response Trust Site, Henderson, Nevada. August 25.
Ramboll. 2022. Phase 3 RI Modification No. 15, Nevada Environmental Response Trust Site, Henderson, Nevada. August 2.

TABLE 4-2a. Shallow Groundwater Monitoring Wells with Sampling Data Evaluated for Vapor Intrusion Pathway in the OU-3 BHRA Work Plan
Nevada Environmental Response Trust Site
Henderson, Nevada

Well ID	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Water Bearing Zone	Located East or West of Pabco Road?	Within Open Space?	Within WRF Area?	Minimum Water Level Depth (ft bgs) [1]	Average Water Level Depth (ft bgs) [1]	Well Depth Category to Use in BHRA	Sampling Events	Note
COH-2B1	36	66	Shallow	W	F	F	16	17	> 10 ft bgs	Phase 3 RI	
DBMW-19	15	40	Shallow	W	F	F	27	27	> 10 ft bgs	Phase 3 RI	
ES-55B	38	53	Shallow	W	F	F	25	25	> 10 ft bgs	Phase 3 RI Mod. Number 8, 11, or 13 sampling location	
MW-K5	28.5	44	Shallow	W	F	T	10	27	< or around 10 ft bgs	Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	
NERT6.21N1	30	45	Shallow	W	F	F	11	11	< or around 10 ft bgs	Phase 3 RI	Conservatively evaluated as wells as < or around 10 ft bgs
PC-1	14.7	29.7	Shallow	W	F	T	26	26	> 10 ft bgs	2022 Annual Groundwater Monitoring	Sampling data not validated yet
PC-103	9	29	Shallow	W	F	F	13	22	< or around 10 ft bgs	Phase 1 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	Conservatively evaluated as wells as < or around 10 ft bgs
PC-155A	10	30	Shallow	W	F	F	12	13	< or around 10 ft bgs	Phase 1 RI, Phase 2 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring	Conservatively evaluated as wells as < or around 10 ft bgs
PC-156A	10	20	Shallow	W	F	F	7	8	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, Phase 1 RI, Phase 2 RI	
PC-156B	25	45	Shallow	W	F	F	10	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, Phase 1 RI, Phase 2 RI	
PC-157A	9	24	Shallow	W	F	F	10	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, Phase 1 RI, Phase 2 RI	
PC-178	55	70	Shallow	W	F	T	22	24	> 10 ft bgs	Phase 2 RI, Phase 3 RI	
PC-191	10	25	Shallow	W	F	F	9	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, Phase 2 RI	
PC-2	16.7	31.7	Shallow	W	F	T	21	26	> 10 ft bgs	Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring	
PC-200	18	28	Shallow	W	F	T	--	--	> 10 ft bgs	Phase 3 RI	No groundwater depth data; evaluated as wells > 10 ft bgs based on nearby well depth
PC-201	19	29	Shallow	W	F	F	21	21	> 10 ft bgs	Phase 3 RI	
PC-205A	20	30	Shallow	W	F	F	7	7	< or around 10 ft bgs	Phase 3 RI	
PC-4	17.7	42.7	Shallow	W	F	T	29	33	> 10 ft bgs	Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring	
PC-53	13	32.5	Shallow	W	F	T	5	24	< or around 10 ft bgs	Phase 1 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	

TABLE 4-2a. Shallow Groundwater Monitoring Wells with Sampling Data Evaluated for Vapor Intrusion Pathway in the OU-3 BHRA Work Plan
Nevada Environmental Response Trust Site
Henderson, Nevada

Well ID	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Water Bearing Zone	Located East or West of Pabco Road?	Within Open Space?	Within WRF Area?	Minimum Water Level Depth (ft bgs) [1]	Average Water Level Depth (ft bgs) [1]	Well Depth Category to Use in BHRA	Sampling Events	Note
PC-76	15	20	Shallow	W	F	F	10	11	< or around 10 ft bgs	AECOM Round 1	Conservatively evaluated as wells as ≤ 10 ft bgs
PC-77	29.5	39.5	Shallow	W	F	F	4	6	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring , AECOM Round 1	
PC-96	29	39	Shallow	W	F	F	4	6	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	
PC-97	23	33	Shallow	W	F	F	0	4	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring, SWF 2016	
PC-98R	20	35	Shallow	W	F	T	6	21	< or around 10 ft bgs	Phase 1 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	
PMW-8	21	41	Shallow	W	F	F	7	8	< or around 10 ft bgs	AECOM Round 1	
PZ-2S	45	46	Shallow	W	F	F	--	--	> 10 ft bgs	Phase 3 RI	No groundwater depth data; categorized as well > 10 ft bgs based on groundwater depths from nearby wells and well development log
RIT-10	25	40	Shallow	W	F	F	6	7	< or around 10 ft bgs	AECOM Round 1	
WMW6.15S	7.5	17.5	Shallow	W	F	F	8	9	< or around 10 ft bgs	Phase 1 RI, AECOM Round 1, Weir 2016	
WMW6.55S	18	43	Shallow	W	F	F	6	16	< or around 10 ft bgs	Phase 1 RI, AECOM Round 1, Weir 2016	
WMW6.9N	18	53	Shallow	W	F	F	18	18	> 10 ft bgs	Phase 3 RI	
WMW6.9S	15	45	Shallow	W	F	F	10	11	< or around 10 ft bgs	AECOM Round 1	

Notes:
-- = not applicable
bgs = below ground surface
BHRA = Baseline Health Risk Assessment
E = East
ft = feet
OU = Operable unit
RI = Remedial Investigation
SWF = Seep Well Field Flow Quantification
W = West

[1] Based on groundwater elevation measurement data collected after January 1, 2015.

TABLE 4-2b. Shallow Groundwater Monitoring Wells with Sampling Data Evaluated for Direct Contact Pathway in the OU-3 BHRA Work Plan
Nevada Environmental Response Trust Site
Henderson, Nevada

Well ID	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Water Bearing Zone	Located East or West of Pabco Road?	Within Open Space?	Within WRF Area?	Minimum Water Level Depth (ft bgs) [1]	Average Water Level Depth (ft bgs) [1]	Well Depth Category to Use in BHRA	Sampling Events	Note
ES-25A	30	50	Shallow	E	F	F	14	15	< or around 10 ft bgs	Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring	Conservatively evaluated as wells as < or around 10 ft bgs
LVWPS-MW101A	23.3	33	Shallow	E	F	F	18	18	< or around 10 ft bgs	Phase 3 RI	Conservatively evaluated as wells as < or around 10 ft bgs
LVWPS-MW102A	47	66.6	Shallow	E	F	F	8	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring	
LVWPS-MW108A	20.8	40.7	Shallow	E	F	F	12	12	< or around 10 ft bgs	Phase 3 RI	Conservatively evaluated as wells as < or around 10 ft bgs
LVWPS-MW111A	20.8	40.5	Shallow	E	F	F	15	15	< or around 10 ft bgs	Phase 3 RI	Conservatively evaluated as wells as < or around 10 ft bgs
LVWPS-MW112A	28.8	48	Shallow	E	F	F	15	15	< or around 10 ft bgs	Phase 3 RI	Conservatively evaluated as wells as < or around 10 ft bgs
LVWPS-MW215A	13.5	33.2	Shallow	E	F	F	11	11	< or around 10 ft bgs	Phase 3 RI	Conservatively evaluated as wells as < or around 10 ft bgs
LVWPS-MW216	10.4	20	Shallow	E	F	F	7	7	< or around 10 ft bgs	Phase 3 RI	
MW-1(CHIM)	--	--	Shallow	E	F	F	4	5	< or around 10 ft bgs	Phase 3 RI, AECOM Round 1	No screen top and bottom depth measurements available but confirmed to be shallow wells
MW-3(CHIM)	--	--	Shallow	E	F	F	2	3	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, AECOM Round 1, AECOM Round 3, AECOM Round 4	No screen top and bottom depth measurements available but confirmed to be shallow wells
MW-4(CHIM)	--	--	Shallow	E	F	F	3	6	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, AECOM Round 1, AECOM Round 3, AECOM Round 4	No screen top and bottom depth measurements available but confirmed to be shallow wells
MW-K5	28.5	44	Shallow	W	F	T	10	27	< or around 10 ft bgs	Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	
NERT3.80S1	10	20	Shallow	E	F	F	9	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, AECOM Round 3, AECOM Round 4	
NERT3.98S1	15	35	Shallow	E	F	F	10	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, AECOM Round 4	
NERT5.11S1	35	45	Shallow	E	F	F	12	21	< or around 10 ft bgs	Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, AECOM Round 3, AECOM Round 4	Conservatively evaluated as wells as < or around 10 ft bgs
NERT5.91S2	15	25	Shallow	E	F	F	14	14	< or around 10 ft bgs	Proposed Phase 3 RI Mod. Number 8, 11, or 13 sampling location	Conservatively evaluated as wells as < or around 10 ft bgs
NERT5.98S1	15	30	Shallow	E	F	F	15	15	< or around 10 ft bgs	Shallow groundwater wells with depth of groundwater ≤ 10 ft bgs	Conservatively evaluated as wells as < or around 10 ft bgs
NERT6.21N1	30	45	Shallow	W	F	F	11	11	< or around 10 ft bgs	Phase 3 RI	Conservatively evaluated as wells as < or around 10 ft bgs
PC-103	9	29	Shallow	W	F	F	13	22	< or around 10 ft bgs	Phase 1 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	Conservatively evaluated as wells as < or around 10 ft bgs
PC-155A	10	30	Shallow	W	F	F	12	13	< or around 10 ft bgs	Phase 1 RI, Phase 2 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring	Conservatively evaluated as wells as < or around 10 ft bgs
PC-156A	10	20	Shallow	W	F	F	7	8	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, Phase 1 RI, Phase 2 RI	
PC-156B	25	45	Shallow	W	F	F	10	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, Phase 1 RI, Phase 2 RI	

TABLE 4-2b. Shallow Groundwater Monitoring Wells with Sampling Data Evaluated for Direct Contact Pathway in the OU-3 BHRA Work Plan
Nevada Environmental Response Trust Site
Henderson, Nevada

Well ID	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Water Bearing Zone	Located East or West of Pabco Road?	Within Open Space?	Within WRF Area?	Minimum Water Level Depth (ft bgs) [1]	Average Water Level Depth (ft bgs) [1]	Well Depth Category to Use in BHRA	Sampling Events	Note
PC-157A	9	24	Shallow	W	F	F	10	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, Phase 1 RI, Phase 2 RI	
PC-191	10	25	Shallow	W	F	F	9	10	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, Phase 2 RI	
PC-205A	20	30	Shallow	W	F	F	7	7	< or around 10 ft bgs	Phase 3 RI	
PC-53	13	32.5	Shallow	W	F	T	5	24	< or around 10 ft bgs	Phase 1 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	
PC-76	15	20	Shallow	W	F	F	10	11	< or around 10 ft bgs	AECOM Round 1	Conservatively evaluated as wells as < or around 10 ft bgs
PC-77	29.5	39.5	Shallow	W	F	F	4	6	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring , AECOM Round 1	
PC-96	29	39	Shallow	W	F	F	4	6	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	
PC-97	23	33	Shallow	W	F	F	0	4	< or around 10 ft bgs	2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring, SWF 2016	
PC-98R	20	35	Shallow	W	F	T	6	21	< or around 10 ft bgs	Phase 1 RI, Phase 3 RI, 2021 Annual Groundwater Monitoring, 2020 Annual Groundwater Monitoring, 2019 Annual Groundwater Monitoring, 2018 Annual Groundwater Monitoring, 2017 Annual Groundwater Monitoring, 2016 Annual Groundwater Monitoring, 2015 Annual Groundwater Monitoring	
PMW-8	21	41	Shallow	W	F	F	7	8	< or around 10 ft bgs	AECOM Round 1	
RIT-10	25	40	Shallow	W	F	F	6	7	< or around 10 ft bgs	AECOM Round 1	
WMW5.5S	14	44	Shallow	E	F	F	14	14	< or around 10 ft bgs	Phase 3 RI, AECOM Round 1, AECOM Round 3, AECOM Round 4	Conservatively evaluated as wells as < or around 10 ft bgs
WMW5.7N	5	20	Shallow	E	F	F	6	8	< or around 10 ft bgs	AECOM Round 1, AECOM Round 3, AECOM Round 4	
WMW6.15S	7.5	17.5	Shallow	W	F	F	8	9	< or around 10 ft bgs	Phase 1 RI, AECOM Round 1, Weir 2016	
WMW6.55S	18	43	Shallow	W	F	F	6	16	< or around 10 ft bgs	Phase 1 RI, AECOM Round 1, Weir 2016	
WMW6.9S	15	45	Shallow	W	F	F	10	11	< or around 10 ft bgs	AECOM Round 1	
ZTS-MW114	50	70	Shallow	E	F	F	9	9	< or around 10 ft bgs	Phase 3 RI	

Notes:
-- = not applicable
bgs = below ground surface
BHRA = Baseline Health Risk Assessment
E = East
ft = feet
OU = Operable unit
RI = Remedial Investigation
SWF = Seep Well Field Flow Quantification
W = West

[1] Based on groundwater elevation measurement data collected after January 1, 2015.

TABLE 6-1. Preliminary COPCs to Include in the OU-3 BHRA
Nevada Environmental Response Trust Site
Henderson, Nevada

Chemical Group	Chemical [1]	OU-3 West of Pabco Road (including the Northern Portion of the NERT Off-Site Study Area and the Downgradient Study Area West of Pabco Road, excluding the Open Space Sub-Area)							OU-3 East of Pabco Road (including the Northeast Sub-Area and the Downgradient Study Area East of Pabco Road)			
		Soil Gas		Shallow Groundwater		Soil	Surface Water	Sediment	Shallow Groundwater	Soil	Surface Water	Sediment
		5 ft bgs	10 - 15 ft bgs	≤ 10 ft bgs	> 10 ft bgs	0-10 ft bgs			≤ 10 ft bgs	0-10 ft bgs		
General Chemistry	Chlorate			X			X		X		X	
General Chemistry	Nitrate			X			X					
General Chemistry	Perchlorate			X			X		X		X	
Metals	Arsenic			X		X	X					
Metals	Chromium (total)			X								
Metals	Chromium VI			X								
Metals	Magnesium			X								
VOCs	Carbon tetrachloride				X							
VOCs	Chloroform	X	X	X	X							
VOCs	1,1-Dichloroethane			X								
VOCs	1,4-Dioxane			X	X							
VOCs	1,2,3-Trichloropropane			X	X							

Notes:

X = COPCs identified in the screening analysis for each medium at indicated depth interval and area (see Appendix F for detailed screening results).

bgs = below ground surface
BHRA = Baseline health risk assessment
COPC = Chemical of potential concern
ft = feet
NERT = Nevada Environmental Response Trust
OU = Operable unit
RI = Remedial investigation
VOC = Volatile organic compound

[1] Chemicals listed as OU-2 groundwater COPCs identified in RI Report for OU-1 and OU-2 Table 8-2 (Ramboll 2021) and failed the health-based screening for at least one of the evaluated environmental media listed in this Table.

References:

Ramboll. 2021. Remedial Investigation Report for OU-1 and OU-2, Nevada Environmental Response Trust Site, Henderson, Nevada. July 9.

TABLE 6-2. Physical/Chemical Properties of the Preliminary COPCs to Include in the OU-3 BHRA
Nevada Environmental Response Trust Site
Henderson, Nevada

Chemical Group	Chemical [1]	Molecular Weight	Organic Carbon Partition Coefficient	Diffusivity in Air	Diffusivity in Water	Pure Component Water Solubility	Henry's Law Constant at 25° C	Normal Boiling Point	Critical Temperature	Enthalpy of Vaporization at the Normal Boiling Point	Permeability Coefficient	Source
		MW	K_{oc}	D_a	D_w	S	H	T_B	T_C	ΔHv,b	Kp	
		(g/mol)	(cm^3/g)	(cm^2/s)	(cm^2/s)	(mg/L)	(atm-m^3/mol)	(^oK)	(^oK)	(cal/mol)	(cm/hr)	
General Chemistry	Chlorate	8.35E+01	--	--	--	--	--	--	--	--	1.00E-03	MW from EPISUITE, Kp from USEPA 2004a
General Chemistry	Nitrate	6.20E+01	--	--	--	--	--	--	--	--	1.00E-03	MW from NDEP, Kp from USEPA RSLs
General Chemistry	Perchlorate	1.17E+02	--	--	--	2.45E+05	--	--	--	--	1.00E-03	MW and S from NDEP, Kp from USEPA RSLs
Metals	Arsenic	7.79E+01	--	--	--	--	--	--	--	--	1.00E-03	MW from NDEP. Kp from USEPA RSLs
Metals	Chromium VI	5.20E+01	--	--	--	1.69E+06	--	--	--	--	2.00E-03	MW from NDEP, S and Kp from RSL
Metals	Magnesium	2.63E+01	--	--	--	--	--	--	--	--	1.00E-03	MW from EPISUITE, Kp from USEPA 2004a
Metals	Manganese	5.49E+01	--	--	--	--	--	--	--	--	1.00E-03	MW from NDEP, Kp from USEPA RSLs
VOCs	Carbon tetrachloride	1.54E+02	4.39E+01	5.71E-02	9.78E-06	7.93E+02	2.76E-02	3.50E+02	5.57E+02	7.13E+03	1.63E-02	NDEP, Kp from USEPA RSLs
VOCs	Chloroform	1.19E+02	3.18E+01	7.69E-02	1.09E-05	7.95E+03	3.67E-03	3.34E+02	5.36E+02	6.99E+03	6.83E-03	NDEP, Kp from USEPA RSLs
VOCs	1,1-Dichloroethane	9.90E+01	3.18E+01	8.36E-02	1.06E-05	5.04E+03	5.62E-03	3.30E+02	5.23E+02	6.90E+03	6.75E-03	NDEP, Kp from USEPA RSLs
VOCs	1,4-Dioxane	8.81E+01	2.63E+00	8.74E-02	1.05E-05	1.00E+06	4.80E-06	3.75E+02	5.85E+02	8.69E+03	3.32E-04	NDEP, Kp from USEPA RSLs
VOCs	1,2,3-Trichloropropane	1.47E+02	1.16E+02	5.75E-02	9.24E-06	1.75E+03	3.43E-04	4.30E+02	6.52E+02	9.17E+03	7.52E-03	NDEP, Kp from USEPA RSLs

Notes:

-- = Not available
atm-m^3/mol = atmosphere-cubic meter per mole
cal/mol = calorie per mole
cm^3/g = cubic centimeter per gram
cm^3/hr = cubic centimeter per hour
cm^2/s = square centimeter per second
COPC = Chemical of potential concern
g/mol = gram per mole
mg/L = milligram per liter
NDEP = Nevada Division of Environmental Protection
USEPA = United States Environmental Protection Agency
VOC = Volatile organic compound
^oK = degrees Kelvin

[1] Physical/chemical properties are only presented for the preliminary COPCs as identified in Table 6-1.

Sources:

EPISUITE: United States Environmental Protection Agency (USEPA). 2012. Estimation Programs Interface Suite™ for Microsoft® Windows, v 4.11. Washington, DC, USA.
Nevada Division of Environmental Protection (NDEP). 2020. Basic Screening Levels (BCLs) Version 2.0. August.
United States Environmental Protection Agency (USEPA). 2004a. Risk Assessment Guidance for Superfund. Vol. 1: Part E, Supplemental Guidance for Dermal Risk Assessment). Final. July.
USEPA. 2004b. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings Office of Emergency and Remedial Response. February.
USEPA. 2022. Regional Screening Levels (RSLs) - User's Guide. May.

TABLE 6-3. Exposure Assumptions
Nevada Environmental Response Trust Site
Henderson, Nevada

Exposure Factors [1]	Units	Symbol	Indoor Commercial/Industrial Worker		Outdoor Commercial/Industrial Worker		Construction Worker (Dry Trench Scenario) [2]		Maintenance/Utility Worker (Dry and Wet Trench Scenarios)		Recreational User - Adult [3]		Recreational User - Child [3]		Adolescent Trespasser (7 - 18 year old)	
			Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source
Receptor-Specific Exposure Factors																
Target Risk	unitless	TR	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--
Target Hazard Quotient	unitless	THQ	1	--	1	--	1	--	1	--	1	--	1	--	1	--
Population-Specific Exposure Assumptions																
Exposure Time	hours/day	ET	8	NDEP 2017a	8	NDEP 2017a	4	VDEQ 2020	4	VDEQ 2020	2	Site-specific	2	Site-specific	2	Site-specific [8]
Exposure Frequency	days/year	EF	250	NDEP 2017a	225	NDEP 2017a	30	[4]	5	Site-specific [5]	100	Site-specific [6]	100	Site-specific [6]	12	Site-specific [8]
Exposure Duration	years	ED	25	NDEP 2017a	25	NDEP 2017a	1	USEPA 2022	25	USEPA 2022	20	NDEP 2017a	6	NDEP 2017a	12	Site-specific
Body Weight	kg_{BW}	BW	80	NDEP 2017a	80	NDEP 2017a	80	USEPA 2022	80	USEPA 2022	80	NDEP 2017a	15	NDEP 2017a	50	USEPA 2011 [9]
Averaging Time for Carcinogens	days	AT_c	25,550	NDEP 2017a	25,550	NDEP 2017a	25,550	USEPA 2022	25,550	USEPA 2022	25,550	NDEP 2017a	25,550	NDEP 2017a	25,550	NDEP 2017a
Averaging Time for Noncarcinogens	days	AT_{nc}	9,125	NDEP 2017a	9,125	NDEP 2017a	365	USEPA 2022	9,125	USEPA 2022	7,300	NDEP 2017a	2,190	NDEP 2017a	4,380	NDEP 2017a
Surface Water Dermal Contact																
Event Duration	hour/event	t_{event}	--	--	--	--	--	--	--	--	--	--	--	--	2	Site-specific
Event Frequency	event/day	EV	--	--	--	--	--	--	--	--	--	--	--	--	1	Site-specific
Skin Surface Area for Surface Water Contact	cm^2	SA_{sw}	--	--	--	--	--	--	--	--	--	--	--	--	19,652	USEPA 2022
Intake Factor for Surface Water Dermal Contact, cancer	cm^2-event/kg_{BW}/day	$IF_{sw.derm\_c}$	--	--	--	--	--	--	--	--	--	--	--	--	2.2E+00	USEPA 2004
Intake Factor for Surface Water Dermal Contact, noncancer	cm^2-event/kg_{BW}/day	$IF_{sw.derm\_nc}$	--	--	--	--	--	--	--	--	--	--	--	--	1.3E+01	USEPA 2004
Soil or/and Sediment Dermal Contact																
Skin Surface Area for Soil Contact	cm^2/day	SAs	--	--	--	--	--	--	--	--	--	--	--	--	4,657	USEPA 2011 [10]
Adherence Factor	mg_{soil}/cm^2	AF	--	--	--	--	--	--	--	--	--	--	--	--	0.07	USEPA 2022 [11]
Conversion Factor	kg_{soil}/mg_{soil}	CF	--	--	--	--	--	--	--	--	--	--	--	--	1E-06	--
Intake Factor for Bank Soil and Sediment Dermal Contact, cancer	kg_{soil}/kg_{BW}/day	$IF_{soil.derm\_c}$	--	--	--	--	--	--	--	--	--	--	--	--	3.6E-08	USEPA 2004
Intake Factor for Bank Soil and Sediment Dermal Contact, noncancer	kg_{soil}/kg_{BW}/day	$IF_{soil.derm\_nc}$	--	--	--	--	--	--	--	--	--	--	--	--	2.1E-07	USEPA 2004
Soil Ingestion																
Seep Area Soil Ingestion Rate	$mg_{seep\ soil}$/day	IR_s	--	--	--	--	--	--	330	USEPA 2022	100	USEPA 2022	200	USEPA 2022	--	--
Conversion Factor	$kg_{seep\ soil}/mg_{seep\ soil}$	CF	--	--	--	--	--	--	1E-06	--	1E-06	--	1E-06	--	--	--
Intake Factor for Seep Area Soil Ingestion, cancer	$kg_{seep\ soil}/kg_{BW}$/day	$IF_{soil.ing\_c}$	--	--	--	--	--	--	2.0E-08	USEPA 1989	9.8E-08	USEPA 1989	3.1E-07	USEPA 1989	--	--
Intake Factor for Seep Area Soil Ingestion, noncancer	$kg_{seep\ soil}/kg_{BW}$/day	$IF_{soil.ing\_nc}$	--	--	--	--	--	--	5.7E-08	USEPA 1989	3.4E-07	USEPA 1989	3.7E-06	USEPA 1989	--	--
Soil Dermal Contact																
Skin Surface Area for Seep Area Soil Contact	cm^2/day	SAs	--	--	--	--	--	--	3,527	USEPA 2022	6,032	USEPA 2022	2,373	USEPA 2022	--	--
Adherence Factor	$mg_{seep\ soil}/cm^2$	AF	--	--	--	--	--	--	0.3	USEPA 2022	0.07	USEPA 2022	0.2	USEPA 2022	--	--
Conversion Factor	$kg_{seep\ soil}/mg_{seep\ soil}$	CF	--	--	--	--	--	--	1E-06	--	1E-06	--	1E-06	--	--	--
Intake Factor for Seep Area Soil Dermal Contact, cancer	$kg_{seep\ soil}/kg_{BW}$/day	$IF_{soil.derm\_c}$	--	--	--	--	--	--	6.5E-08	USEPA 2004	4.1E-07	USEPA 2004	7.4E-07	USEPA 2004	--	--
Intake Factor for Seep Area Soil Dermal Contact, noncancer	$kg_{seep\ soil}/kg_{BW}$/day	$IF_{soil.derm\_nc}$	--	--	--	--	--	--	1.8E-07	USEPA 2004	1.4E-06	USEPA 2004	8.7E-06	USEPA 2004	--	--
Inhalation of Soil Particulates																
Conversion Factor	hour/day	CF	--	--	--	--	--	--	24	--	24	--	24	--	24	--
Intake Factor for Soil Particulate Inhalation, cancer	unitless	$IF_{part.inh\_c}$	--	--	--	--	--	--	8.2E-04	USEPA 2009	6.5E-03	USEPA 2009	2.0E-03	USEPA 2009	4.7E-04	USEPA 2009
Intake Factor for Soil Particulate Inhalation, noncancer	unitless	$IF_{part.inh\_nc}$	--	--	--	--	--	--	2.3E-03	USEPA 2009	2.3E-02	USEPA 2009	2.3E-02	USEPA 2009	2.7E-03	USEPA 2009
Inhalation of Vapor Migrating from Seep Area Soil to Outdoor or Trench Air																
Conversion Factor	hour/day	CF	--	--	--	--	--	--	24	--	24	--	24	--	--	--
Intake Factor for Vapor Inhalation, cancer	unitless	$IF_{vapor.inh\_c}$	--	--	--	--	--	--	8.2E-04	USEPA 2009	6.5E-03	USEPA 2009	2.0E-03	USEPA 2009	--	--
Intake Factor for Vapor Inhalation, noncancer	unitless	$IF_{vapor.inh\_nc}$	--	--	--	--	--	--	2.3E-03	USEPA 2009	2.3E-02	USEPA 2009	2.3E-02	USEPA 2009	--	--
Incidental Groundwater Ingestion (Wet Trench Scenario)																
Incidental Groundwater Ingestion Rate	L_{gw}/day	IR_{gw}	--	--	--	--	--	--	0.020	VDEQ 2020	--	--	--	--	--	--
Intake Factor for Incidental Groundwater Ingestion, cancer	L_{gw}/kg_{BW}/day	$IF_{gw.ing\_c}$	--	--	--	--	--	--	1.2E-06	USEPA 1989	--	--	--	--	--	--
Intake Factor for Incidental Groundwater, noncancer	L_{gw}/kg_{BW}/day	$IF_{gw.ing\_nc}$	--	--	--	--	--	--	3.4E-06	USEPA 1989	--	--	--	--	--	--

TABLE 6-3. Exposure Assumptions
Nevada Environmental Response Trust Site
Henderson, Nevada

Exposure Factors [1]	Units	Symbol	Indoor Commercial/Industrial Worker		Outdoor Commercial/Industrial Worker		Construction Worker (Dry Trench Scenario) [2]		Maintenance/Utility Worker (Dry and Wet Trench Scenarios)		Recreational User - Adult [3]		Recreational User - Child [3]		Adolescent Trespasser (7 - 18 year old)	
			Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source
Receptor-Specific Exposure Factors																
Target Risk	unitless	TR	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--
Target Hazard Quotient	unitless	THQ	1	--	1	--	1	--	1	--	1	--	1	--	1	--
Population-Specific Exposure Assumptions																
Exposure Time	hours/day	ET	8	NDEP 2017a	8	NDEP 2017a	4	VDEQ 2020	4	VDEQ 2020	2	Site-specific	2	Site-specific	2	Site-specific [8]
Exposure Frequency	days/year	EF	250	NDEP 2017a	225	NDEP 2017a	30	[4]	5	Site-specific [5]	100	Site-specific [6]	100	Site-specific [6]	12	Site-specific [8]
Exposure Duration	years	ED	25	NDEP 2017a	25	NDEP 2017a	1	USEPA 2022	25	USEPA 2022	20	NDEP 2017a	6	NDEP 2017a	12	Site-specific
Body Weight	kg_{BW}	BW	80	NDEP 2017a	80	NDEP 2017a	80	USEPA 2022	80	USEPA 2022	80	NDEP 2017a	15	NDEP 2017a	50	USEPA 2011 [9]
Averaging Time for Carcinogens	days	AT_c	25,550	NDEP 2017a	25,550	NDEP 2017a	25,550	USEPA 2022	25,550	USEPA 2022	25,550	NDEP 2017a	25,550	NDEP 2017a	25,550	NDEP 2017a
Averaging Time for Noncarcinogens	days	AT_{nc}	9,125	NDEP 2017a	9,125	NDEP 2017a	365	USEPA 2022	9,125	USEPA 2022	7,300	NDEP 2017a	2,190	NDEP 2017a	4,380	NDEP 2017a
Dermal Contact with Shallow Groundwater (Wet Trench Scenario)																
Event Duration	hour/event	t_{event}	--	--	--	--	--	--	4.0	Site-specific	--	--	--	--	--	--
Event Frequency	event/year	EV	--	--	--	--	--	--	5	Site-specific	--	--	--	--	--	--
Skin Surface Area for Groundwater Contact	cm^2	SA_{gw}	--	--	--	--	--	--	3,527	USEPA 2022 [7]	--	--	--	--	--	--
Intake Factor for Groundwater Dermal Contact, cancer	cm^2-event/kg_{BW}/day	$IF_{gw.derm\_c}$	--	--	--	--	--	--	2.2E-01	USEPA 2004	--	--	--	--	--	--
Intake Factor for Groundwater Dermal Contact, noncancer	cm^2-event/kg_{BW}/day	$IF_{gw.derm\_nc}$	--	--	--	--	--	--	6.0E-01	USEPA 2004	--	--	--	--	--	--
Inhalation of Air Migrating from Soil, Soil Gas, or Shallow Groundwater to Indoor, Outdoor, or Trench Air																
Conversion Factor	hour/day	CF	24	--	24	--	24	--	24	--	24	--	24	--	--	--
Intake Factor for Vapor Inhalation, cancer	unitless	$IF_{vapor.inh\_c}$	8.2E-02	USEPA 2009	7.3E-02	USEPA 2009	2.0E-04	USEPA 2009	8.2E-04	USEPA 2009	6.5E-03	USEPA 2009	2.0E-03	USEPA 2009	--	--
Intake Factor for Vapor Inhalation, noncancer	unitless	$IF_{vapor.inh\_nc}$	2.3E-01	USEPA 2009	2.1E-01	USEPA 2009	1.4E-02	USEPA 2009	2.3E-03	USEPA 2009	2.3E-02	USEPA 2009	2.3E-02	USEPA 2009	--	--

Notes:

-- = Not applicable
COPC = Chemical of Potential Concern
NDEP = Nevada Division of Environmental Protection
RSL = Regional Screening Level
USEPA = United States Environmental Protection Agency
VDEQ = Virginia Department of Environmental Quality

[1] Soil direct contact is not evaluated for any receptor as transport of contamination is not anticipated to soil. Any impacts to soil are not anticipated to be site-related.

[2] Based on land-use and zoning information, construction activities are only expected to occur on the City of Henderson Water Reclamation Facility property, where groundwater is deep enough that construction workers are not anticipated to contact groundwater during excavation.

[3] The recreational users west of Pabco Road are assumed to be exposed to chloroform vapors. Exposures for visitors to the portion of the Wetlands Park east of Pabco Road through the vapor inhalation pathway are not evaluated because NERT is not responsible for VOCs in OU-3 east of Pabco Road (see Section 3 of the text for details). According to the Wetland Park rules, direct contact with surface water and sediment in the Wetland Park is prohibited, therefore chronic exposures through this pathway are not expected.
Due to Park rules, direct contact with surface water, sediment and bank soil is not expected to occur on a regular basis and, therefore, will not be evaluated quantitatively. Inhalation of bank soil particulates will be evaluated quantitatively.

[4] Recommended exposure frequency in NDEP's January 12, 2017 comment letter (NDEP 2017b).

[5] It was assumed that a maintenance worker would be conducting small-scaled utility or landscaping work for five days a year.

[6] It was assumed that a regular recreational visitor would participate in activities (walking, jogging, biking, sports) 2 days per week for 50 weeks per year.

[7] Assumed to be the same as the default skin surface area for soil contact for workers from USEPA guidance (USEPA 2022).

[8] It was assumed that an adolescent may visit the Clark County Wetlands Park and the surrounding areas 2 hours per month for 12 months per year.

[9] Bodyweight was calculated as the time weighted average (TWA) of age-specific bodyweights presented in the Exposure Factors Handbook (USEPA 2011).

[10] Skin surface area for soil and sediment dermal contact pathway was calculated as the time weighted average (TWA) of face (1/3 of head), hands, forearms (45% of arms), lower legs (40% of legs), and feet provided in the Exposure Factors Handbook (USEPA 2011).

[11] Assumed the mutagenic skin adherence factor for 6 to 26 years old (USEPA 2022).

Sources:

NDEP 2017a. User's Guide and Background Technical Document for the Nevada Division of Environmental Protection (NDEP) Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas. Las Vegas, NV. July.
NDEP 2017b. NDEP Response to: Soil Gas Investigation and Health Risk Assessment for Parcels C, D, F, G and H, Revision 1. January 12, 2017.
Virginia Department of Environmental Quality (VDEQ). 2020. Virginia Unified Risk Assessment Model - VURAM User's Guide. Appendix 3. June.
USEPA. 1989. Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual (Part A). Interim Final. December.
USEPA. 2004. Risk Assessment Guidance for Superfund. Vol. 1: Part E, Supplemental Guidance for Dermal Risk Assessment). Final. July.
USEPA. 2009. Risk Assessment Guidance for Superfund. Vol. 1: Part F, Supplemental Guidance for Inhalation Risk Assessment. Final. January.
USEPA. 2011. Exposure Factors Handbook, 2011 Edition. September.
USEPA. 2022. User's Guide for Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. May.

TABLE 6-4. Chronic and Subchronic Toxicity Criteria for Selected Preliminary COPCs to Include in the OU-3 BHRA
Nevada Environmental Response Trust Site
Henderson, Nevada

Chemical Group	Chemical[1]	Oral Cancer Slope Factor (mg/kg-day)$^{-1}$		Inhalation Unit Risk (µg/m^3)$^{-1}$		USEPA Weight-of-Evidence Carcinogen Classification		Oral Chronic RfD (mg/kg-day)		Inhalation Chronic RfC (µg/m^3)		Oral Subchronic RfD (mg/kg-day)		Inhalation Subchronic RfC (µg/m^3)		Soil Dermal Absorption Factor ABS_{soil}	
General Chemistry	Chlorate	--	--	--	--	--	--	0.030	NDEP	--	--	0.030	NDEP [2]	--	--	--	--
General Chemistry	Nitrate	--	--	--	--	--	--	1.6	IRIS	--	--	4.0	ATSDR	--	--	--	--
General Chemistry	Perchlorate	--	--	--	--	E	IRIS	0.00070	IRIS	--	--	0.00070	IRIS [2]	--	--	--	--
Metals	Arsenic	1.5	IRIS	0.0043	IRIS	A	IRIS	0.00030	IRIS	0.015	Cal/EPA	0.00030	IRIS [2]	0.015	Cal/EPA [2]	0.030	NDEP
Metals	Chromium (total)	--	--	--	--	--	--	1.5	IRIS	--	--	1.5	HEAST	5.0	ATSDR	0.10	NDEP
Metals	Chromium VI	0.50	Cal/EPA	0.084	IRIS [3]	A	IRIS	0.0030	IRIS	0.10	IRIS	0.0050	ATSDR	0.30	ATSDR	--	--
Metals	Magnesium	--	--	--	--	--	--	5.7	NDEP	--	--	5.7	NDEP [2]	--	--	0.10	NDEP
Metals	Manganese	--	--	--	--	D	IRIS	0.14	IRIS [4]	0.050	IRIS	0.14	IRIS [2,4]	0.050	IRIS [2]	--	--
VOCs	Carbon tetrachloride	0.070	IRIS	0.0000060	IRIS	B2	IRIS	0.0040	IRIS	100	IRIS	0.0070	ATSDR	190	ATSDR	--	--
VOCs	Chloroform	0.031	Cal/EPA	0.000023	IRIS	B2	IRIS	0.010	IRIS	98	ATSDR	0.10	ATSDR	240	ATSDR	--	--
VOCs	1,1-Dichloroethane	0.0057	Cal/EPA	0.0000016	Cal/EPA	C	IRIS	0.20	PPRTV	--	--	2.0	PPRTV	--	--	--	--
VOCs	1,4-Dioxane	0.10	IRIS	0.0000050	IRIS	B2	IRIS	0.030	IRIS	30	IRIS	0.50	ATSDR	720	ATSDR	--	--
VOCs	1,2,3-Trichloropropane	30	IRIS	--	--	B2	IRIS	0.0040	IRIS	0.30	IRIS	0.030	ATSDR	0.30	IRIS [2]	--	--

Notes:

-- = Not available
mg/kg-day = milligram per kilogram per day
µg/m^3 = microgram per cubic meter
ABS_{soil} = Soil dermal absorption factor
ATSDR = Agency for Toxic Substances and Disease Registry (values as cited in USEPA 2022a)
Cal/EPA = California Environmental Protection Agency (values as cited in USEPA 2022a)
COPC = Chemical of potential concern
IRIS = Integrated Risk Information System (USEPA 2022b)
NDEP = Nevada Division of Environmental Protection
OU = Operable unit
RBA_{oral} = Relative bioavailability for oral ingestion
RfD = Reference dose
RfC = Reference concentration
USEPA = United States Environmental Protection Agency
VOC = Volatile Organic Compound

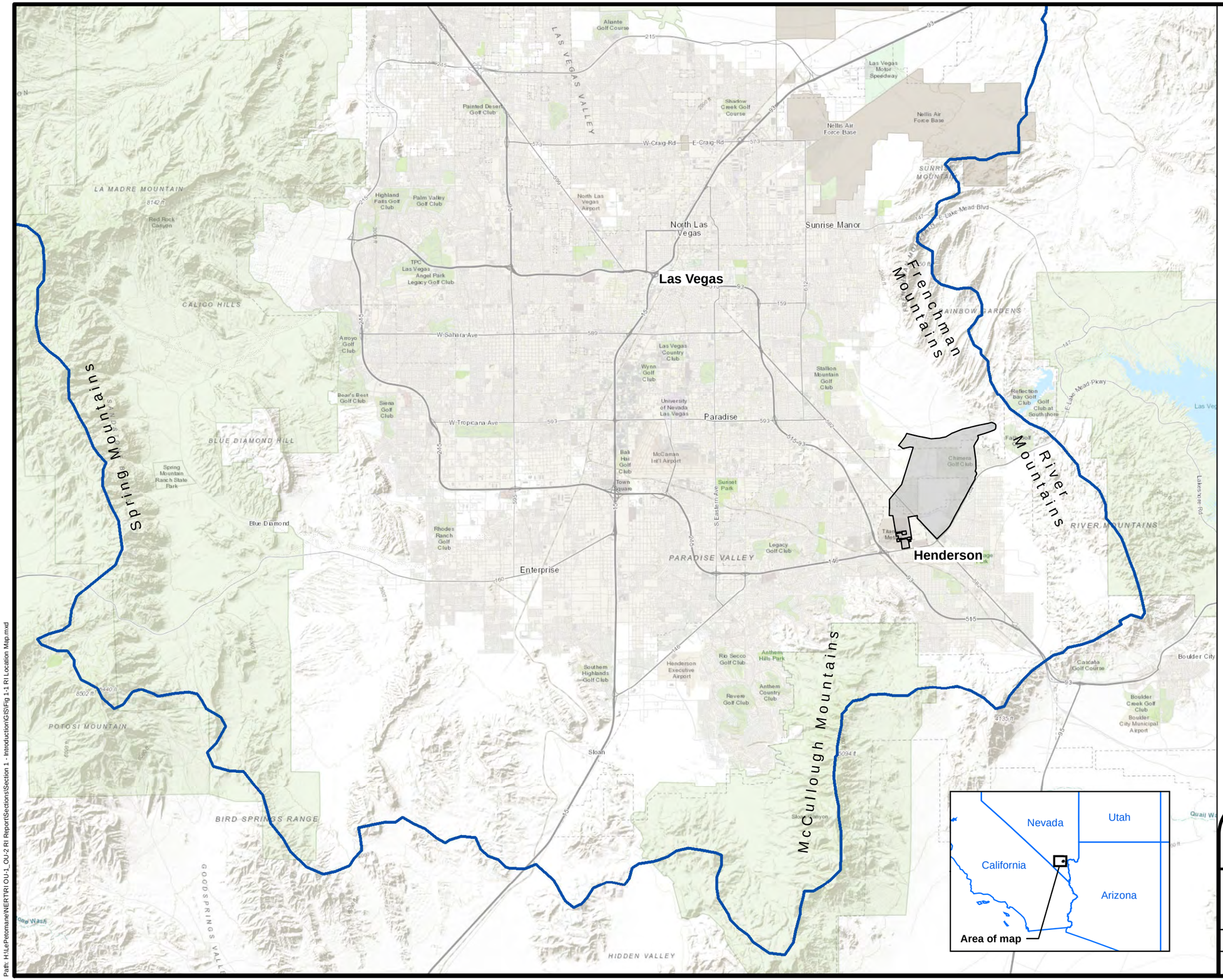
USEPA Weight-of-Evidence Carcinogen Classification:
A = Human carcinogen
B1 = Probable carcinogen, limited human evidence
B2 = Probable carcinogen, sufficient evidence in animals
C = Possible human carcinogen
D = Not classifiable
E = Evidence of noncarcinogenicity

[1] The chemicals shown are the preliminary COPCs for soil gas and shallow groundwater identified in Table 6-1.
[2] Use chronic value as surrogate.
[3] The IRIS inhalation unit risk value was multiplied by seven to account for an assumed ratio of 6:1 for chromium III to chromium VI in the data used to derive the IRIS value (USEPA 2022b).
[4] The IRIS RfD for manganese from all sources, including diet, was corrected to account for the dietary contribution and uncertainties associated with non-food sources (USEPA 2022b).
[5] Use dichloromethane (methylene chloride) as surrogate

Sources:

NDEP. 2020. Basic Comparison Level (BCL) Table. August.
USEPA. 2022a. Regional Screening Levels Table. November.
USEPA. 2022b. Integrated Risk Information System (IRIS). Available online at https://www.epa.gov/iris. Accessed on Decembter 2, 2022.

FIGURES



LEGEND:

- Las Vegas Valley Hydrologic Basin
- NERT RI Study Area

Note:
See Figure 1-2 for NERT RI Study Area details.

N

0 2.5 5 Miles

RAMBOLL

NERT RI Study Area Location Map
Nevada Environmental Response Trust Site
Henderson, Nevada

Date:	Contract Number:		Figure
2/23/2022	1690025040-003		1-1
Drafter: RS	Approved:	Revised:	

Path: H:\LePetomane\NERT\RI OU-1_OU-2 RI Report\Sections\Section 1 - Introduction\GIS\Fig 1-1 RI Location Map.mxd

N

0 1,500 3,000
Feet

Las Vegas Wash

Operable Unit 3

BMI

GALLERIA DR
(Formerly Athens Road)

SUNSET RD

WARM SPRINGS RD

BOULDER HWY

PABCO RD

LAKE MEAD PARKWAY

Operable Unit 2

BMI
(CAMU)

NERT

TIMET

OSSM

Current BMI
Complex

Former PEPCON

LAKE MEAD PARKWAY

Operable Unit 1

US HIGHWAY 95

NEVADA

HENDERSON

AERIAL SOURCE: SNWA, 2020.

LEGEND:

- Cadence Master Planned Community
- Current BMI Complex
- Operable Units

Land Ownership

- BMI
- Bureau of Reclamation
- City of Henderson
- Clark County
- Coyote Valley
- Henderson Groundwater
- Lhoist
- NERT
- Former NERT-Owned Property
- OSSM
- TIMET
- WAPA

Note:
Property ownership is not depicted in the Eastside Sub-Area due to ongoing rapid development and changes in ownership.

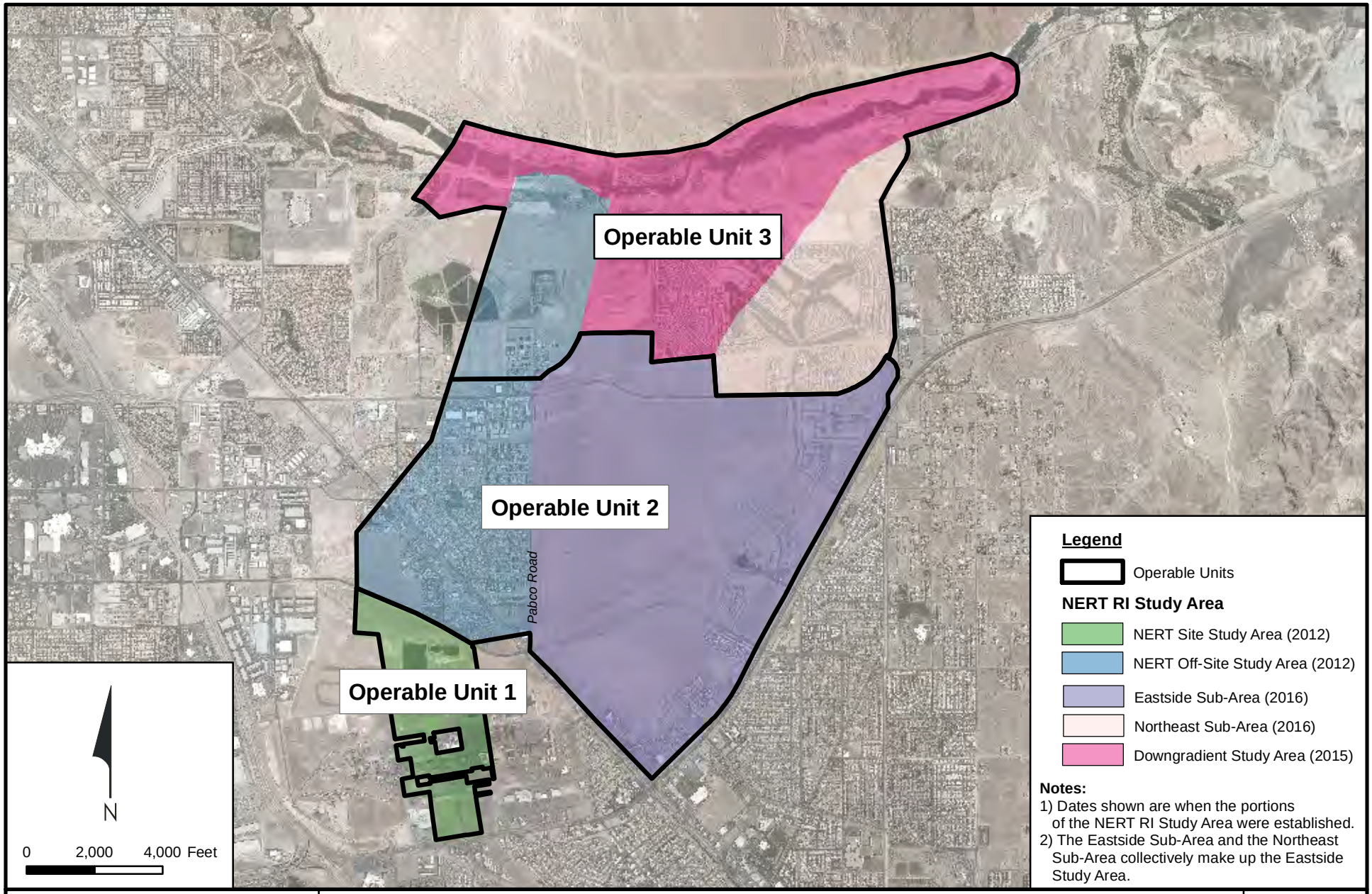
Path: H:\LePetomane\NERT\Risk Assessment-Human Health\2018 BHRAs\OU-3 BHRA Work Plan\GIS\Fig 1-3a BMI Complex Land Ownership and Surrounding Area.mxd

RAMBOLL

Major Land Ownership in the RI Study Area
Nevada Environmental Response Trust Site, Henderson, Nevada

Figure
1-2

Drafter: RS/JC | Date: 02/25/2022 | Contract Number: 1690025040-003 | Approved by: | Revised:



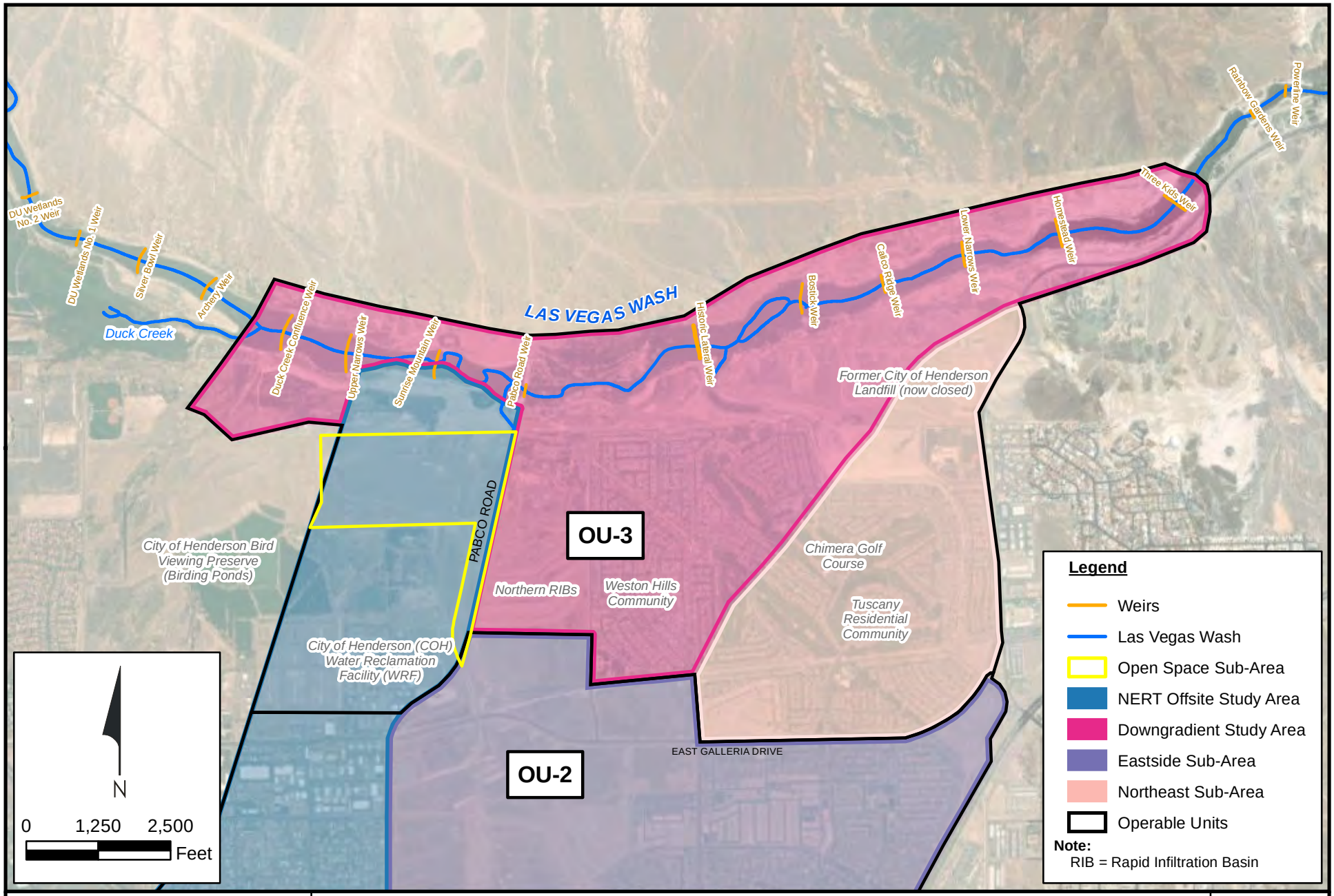
RAMBOLL

NERT RI Study Area Operable Units
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
1-3

Drafter: RS Date: 2/23/2022 Contract Number: 1690025040-003 Approved: Revised:

Path: H:\LePetomane\NERT\Risk Assessment-Human Health\2018 BHRAs\OU-1 Soil BHRA\GIS\Fig 1-2 RI Study Area Operable Units.mxd



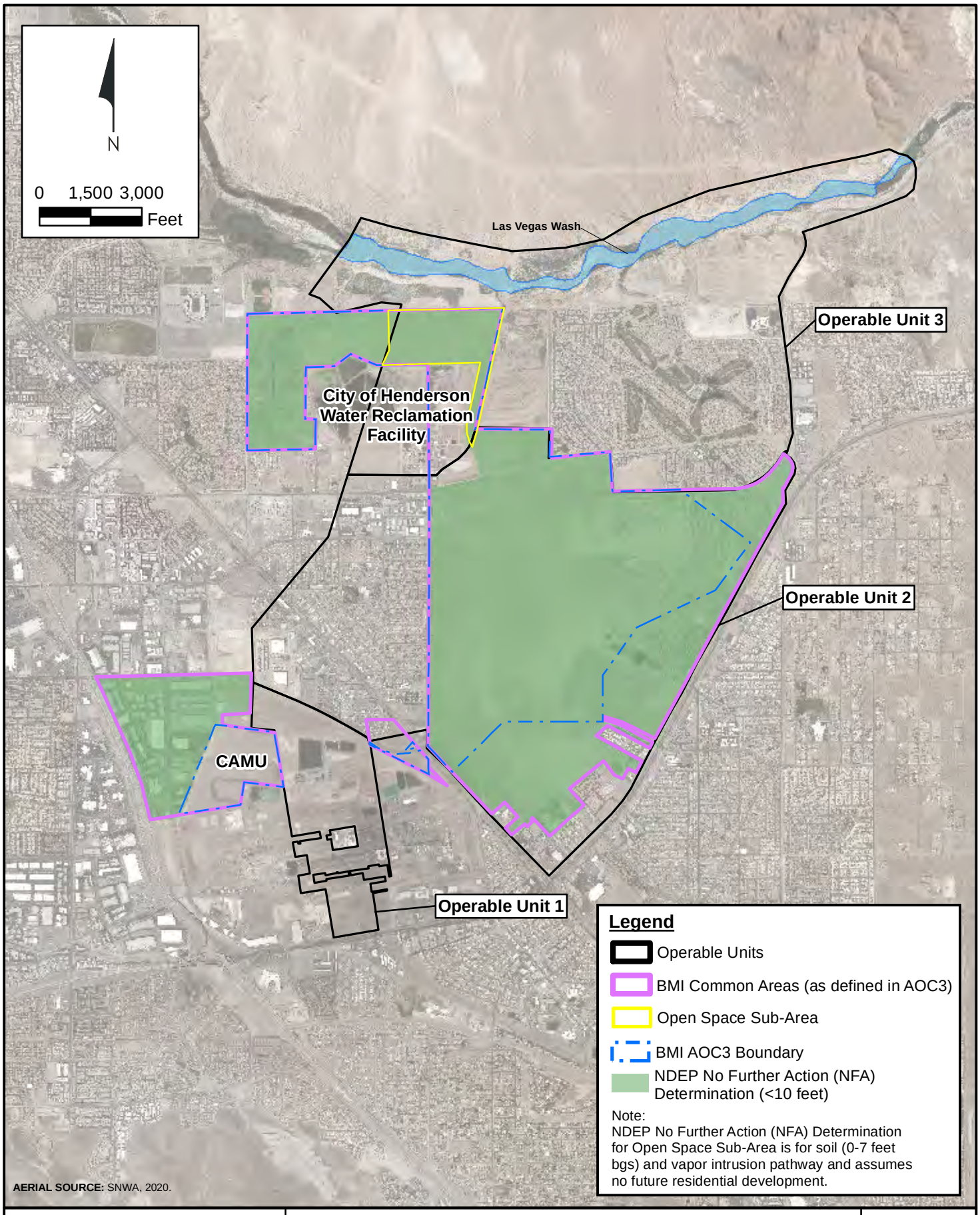
RAMBOLL

Layout of OU-3
Nevada Environmental Response Trust Site, Henderson, Nevada

Figure
1-4

Drafter:	RS	Date:	2/23/2022	Contract Number:	1690025040-003	Approved:		Revised:	

Path: H:\LePetomane\NERT\Risk Assessment-Human Health\2018 BHRAs\OU-3 BHRA Work Plan\GIS\Figure 1-3 OU3 + Weirs_8.5x11.mxd



RAMBOLL

BMI Common Areas and No Further Action Determination Areas

Nevada Environmental Response Trust Site, Henderson, Nevada

Figure

1-5

Drafter:	RS	Date:	02/23/2022	Contract Number:	1690025040-003	Approved:	Revised:

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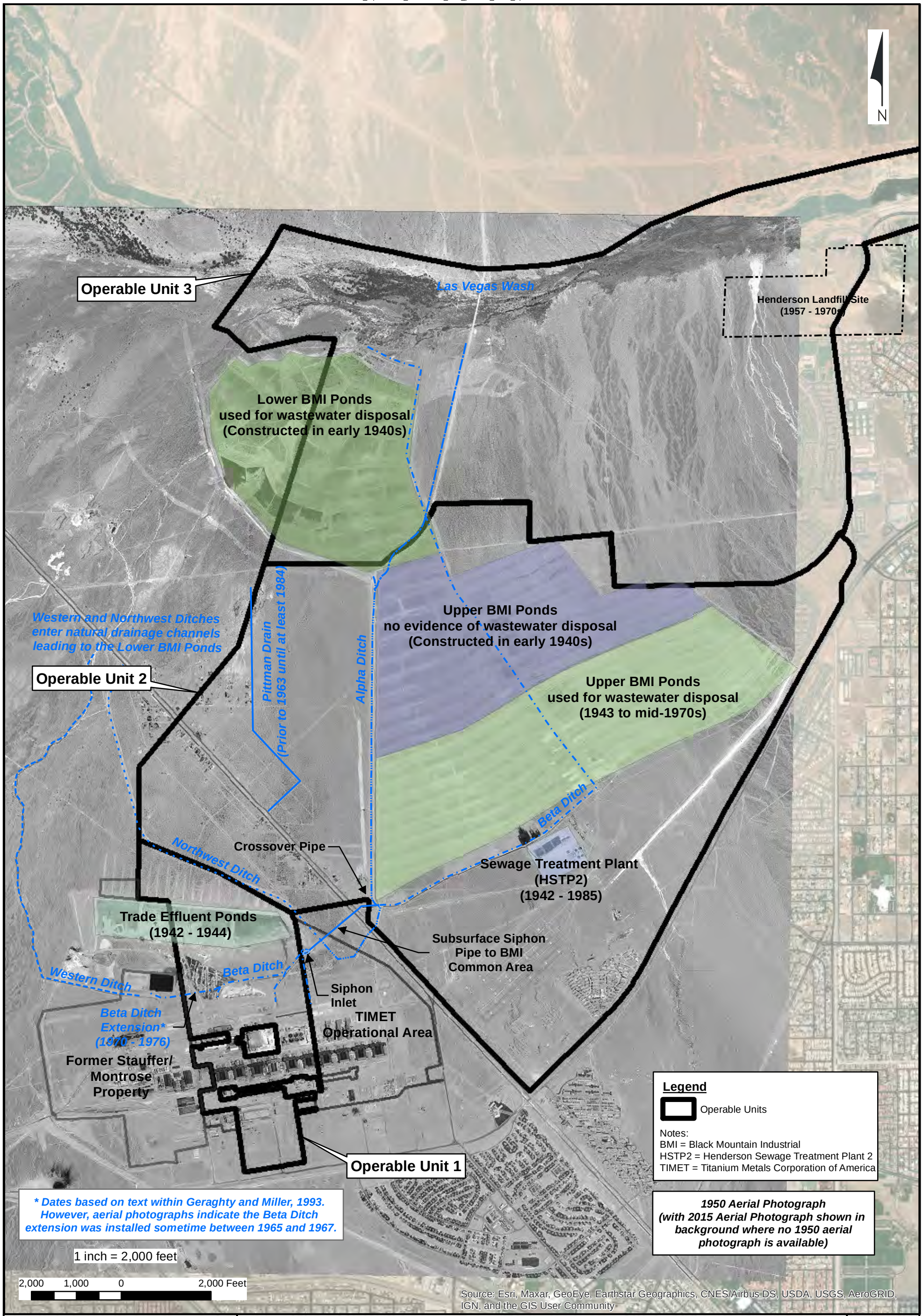

RAMBOLL

Historical Wastewater Ponds (established before 1975)
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-1

Drafter: RS/JC | Date: 2/23/2022 | Contract Number: 1690025040-003 | Approved by: | Revised:

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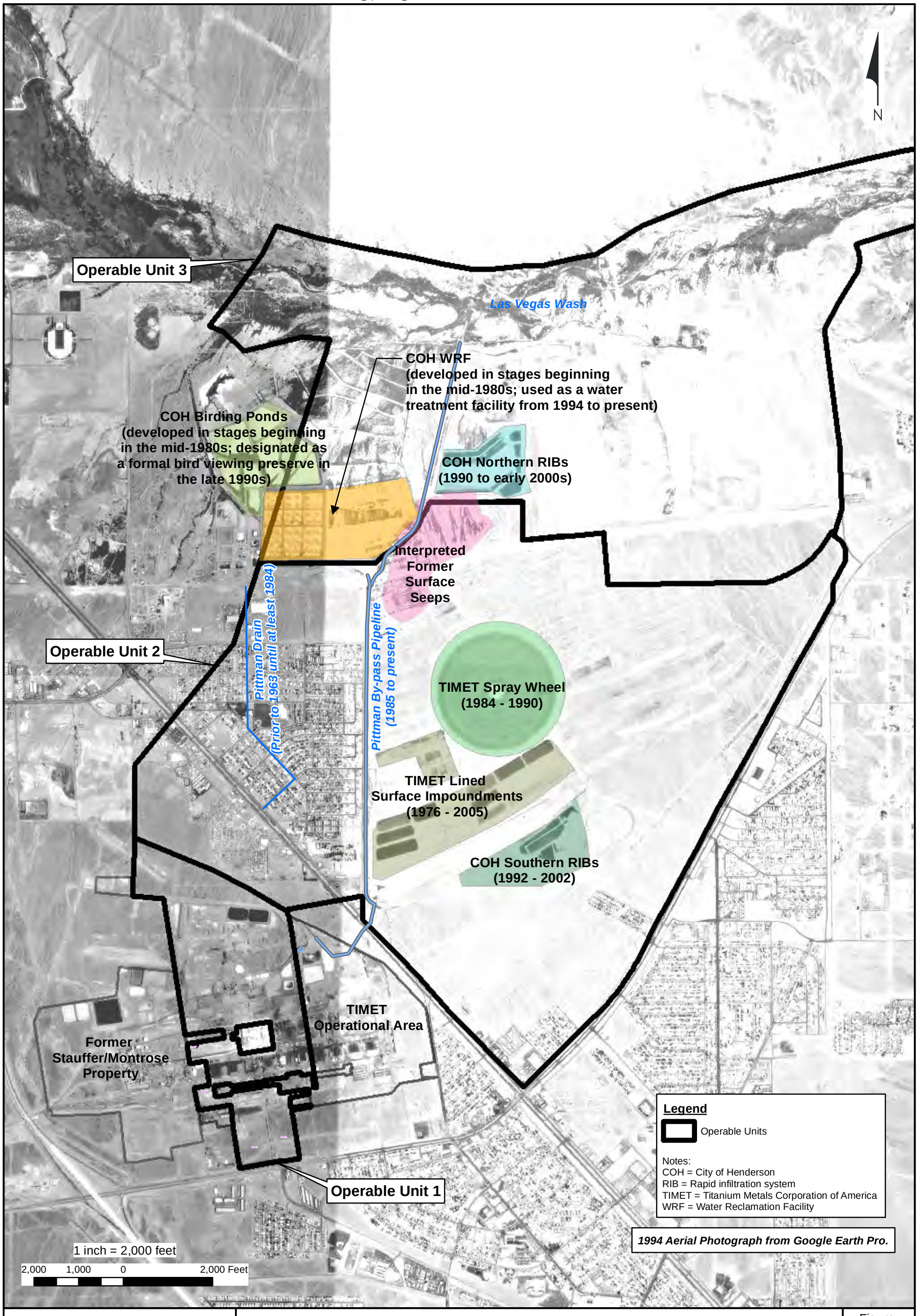


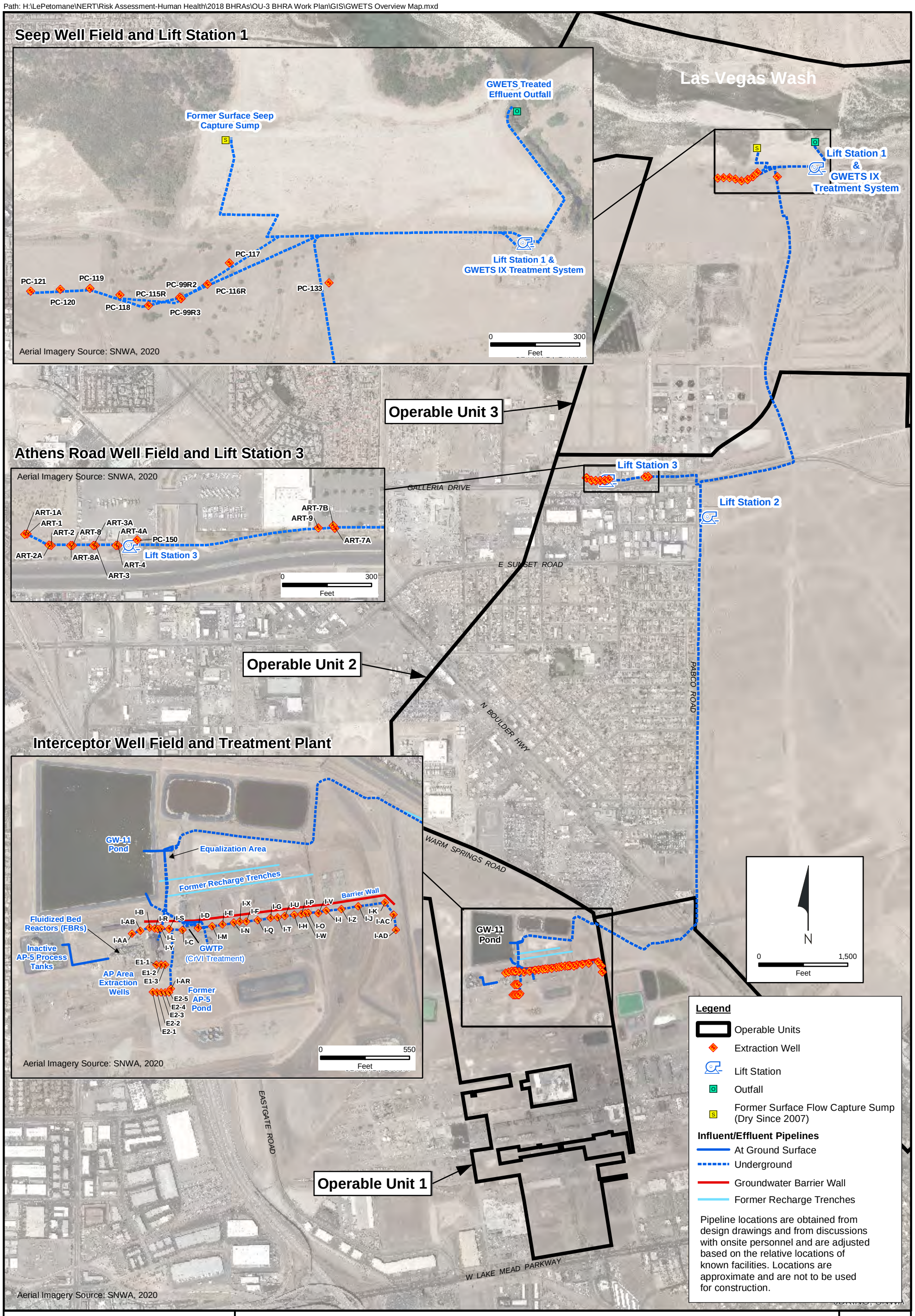
RAMBOLL

Historical Wastewater Ponds (1976 - Present)
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-2

Drafter: RS	Date: 2/23/2022	Contract Number: 1690025040-003	Approved by:	Revised:

Path: H:\LePetomane\NERT\Risk Assessment-Human Health\2018 BHRAs\OU-3 BHRA Work Plan\GIS\GWETS Overview Map.mxd



RAMBOLL

Groundwater Extraction and Treatment System (GWETS) Components Location Map

Nevada Environmental Response Trust Site; Henderson, Nevada

Figure **3-3**

Drafter: RS	Date: 02/23/2022	Contract Number: 1690025040-003	Approved by:	Revised:

Legend

- Groundwater Wells (Minimum Groundwater Elevation < or around 10 ft bgs)
- Groundwater Wells (Minimum Groundwater Elevation > 10 ft bgs)
- Soil Gas Sample Locations (5' bgs)
- Soil Gas Sample Locations (5' and 10' bgs)
- Soil Gas Sample Locations (5' and 15' bgs)
- Proposed Soil Gas Sample Locations (Phase 3 RI Modification No. 15)
- Open Space Sub-Area
- Operable Units
- NERT Offsite Study Area
- Downgradient Study
- Eastside Sub-Area
- Northeast Sub-Area
- Las Vegas Wash

Groundwater Chloroform Concentration (µg/L)

- < 70
- 70 - 500
- 500 - 1,000
- 1,000 - 10,000
- > 10,000

WMW6.9N
WMW6.9S
WMW6.55S
NERT6.21N1
WMW6.15S
PMW-8
PC-76
RISG-50
PC-155A
PC-156A
PC-156B
PC-157A
RIT-10
RISG-51
PC-77
PC-205A
COH-2B1
PC-96
PC-97
PABCO ROAD
ES-55B
RISG-45
PC-201
DBMW-19
RISG-42
PC-4
PC-1
RISG-36
PC-103
PC-98R
MW-K5
PC-178
RISG-44
PC-53
RISG-43
PC-2
RISG-92
RISG-40
RISG-39
RISG-38
PC-200
RISG-91
RISG-35
PC-191
RISG-37
PZ-2S
EAST GALLERIA DRIVE

N

0 250 500

Feet

H:\LePetomane\NERT\Risk Assessment-Human Health\2018 BHRAs\OU-3 BHRA Work Plan\GIS\Figure 4-1 Proposed Soil Gas Sampling Loc in OU-3-2.mxd

RAMBOLL

Soil Gas and Groundwater Sample Locations for Use in the BHRA for OU-3 - West of Pabco Road (Chloroform Plume as Depicted in 2021)

Nevada Environmental Response Trust Site, Henderson, Nevada

Figure **4-1**

Drafter: JA	Date: 11/2/2022	Contract Number: 1690025040-003	Approved by:	Revised:

N

0 1,000 2,000

Feet

NERT3.80S1
NERT3.98S1
LVWPS-MW216
LVWPS-MW215A
NERT5.11S1
WMW5.7N
WMW5.5S
NERT5.91S2
NERT5.98S1
MW-4(CHIM)
MW-3(CHIM)
LVWPS-MW111A
LVWPS-MW112A
LVWPS-MW108A
LVWPS-MW101A
ZTS-MW114
LVWPS-MW102A
ES-25A
MW-1(CHIM)
PABCO ROAD
EAST GALLERIA DRIVE

Legend

- Groundwater Wells (Minimum Groundwater Elevation < or around 10 ft bgs)
- Las Vegas Wash
- Open Space Sub-Area
- NERT Offsite Study Area
- Downgradient Study
- Eastside Sub-Area
- Northeast Sub-Area
- Operable Units

2021 Perchlorate Plume (mg/L)

- <1
- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1,000
- >1,000

H:\LePetomane\NERT\Risk Assessment-Human Health\2018 BHRAs\OU-3 BHRA Work Plan\GIS\Figure 4-2 Shallow GW Locations.mxd

RAMBOLL

DRAFTED BY: MFS | DATE: 02/23/2022

Shallow Groundwater Sample Locations (GWE ≤ 10 ft bgs) for Use in the BHRA for OU-3 – East of Pabco Road (Perchlorate Plume as Depicted in 2021)

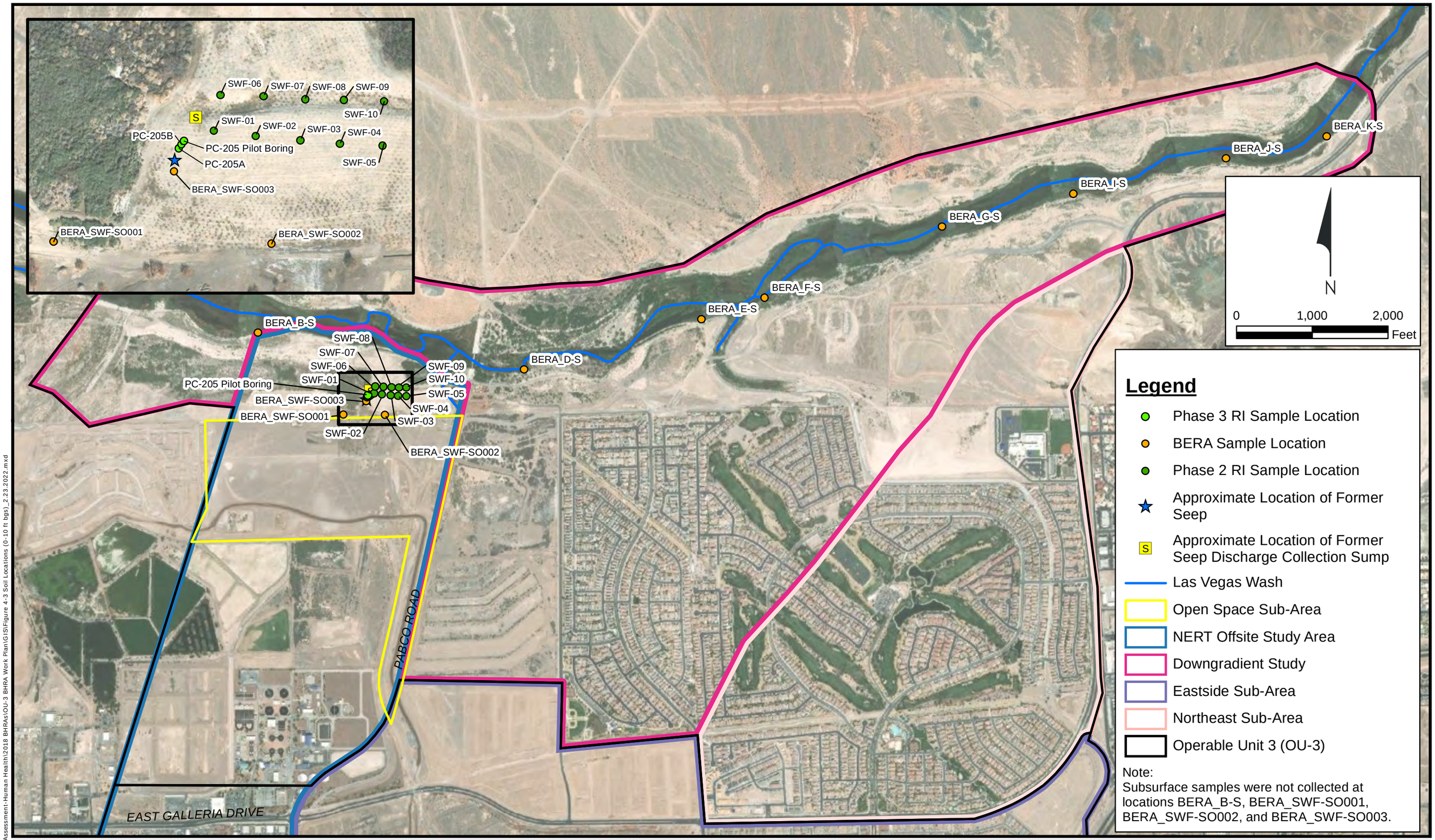
Nevada Environmental Response Trust Site

Henderson, Nevada

Figure

4-2

PROJECT: 1690025040-003



Legend

- Phase 3 RI Sample Location
- BERA Sample Location
- Phase 2 RI Sample Location
- Approximate Location of Former Seep
- Approximate Location of Former Seep Discharge Collection Sump
- Las Vegas Wash
- Open Space Sub-Area
- NERT Offsite Study Area
- Downgradient Study
- Eastside Sub-Area
- Northeast Sub-Area
- Operable Unit 3 (OU-3)

Note:
Subsurface samples were not collected at locations BERA_B-S, BERA_SWF-SO001, BERA_SWF-SO002, and BERA_SWF-SO003.

RAMBOLL

DRAFTED BY: MFS | DATE: 10/21/2022

Soil Sampling Locations for Use in the BHRA for OU-3

Nevada Environmental Response Trust Site

Henderson, Nevada

Figure **4-3**

PROJECT: 1690025040-003

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N

0 300 600

Feet

T6.8E
T6.8E
T6.8D
BERA_A-N
T6.8D
LW7.2
T6.8C
LVW 7.2
LW6.85
LVW 7.2
T6.8C
T6.8B
T6.8B
BERA_A-S
T6.8A
LW6.7
T6.55D
T6.55C
T6.55B
BERA_B-S
T6.55A
LVW 6.6-3
T6.5D
LVW 6.6-3
T6.5C
LVW 6.6-2
T6.5B
LVW-01
T6.5A
LVW 6.6-1
LVW 6.6-2
LVW 6.6-1
LVW-02
BERA_C-N
BERA_B-N
LVW-03
LVW-04
LVW-05
BERA_C-S
W4 SUNRISE MOUNTAIN
LVW-06
T6.35C
T6.35B
T6.35A
LVW-07
LVW-08
LVW-10
W4-5
LVW-09
T6E
T6D
T6D
LW6.05
T6C
T6C
T6B
LVW 6.05
T6A
T6B
GLWC6.1
LWC6.1
GLWC6.1
T6A
GLWC6.1
LWC6.3
S
GLWC6.1
LWC6.1
LWC6.1

Legend

Surface Water Sampling Event

- AECOM Round 1
- AECOM Round 2 Discrete
- AECOM Round 2 Transect
- AECOM Round 2 USGS
- AECOM Round 3
- OU-3 BERA
- GWM
- Phase 3 RI Modification No.10
- SWF 2016

Sediment Sampling Event

- OU-3 BERA

- Approximate Location of Former Seep
- Approximate Location of Former Seep Discharge Collection Sump
- Las Vegas Wash
- Open Space Sub-Area
- NERT Offsite Study Area
- Downgradient Study Area
- Operable Unit 3 (OU-3)

RAMBOLL

DRAFTED BY: SS | DATE: 11/3/2022

Surface Water and Sediment Sampling Locations for Use in the BHRA for OU-3 - West of Pabco Road

Nevada Environmental Response Trust Site

Henderson, Nevada

Figure

4-4a

PROJECT: 1690025040-003

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N

0 500 1,000

Feet

BERA_H-N
BERA_G-N
BERA_G-S
BERA_H-S
BERA_I-N
BERA_I-S
BERA_J-N
BERA_J-S
BERA_K-N
BERA_K-S
BERA_F-N
BERA_F-S
BERA_E-N
BERA_E-S
BERA_D-N
BERA_D-S
W7 LOWER NARROW
W8-9 3KIDS WEIR
W5 MIDDLE WAY
W5-6
C1-W
C1-E
GLW4.9
GLW4.85
LW4.95
LW5.5
LW5.3
LW5.7
LW5.9
LW4.1
LW3.85
LW3.75
GLW3.78
LWC4.1
LWC4.6
LWC3.7
GLW4.4
LVW 5.3-N
LVW 5.3-6
LVW 5.3-5
LVW 5.3-4
LVW 5.3-C
LVW 5.3-3
LVW 5.3-2
LVW 5.3-1
LVW 5.3-S
LVW 4.75-5
LVW 4.75-4
LVW 4.75-3
LVW 4.75-2
LVW 4.75-1
LVW 4.2-4
LVW 4.2-N
LVW 4.2-3
LVW 4.2-C
LVW 4.2-2
LVW 4.2-S
LVW 4.2-1
T5.3C
T5.3B
T5.3A
T4.85E
T4.85D
T4.85C
T4.85B
T4.85A
T4.8E
T4.8D
T4.8C
T4.8B
T4.8A
T4.75A
T4.75D
T4.75C
T4.75B
T4.7H
T4.7G
T4.7F
T4.7E
T4.7D
T4.7C
T4.7B
T4.7A
T4.65D
T4.65C
T4.6C
T4.6B
T4.65B
T4.6D
T4.6A
T4.65A
T4.65A
T4.2D
T4.2C
T4.2B
T4.2A
T3.9D
T3.9C
T3.9A
T3.9B
T3.8D
T3.8E
T3.8D
T3.8C
T3.8C
T3.8B
T3.8A
T3.75E
T3.75D
T3.75D
T3.75C
T3.75C
T3.75B
LW3.75
LW3.75
T3.75B
T3.75A
LWC3.7
LWC3.7
LWC3.7
GLW3.78
GLW3.78
LW3.85

Legend

Surface Water Sampling Event

- AECOM Round 1
- AECOM Round 2 Discrete
- AECOM Round 2 Transect
- AECOM Round 2 USGS
- AECOM Round 3
- OU-3 BERA
- GWM
- Phase 3 RI
- Phase 3 RI Modification No.10

Sediment Sampling Event

- OU-3 BERA

- Las Vegas Wash
- Downgradient Study Area
- Northeast Sub-Area
- Operable Unit 3 (OU-3)

RAMBOLL

DRAFTED BY: SS | DATE: 11/2/2022

Surface Water and Sediment Sampling Locations for Use in the BHRA for OU-3 - East of Pabco Road

Nevada Environmental Response Trust Site

Henderson, Nevada

Figure

4-4b

PROJECT: 1690025040-003

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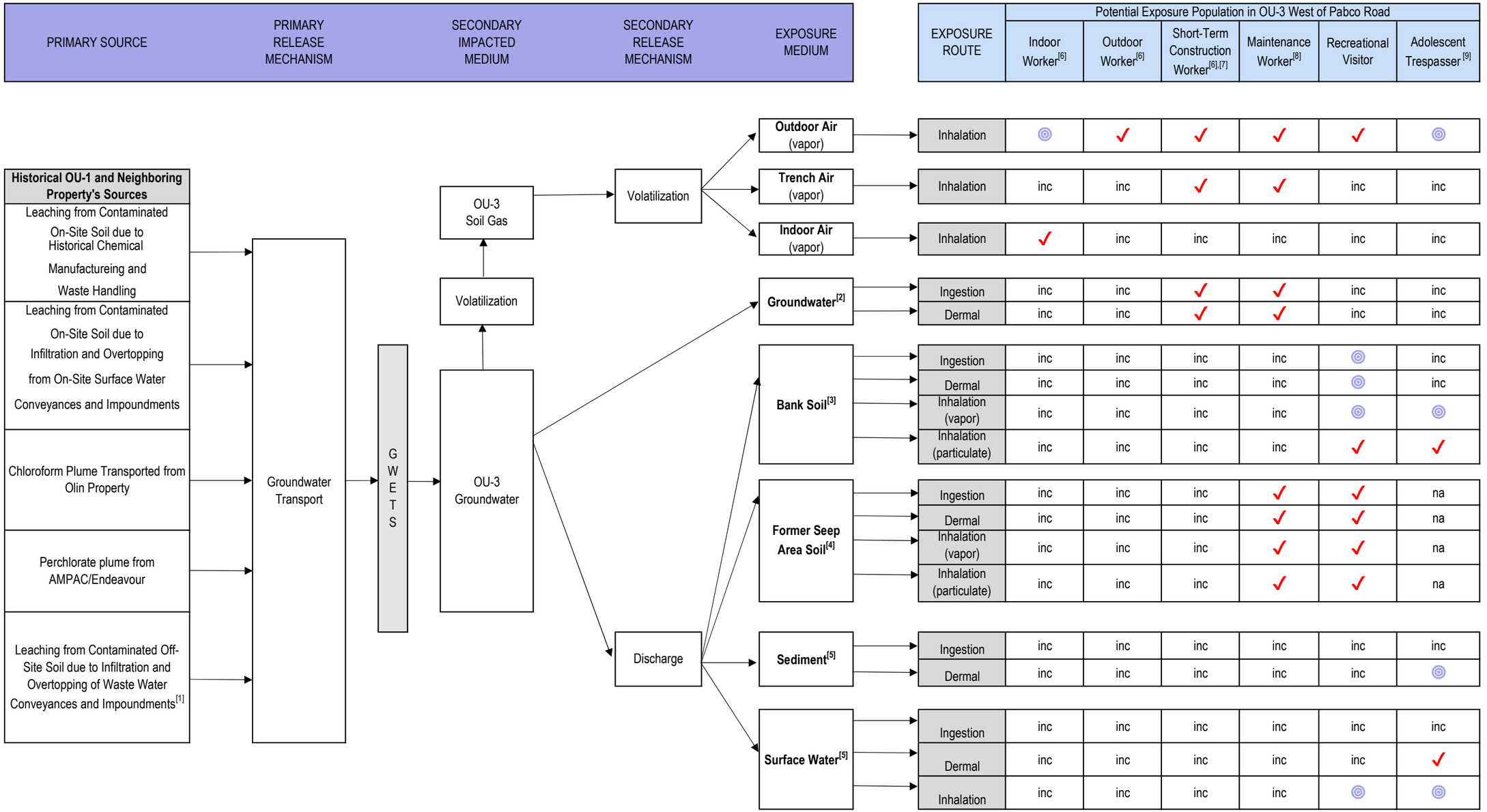


EXPOSURE MEDIUM	EXPOSURE ROUTE	Potential Exposure Population in OU-3 West of Pabco Road					
		Indoor Worker[6]	Outdoor Worker[6]	Short-Term Construction Worker[6],[7]	Maintenance Worker[8]	Recreational Visitor	Adolescent Trespasser[9]
Outdoor Air (vapor)	Inhalation	◎	✓	✓	✓	✓	◎
Trench Air (vapor)	Inhalation	inc	inc	✓	✓	inc	inc
Indoor Air (vapor)	Inhalation	✓	inc	inc	inc	inc	inc
Groundwater[2]	Ingestion	inc	inc	✓	✓	inc	inc
	Dermal	inc	inc	✓	✓	inc	inc
Bank Soil[3]	Ingestion	inc	inc	inc	inc	◎	inc
	Dermal	inc	inc	inc	inc	◎	inc
	Inhalation (vapor)	inc	inc	inc	inc	◎	◎
	Inhalation (particulate)	inc	inc	inc	inc	✓	✓
Former Seep Area Soil[4]	Ingestion	inc	inc	inc	✓	✓	na
	Dermal	inc	inc	inc	✓	✓	na
	Inhalation (vapor)	inc	inc	inc	✓	✓	na
	Inhalation (particulate)	inc	inc	inc	✓	✓	na
Sediment[5]	Ingestion	inc	inc	inc	inc	inc	inc
	Dermal	inc	inc	inc	inc	inc	◎
Surface Water[5]	Ingestion	inc	inc	inc	inc	inc	inc
	Dermal	inc	inc	inc	inc	inc	✓
	Inhalation	inc	inc	inc	inc	◎	◎

RAMBOLL

Conceptual Site Model for OU-3 - West of Pabco Road
Nevada Enviornmental Response Trust Site, Henderson, Nevada

Figure
6-1

Date: 11/2/22 Contract Number: 1690025040-003 Approved by: Revised:

Notes:

BHRA	Baseline Health Risk Assessment
ft	foot
GWETS	Groundwater Extraction and Treatment Systems
OU	Operable Unit

[1] Process wastewater generated by industrial operations within OU-1 and surrounding BMI Complex was accumulated on-site and later supplanted by disposal in off-site ponds.

[2] Exposure via domestic use of groundwater is not evaluated because the groundwater in OU-3 is not and will not be used as a source of drinking water.

[3] Exposure via inhalation of re-suspended particulates and vapors from the bank soil to outdoor air will be evaluated quantitatively; exposures due to direct contact with bank soil in the Wetland Park in OU-3 are not expected to occur according to the Wetlands Park rules therefore will not be evaluated quantitatively.

[4] Exposure pathways from seep area soil at 0-10 ft below ground surface (bgs) and at 0-2 ft bgs will be evaluated quantitatively for construction workers, maintenance workers, and recreational visitors respectively.

[5] Due to Wetlands Park rules, direct contact with surface water and sediment are prohibited therefore the exposures due to these pathways are considered incomplete for workers and recreational users. In addition, the exposures associated with inhalation of VOCs migrating from surface water to outdoor air for the recreational users near the Wash are expected to be low due to low exposure time for the recreational users and high mixing rate in outdoor air. Therefore, the exposures associated with this pathway will not be quantitatively evaluated.

[6] The indoor workers, outdoor workers and short-term construction workers are assumed to work in the City of Henderson Water Reclamation Facility which is the only commercial/industrial area in OU-3.

[7] The short-term construction workers are assumed to only work in the commercial/industrial area (e.g. City of Henderson Water Reclamation Facility). Beneath the Water Reclamtion Facility the short-term construction workers are not expected to contact the groundwater directly but are assumed to be exposed to vapors migrating from soil gas or groundwater while standing in a 10-ft construction trench under a dry trench scenario. For some areas near the facility where the groundwater is shallow at least during some years, a wet trench scenario will be considered.

[8] The maintenance workers are conservatively assumed to be exposed to vapors migrating from soil gas or groundwater while standing in a 5-ft utility trench under both a dry trench scenario (in the unsaturated zone) or a wet trench scenariothe (in the saturated zone). In addition, exposures to 0-5 ft bgs soil via direct contact could also occur at the former seep area for this population while performing excavation, land scaping, or utility work.

[9] Adolescent trespassers in the Wetlands Park are conservatively assumed to be exposed to surface water and sediment through dermal contact, and bank soil through inhalation of airborne particulates from surface soil. Inhalation of vapor of volatile compounds migrating to outdoor air is considered insignificant and will not be evaluated quantitatively. No preliminary COPCs were identified in sediment, therefore, the exposure through

Key:

inc	Incomplete exposure pathway
na	not applicable
◎	Complete exposure pathway; evaluated qualitatively in BHRA
✓	Complete exposure pathway; evaluated quantitatively in BHRA

RAMBOLL

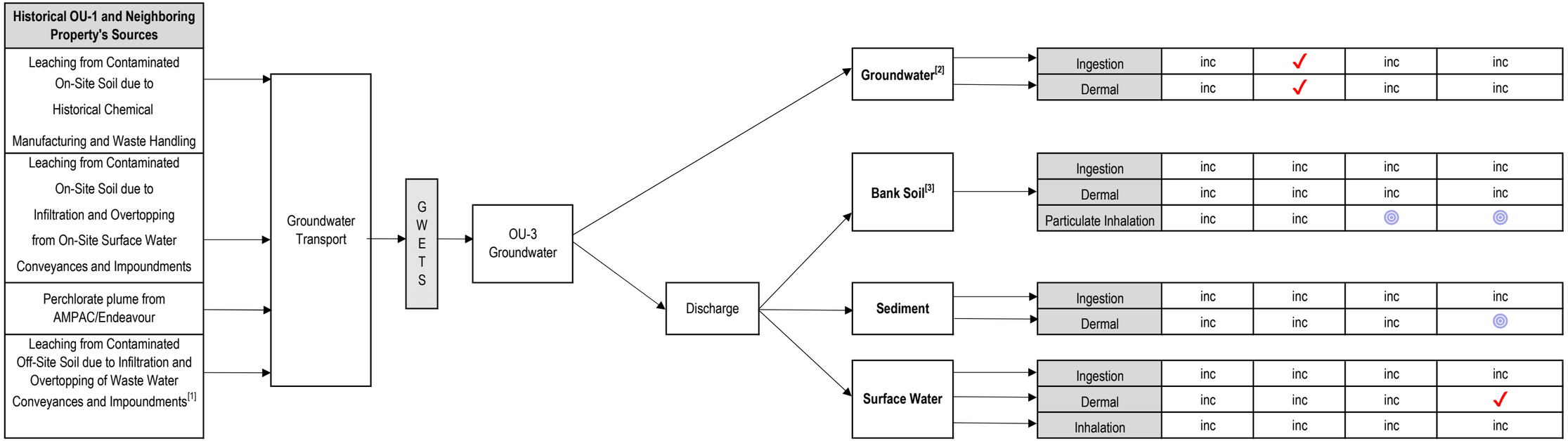
Conceptual Site Model for OU-3 - West of Pabco Road
Nevada Enviornmental Response Trust Site, Henderson, Nevada

Figure
6-1

Date: 11/2/22 | Contract Number: 1690025040-003 | Approved by: | Revised:

PRIMARY SOURCE	PRIMARY RELEASE MECHANISM	SECONDARY IMPACTED MEDIUM	SECONDARY RELEASE MECHANISM	EXPOSURE MEDIUM

EXPOSURE ROUTE [4]	Potential Exposure Population in OU-3 East of Pabco Road			
	Resident	Maintenance Worker[5]	Recreational User	Adolescent Trespasser [6]



Groundwater[2] — Ingestion	inc	✓	inc	inc
Groundwater[2] — Dermal	inc	✓	inc	inc
Bank Soil[3] — Ingestion	inc	inc	inc	inc
Bank Soil[3] — Dermal	inc	inc	inc	inc
Bank Soil[3] — Particulate Inhalation	inc	inc	◎	◎
Sediment — Ingestion	inc	inc	inc	inc
Sediment — Dermal	inc	inc	inc	◎
Surface Water — Ingestion	inc	inc	inc	inc
Surface Water — Dermal	inc	inc	inc	✓
Surface Water — Inhalation	inc	inc	inc	inc

RAMBOLL

Conceptual Site Model for OU-3 - East of Pabco Road
Nevada Enviornmental Response Trust Site, Henderson, Nevada

Figure
6-2

Date: 11/2/22 | Contract Number: 1690025040-003 | Approved by: | Revised:

Notes:

BHRA	Baseline Health Risk Assessment
ft	foot
GWETS	Groundwater Extraction and Treatment Systems
OU	Operable Unit

[1] Process wastewater generated by industrial operations within OU-1 and surrounding BMI Complex was accumulated on-site and later supplanted by disposal in off-site ponds.

[2] Exposure via domestic use of groundwater is not evaluated because the groundwater in OU-3 is not and will not be used as a source of drinking water.

[3] Exposures due to direct contact with bank soil in the Wet Land Park in OU-3 are not expected to occur. No preliminary COPCs were identified in bank soil in OU-3 east of Pabco Road, therefore, the potential exposures to bank soil for the inhalation of airborne particulates are not quantitively evaluated.

[4] Per discussion in Section 6.1, the COPCs in OU-3 east of Pabco Road are limited to chlorate and perchlorate which are both non-vilatile chemicals. Therefore, exposures due to the vapor inhalation pathway is not evaluated in OU-3 east of Pabco Road.

[5] The maintenance workers are conservatively assumed to be exposed to chlorate and perchlorate in shallow groundwater while standing in a 5-ft utility trench in the saturated zone (wet trench scenario).

[6] Adolescent trespassers in the Wetlands Park are conservatively assumed to be exposed to surface water and sediment through dermal contact, and shallow bank soil through inhalation of airborne particulates. No preliminary COPCs were identified in bank soil or sediment in OU-3 east of Pabco Road, therefore, the potential exposures to sediment or bank soil are not quantitively evaluated.

Key:

inc	Incomplete exposure pathway
◎	Complete exposure pathway; evaluated qualitatively in BHRA
✓	Complete exposure pathway; evaluated quantitatively in BHRA

RAMBOLL

Conceptual Site Model for OU-3 - East of Pabco Road
Nevada Enviornmental Response Trust Site, Henderson, Nevada

Figure
6-2

Date: 11/2/22 | Contract Number: 1690025040-003 | Approved by: | Revised:

APPENDIX A
OU-3 PRELIMINARY SOIL GAS BHRA DATA SET (PROVIDED ELECTRONICALLY)

APPENDIX B
OU-3 PRELIMINARY SHALLOW GROUNDWATER BHRA DATA SET (PROVIDED ELECTRONICALLY)

APPENDIX C
OU-3 PRELIMINARY SOIL BHRA DATA SET (PROVIDED ELECTRONICALLY)

APPENDIX D
OU-3 PRELIMINARY SURFACE WATER BHRA DATA SET (PROVIDED ELECTRONICALLY)

APPENDIX E
OU-3 PRELIMINARY SEDIMENT BHRA DATA SET (PROVIDED ELECTRONICALLY)

APPENDIX F
SUPPORTING DOCUMENTS FOR THE HEALTH RISK-BASED SCREENING ANALYSIS (PROVIDED ELECTRONICALLY)