1956 Caneel Bay Resort brochure illustration (Source: Electro's Spark 2009)

Sampling and Analysis Plan for Engineering Evaluation/Cost Analysis Site Investigation

Virgin Islands National Park

EDL #: 5SER3346

Caneel Bay Resort Site

Prepared by

vhb

February 5, 2021

Signatories

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By signing above, the signatories verify that they understand and concur with the information, procedures, and recommendations presented herein.

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List of Abbreviations and Acronyms

α	Alpha (Type I error probability; false rejection)
amsl	Above mean sea level
ARAR	Applicable or relevant and appropriate requirement
AST	Aboveground storage tank
β	Beta (Type II error probability, false acceptance)
CBR	Caneel Bay Resort
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain-of-custody
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
CSM	Conceptual site model
DOT	Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel range organics
DU	Decision unit
EE/CA	Engineering Evaluation/Cost Analysis
EDD	Electronic data deliverable
EMI	Electromagnetic induction
EPC	Exposure point concentration
ESV	Ecological Screening Value
fbgs	Feet below ground surface
FSP	Field Sampling Plan
ft	Foot or feet
GPR	Ground penetrating radar
GPS	Global positioning system
GRO	Gasoline range organics
HASP	Health and Safety Plan
HHRA	Baseline Human Health Risk Assessment
IDW	Investigation-derived waste
ISM	Incremental Sampling Methodology
ITRC	Interstate Technology Regulatory Council
JCO	The Johnson Company, Inc.
LIMS	Laboratory information management system
MCL	Maximum Contaminant Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan (AKA, National Contingency Plan)
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NTU	Nephelometric Turbidity Units
ORO	Oil range organics
ORP	Oxidation-reduction potential

PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PDF	Portable document format
PDOP	Position dilution of precision
PID	Photoionization detector
PQL	Practical quantitation limit
PRG	Preliminary remedial goal
QA	Quality assurance
QC	Quality control
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
RAO	Response action objective
RCRA	Resource Conservation and Recovery Act
RL	Reporting limit
RSE	Removal Site Evaluation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SLERA	Screening Level Ecological Risk Assessment
SOP	Standard operating procedure
SVOC	Semi-volatile organic compound
SU	Sampling unit
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
UCL	Upper confidence limit
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
UST	Underground storage tank
VIIS	Virgin Islands National Park
VISL	Vapor Intrusion Screening Level
VOC	Volatile organic compound
WWTP	Wastewater treatment plant

1 Introduction

This document is the Sampling and Analysis Plan (SAP) for the Engineering Evaluation/Cost Analysis (EE/CA) at the Caneel Bay Resort (CBR) within the Virgin Islands National Park (VIIS, or the Park) on the northwest side of the island of St. John, U.S. Virgin Islands (Figure 1). This SAP defines:

- The purpose of this study;
- The use for the data generated;
- The quality of data needed to accomplish the goals of this study; and
- The data collection methods.

This SAP has nine sections: 1) introduction; 2) Site description, previous investigations, and the Conceptual Site Model (CSM); 3) introduction of the Data Quality Objectives (DQOs) planning team and stakeholders; 4) detailed DQOs; 5) the Field Sampling Plan (FSP); 6) description of how the data will be managed; 7) assessment and oversight requirements; 8) investigation outputs, and 9) references.

Appendix 1 contains forms to be used in the field work. Details regarding field and laboratory quality assurance/quality control are presented in the Quality Assurance Project Plan (QAPP) in Appendix 2. A site-specific health and safety plan (HASP) for the EE/CA investigation is presented in Appendix 3.

1.1 CERCLA and NPS Authority

The National Park Service (NPS) is authorized under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code (U.S.C.) §§ 9601 *et seq*. and Executive Order 12580, as amended by Executive Order 13016, to respond as the federal Lead Agency to any release or threatened release of hazardous substances, and/or any release or threatened release of a pollutant or contaminant that may present an imminent and substantial danger to public health or welfare, on or from land under the jurisdiction, custody, or control of NPS.

In addition, NPS has a number of substantive requirements that apply to response actions addressing releases of hazardous substances on NPS land (see NPS 2014) including the NPS Organic Act of 1916 (54 U.S.C. §§100101 et. seq.), which requires NPS to manage parks in order to conserve the scenery, natural and historic objects, and wildlife and to provide for their enjoyment by such means as will leave them unimpaired for the enjoyment of future generations.

CERCLA's implementing regulations, codified in the National Contingency Plan (NCP) (40 Code of Federal Regulations (CFR) Part 300), establish the framework for responding to the release or threatened release of hazardous substances. The NCP prescribes two alternative processes for responding to releases: removal actions and remedial actions (See NCP Sections 300.400 through 300.440). If environmental samples are to be collected under either process, a SAP is required (See NCP Sections 300.415 and 300.430).

The SAP for investigation activities under the EE/CA process includes the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP). The FSP describes the number, types, analyses, and locations of samples. The QAPP describes the investigation's policy, organization, functional activities, and measures necessary to achieve the goals of the investigation.

1.2 Purpose of Field Sampling

The purpose of the EE/CA field sampling is to provide sufficient data of adequate quality to:

- Characterize the nature and extent of contamination at the Site
- Evaluate potential risks to human health and the environment resulting from such contamination
- Identify applicable or relevant and appropriate requirements (ARARs) for the Site
- Define the response action objectives (RAOs) and preliminary remediation goals (PRGs)
- Conduct a comparative evaluation of response action alternatives
- Present a preferred response action alternative

NPS will use data collected during this field investigation to support potential response actions that may be undertaken by NPS or other parties. This SAP proposes the following activities within the investigation areas: surface soil, debris landfill contents, and groundwater sampling; and debris landfill delineation. NPS will use the data obtained from these investigations in accordance with the provisions outlined in the DQOs detailed in Section 4.

The initial phase of sampling described in this document is planned for one season (relatively dry) in early 2021. If the Principal Investigation Questions (developed in Section 4.2.1) are not satisfactorily addressed by the initial phase of sampling, data gaps will be identified in the field investigation summary, which is an appendix to the EE/CA, and an additional phase of sampling will be described in a SAP addendum.

1.3 Site Location

The following information can be used to locate the Site. Figures 1 and 2 also provide Site location information. Additional Site information is provided in Section 2.

- Site name: Caneel Bay Resort
- Resort address: North Shore Road, St. John, U.S. Virgin Islands 00830. The Site is approximately 1.7 miles by road from the ferry dock in the island's main town of Cruz Bay.
- The Site Environmental and Disposal Liabilities (EDL) number is 5SER3346.
- Coordinates: Longitude and latitude 18.342758 degrees north, -64.786340 degrees west.

2 Site Description, Previous Investigations, and Conceptual Site Model

This section summarizes the known environmental information and historical activities that have occurred at the Site and presents the CSM. Figure 7 is a simplified graphical representation of the preliminary CSM. The development and ongoing update/refinement of a clear and thorough CSM is a critical component for verifying that key Site elements are considered before samples are collected and assisting the planning team in developing the DQOs (Section 4), as well as assisting the field team in making decisions in the field.

2.1 Site Description and Operational History

2.1.1 Site Description

Caneel Bay Resort ("the resort") is located on northwestern shore of the island of St. John, on the Atlantic Ocean. This approximately 150-acre vacation resort is located approximately 1 mile northeast of the major port town of Cruz Bay. The resort includes the entire 150 acres covered by the Retained Use Estate Indenture Agreement (RUE) and other lands Caneel Bay owns/operates on.

The resort occupies a peninsula on the Atlantic Ocean and is surrounded by water to the west and north and by VIIS forest to the south and east, which is crossed by hiking trails and public roads. The popular NPS-managed, publicly accessible Honeymoon Beach is located southwest of the resort. Hawksnest Bay located east of the resort also hosts multiple public beaches. The resort is located at the northern edges of Margaret Hill (elevation approximately 800 feet above mean sea level, amsl) to the southeast and Caneel Hill (elevation approximately 700 feet amsl). The resort's topography is gently rolling and varies between approximately 140 feet amsl and sea level (Figure 1).

A site reconnaissance for this EE/CA was performed on September 15, 2016 and attended by Keith Macneir and Kenneth Wild from VIIS, Rhonda Kay from The Johnson Company, Inc. (JCO, which was acquired by VHB in 2019), and Brad Dow from CBR. Photoplates from the September 2016 site reconnaissance are provided in Figure 3.

Based on historical investigations and the recent reconnaissance, the Site has been divided into three areas which encompass the areas of concern identified in the Level 2 Environmental Site Assessment Report (Barksdale & Associates 2014) and the Removal Site Evaluation (RSE) report (3E Consultants 2017). These areas are described below and shown on Figure 2.

- **Area 1**: approximately 1.7 acres in the vicinity of the wastewater treatment plant (WWTP) structures, located on the southeastern side of the resort.
- **Area 2**: approximately 5.4 acres that encompass the engineering, maintenance, landscaping, and fuel buildings and facilities, located to the southwest of the WWTP.
- **Area 3**: approximately 0.5 acres of land (undeveloped except for a donkey shelter) that will be referred to in this document as the debris landfill to reflect historical usage, located immediately east of Honeymoon Beach.

The WWTP building in Area 1 includes a building but there are no offices or other occupied spaces.

Occupied office and maintenance buildings are located within Area 2. Immediately west of Area 3, there are two small canteens, occupied during the day, that sell packaged food and drinks. Until Hurricanes Irma and Maria inflicted severe damage on the resort in September 2017, the resort was open to overnight guests from November through August, and employees stayed at CBR throughout the year. The resort did not reopen after the 2017 hurricane season and is closed at least through 2021. Housing on the adjacent property has reopened since the hurricane, according to Park staff.

Honeymoon Beach, located west of Area 3, is open to the public year-round. There are some residences within the resort, including to the northwest of Area 1 and to the southwest of Area 3, but there are no residential neighborhoods near the resort.

The Site does not include the marina and fuel facility on Tracts 04-104 and 04-115, which are part of the resort but not NPS property.

In total, the Site includes approximately 8 acres of the 150-acre resort. Areas 1 through 3 comprise the 8-acre Site, which is in the resort. The individual areas are described in additional detail in the following section.

2.1.2 Operational History

The resort property occupies a prominent place in the history of St. John, with evidence of pre-Columbian settlement and development in the early 1700s as a plantation (NPS 2013). The resort operated from 1956 through 2017 when it closed due to hurricane damage. The resort is not currently listed on National Register of Historic Places, but plantation ruins have been preserved in the central portion of the resort (NPS 2013). There are no aboveground plantation ruins on the Site (Areas 1 through 3). The operational history of the resort is as follows.

1938: The West Indies Company built seven small rental cottages on the former sugar plantation and the resort had been developed with a small hotel and eight rental cottages by 1952, when the owner at that time, Rhode Island Charities Trust, sold the property to Laurance Rockefeller (The Daily News of the Virgin Islands 1976).

1956: Caneel Bay Resort was opened by Laurance Rockefeller's RockResorts (RockResorts n.d.) and later became part of the Jackson Hole Preserve, a non-profit organization headed by Rockefeller.

1983: Jackson Hole Preserve donated the 150 acres of resort "land to the U.S. government subject to a 40 year Retained Use Estate Indenture Agreement (RUE)" (NPS 2013). RockResorts/The Jackson Hole Preserve continued to operate the resort.

1986: RockResorts was sold to CSX Corporation (RockResorts n.d.), which continued to operate the resort.

1989: RockResorts was sold to VMS Realty, via a loan from Bankers Trust, which foreclosed on the resort shortly thereafter (Kerch 1991). The RUE was transferred to Bankers Trust in 1989 (NPS 2013).

1993: Rosewood Hotels and Resorts began managing the resort (Lohr 2013).

1998: Bankers Trust was acquired by Deutsche Bank (Andrews 1998).

2004: EHI Acquisitions (EHI) , a CBIA affiliate, purchased the RUE from Deutsche Bank (Business Wire 2004). Rosewood Hotels and Resorts continued to manage the resort (Lohr 2013).

2014: EHI/CBIA did not renew the management contract with Rosewood Hotels and Resorts and began managing the resort (Lohr 2013). The RUE status did not change.

2017: Hurricanes Irma and Maria cause significant damage to resort, leading to its closure through at least 2021.

The RUE will expire on September 30, 2023 (NPS 2013). Following expiration of the RUE, it is anticipated that Caneel Bay Resort will resume resort operations after hurricane damage is addressed.

After the RSE was completed, NPS reviewed correspondence from David DiGiacomo to CBIA and EHI, as well as various federal government agencies (DiGiacomo 2020). The DiGiacomo correspondence identified several alleged environmental concerns and conditions. Several of the alleged conditions are within the Site areas to be investigated and will be assessed as part of the CERCLA investigation. The alleged environmental concerns are identified in the summary of historical operations, below.

Many of the buildings and facilities at the resort provided guest accommodations, food services, or recreation services and are not associated with recognized environmental conditions. Due to the age of the buildings, the presence of hazardous building materials, including asbestos-containing materials (ACM) and lead-based paint is possible. The DiGiacomo correspondence states that asbestos was removed from buildings and buried on the resort property. Because asbestos is not metallic or water soluble, buried asbestos is difficult to locate without additional location information; in addition, earlier investigations did not reveal evidence of unnatural fill other than the quarry/landfill area. Nevertheless, NPS will endeavor to determine whether additional information regarding potential locations for such alleged disposal activities is available.

Due to hurricane and other damage, the potential exists for actual or potential impacts to the environment by ACM if present on existing buildings.

The *Level 2 Environmental Site Assessment Report* (Barksdale & Associates 2014) discussed reports of a possible underground storage tank (UST) and bomb shelter at Cottage 7, but no evidence of either was observed during the 2016 reconnaissance. JCO personnel inspected the exterior of Cottage 7, and no evidence of vent or fill pipes, stained soil, stressed vegetation, or groundwater seeps with staining were observed. Based on the statement in the *Level 2 Environmental Site Assessment Report* that the bomb shelter pre-dated World War II, and the construction date of the resort after World War II, it is possible that the UST, if it existed, was removed during the construction of Cottage 7 before the resort was opened in 1956.

The remainder of this section will focus on historical operations at the three areas that comprise the Site.

- **Area 1**. The existing WWTP was constructed in 1968 (NPS 2012), and the gravel staging area above the WWTP building and ponds may have been constructed around the same time. The WWTP includes a holding pond for sludge, which is removed for disposal off-site (as noted in the Area 3 discussion below, historical disposal may have been on-site at the landfill). The DiGiacomo correspondence raises a concern regarding disposal of human wastes, especially since the 2017 hurricanes, and inquires whether permits were acquired to construct the facility. The 2013 EA states that the WWTP was permitted, but did not include copies of permits. In 2016, a CBIA representative stated that since 2014 the practice was to dispose of sewage sludge at the St. Thomas landfill (Dow 2016). NPS will request documentation from EHI/CBIA regarding the use of the WWTP since the 2017 hurricanes.

  A material re-use staging area is located in a gravel clearing north of the WWTP building. In the RSE, 3E Consultants reported multiple unmarked and unlabeled 55-gallon drums in the northeastern corner of the staging area within a wooded area; the drums were partially buried, covered with shade cloth, and reported to contain unknown liquid (3E Consultants 2017). The photograph of the drums provided in Figure 8 of the RSE shows two drums and the shade cloth. JCO did not observe these drums during the 2016 JCO Site visit.
- **Area 2.** The majority of the buildings in Area 2 were constructed circa 1956 to 1960 (NPS 2012), although buildings and roads are visible in this Area on the 1954 aerial photograph provided in the RSE report (3E Consultants 2017). The existing gasoline and diesel aboveground storage tanks (ASTs) are newer than 1960, but the installation date was not provided in documents reviewed for this SAP. The installation date of the gasoline dispenser pump is not provided in documents reviewed for this SAP. This area also hosts the grounds and landscaping buildings and chemical (including pesticide) storage sheds. The DiGiacomo correspondence references alleged use of various pesticide. Pesticide sampling in this area was included in previous investigations, and pesticides will be included in this assessment.
- **Area 3.** The debris landfill, located in a cleared area to the east of Honeymoon Beach, appears to be a historical quarry, and is located next to a more recently developed quarry. The landfill has reportedly been used for more than "50 years to dispose of all types of wastes" from the resort, including sewage sludge from the CBR WWTP, which was disposed "every 10 years" for an unknown period of time before 2014 (Barksdale & Associates 2012; 2014). Currently, the area reportedly is used for disposal of compostable materials, such as trees and brush, although plastic plant pots were also visible among vegetative waste during the 2016 reconnaissance. A rock borrow pit has been developed along the southeastern edge of the cleared area, which is defined by a

rock face, as shown in Photoplate 12 in Figure 3. During the 2016 reconnaissance, there appeared to be separation between the debris landfill and the rock borrow pit, and there were no depressions that indicated removal of landfilled material from this area.

The DiGiacomo correspondence described the following reported activities that are not within the scope this investigation and/or CERCLA:

- **Disposal to the ground of laundry water containing bleach and other chemicals and surface water discharges of desalinization plant by-products with high concentrations of chlorine.** According to the EPA, products commonly used as bleach and for water disinfection, sodium hypochlorite and calcium hypochlorite, "react easily with organic matter and convert readily into sodium chloride (table salt) and calcium chloride (road salt) (USEPA 1991). These degradation products are not CERCLA hazardous substances or pollutants. Laundry operations that involve dry cleaning chemicals have been known to result in the release of certain CERCLA hazardous substances. However, there is no evidence to suggest that Caneel Bay operated a dry cleaning operation on-site. Dry cleaning chemicals are regulated under CERCLA, and are detectable in soil and groundwater by standard laboratory analyses for volatile organic compounds (VOCs), which will be performed during this investigation.
- **Rotting food left on-site.** This issue is outside of the CERCLA scope.
- **Baygon pesticide.** Certain historical formulations of pesticides included chemicals that are persistent and toxic; these pesticides are included in the list of organochlorine and organophosphorus pesticides that have been analyzed. While some organochlorine and organophosphorus pesticides have been detected at concentrations above screening levels in Site soil samples, chlorpyrifos—an ingredient of Baygon with a risk-based screening level for human or ecological receptors—was not detected in any of the 13 soil samples collected from the Site. Therefore, Baygon is not considered to be a Site contaminant of potential concern, although some organochlorine pesticides are.
- **Catchment basin pesticide storage and waste burial.** Previous environmental assessments and investigations have not identified the potential presence of hazardous wastes at the catchment basin, which appears to have been constructed in the 1950s to capture rainwater for use at the resort. The DiGiacomo correspondence, however, states "at least one former employee reports that the area above Caneel often referred to as the catchment basin and also referred to as the Caneel Quarry was used not only to store DDT but also other chemicals that may still be leaching into the soil. It is rumored that employees were told to go up to that area with a backhoe at night to bury things" (DiGiacomo 2020). JCO did not observe piles, mounds, or other indications of buried wastes, staining, or stressed vegetation in the cleared gravel turnaround below the catchment basin in 2016. NPS will request clarification as to whether the reported

allegations refer to the former quarry at the landfill, rather than the catchment basin. If there is evidence to suggest the release of hazardous substances in the catchment area, NPS may elect to perform a supplemental investigation.

Wastes associated with each area of the Site are described in the following section.

2.1.1 Waste Characteristics

Photographs of the three areas within the Site are provided in Figure 3. Their waste characteristics are described below.

Area 1 (approximately 1.7 acres) includes the used equipment staging area located in the flat terrace above the WWTP building and ponds but does not currently include the building and ponds. The staging area, which has a gravel surface, has been historically used to store materials awaiting disposal, including broken or out-of-service mechanical equipment, such as washers and dryers, building materials, and broken furniture and recreational equipment. During the RSE site visit in 2016, rusted drums with unspecified contents were observed in the northern corner of the staging area (3E Consultants 2017). It is possible, based on the historical operations at the facility, that cleaning chemicals, petroleum, and/or pesticides or their partially empty containers may have been stored in this area. Pesticides have been reportedly used at various locations at the Site, although they are more likely to be present at concentrations above risk-based screening levels where they have been stored and handled in larger volumes.

No samples have been collected in the gravel terrace staging area; samples collected from near this area were limited to the immediate vicinity of the WWTP building. At the WWTP building, one sample was previously collected from soil stockpile that had been visibly impacted by oil from a water pump failure. The results indicated the presence of oil range organics, but no polycyclic aromatic hydrocarbons (PAHs). During the 2016 reconnaissance, this oil-impacted soil stockpile was no longer present. The floor of the building has been sealed and repainted and a concrete step has been placed at the doorway, covering the previously-impacted soil (3E Consultants 2017). JCO did not observe evidence of contamination, such as sheens, staining, stressed vegetation, or odors indicative of remaining contamination, and the concrete step will limit infiltration of surface water, which could in turn result in petroleum leaching to underlying groundwater.

Area 2 (approximately 5.4 acres) includes the engineering, maintenance, landscaping, and fuel buildings and facilities, located southwest of the WWTP. In addition, Area 2 contains the landscaping chemical storage sheds, which house pesticides and other landscaping products (Barksdale & Associates 2012).

The majority of engine and equipment maintenance for the resort is performed in this area. At least one UST was removed from the eastern end of Area 2 in the 1990s and a monitoring well was installed, but little else is known about this area's UST history (Barksdale & Associates 2012). One groundwater sample collected from the monitoring well contained concentrations of benzene, ethylbenzene, and several PAHs above screening levels, but soil samples from the surrounding area did not (Barksdale & Associates 2014). There are two existing petroleum ASTs – one 20,000-gallon diesel AST and one 10,000-gallon gasoline AST – that supply an emergency generator building and a fuel pump located on the service road at the southwestern end of Area 2. The *Level 1 Pre-Acquisition Environmental Site Assessment Survey* (Barksdale & Associates 2012) notes multiple petroleum-related incidents near the ASTs and the emergency generator building, including:

- Floor gutters in the emergency generator building that appeared to discharge to two areas of stained soil on the east side of the building. JCO did not observe this staining in 2016.
- A diesel fuel leak occurred in 2010 when a contractor for Chevron accidentally punctured a buried fiberglass diesel line while installing a grounding rod. A report by Chevron's contractor states that approximately 1,000 gallons of diesel were released and migrated primarily along the electrical line bedding sand toward the northwest and the pipe bedding sand to the gasoline and diesel dispenser to the north-northeast (ERTEC 2010). The same report stated that "impacted soil" was excavated and placed inside polyethylene sheeting on a concrete slab. A 15-foot (ft) by 40-ft stockpile of soil covered with a tarp was observed in 2012 by Barksdale & Associates, but this stockpile was not observed during JCO's 2016 reconnaissance. An additional test pit investigation was planned and approved by the USVI Department of Natural Planning and Resources in 2012, but NPS was not provided with a record the investigation, additional soil removal, or disposal.
- A 1.5-inch pipe dripping fuel (reported to be diesel) onto a 3-ft by-6 ft area of soil near a 500-gallon AST outside the northwestern corner of the power generators building (visible on Figure 3 in ERTEC 2000). The pipe, AST, and stained soil are no longer present.
- A 5-ft by 12-ft area of distressed vegetation and stained soil, "more than" 6 inches deep, immediately to the east of the 10,000-gallon gasoline AST.

Soil samples were collected of oil-stained soil at discharge points outside the emergency generator building during the Level 2 investigation; however, no samples were collected near the ASTs or fuel pump during that investigation (Barksdale & Associates 2014). The PAH results for the four surficial soil samples collected east of the generator building were below laboratory reporting limits and do not indicate the presence of a significant petroleum release.

JCO did not observe soil staining near the pump or ASTs during the 2016 reconnaissance. 3E Consultants reported staining around the fuel pump on the pervious surface during their 2016 reconnaissance, but because the fuel pump is immediately adjacent to pavement (3E Consultants 2017), the area of stained soil is likely less than 5 square feet.

A suspected asbestos 6-inch diameter pipe was observed in the subsurface near the Grounds and Landscaping Equipment Maintenance Building during the Level 2 investigation. Results of two samples collected for laboratory analysis indicate that the pipe consists of approximately 30% asbestos (Barksdale & Associates 2014).

Area 3 (approximately 0.5 acres) is the debris landfill, which reportedly accepted a variety of wastes, possibly in pits that resulted from quarrying stone. Although there is no history of manufacturing or industrial chemical use at CBR, the landfill may have received other wastes containing contaminants, particularly related to landscaping chemicals, in addition to sewage sludge, which may contain organic and inorganic contaminants of concern. The samples collected during the Level 2 investigation contained a regulated pesticide, some PAHs, and low concentrations of polychlorinated biphenyls (PCBs).

There are approximately 50 buildings on the resort, many of which are likely to be of similar age and construction. Given the age of the resort buildings, the paint on building exteriors likely contains lead. Lead from lead-based paint can be released to soil around building perimeters if the paint flakes or erodes. If lead is detected in soils around building perimeters at elevated concentrations, additional investigations, risk assessment, or removal actions may be necessary.

2.2 Summary of Previous Investigations

Two environmental investigations and an RSE have been performed at the Site since 2012. The investigations were performed through an NPS program for property acquisitions. A summary of each investigation follows.

2012 Level 1 Pre-Acquisition Environmental Site Assessment Survey (Barksdale & Associates 2012)**.** The purpose of this due diligence investigation was to identify recognized environmental conditions related to hazardous substances or petroleum at CBR. Recognized environmental conditions were identified in the following areas: the maintenance and engineering area; the landscaping and grounds maintenance area; the WWTP; the emergency generator building; the emergency generator fuel tanks; the marina; the former fuel storage tanks for the marina; and the debris landfill. No samples were collected during this investigation.

2012 Level 2 Environmental Site Assessment Report (Barksdale & Associates 2014). The purpose of this investigation was to collect samples at locations where recognized environmental conditions had previously been identified to characterize their impacts to soil and groundwater, as appropriate. The following samples were collected in January 2014. Sampling locations are shown on Figure 6.

- Area 1:
  - Near the WWTP building (sample prefix "06-"):
    - Three surface soil samples. Samples were analyzed for the Resource Conservation and Recovery Act (RCRA) list of eight regulated metals (RCRA 8 metals); gasoline range organics, diesel range organics, and oil range organics (GRO, DRO, ORO); PCBs; and PAHs.
- Area 2:
  - Engineering and Maintenance (sample prefix "01-"):
    - Six surface soil samples collected in stormwater runoff areas near the concrete. Samples were analyzed for RCRA 8 metals; GRO, DRO, ORO; PCBs; and PAHs.
    - Four surface soil samples (called sediment in the report, but not typical of sediment habitat) from the concrete-lined drainage ditch. Samples were analyzed for GRO, DRO, ORO; PCBs; PAHs; organochlorine and organophosphorus pesticides; and herbicides.
  - Engineering Area Former UST (sample prefix "02-"):
    - Two subsurface soil samples (5-7 feet below ground surface, or fbgs) within the former UST footprint. Samples were analyzed for RCRA 8 metals; PAHs; and the volatile organic compounds (VOCs) benzene, toluene, ethylbenzene, and xylenes.
    - One groundwater sample from the monitoring well downgradient of the former UST. The sample was analyzed for lead, PAHs, and the VOCs benzene, toluene, ethylbenzene, and xylenes.
  - Grounds and Landscaping Chemical Storage Sheds (sample prefix "03-"):
    - Six surface soil samples collected from a compost pile, the greenhouse, a former chemical storage area, a potted plant storage area, and locations adjacent to chemical storage. Samples were analyzed for RCRA 8 metals; organochlorine and organophosphorus pesticides; and herbicides.
  - Grounds and Landscaping Equipment Maintenance Building (sample prefix "04-"):
    - Two surface soil samples collected as composites of three increments each, beside a maintenance building with oily equipment. Samples were analyzed for RCRA 8 metals; GRO, DRO, ORO; and PAHs.
  - Emergency Generator Building (sample prefix "05-"):
    - Four surface soil samples collected near the building drain discharge. Samples were analyzed for RCRA 8 metals; GRO, DRO, ORO; and PAHs.

- Area 3:
  - Debris Landfill (sample prefix "07-"):
    - Four surface soil samples collected as composites of two increments each, from the edge of the landfill and depressions within the landfill. Samples were analyzed for RCRA 8 metals; PCBs; PAHs; organochlorine and organophosphorus pesticides; and herbicides.

Current screening and action levels for soil and groundwater are summarized in Tables 11 and 2, respectively. Analytical data from the Level 2 investigation is presented in Tables 3 through 13.

Barksdale & Associates (2014) compared analytical data to screening levels that were relevant at the time but are not consistent with the NPS Contaminated Sites Program's current standard practices for selecting action levels. Thus, conclusions drawn in the 2014 report based on previous screening levels are not typically repeated in this report. Nonetheless, the 2014 results were used to assist in selecting sampling locations for this EE/CA. In the attached tables, the Level 2 data are compared against the current action levels presented in Tables 1 and 2.

2017 Removal Site Evaluation Report (3E Consultants 2017). The purpose of the RSE was to evaluate the need for additional CERCLA action at the Site. The RSE found that additional CERCLA action is necessary and recommended that NPS conduct a non-time critical removal action.

2.2.1 Data Quality/Usability

Previously collected data are evaluated relative to the EPA General Assessment Factors (as defined in EPA, 2012 and summarized in Text Table 2.2.1 below) to determine their quality and usability for development of this SAP.

Text Table 2.2.1: EPA General Assessment Factors

Assessment Factor	Description
Soundness	The extent to which the scientific and technical procedures, measures, methods, or models employed to generate the information is reasonable for, and consistent with, the intended application.
Applicability and Utility	The extent to which the information is relevant for the project's intended use.
Clarity and Completeness	The degree of clarity and completeness with which the data, assumptions, methods, quality assurance, sponsoring organizations, and analyses employed to generate the information are documented.
Uncertainty and Variability	The extent to which the variability and uncertainty (quantitative and qualitative) in the information or the procedures, measures, methods, or models are evaluated and characterized.
Evaluation and Review	The extent of independent verification, validation, and peer review of the information or of the procedures, measures, methods, or models.

Soundness: The Level 2 sampling event was completed to gain specific information relevant to the requirements of the specific investigation. A qualified laboratory was used to analyze the data, and the samples were collected by environmental professionals. Sample collection techniques appear to have been appropriate.

Applicability and utility: Investigation results must always be viewed as representing the conditions at the time of the investigation, and historical results can rarely represent current environmental conditions or impacts. The existing data can be useful to discern patterns or trends over time, but the results were collected only at one time at each location, therefore, a trend analysis of contaminant migration or degradation is not possible. The advantages of the existing dataset are a large total number of samples, a comprehensive analyte list, and expansive spatial coverage across the Site. As such, all of the existing data will be used to plan the EE/CA investigation. The EE/CA investigation will be performed using a more representative incremental sampling approach for soil, and the results cannot be compared statistically to the existing discrete or composite results (the two types of data can be compared qualitatively in a lines of evidence approach to refining the conceptual site model).The previous soil sampling and analysis data will primarily be viewed qualitatively as a basis for choosing EE/CA sampling locations. The groundwater result can be used quantitatively.

Clarity and completeness: In all studies, the descriptions of sampling locations, analytical methods, and sample results were clear and complete for all data presented in this SAP.

Uncertainty and variability: The Level 2 report did not include a discussion of uncertainty. The laboratories used data qualifiers to indicate when results may be less certain, and these qualifiers are shown on the data tables presented. Because the data are being used for EE/CA investigation planning, any contaminant detection above an action level, regardless of the data qualifier, is considered to be representative. This is a conservative assumption.

Evaluation and review: Existing data were collected in 2014 and were not validated. The report appears to have been reviewed and accepted by NPS, which is an appropriate regulatory agency.

2.2.2 Preliminary Identification of Data Gaps

The Level 2 investigation provided data for areas with previously recognized environmental conditions. After reviewing the previous Site investigations, the following data gaps were identified:

- Site-wide assessment of nature and extent of groundwater contamination and transport pathways has not been performed;
- Some areas of concern, such as stained soil around the ASTs, the gasoline pump, and the used equipment staging area above the WWTP (where the 3E Consultants inspector observed drums in 2016), were not sampled;
- Soil samples of the debris landfill materials were limited, and the extent of the debris landfill contents was not evaluated;
- Reference samples (i.e., from areas not affected by Site contamination) have not been collected for comparison with Site soil and groundwater sample data; and
- Site-wide human health and ecological risk assessments have not been conducted.

2.2.3 Chemicals of Potential Concern

Based on the previous investigations, preliminary contaminants of potential concern (COPCs) have been identified for the EE/CA investigation. They are listed in Text Table 2.2.3. The media of concern and the operation(s) suspected of generating the contaminants are also listed. These contaminants are considered to be preliminary COPCs; the list will be updated based on the EE/CA investigation. Herbicides and organophosphorus pesticides are not COPCs based on the Level 2 investigation results, which were not above screening levels. The presence of asbestos in soil will also be evaluated during the investigation, but it is not currently identified as a COPC.

Table 2.2.3: Preliminary Contaminants of Potential Concern

Contaminant	Media	Area	Reason Identified
Metals			
RCRA 8 and 13 Priority Pollutant metals	Soil (surface, landfill contents); groundwater	All areas.	Most of the RCRA 8 metals were present in multiple soil samples collected in 2014. The remainder of the 13 Priority Pollutant list are regulated under the Clean Water Act and their concentrations should be evaluated at the Site.
Toxicity Characteristic Leaching Procedure RCRA 8 metals	Soil (landfill contents)	Area 3.	To evaluate hazardous metals characteristics of landfill contents for disposal, if required.
Volatile Organic Compounds (VOCs)			
VOCs	Surface soil near ASTs, landfill contents, groundwater	In Area 2 near the petroleum ASTs and fuel pump. In Area 3 in the landfill contents. Throughout the Site in groundwater.	The Level 1 report identified petroleum staining near the ASTs. Landfill contents may contain petroleum or other VOCs from cleaning or maintenance chemicals. The extent of petroleum in groundwater from the former UST has not been characterized.
PCBs			
PCBs	Soil (landfill contents); groundwater near the landfill	Area 3.	The Level 2 results indicated the presence of PCBs in the landfill. PCBs were not detected in other sampled locations, and they are not likely to have been widely used in other areas.
Semi-Volatile Organic Compounds (SVOCs)			
SVOCs - PAHs	Soil (surface, and landfill contents); groundwater	All areas.	PAHs are present throughout the Site and are produced by burning fossil fuels. Potential PAH migration from soils to groundwater should be evaluated.
Pesticides			
Pesticides	Soil (surface, landfill contents); groundwater	All areas.	Present in various soil samples collected during the Level 2 investigation. Potential pesticide migration from soils to groundwater should be evaluated.

2.2.4 Media of Potential Concern

As shown in Text Table 2.2.3, the media at the Site that are known or suspected to be contaminated and, therefore, should be sampled are:

- Soil – surface and landfill contents; and
- Groundwater.

2.3 Current and Future Property Use Scenarios

The Site's three areas are mainly used by CBR employees. These areas have not been part of the resort's public-use amenities since 1956, and it is anticipated that future use scenarios would remain unchanged. NPS employees and construction or utility workers may work in these areas of the Site for short periods.

2.4 Graphical Conceptual Site Model

A graphical CSM that incorporates the information summarized in the previous sections is provided as Figure 7.

2.4.1 Key CSM Assumptions

The graphical CSM is based on the following assumptions regarding subsurface conditions:

- The Caneel Bay Resort does not have a manufacturing or industrial history and is unlikely to have used large volumes of solvents, degreasers, or similarly toxic chemicals. Based on previous sampling and reports of historical site use, contamination appears to be related to standard maintenance and operations of vehicles, pumps, and buildings, or to landscaping. PCBs have been detected at low concentrations and may be related to building materials or mechanical/electrical systems.
- The storage area near the WWTP is composed mainly of materials with potential salvage use. The RSE stated that drums observed in this area were mostly empty, but some contained unknown liquids.
- Soil deposits above bedrock are relatively thin and consistent across the Site. The near surface soil is primarily sandy.
- Groundwater flow is inferred to be west towards the ocean.
- The landfill has been reported to be confined by a berm of soil as much as 15 feet tall, which is on a side-slope. The berm is covered with vegetation and no evidence of erosion or slope failure was observed during JCO's site visit in 2016. The Level 2 investigation recorded surface depressions with exposed plastic and metal debris, but these have been infilled. Given the presence of a rock borrow pit near the landfill, it is

possible that the landfill is a former borrow pit, where debris may have been deposited in discrete pits or uniformly across the surface. There are no reports of a liner or cover system being used at the landfill.

- There is no reason to suspect that lead has been released to soils by industrial processes. Lead in soil should be present at concentrations consistent with natural background, unless released to soil from lead-based paint on building exteriors.

3 DQO Planning Team and Stakeholders

Identifying an appropriate DQO Planning Team is key to successfully developing DQOs. The DQO Planning Team should include the primary decision makers and project team members, such as risk assessors or remediation engineers, who will use the data generated as a result of the DQOs. The size of the DQO Planning Team will often depend on the size and complexity of the site under investigation (USEPA 2006).

3.1 DQO Planning Team

The DQO Planning Team develops the project DQOs according to the DQO process. The DQO process is iterative, and team members may be added or changed to address technical issues that were not initially identified. Table 3.1 below provides the DQO Planning Team for this project.

Table 3.1: DQO Planning Team

Name	Project Role	Area of Expertise
Kelly Kachurak, Sustainability, Environmental, and Accessibility Program Branch Manager Interior Region 2 South Atlantic Gulf kelly_kachurak@nps.gov	Provides information about current and future use of the Site, ensures consistency with NPS Environmental Contaminated Cleanup Division requirements	Federal Government Lead
Lois Godfrey Wye U.S. Department of the Interior, Office of the Solicitor lois_wye@sol.doi.gov	Solicitor	Legal Lead

Name	Project Role	Area of Expertise
Jonathan Ordway, Senior Engineer/Environmental Program Manager, VHB jordway@vhb.com Rhonda Kay, Senior Engineer, VHB rkay@vhb.com Ben Deede Senior Project Engineer, VHB bdeede@vhb.com	Compile and assess historical Site information, develop the CSM, design the technical aspects of the EE/CA investigation, and perform the EE/CA investigation, Prepare EE/CA Report	CERCLA investigation and remediation. Geology, hydrogeology, and soil and groundwater contamination. Jonathan Ordway is the Cleanup Lead for the Contaminated Site Team
Janet Robinson, Woodard & Curran jrobinson@woodardcurran.com	Risk Assessor	Ecological Risk Assessment
Lisa McIntosh Woodard & Curran lmcintosh@woodardcurran.com	Risk Assessor	Human Health Risk Assessment
Susan Chapnick New Environmental Horizons schapnick@neh-inc.com	Chemistry Quality Assurance Officer/Data Validator	Data Validation

3.2 Decision Makers

The decision makers have the ultimate authority for making final decisions regarding the selection of DQOs based on the recommendations of the DQO Planning Team. The decision makers for this project are Kelly Kachurak, NPS Federal Government Lead and Lois Godfrey Wye, Legal Lead.

3.3 Stakeholders

Stakeholders are parties other than those identified in Section 3.1 who may be affected by the results of the investigation and/or persons who may later use the data resulting from the DQO process. Other stakeholders are EHI, as the owner of the RUE, and CBIA, as the operator of the resort. However, the entities or people who will be informed at milestones in the EE/CA process will be specified in the Community Involvement Plan for the EE/CA, which will be finalized and made available to the public before the EE/CA is complete.

4 Data Quality Objectives

The DQO process specifies anticipated project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified.

The DQO process consists of the following seven steps:

1. State the Problem.
2. Identify the Goal of the Investigation.
3. Identify the Information Inputs.
4. Define the Boundaries of the Investigation.
5. Develop the Analytic Approach.
6. Specify Performance or Acceptance Criteria.
7. Develop the Plan for Obtaining Data.

The following subsections detail each step in the DQO process for this investigation.

4.1 State the Problem

Previous investigations have included sampling in limited areas as part of real estate transaction screening. These investigations identified potential and actual sources and releases of contaminants to soil and groundwater. Section 2.2.3 presents preliminary COPCs. Based on these preliminary COPCs and historical Site information, the following COPCs are retained for the EE/CA investigation.

- Metals (in soil and groundwater);
- VOCs (in soil and groundwater);
- PCBs (in soil and groundwater);
- PAHs (in soil and groundwater); and
- Pesticides (in soil and groundwater).

Potential transport pathways through Site media to human and ecological receptors are present. However, available data are insufficient to characterize the nature and extent of COPCs in Site media and whether COPCs are present above concentrations that pose a risk to human and ecological receptors. Therefore, measured concentrations of COPCs in Site media are needed to support human health and ecological risk assessments and to identify and evaluate removal actions and to select a preferred removal action for the Site, if required.

4.2 Identify the Goal of the Investigation

The primary goal of this investigation is to provide sufficient data of adequate quality to complete an EE/CA to decide if response actions are needed to address unacceptable risks at the Site and, if warranted, identify a recommended removal action alternative for the Site. To achieve this goal, the field investigation is designed to perform the following functions:

1. Assess the nature and extent of Site-related contamination in Site surface soil.
2. Assess the nature and extent of COPCs in landfill debris.
3. Provide sufficient data to support assessing risk to human receptors.
4. Provide sufficient data to support assessing risk to ecological receptors.
5. Assess local background/reference concentrations for the COPCs in soil.
6. Assess whether COPCs in groundwater downgradient of potential source areas are present in elevated concentrations.
7. Assess local reference concentrations for the COPCs in groundwater.
8. Survey the area around Cottage 7 for evidence of an abandoned UST.
9. Provide preliminary data to assess the need for further investigation of potential impacts from the presence of lead-based paint and asbestos.
10. Provide sufficient data to evaluate if the known asbestos pipe is connected to an existing pipe network or if it has been removed.
11. Provide sufficient data to determine and evaluate potential response actions with respect to territorial and federal ARARs.
12. Provide information to support the evaluation of removal alternatives and their costs.

Local reference/background soil and groundwater samples will be collected within 1 mile of the Site at relatively undisturbed locations within VIIS where Site impacts are unlikely to have occurred.

Soil, debris landfill contents, and groundwater will be sampled during this EE/CA investigation. If there is evidence of contaminant migration to surface water or building indoor air from the groundwater investigation, subsequent investigations in these potentially affected areas may be necessary.

4.2.1 Principal Investigation Questions

This section defines the principal decision and estimation questions and statements. The principal investigation questions support efficient collection of data needed to resolve the investigation problem identified in Section 4.1.

There are two types of principal investigation questions: decision-making and estimation. Decision-making questions (decision questions) will lead to the development of decision statements. Estimation questions will be framed with an estimation statement.

Principal Decision Questions and Statements

- Decision Question 1: Has the distribution of COPCs across the Site been adequately delineated such that human health and ecological risks can be quantified?

  Statement: Evaluate the nature and extent of contaminants related to potential source areas at the Site.

- Decision Question 2: Are concentrations of COPCs present in Site surface soil posing an unacceptable potential for risk to human and/or ecological receptors?

  Statement: Determine if concentrations of COPCs in Site surface soil pose an unacceptable potential for human and/or ecological risk.

- Decision Question 3: Are concentrations of COPCs present in soil in the debris landfill posing an unacceptable potential for risk to human and/or ecological receptors?

  Statement: Determine if concentrations of COPCs in soil in the debris landfill pose an unacceptable potential for human and/or ecological risk.

- Decision Question 4: Are concentrations of COPCs present in Site groundwater posing an unacceptable potential for risk to human and/or ecological receptors?

  Statement: Determine if concentrations of COPCs in Site groundwater pose an unacceptable potential for human and/or ecological risk.

- Decision Question 5: Do COPC concentrations in Site soil exceed COPC concentrations in reference/background soil samples?

  Statement: Determine if COPC concentrations in Site soil are statistically greater than COPC concentrations in soil collected from reference locations and, thus, are Site-related COPCs.

- Decision Question 6: Do COPCs in groundwater downgradient of potential source areas exceed screening levels?

Statement: Determine if COPCs in groundwater downgradient of potential source areas exceed screening levels.

- Decision Question 7: Are the COPCs detected in groundwater above screening levels related to a release on Site, or are they consistent with local background/reference concentrations?

  Statement: Determine if COPC concentrations in Site groundwater are statistically greater than COPC concentrations in groundwater collected from reference locations and thus are Site-related COPCs.

- Decision Question 8: Is the soil in the debris landfill characterized as hazardous by chemical concentration?

  Statement: Determine if the debris landfill contents are characteristic of hazardous waste.

- Decision Question 9: Is there evidence of a UST at Cottage 7?

  Statement: Survey the area around Cottage 7 for evidence of a UST.

- Decision Question 10: Is there visual evidence of asbestos-containing materials (ACM) within and around Site structures at the resort that may be impacting the environment?

  Statement: Identify potential evidence of ACM within and around Site structures in the resort that may be impacting the environment.

- Decision Question 11: Is there evidence that known asbestos pipes are connected to an existing buried network?

  Statement: Survey the area around the known asbestos pipes to evaluate if the buried pipes remain in-place.

- Decision Question 12: Is there visual and/or analytical evidence of lead-based paint on and around Site structures that may be impacting the environment?

  Statement: Identify potential visual and/or analytical evidence of lead-based paint on and around Site structures that may be impacting the environment.

Estimation Questions and Statements

- Estimation Question 1: In the event potential response actions are necessary, what is the areal and vertical extent of the debris landfill at the Site?

  Statement: Estimate the volume of landfill debris by performing an areal and vertical delineation.

4.3 Identify Information Inputs

The purpose of this step is to identify data required to answer the principal investigation questions listed in Section 4.2.1 and to determine which inputs require environmental measurements.

4.3.1 Previous Data Usability

This subsection summarizes the quality and usability of previously collected data (see Section 2.2.1. Existing data are compared with current action levels in Tables 3 to 13. To evaluate the usability of existing data for this EE/CA investigation, the decision questions developed in Section 4.2.1 are repeated.

- Decision Question 1: Has the distribution of COPCs across the Site been adequately delineated such that human health and ecological risks can be quantified?
  - Quality and usability of existing data: Multiple reports have documented historical site uses, and locations of historical petroleum and chemical uses are limited to parts of the resort that are not accessible to resort guests. As such, the COPC source areas are in the three physical areas defined in this SAP. There is a dataset consisting of discrete samples previously collected at the Site. These samples can be used to identify areas of contaminant release or accumulation that should be investigated further. These historical data may be considered the first stage of data collection and used to design successive stages of investigation to delineate the nature and extent of Site contamination and associated contaminant source areas. A discussion of the quality and usability of existing data for each medium follows.
    - Surface soil/debris landfill: All RCRA 8 metals, multiple PAHs, and three organochlorine pesticides exceeded action levels in surface soil. Two PCBs were detected in surface samples from the debris landfill; although these detections were not above action levels, the presence of PCBs should be further investigated.
    - Groundwater: Petroleum-related VOCs and several PAHs were detected above action levels in groundwater in the only sample that has been collected, in the vicinity of a closed UST.

- Decision Question 2: Are concentrations of COPCs present in Site surface soil posing an unacceptable potential for risk to human and/or ecological receptors? And Decision Question 3: Are concentrations of COPCs present in soil in the debris landfill posing an unacceptable potential for risk to human and/or ecological receptors?
  - Quality and usability of existing data: Previous sample data will not be used in the risk assessment because they are not representative of current conditions. VHB screened these data against current project action levels to assess the need for additional investigation, as discussed above.
  - There is observable evidence of contaminant removal and implementation of an engineering control at the WWTP building, where stained soil was removed and a concrete step installed. In this location, the exposure pathway is no longer complete.

- Decision Question 4: Are concentrations of COPCs present in Site groundwater posing an unacceptable potential for risk to human and/or ecological receptors?
  - Quality and usability of existing data: One sample was collected from the monitoring well. The data were collected several years ago and cannot be used to assess current risk.
- Decision Question 5: Do COPC concentrations in Site soil exceed COPC concentrations in reference/background soil samples?
  - Quality and usability of existing data: No background/reference samples have been collected using the ISM for soils.
- Decision Question 6: Do COPCs in groundwater downgradient of potential source areas exceed screening levels?
  - Quality and usability of existing data: There is only one groundwater monitoring well on the Site, in Area 2; therefore, there are insufficient data to evaluate COPC migration in groundwater. The previous data can provide limited information regarding concentration changes over time.
- Decision Question 7: Are the COPCs detected in groundwater above screening levels related to a release on Site, or are they consistent with local background/reference concentrations?
  - Quality and usability of existing data: No groundwater reference samples have been collected.
- Decision Question 8: Is the soil in the debris landfill characterized as hazardous by chemical concentration?
  - Quality and usability of existing data: No waste characterization samples have been collected from the debris landfill contents.
- Decision Question 9: Is there evidence of a UST at Cottage 7?
  - Quality and usability of existing data: No evidence of vent and fill pipes, depressions, or mounds are visible, but no subsurface data have been collected.
- Decision Question 10: Is there visual evidence of asbestos-containing materials (ACM) within and around Site structures at the resort that may be impacting the environment?
  - Quality and usability of existing data: The age of the structures on the Site suggest that ACM may be present and hurricane or other damage to those structures may have resulted in actual or potential impacts to the environment. No data have been collected apart from the subsurface asbestos pipe in Area 2.
- Decision Question 11: Is there evidence that known asbestos pipes are connected to an existing buried network?
  - Quality and usability of existing data: Asbestos pipe was previously identified at the ground surface in one location. No data have been collected regarding the subsurface extent of that piping.

- Decision Question 12: Is there visual and/or analytical evidence of lead-based paint on and around Site structures that may be impacting the environment?
  - Quality and usability of existing data: The age of the structures on the Site suggest that lead-based paint may be present and hurricane or other damage to those structures may have resulted in actual or potential impacts to the environment. No data have been collected regarding impacts from lead-based paint.
- Estimation Question 1: In the event potential response actions are necessary, what is the areal and vertical extent of the debris landfill at the Site?
  - Quality and usability of existing data: The areal extent of the debris landfill has been estimated at approximately 0.5 acres based on historical aerial photographs, and the vertical extent is reported to be as much as 15 feet deep; however, the debris landfill volume is not sufficiently defined to assess response actions.

4.3.2 Data to be Collected in the Current Investigation

The new data required to answer the principal investigation questions are as follows. The decision questions developed in Section 4.2.1 are repeated for reference.

- Decision Question 1: Has the distribution of COPCs across the Site been adequately delineated such that human health and ecological risks can be quantified?
  - VHB will collect current data on COPCs in surface soil, debris landfill contents, and groundwater. Preliminary COPCs are listed in Table 2.2.3 and expanded upon in the following bullets.
  - The analyte list of metals will include the RCRA 8 metals list and the 13 Priority Pollutant list, as follows: antimony, arsenic, barium, beryllium, barium, cadmium, chromium (III and VI), copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Metals are COPCs in all media.
  - Because the use and disposal of a variety of VOCs is possible, the full standard analytical VOC list will be analyzed for all media. However, because VOCs do not persist in surface soil and are not expected to be present in areas without a suspected source, surface soil sampling for VOCs will be limited to the areas around the ASTs and the reference areas.
  - The standard laboratory analysis for seven PCB Aroclors will be used in this investigation. PCBs are COPCs in media at the debris landfill only.
  - The standard list of 18 PAHs will be used for this investigation: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, dibenz(a,h)anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, pyrene, and phenanthrene). PAHs are COPCs in all media. There is no historical evidence,

including previous sampling results and a review of historical Site practices, to suggest the presence of other SVOCs above action levels.
  - Organochlorine pesticides were previously detected above action levels. As such, the full laboratory list of organochlorine pesticides will be analyzed in all media.

- Decision Question 2: Are concentrations of COPCs present in Site surface soil posing an unacceptable potential for risk to human and/or ecological receptors?
  - Laboratory analysis of COPCs in surface soil with complete exposure pathways for humans and ecological receptors is required.
- Decision Question 3: Are concentrations of COPCs present in soil in the debris landfill posing an unacceptable potential for risk to human and/or ecological receptors?
  - To evaluate the landfill wastes, the horizontal and vertical boundaries of the landfill, or discrete pits containing waste within the landfill must be assessed. Laboratory analysis of COPCs in representative samples of landfill wastes are required to evaluate complete exposure pathways for humans and ecological receptors. Subsurface soil to a depth appropriate for utility worker risk assessment will be evaluated based on the results of the debris landfill sampling and other observations.
- Decision Question 4: Are concentrations of COPCs present in Site groundwater posing an unacceptable potential for risk to human and/or ecological receptors?
  - Laboratory analysis of COPCs in surface soil with complete exposure pathways for humans and ecological receptors is required. According to the USVI Water Quality Standards, inland groundwater in the USVI with a naturally occurring salinity of less than 10,000 milligrams per liter (mg/l) is a considered a potential supply of drinking water.
- Decision Question 5: Do COPC concentrations in Site soil exceed COPC concentrations in reference/background soil samples?
  - Reference samples will be collected from surface soil and deeper soil, and analyzed for all COPCs that may be naturally occurring or present at the Site as a result of non-Site related anthropogenic impacts:
    - VHB will select two surface soil reference locations off-site and within VIIS for collection of ISM samples from a similar soil type at a similar elevation
    - VHB will select three reference locations on the slope above or at a similar elevation to and near the landfill, outside the delineated boundaries of the landfill. VHB will collect discrete samples of soil types that are similar to soil surrounding the landfill and at a similar elevation.

- Decision Question 6: Do COPCs in groundwater downgradient of potential source areas exceed screening levels?

  - VHB will install groundwater monitoring wells downgradient of potential sources in investigation areas 2 and 3. As there are no currently identified sources in investigation area 1, no monitoring wells are planned, although surface soil sampling may indicate the need for groundwater sampling.
- Decision Question 7: Are the COPCs detected in groundwater above screening levels related to a release on Site, or are they consistent with local background/reference concentrations?
  - VHB will install two monitoring wells for collection of reference samples. One well will be installed near Area 2 and one well will be installed near Area 3. Both wells will be installed upgradient of the Site with respect to the groundwater flow direction assumed for the CSM.
- Decision Question 8: Is the soil in the debris landfill characterized as hazardous by chemical concentration?
  - VHB will analyze debris landfill contents by the Toxicity Characteristic Leaching Procedure (TCLP) to characterize the waste for disposal. TCLP analyses will include VOCs, pesticides, and metals. The PCB analytical results for samples from the debris landfill will also be used for debris landfill characterization.
- Decision Question 9: Is there evidence of a UST at Cottage 7?
  - The ground penetrating radar (GPR) and electromagnetic induction (EMI) contractor will survey the area around Cottage 7 to identify and locate anomalies that could be historical USTs.
- Decision Question 10: Is there visual evidence of asbestos-containing materials (ACM) within and around Site structures at the resort that may be impacting the environment?
  - VHB will conduct a reconnaissance of Site structures to identify and document potential ACM that is both exposed and friable and has evidently been released to soil or poses a current risk of release. VHB will not sample suspected ACM and will not attempt to identify non-friable ACM, such as tiles, mastic, and roofing materials.
- Decision Question 11: Is there evidence that known asbestos pipes are connected to an existing buried network?
  - VHB will coordinate a GPR survey surrounding the area of the identified asbestos pipe to trace its approximate extent.
- Decision Question 12: Is there visual and/or analytical evidence of lead-based paint on and around Site structures that may be impacting the environment?
  - VHB will conduct a reconnaissance of Site structures to identify and document potential lead-based paint that may be impacting the environment. VHB will collect discrete surface soil samples at select locations where impacts due to lead-based paint are suspected (e.g. along building drip lines, where paint chipping is evident, or where paint chips are observed on the ground surface).

- Estimation Question 1: In the event potential response actions are necessary, what is the areal and vertical extent of the debris landfill at the Site?
  - VHB will coordinate a GPR and EMI survey at the surface of the landfill to estimate the outer boundary of the buried wastes. VHB will use soil coring information to estimate the depth of waste.

4.4 Define the Boundaries of the Investigation

4.4.1 Spatial Boundaries

The lateral extent of each investigation area is shown on Figure 8. Determination of the lateral extent of each investigation area is described in Section 2.1.1.

The vertical depth of investigation is determined by the potential receptors in each area. Different receptors may be exposed to different soil depth intervals. For the future recreational visitor, park visitor, NPS worker, and ecological receptors that do not burrow, the depth interval of interest is 0 to 0.5 ft; for construction/utility workers , it is 0 to 6 ft; and for burrowing ecological receptors, it is 0 to 3 ft. Surface soil samples will include soils between 0 and 0.5 fbgs, collected using ISM.

Because Area 1 is a gravel terrace, it is not a habitat for burrowing mammals, subsurface samples will not be collected from this area. In Area 2, the layout of the buildings has not changed substantially in several decades, and there is no reason to suspect that surrounding yards have been filled with imported soil; therefore, no subsurface soil samples will be collected from this area. At Area 3, surface soils will be collected separately from samples of the debris landfill contents in the subsurface.

The distribution of wastes in the debris landfill will be better understood following the GPR and EMI surveys. Decision unit sizes will depend on the size of each pit or, if pits are not present, the overall size of the landfill. Discrete samples will be collected from pits or from a grid over the whole landfill surface (approximately 0.5 acre) if pits are not present. Samples from the landfill will be composed of materials at two depths:

- one in the 0.5 to 3 fbgs interval (i.e., the burrowing mammal exposure depth)
- one in the 4 to 6 fbgs interval (i.e., the utility worker exposure depth)

In the Level 2 report, the depth of the debris landfill contents was estimated at 15 ft; this depth has not been confirmed. The driller will complete borings in the landfill to the following maximum depth, whichever is encountered first:

- 1 foot below the bottom of observed waste

- Refusal
- 15 fbgs
- 1 ft below the water table

Shallow groundwater monitoring wells will be completed to cross the water table, which is anticipated to be approximately 2 to 6 fbgs.

Reference sampling locations will be outside the investigation areas in locations where Site-related impacts are not expected to have occurred. Two groundwater reference locations will be identified upgradient of the Site, one near Area 2 and another near Area 3. For soil, reference locations will be selected upgradient of the Site in areas with similar soil characteristics (soil type, grain size, pH, etc.) and similar topography. VHB will select soil boring reference locations that are accessible and safe for drill rig access. If waste is encountered in a reference soil boring, the driller will abandon the hole and move the rig at least 10 feet away from the current location.

4.4.2 Temporal Boundaries

Samples will be collected once during this investigation. The investigation will be performed during a relatively dry time of year. Concentrations of contaminants in soil and groundwater are potentially higher at this time of year than during the rainy season. If additional samples are required to evaluate trends, they will be collected in a later investigation phase that is not part of this SAP.

4.4.3 Decision Units

Decision units (DUs) are the smallest defined areas for which a decision will be made (e.g., to cleanup or not cleanup) based on sampling. DUs are designed to have relatively low heterogeneity, based on potential contaminant sources. A DU may consist of one or more sampling units (SUs, described in Section 4.4.4). Human use areas and ecological receptor home ranges have a primary role in defining the DUs for the Site. ISM techniques will be used for surface (0-0.5 ft) and the debris landfill contents (full depth). For surface soil, each ISM DU will be composed of 40 approximately equal volume increments. This number of increments was selected in accordance with ISM guidance.

For debris landfill contents, the number of samples that compose a decision unit will depend on whether waste is present in pits or in a more consistent layer over the whole footprint. A small pit will be considered a singular decision unit, but more than one sampling location may be installed in larger pits. A summary of the DUs identified for each media type is provided below.

Surface Soil

For surface soil, it is anticipated that ecological receptors' home range sizes will be smaller than human use areas. Thus, DU sizes are primarily dictated by ecological receptor considerations. For ecological receptors, each soil DU will be a maximum of approximately 0.25 acres, or approximately 100 ft by 100 ft. This size is equivalent to the home range of the mouse, which is a commonly selected ecological receptor with a small home range. For human receptors, the soil DUs are determined based on larger receptor-specific use areas. For example, a human receptor would be exposed to all soil in Area 1, but two ecological DUs are required. Rather than separately sampling DUs for ecological and human receptors, the smaller ecological receptor-based DUs may be combined as appropriate to represent areas of human exposure to surface (and subsurface) soil. Nine surface soil DUs have been identified: two in Area 1; five in Area 2; and two in Area 3.

Surface Soil around Buildings for Lead Sampling

VHB will use factors including similarity of construction materials and apparent age to group buildings into DUs. One discrete soil sample will represent a grouping of buildings. This density of samples is not sufficiently representative of soil conditions to be used for risk assessment. Hence, the results will be used to screen for the presence or absence of lead-based paint impacts to soils and the need for additional actions.

Debris Landfill Contents

The contents of the debris landfill are reportedly much deeper than 0.5 ft, although the total depth is unknown. Because the landfill contents are likely not suitable habitat for burrowing mammals, the primary determinant for selecting the DU size is the distribution of the waste – in pits or as a single layer. The entire 0.5-acre landfill may comprise a single DU, including all soil throughout the full depth of the debris landfill, or pits may be considered singular DUs. The objective is to appropriately characterize the contents to 1) evaluate potential risk to the construction/utility worker, 2) evaluate the potential for COPCs to leach to subsurface soils and groundwater, and 3) provide information for disposal requirements. The debris landfill contents will be sampled using discrete coring techniques. Results may be used in risk assessments for ecological and construction/utility worker scenarios. VHB will advance a total of 10 soil borings in and at the boundaries of the landfill waste, and will complete 3 reference soil cores outside the landfill.

VHB will collect waste characterization (TCLP) samples of waste materials only. Reference or native soil samples will not require waste characterization. Thus, VHB will analyze up to 10 samples of waste for disposal/hazardous waste characterization.

Groundwater

Potential release areas, groundwater flow directions, and groundwater to surface water discharge areas have been considered in defining groundwater DUs. Ecological receptors are not expected to be directly exposed to groundwater at the Site. The only human receptor expected to be exposed to groundwater is the construction/utility worker. Groundwater is potentially impacted by multiple sources at the Site, and the specific locations where construction activities may occur in the future is unknown. Therefore, DUs for groundwater were designed so that groundwater monitoring wells (individual DUs) are placed downgradient of known and suspected source areas. Five groundwater DUs have been identified: four in Area 2 and one in Area 3.

Groundwater at Area 1 will not be evaluated during this investigation because there are no indications of chemical releases that would warrant a groundwater investigation at this time. Soil sampling results from this investigation will be used to evaluate the potential for groundwater contamination. Depending on the concentrations in soil and the locations of the detections, additional groundwater sampling may be required as an addendum to this investigation.

4.4.4 Sampling Units

SUs are the smallest defined areas for which samples are collected to determine a representative concentration for that area. SUs for surface soil, debris landfill contents, and groundwater will be the same as the DUs for these media types.

4.5 Develop the Analytic Approach

This section defines the analytic or evaluation approach that will be used to answer the principal investigation questions and what screening values or standards will be used.

4.5.1 Decision or Estimation Parameters

This section details the population parameters that will be applied to the sample populations in order to draw conclusions or make inferences about the data set and to compare the sample population results to the action levels defined in the following section.

- Decision Question 1: Has the distribution of COPCs across the Site been adequately delineated such that human health and ecological risks can be quantified?
  - Parameter: VHB will use samples collected within the physical boundaries of the investigation areas to evaluate the nature and extent of COPCs in soil. VHB will assess the nature and extent of COPCs in groundwater through sampling

downgradient of potential source areas. If data validation indicates that sample results are usable, the data will be appropriate for use in risk assessment.

- Decision Question 2: Are concentrations of COPCs present in Site surface soil posing an unacceptable potential for risk to human and/or ecological receptors?
    - Parameter: The risk assessor will compare the maximum analyte concentration of the replicate Site surface soil samples from each DU to the COPC screening levels. A risk assessment will be conducted for both human and ecological receptors using measured concentrations of COPCs in Site surface soil to derive exposure point concentrations (EPCs). These EPCs will be combined with appropriate exposure parameters and toxicity values to calculate risk estimates to determine if concentrations pose an unacceptable risk to human and/or ecological receptors. If the risk assessment concludes that one or more COPCs pose an unacceptable risk, the EE/CA will evaluate appropriate removal actions to address these risks; otherwise, the EE/CA will conclude that no removal actions are necessary to address risks. The EE/CA Risk Assessment Work Plan (Woodard & Curran 2016) provides additional details on the risk assessment approach.
- Decision Question 3: Are concentrations of COPCs present in soil in the debris landfill posing an unacceptable potential for risk to human and/or ecological receptors?
    - Parameter: The risk assessor will compare the 95 percent upper confidence limit (UCL) analyte concentration in debris landfill contents to the COPC screening levels. Woodard and Curran will assess risks as detailed in the previous bullet for Decision Question 2.
- Decision Question 4: Are concentrations of COPCs present in Site groundwater posing an unacceptable potential for risk to human and/or ecological receptors?
    - Parameter: VHB will collect one groundwater sample per monitoring well. The result for each well will be compared to the COPC screening levels. Woodard and Curran will assess risks as detailed in the previous bullet for Decision Question 2.
- Decision Question 5: Do COPC concentrations in Site soil exceed COPC concentrations in reference/background soil samples? and Decision Question 7: Are the COPCs detected in groundwater above screening levels related to a release on Site, or are they consistent with local background/reference concentrations?
    - Parameter: Results from each DU will be compared statistically to the applicable reference area using non-parametric methods as outlined in the USEPA document Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (USEPA 2002). If COPC concentrations in the reference DU are statistically higher than concentrations in the Site DU, then the COPC may be considered non-Site-related.
- Decision Question 6: Do COPCs in groundwater downgradient of potential source areas exceed screening levels?

- Parameter: Groundwater concentrations in potential source areas and downgradient areas will be compared, and geological factors and groundwater gradients will be considered, to evaluate COPC migration. A risk assessment will be conducted for both human and ecological receptors using measured concentrations of COPCs in Site surface soil, debris landfill contents, and groundwater samples to derive exposure point concentrations (EPCs). These EPCs will be combined with appropriate exposure parameters and toxicity values to calculate risk estimates to determine if concentrations pose an unacceptable risk to human and/or ecological receptors. If the risk assessment concludes that one or more COPCs pose an unacceptable risk, the EE/CA will evaluate appropriate removal actions to address these risks; otherwise, the EE/CA will conclude that no removal actions are necessary to address risks. The EE/CA Risk Assessment Work Plan (Woodard & Curran 2016) provides additional details on the risk assessment approach.

- Decision Question 8: Is the soil in the debris landfill characterized as hazardous by chemical concentration?
  - Parameter: Waste characterization results will be compared to TCLP limits to determine disposal requirements for the debris landfill contents.
- Decision Question 9: Is there evidence of a UST at Cottage 7?
  - Parameter: The GPR and EMI contractor will review the survey data to identify anomalies indicative of a UST.
- Decision Question 10: Is there visual evidence of asbestos-containing materials (ACM) within and around Site structures at the resort that may be impacting the environment?
  - Parameter: VHB will conduct a reconnaissance of Site structures to identify and document visual evidence of friable potential asbestos to inform decision-making on the need for further evaluation.
- Decision Question 11: Is there visual and/or analytical evidence of lead-based paint on and around Site structures that may be impacting the environment?
  - Parameter: Based on the GPR survey results, the approximate extents of the subsurface asbestos piping will be mapped sufficiently to evaluate if the pipe network exists or has been removed. The survey will not locate all buried pipes.
- Decision Question 12: Is there visual and/or analytical evidence of lead-based paint on and around Site structures that may be impacting the environment?
  - Parameter: VHB will conduct a reconnaissance of Site structures to identify and document visual evidence of lead-based paint that may be impacting the environment and collect analytical soil samples at select locations to inform decision-making on the need for further evaluation.
- Estimation Question 1: In the event potential response actions are necessary, what is the areal and vertical extent of the debris landfill at the Site?

- Parameter: The debris landfill contents will be delineated sufficiently to assess removal or other actions during the EE/CA.

4.5.2 Action Levels

The human health screening levels and ecological screening values used to select the action levels are summarized on Table 1 for soil and Table 2 for groundwater. In the EE/CA report, the action levels will provide initial screening levels for the risk assessments, and other federal and state ARARs will be applied or considered.

The following project screening levels will be used to identify COPCs. When screening levels are available from multiple sources, the lowest value will be used in the screening process. For example, if a federal Maximum Contaminant Level (MCL) is lower than an NPS Environmental Screening Value (ESV) for water, the MCL will be used in preference to the ESV. However, the screening levels will only be used for the risk assessments identified (i.e., ESVs will not be used in the human health risk assessment, and MCLs will not be used in the ecological risk assessment).

- Soil:
  - Human health:
    - USEPA Regional Screening Level (RSL) for Resident Soil, target cancer risk of 1E-06 and target hazard quotients of 0.1 (USEPA 2020).
    - Virgin Islands UST Rules and Regulations Soil Cleanup Target Levels (Virgin Islands Rules and Regulations 2014).
  - Ecological:
    - NPS ESVs for Soil – Screening Level Ecological Risk Assessment (SLERA) Contaminant of Potential Ecological Concern (COPEC) Selection ESV, lowest ESV from Table 5: Soil ESVs for Plants and Soil Invertebrates and Table 6: Soil ESVs for Birds and Mammals (NPS 2020). This document reviews candidate sources for ecological screening levels and selects the most appropriate ESVs.
  - Representativeness of background/reference concentration:
    - Regional background concentrations will be used to evaluate the representativeness of the Site background/reference samples.
- Groundwater:
  - Human health:
    - USEPA RSL for Tapwater, target cancer risk of 1E-06 and target hazard quotients of 0.1 (USEPA 2020).
    - USEPA Vapor Intrusion Screening Levels (VISLs) for groundwater adjusted for a target hazard quotient of 0.1 (USEPA 2016).
    - Virgin Islands MCLs, which are the same as the National Primary Drinking Water Regulations (USEPA 2010).

  - Virgin Islands UST Rules and Regulations Water Cleanup Target Levels, Groundwater Cleanup Criteria (Virgin Islands Rules and Regulations 2014).
- Ecological:
  - NPS ESVs for Surface Water – lowest value from SLERA COPEC ESV, Table 1a: Surface Water ESVs for Aquatic Receptors (Freshwater) and SLERA COPEC Selection ESV, Table 7, Surface Water Ecological Screening Values for Amphibian Receptors (NPS 2020). This document reviews candidate sources for ecological screening levels and selects the most appropriate ESVs. The document suggests that if aquatic receptors may come into contact with contaminated groundwater, it would be appropriate to compare groundwater "concentrations to surface water ESVs to determine if further assessment of this exposure scenario is warranted" (NPS 2020).

During the risk management process in the EE/CA, remedial goals may consider analyte concentrations in samples from reference locations. These concentrations will not be used before the risk management process to dismiss any COPCs from the risk assessments.

Detection limits that will be required to determine sample concentrations at or below the action levels will be presented in the QAPP.

4.6 Performance or Acceptance Criteria

The purpose of this step is to establish the criteria needed to obtain data that can be used to answer the principal investigation questions accurately and with confidence.

4.6.1 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) measures will be implemented during the investigation to limit variability, mitigate the potential for false positive and/or false negative error, and increase the accuracy and defensibility of the collected data.

Standard operating procedures (SOPs) for field and laboratory work will be used to achieve acceptable data quality for the purposes of determining the nature and extent of contamination, Site delineation, and for risk screening and assessments. Internal SOPs that will be used for this project are listed in Table 17 and are available upon request. Laboratory SOPs are listed in Table 17 and are available upon request; all SOPs are for internal use and are not for distribution.

Field and laboratory precision and accuracy are specified in Tables 1 and 2, including detection limits and reporting limits as necessary to meet the project goals.

Laboratory Quality Assurance/Quality Control

The laboratory project manager who will coordinate all analytical services is Opal Johnson of Eurofins TestAmerica, Inc. in North Canton, Ohio.

Lab certifications and audits provide an evaluation of the lab's capability to perform the necessary analysis with acceptable precision and accuracy. The Eurofins TestAmerica laboratory is certified through the National Environmental Laboratory Accreditation Program.

The data quality indicators (DQIs) and their associated measurement performance criteria specific to each analytical method include Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity and are evaluated from QA/QC samples including, blanks, duplicates, matrix spikes, and instrument quality assurance samples described in detail in the laboratory SOPs attached in Appendix 2 (a list of laboratory SOPs applicable to this project is provided in Table 17). The numbers and types of the quality assurance/quality control samples are included in Tables 15A and 15B, and are consistent with EPA requirements and industry standards.

Field and laboratory precision and accuracy are specified in the laboratory SOPs as necessary to meet the project goals, including method detection limits (MDLs) and reporting limits (RLs).

Field QA/QC

The field team will rely on SOPs to guide sample collection and documentation, which will minimize the variability introduced during sample collection. A list of SOPs is provided in Table 17. The field team will also follow procedures presented in Section 5 of this SAP.

Field Quality Control Samples

The following field QC samples are planned, as summarized in Tables 15A and 15B:

- Duplicates for discrete samples will be collected at a frequency of 10 percent (i.e., one replicate per 10 samples). No duplicates are required for ISM samples.
- Matrix spike/matrix duplicate (MS/MD) samples will be collected and analyzed at a minimum frequency of 5 percent (i.e., one per 20 samples).
- Equipment blank samples will be collected from non-dedicated sampling equipment and analyzed at a frequency of 5 percent (i.e., one per 20 samples).
- Method blanks and laboratory control samples will be analyzed by the laboratory in accordance with applicable analytical methods and equipment.

A sample identification protocol for identifying field QC samples is provided in Section 5.2.1.

Decontamination Procedures

Section 5.1.3 describes how the field team will decontaminate field equipment and how often that procedure will be conducted and documented.

Instrument/Equipment Testing, Inspection, and Maintenance

Electrical or mechanized sampling equipment will be rented; testing, inspection, or maintenance will be performed by the rental agency. Equipment that is found to be non-functional in the field will be returned and replaced as soon as possible.

Instrument/Equipment Calibration and Frequency

Sampling equipment requiring field calibration includes the photoionization detector (PID) and YSI multi-parameter instrument. These instruments will be calibrated in the morning before each day of use.

Inspection/Acceptance of Supplies and Consumables

The Field Team Leader will be responsible for ordering all necessary equipment and materials and inspecting items before use. All items that will contact samples must be new or properly decontaminated before use.

Special Training and Certification

All field personnel who collect samples during this investigation must have a valid 40-hour (or 8-hour refresher, as appropriate) Hazardous Waste Operations and Emergency Response training certificate. No additional special training is required.

Field Audits

A field audit will not be performed during this investigation.

Data Quality Indicators

Data usability will be assessed mainly using DQIs, which will be represented by the following and are presented for each analytical group in Text Table 2.2.3.

- Precision: field precision will be assessed using field duplicates; laboratory precision will be assessed using the laboratory control samples (LCS/LCSD); precision in the sample matrix will be assessed using matrix spike (MS) and matrix duplicates (MD).
- Accuracy: field accuracy will be assessed using equipment blanks; laboratory accuracy will be assessed using method blanks, calibration criteria, and LCS recoveries; accuracy in the sample matrix will be assessed using the MS recovery results.
- Representativeness: will be assessed quantitatively through the relative percent difference of field duplicates and qualitatively for all data by verifying that sampling

procedures and locations were followed as designed, validating the data received for COPCs, and checking that DQOs were met.

- Completeness: will be assessed by comparing the number of samples that are not rejected to the planned number of samples; if fewer than 95 percent of sample results are usable, the program should be reevaluated to determine if additional samples are required. Because there is only one background/reference soil DU, one background sample of the Little Buffalo River surface water, and one background sample of the unnamed stream surface water, these results must be 100 percent usable.
- Comparability: will be assessed by evaluating whether DQOs were achieved and SOPs were followed.
- Sensitivity: field sensitivity will be assessed using the field equipment blanks; laboratory sensitivity will be assessed using the laboratory method blanks, LCS, and calibration criteria; sensitivity in the site matrix will be assessed based on the sample-specific limit of quantitation (LOQ) achieved for COPCs.

4.6.2 Decision Error Limits and Uncertainty Evaluation

The project decision makers will use analytical results to decide whether additional investigations may be needed. Upon the receipt of sample analytical results, each of the principal investigation questions will be addressed using the "Statistical Hypothesis Testing" method, as outlined in "Guidance on Systematic Planning Using the Data Quality Objectives Process" (USEPA 2006).

The tolerable limits on decision errors, which are used to establish performance goals for the data collection design, are specified in this step. Decision-makers are interested in knowing the true value of the concentrations and/or measurements. Because measured data can only estimate these values, decisions that are based on these data could be in error (decision error). The decision-maker cannot know the true value of a constituent concentration for two reasons:

- Concentrations may vary over time and space. Limited sampling may miss some features of this natural variation because it is usually impossible or impractical to measure every point of a population. Sampling design error occurs when the sampling design is unable to capture the complete extent of natural variability that exists in the true state of the environment.
- Analytical methods and instruments are never perfect; hence, a measurement can only estimate the true value of an environmental sample. Measurement error refers to a combination of random and systematic errors that inevitably arise during the various steps of the measurement process.

The combination of sampling design error and measurement error is the total study error. Because it is impossible to eliminate total study error, basing decisions on sample data may lead to a decision error. The probability of a decision error is controlled by adopting a scientific approach in which the data are used to select between one condition (the null hypothesis [H_0]) and another (the alternative hypothesis [H_A]). The null hypothesis is presumed to be true (not rejected) in the absence of evidence to the contrary. A false rejection, or "Type I" decision error, refers to the type of error made when the null hypothesis is rejected when it is actually true. A false acceptance, or "Type II" decision error, refers to the type of error made when the null hypothesis is accepted when it is actually false. The probability of a Type I error is called alpha (α) and the probability of a Type II error is called beta (β). The confidence level is related to α and the statistical power is related to β.

Decision Question 1: Has the distribution of COPCs across the Site been adequately delineated such that human health and ecological risks can be quantified?

Simple "yes/no" decisions will be made based the investigation results and professional judgment. As described in EPA's DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For **Decision Question 2** (Are concentrations of COPCs present in Site surface soil posing an unacceptable potential for risk to human and/or ecological receptors?), the null and alternative hypotheses are as follows:

> H_0: The true mean DU analyte concentration exceeds the relevant exposure point concentration associated with the acceptable risk level, as determined by a risk assessment. The EE/CA will evaluate appropriate actions to address risk related to that exposure scenario
>
> H_A: The true mean DU analyte concentration does not exceed the relevant exposure point concentration associated with the acceptable risk level, as determined by a risk assessment. No action is necessary to address risk related to that exposure scenario.

A Type I error for Question 2 (falsely rejecting the null hypothesis or concluding the true mean DU concentration is less than the exposure point concentration associated the acceptable risk level when it actually exceeds) is considered the more severe type of error as it would result in unacceptable risk remaining unaddressed. The tolerable limit for a Type 1 error for Question 2 is set at 5% (i.e., α=0.05). A Type II error for Question 2 (falsely accepting the null hypothesis or concluding the true mean DU concentration is exceeds the exposure point concentration associated the acceptable risk level when it does not) is considered the less severe type of error as it would only result in a COPC being unnecessarily retained for response action evaluation in the EE/CA. The tolerable limit for a Type II error for Question 2 is set at 20% (i.e., β=0.2) when the true concentration is 50% of the acceptable risk level concentration. Type I and II errors for

Question 2 will be controlled by comparing confidence levels on the sample means to exposure point concentrations associated with the acceptable risk level.

For **Decision Question 3** (Are concentrations of COPCs present in soil in the debris landfill posing an unacceptable potential for risk to human and/or ecological receptors?), the null and alternative hypotheses are as follows:

> H_0: The true mean DU analyte concentration exceeds the relevant exposure point concentration associated with the acceptable risk level, as determined by a risk assessment. The EE/CA will evaluate appropriate actions to address risk related to that exposure scenario.

> H_A: The true mean DU analyte concentration does not exceed the relevant exposure point concentration associated with the acceptable risk level, as determined by a risk assessment. No action is necessary to address risk related to that exposure scenario.

A Type I error for Question 3 (falsely rejecting the null hypothesis or concluding the true mean DU concentration is less than the exposure point concentration associated the acceptable risk level when it actually exceeds) is considered the more severe type of error as it would result in unacceptable risk remaining unaddressed. The tolerable limit for a Type 1 error for Question 3 is set at 5% (i.e., α=0.05). A Type II error for Question 3 (falsely accepting the null hypothesis or concluding the true mean DU concentration is exceeds the exposure point concentration associated the acceptable risk level when it does not) is considered the less severe type of error as it would only result in a COPC being unnecessarily retained for response action evaluation in the EE/CA. The tolerable limit for a Type II error for Question 3 is set at 20% (i.e., β=0.2) when the true concentration is 50% of the acceptable risk level concentration. Type I and II errors for Question 3 will be controlled by comparing confidence levels on the sample means to exposure point concentrations associated with the acceptable risk level.

For **Decision Question 4** (Are concentrations of COPCs present in Site groundwater posing an unacceptable potential for risk to human and/or ecological receptors?), the null and alternative hypotheses are as follows:

> H_0: The groundwater concentration exceeds the relevant exposure point concentration associated with the acceptable risk level, as determined by a risk assessment. The EE/CA will evaluate appropriate actions to address risk related to that exposure scenario.

> H_A: The groundwater concentration does not exceed the relevant exposure point concentration associated with the acceptable risk level, as determined by a risk

assessment. The EE/CA will evaluate appropriate actions to address risk related to that exposure scenario.

Due to the small number of groundwater samples, a simple “yes/no” decision will be made by comparing discrete sample results to risk level concentrations without considering the variability associated with the measured results. As described in EPA’s DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For **Decision Question 5** (Do COPC concentrations in Site soil exceed COPC concentrations in reference/background soil samples?), the comparison of Site concentrations to reference concentrations assumes that concentrations are “Site-related” until proven otherwise. Thus, the null and alternative hypotheses are as follows:

> H_0: The true mean DU analyte concentration exceeds background by a substantial difference (S); the analyte is a Site-related contaminant.

> H_A: The true mean DU analyte concentration does not exceed background by S; the analyte is not a Site-related contaminant.

A Type I error for Question 5 (falsely rejecting the null hypothesis or concluding the true mean DU concentration does not exceed background by “S” when it actually does) is considered the more severe type of error as it would cause the dismissal of a Site-related COPC. Based on the minimum values recommended in EPA (2002a) for a Form 2 background test. Therefore, when making comparisons to reference, the tolerable limit for a Type 1 error for Question 5 is set at 10% (i.e., α=0.1) and the tolerable limit for a Type II error for Question 2 is set at 20% (i.e., β=0.2). “S” is set to 1.0 times the reference/background standard deviation.

For **Decision Question 6** (Do COPCs in groundwater downgradient of potential source areas exceed screening levels?), the null and alternative hypotheses are as follows:

> H_0: The downgradient groundwater concentration exceeds the relevant screening level.

> H_A: The downgradient groundwater concentration does not exceed the relevant screening level.

Due to the small number of groundwater samples, a simple “yes/no” decision will be made by comparing discrete sample results to screening levels without considering the variability associated with the measured results. As described in EPA’s DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For **Decision Question 7** (Do COPCs in groundwater downgradient of potential source areas exceed screening levels?), the null and alternative hypotheses are as follows:

> H_0: The groundwater concentration exceeds the reference/background concentration.
>
> H_A: The groundwater concentration does not exceed the reference/background concentration.

Due to the small number of groundwater samples, a simple "yes/no" decision will be made by comparing discrete sample results to reference/background without considering the variability associated with the measured results. As described in EPA's DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For **Decision Question 8** (Is the soil in the debris landfill characterized as hazardous by chemical concentration?), the null and alternative hypotheses are as follows:

> H_0: The debris landfill contents concentration is greater than or equal to RCRA characteristic limits for hazardous waste; the material would be disposed of as hazardous waste in a hazardous waste landfill permitted by EPA, or by a State authorized RCRA disposal facility.
>
> H_A: The debris landfill contents concentration are less than RCRA characteristic limits for hazardous waste; the material will not require disposal in a RCRA approved disposal facility.

Given that further waste characterization would be required prior to disposal of debris landfill material, a simple "yes/no" decision will be made by comparing discrete sample results to RCRA characteristic limits for hazardous waste without considering the variability associated with the measured results. As described in EPA's DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For **Decision Question 9** (Is there evidence of a UST at Cottage 7?), the null and alternative hypotheses are as follows:

> H_0: There is evidence of a UST at Cottage 7; further investigation or response action will be evaluated.
>
> H_A: There is no evidence of a UST at Cottage 7; no further action will be considered.

A simple "yes/no" decision will be made based the GPR investigation results without considering the variability associated with the measured results. As described in EPA's DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For **Decision Question 10** (Is there visual evidence of asbestos-containing materials (ACM) within and around Site structures at the resort that may be impacting the environment?), the null and alternative hypotheses are as follows:

> H_0: There is evidence of ACM within and around Site structures that may be impacting the environment; further investigation or response action will be evaluated.
>
> H_A: There is no evidence of ACM within and around Site structures that may be impacting the environment; no further action will be considered.

A simple "yes/no" decision will be made based on a Site reconnaissance without considering the variability associated with the results. As described in EPA's DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For **Decision Question 11** (Is there evidence that known asbestos pipes are connected to an existing buried network?), the null and alternative hypotheses are as follows:

> H_0: There is evidence that the known asbestos pipes remain connected to a buried pipe network; further investigation or response action will be evaluated.
>
> H_A: There is evidence that the known asbestos pipe network has been removed; no further action will be considered.

A simple "yes/no" decision will be made based on a Site reconnaissance and preliminary soil sampling without considering the variability associated with the results. As described in EPA's DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

For Decision Question 12 (Is there visual and/or analytical evidence of lead-based paint on and around Site structures that may be impacting the environment?), the null and alternative hypotheses are as follows:

> H_0: There is evidence of lead-based paint on and around Site structures that may be impacting the environment; further investigation or response action will be evaluated.
>
> H_A: There is no evidence of lead-based paint on and around Site structures that may be impacting the environment; no further action will be considered.

A simple "yes/no" decision will be made based on a Site reconnaissance and preliminary soil sampling without considering the variability associated with the results. As described in EPA's DQO Guidance (USEPA 2006), in this situation, no formal statistical hypothesis tests are performed; therefore, it is not necessary to specify tolerable limits on decision errors.

4.6.3 Data Validation and Usability

Data verification includes methods to evaluate the data's completeness, correctness, and conformance to the analytical method as well as procedural and/or contractual requirements. Data validation is the process of evaluating the analytical quality of the data, including both laboratory and field processes.

Data Verification

The following items will be reviewed by the Contractor Project Manager to verify data:

- Generated by the field team: field notes, daily progress reports, chain-of-custody records, corrective action documentation, project-related correspondence
- Generated by the Data Validator: data validation report

The following items will be reviewed by the Laboratory Project Manager or their designated representative:

- Data generated by the laboratory: equipment calibration, testing, maintenance, and inspection logs

The following items will be reviewed by the Data Validator, Laboratory Project Manager, and Contractor Project Manager to verify data:

- Generated by the field team: chain-of-custody upon sample receipt
- Generated by the laboratory: laboratory reports; raw data and reported results for samples, standards, QC checks, and QC samples

Data Validation

The Data Validator will prepare a report documenting completion of the steps outlined in Tables 21 and 22.

4.7 Plan for Obtaining the Data

The purpose of this step is to describe the most resource-effective data collection design for generating data that will satisfy the DQOs specified in the preceding six steps. The planned investigation tasks are outlined in Section 5.

5 Field Sampling Plan

5.1 General Site Procedures

5.1.1 Site Preparation, Preparation, and Restoration Procedures

VHB will pre-mark boring and excavation locations at least 48 hours before drilling or machine-excavating. CBR staff, the Virgin Islands Water and Power Authority (1-340-776-6446), and the GPR surveyor will clear the locations. All planned drilling and excavation locations will be located by global positioning system (GPS) and marked in the field for clearance. White flags, wooden stakes, and/or white paint will be used to pre-mark locations.

The GPR and EMI contractor will perform pre-clearance work at all proposed monitoring well installations, the landfill drilling locations, and at Cottage 7, in that order. VHB will finalize sampling locations based on the results of the GPR and EMI surveys.

Field activities will be planned and implemented in close coordination with VIIS and CBR staff to protect public safety and preserve public enjoyment of the Park and CBR. Coordination with the Park and owners of properties that may be affected by the investigation will performed at least one month in advance whenever possible.

The security gate for the CBR property will be staffed during working hours, but there are no gates to the individual areas in the Site. To keep the public safe during field work, an exclusion zone will be established using safety cones and caution tape. A copy of the Community Update, prepared as part of the Community Involvement Plan, describing the field work will either be posted or will be available for workers to provide to people who express interest in the field work.

Efforts will be made to minimize impacts to work sites; vegetation will not be cut or disturbed without prior approval by appropriate CBR and/or VIIS staff.

After completing ground-disturbing activities, reasonable efforts will be made to restore locations and disturbed ground surfaces to a natural condition. Following the completion of work at each location, all investigation-derived waste (IDW) will be removed. Decontamination and/or purge water and soil cuttings will be transported to the IDW staging area and transferred to appropriate containers.

5.1.2 Archeological Recordation

The use of a small-diameter bit for coring will minimize disturbance to the resort. Area 3 has been largely disturbed and filled in the past 50 years and is not likely to contain historically significant artifacts. However, because there are areas of potential historical significance throughout Areas 1 and 2, VHB will work with the VIIS Cultural Resource Manager to select sampling locations that will minimize potential impacts to historical resources. The VIIS Cultural Resource Manager will also be invited to attend all subsurface disturbing activities, including all drilling and soil sampling, and will be provided access to the soil cores if observation does not pose a health or safety risk per the HASP (Appendix 3). Borings will be halted until an NPS archeology staff member can evaluate the item if either of the following circumstances occurs.

1. Items are uncovered outside the footprint of previously disturbed areas (e.g., the debris landfill) that appear to pre-date 1920; or
2. Items are uncovered that could significantly pre-date the Caneel Bay Resort (e.g., buried bones or Native American artifacts). The use of a small-diameter bit for coring will limit disturbance to the subsurface. Based on information provided by NPS, the resort may contain historically significant artifacts. If a suspected historically significant artifact is encountered during the investigation, the activity will be halted until an NPS staff member can evaluate the item.

5.1.3 Equipment Decontamination Procedures

The driller will establish a centralized decontamination area for drilling rigs and equipment. A staging area adjacent to the decontamination area will be large enough to allow storage of cleaned equipment and materials prepared for use, as well as to stage potable water tanks, fuel, and drums of decontamination IDW. The decontamination pad will be lined with heavy gauge plastic sheeting and designed with a collection system to capture decontamination water. Any 55-gallon drums containing solid or liquid IDW will be placed on heavy gauge plastic sheeting or similar and covered when active field investigation is not occurring. Smaller decontamination areas for personnel and portable equipment will be established and used adjacent to each investigation area as necessary. These locations will include basins or tubs to capture decontamination fluids, which will be transferred to drums. Trash will be disposed of in bins or dumpsters provided by NPS or CBR.

Drilling equipment that contacts subsurface soils, such as Geoprobe rods, will be decontaminated upon completion of drilling at each boring. Hand-held equipment will be decontaminated at the point-of-use before introducing it into a well or sampling point, and after completion of work at a particular well or sampling point. Decontamination water from hand-held equipment will be contained in a 5-gallon bucket or 55-gallon drum and transferred to a drum with a tight-sealing lid for characterization and disposal.

A steam cleaner may be used to clean larger equipment such as core barrels and steel casing on the decontamination pad. Solids and mud may be removed from equipment using a brush, paper towels, and available clean water. All decontamination water will be contained in a bucket or on plastic sheeting and transferred to drums. If encountered, gross contamination such as non-aqueous phase liquids may be removed using Citri-solv to dissolve the contaminant followed by a triple rinse with tap water. Trace decontamination of small equipment will follow removal of solids and gross contamination and generally consists of washing and scrubbing with a laboratory-grade detergent, such as Alconox, and rinsing with a large volume of tap or distilled water. A final triple rinse with deionized or distilled water will be performed. Equipment may be air dried or wiped dry with paper towels.

Decontamination water from hand-held equipment will be contained in a 5-gallon bucket or 55-gallon drum and transferred to a drum with a tight-sealing lid for characterization and disposal.

5.1.4 Mapping and Surveying

Final geographic coordinates and elevations of monitoring wells, soil borings, and other important Site features will be surveyed by a licensed land surveyor. The water-level measuring point and ground surface elevations at all previously-installed and new monitoring wells will be included in the survey, measured to the nearest 0.01 foot based on the nearest elevation benchmark (if reasonably available) or an arbitrary datum established at the Site. At least 10 surveyed elevation points on the debris landfill surface will be collected to evaluate its volume.

Locations that require a lower degree of precision, such as boundaries of surface soil and debris landfill ISM DUs, will be marked and/or recorded using a GPS with submeter accuracy if satellite reception is adequate. Adequate reception will be achieved when the GPS can connect to at least four satellites with a position dilution of precision (PDOP) of 8 or less. If GPS coordinates cannot be recorded at the submeter level, important locations such as the corners of ISM DUs and staked reference positions will be marked in the field and their locations will be recorded by a licensed surveyor. The staked reference positions will then be used to delineate the remainder of the feature using tape measurements from at least two stakes.

Depending on the findings of the GPR survey, VHB may record the nodes or ends of asbestos piping with the submeter GPS. VHB will not map all asbestos piping identified by the GPR.

VHB will record the locations of discrete lead soil samples by submeter GPS. For record-keeping purposes, VHB may also record the perimeter of each set of buildings represented by the sample.

5.1.5 Dust, Vapor, Odor, and Noise Control

Work controls and procedures will be implemented to protect CBR and VIIS workers and visitors. Engineering controls will be applied as needed to manage dust, vapors, odor, and noise emitted during the EE/CA field activities. Drilling activities are not anticipated to create excessive dust, vapor, odor, or noise. These activities will be qualitatively monitored at the drilling site and at the property boundary. If dust, vapor, or odor is observed related to drilling activities it will be mitigated using engineering controls (e.g., spraying the source of dust with potable water from a public water supply). Water tanks or water trucks intended for use at the Site shall arrive empty and be filled from a CBR water source, which will be approved by NPS. Under no circumstances shall any water from the investigation activities be allowed to enter surface water.

Drilling work will be performed during daylight hours. All reasonable attempts will be made to time the work at Area 3 to avoid days when large numbers of cruise ship travelers are in port on St. Thomas because these days are reportedly busiest at Honeymoon Beach. Work may occur seven days per week.

Any noise, odor, or dust complaints received by the public will be evaluated immediately, and practices will be changed to mitigate the situation. The NPS Project Manager will be informed immediately of the complaint and the response measures.

5.1.6 Damage to Site Structures

The EE/CA field activities will involve subsurface investigations and the use of heavy equipment. In the course of the project, precautions will be taken to avoid damage to resort structures including utilities, the existing monitoring well, roads and paths, trees, and buildings. Plywood, plastic “swamp” mats, or similar materials will be used as needed to prevent excessive rutting or similar damage. Cones, stakes and/or flagging shall be placed as needed around investigation locations and travel corridors as necessary to protect sensitive objects (e.g., trees or unstable slopes). Contingency planning for damage includes the following:

- The Field Team Leader will be responsible for assessing and documenting damage and repairs in the daily reports. Documentation will include reports of interviews with those present and photographs of the damage. The NPS Project Manager and the Contract Project Manager will be immediately notified of the damage.
- If an active utility is damaged, the utility owner will be notified immediately.

- Electricity: Virgin Islands Water and Power Authority Electrical Emergencies (340) 774-1424
- Water, Sewer, Cable, Internet, Telephone: CBR Director of Engineering, Brad Dow (340) 776-6111

- Depending on the scope of the damage, repairs will be made in a timeframe commensurate with the degree of damage and planning required for mitigation.
- Damage to an existing monitoring well will be assessed and documented via photo-documentation. Its condition will be assessed and minor repairs made as needed. Minor repairs will include replacing locking well caps and repairing stick-up PVC riser within 1 ft of ground surface to ensure that the damaged well is not open or uncovered, which could provide a potential conduit for surface infiltration or sloughing of soil or other material into the well. At a minimum, the damaged well will be stabilized and capped. PVC couplers, if required, will be affixed with screws, not glue or solvent cements, to avoid potential VOC contamination.
- Any imminent threat of the debris landfill slope collapse will be identified and all equipment will be moved away from the area. The area of damage will be immediately inspected to determine if landfill debris materials have been exposed on the slope.
- Any spills of petroleum that cause a film or sheen on surface water, or cause an oil sludge to be deposited on a shoreline, and any spills of other hazardous substances in reportable quantities will be reported to the National Response Center at (800) 424-8802 as soon as possible.
- Drill rigs and equipment using the road between investigation areas will be decontaminated to prevent soil tracking. Visible soil spilled or tracked onto the roads will be collected and returned to the Site, and decontamination procedures will be reviewed and modified as necessary to improve the process.
- Equipment refueling will be performed off-site whenever possible. If on-site refueling is required and there is a potential for fuel to drip onto the ground, plastic will be laid on the ground and extend at least 5 ft in all directions from the fill port to intercept any drips or minor spills that may occur. On-site spill response kits will include adsorbent pads and boom, sorbent material, a shovel, and a bucket. A fire extinguisher will be available at the fueling site. In the event of a leak or spill, absorbent materials will be used to immediately control and clean up the spill, and affected soil will be excavated and placed in a drum for off-site disposal. Releases of petroleum in reportable quantities will be reported appropriately as described above.

5.2 Sample Handling

This section describes the sample handling protocol for environmental samples collected during the investigation.

The construction material of the sampling devices (e.g., plastic, PVC, metal) discussed below will be appropriate for the COCs and will be selected so as not interfere with the chemical analyses being performed.

Sampling equipment will be dedicated for use at one sampling location if possible and will be clean, unused and will be protected from contamination until ready for use. Non-dedicated sampling equipment will be decontaminated according to the specifications in Section 5.1.3 before initiating sampling activities and will be protected from contamination until ready for use.

Monitoring equipment used on-Site will be maintained, calibrated, and operated properly with consideration of the manufacturer's recommendations and the relevant SOPs. All field water quality measurements and related instrument calibrations will be executed in accordance with manufacturer's guidelines and SOPs.

Sample containers will be clean, unused, and supplied by Eurofins TestAmerica. Following sampling, sample containers will be packed and transported via overnight shipping to the laboratory. Samples will be placed in coolers with ice and maintained at ≤6°C in a secure location with the chain-of-custody throughout sample transport. The laboratory will be responsible for notifying VHB as soon as possible of any inconsistencies or breakage upon receipt, and within one day at the latest. The laboratory will obtain approval from VHB prior to disposing of any samples.

5.2.1 Sample Labeling

Samples will be assigned a unique sample identifier shown on the chain-of-custody form and sample container labels. Table 5.2.1 summarizes the sample nomenclature for all samples, including duplicates, matrix spike/matrix duplicates, and equipment blanks.

Sample container labels will indicate the sample identifier, date and time of collection, identity of the sample collector, and type of analysis required. Labels will be completed using waterproof ink unless impracticable because of weather conditions such as rain. The source of blind duplicate field samples will be provided with a fictional sample time and will only be identified on field forms and/or in field books; this information will not be provided to the laboratory.

Table 5.2.1: Sample Nomenclature

<table>
<tr><th colspan="5">ISM Samples</th></tr>
<tr><td rowspan="3">IA-
(ISM surface soil sample)</td><td rowspan="3">Area identifier[1]-
(Surface soil; e.g., 1-, REF-)</td><td rowspan="3">Additional identifier-
(e.g., 01-, R-, or similar)</td><td>A
(Initial sample)</td><td>, MS/MSD
(Matrix spike and duplicate)</td></tr>
<tr><td colspan="2">B
(Second replicate sample)</td></tr>
<tr><td colspan="2">C
(Third replicate sample)</td></tr>
<tr><th colspan="5">Soil Core and Lead Discrete Samples</th></tr>
<tr><td>SC-
(Soil core)</td><td>Area identifier[1]-
(Subsurface soil; e.g., 3-, Ref-,Bldg)</td><td>Numerical identifier
(e.g., 01; duplicates will be called 101, 102, etc. in sequence)</td><td colspan="2">-MS/MSD
(Matrix spike and duplicate)</td></tr>
<tr><th colspan="5">Groundwater Monitoring Wells</th></tr>
<tr><td>Drill water-</td><td colspan="4">Numerical identifier (in sequence)
(01, 02, etc.)</td></tr>
<tr><td>MW-
(Groundwater monitoring well)</td><td>Area identifier[1]-
(Monitoring well; e.g., 1-, Ref-)</td><td>Numerical identifier
(e.g., 01; duplicates will be called 101, 102, etc. in sequence)</td><td colspan="2">-MS/MSD
(Matrix spike and duplicate)</td></tr>
<tr><td>EB-
(Equipment blank)</td><td>MW-
(Deionized water pumped through tubing with a peristaltic pump)
Soil-
(Deionized water poured over clean drill bit)</td><td colspan="3">Date collected, in YYYYMMDD format (e.g., 20170501 if sample was collected on May 1, 2017)</td></tr>
<tr><td>TB-
(Trip blank for VOC samples prepared by the laboratory)</td><td colspan="4">Date submitted, in YYYYMM date format
(e.g., 20170801 if sample was collected on August 1, 2017)</td></tr>
<tr><td rowspan="2">IDW-
(Investigation-derived waste)</td><td>Soil-</td><td colspan="3" rowspan="2">Numerical identifier
(01, 02, etc.)</td></tr>
<tr><td>Water-</td></tr>
<tr><td colspan="5">[1] Areas are: REF = reference areas; 1 = Area 1 (near WWTP); 2 = Area 2 (engineering, maintenance, landscaping, USTs); 3 = Area 3 (debris landfill), Bldg = Sample outside a building</td></tr>
</table>

Examples: IA-1-02-C = third replicate, 40-increment ISM sample from 0-0.5 fbgs (surface) from the second DU in Area 1

MW-2-01-MS = groundwater sample from MW-2-01 submitted as a matrix spike for laboratory quality control

IDW-Soil-01 = sample from IDW soil drum number 01

5.2.2 Sample Handling and Chain-of-Custody

Field forms and chain-of-custody records will be used to maintain a record of sample collection, custody, and receipt by the laboratory. A chain-of-custody form supplied by the laboratory will list the sampler's initials, sample identifier, date and time of collection, matrix, preservative, and requested analyses. Accompanying chain-of-custody form(s) will be completed for each cooler of samples. The original form will be placed in the cooler in a waterproof plastic bag and a copy will be retained by the sampler.

Samples will be packed in coolers with bagged ice and sufficient padding to prevent breakage. A temperature blank will be provided in each cooler. Coolers will be sealed with a signed custody seal and packing tape. The custody seal will be attached such that the cooler cannot be opened without breaking the seal.

Samples will be delivered to the laboratory as required by hold times during or after the field program via overnight carrier. The waybill will be retained for recordkeeping. Common carrier tracking numbers will be indicated in the field book or on field forms.

5.2.3 Documentation and Records

A daily record of field activities will be recorded by the Field Manager on the Daily Log form provided in Appendix 1; this Daily Log will be transmitted to the NPS Point-of-Contact and NPS Federal Government Lead before 9:00 am on the next business day when possible. Field forms will be used where appropriate. Additional notes may be kept in field logbooks. Blank copies of all field forms are included in Appendix 1.

5.3 Investigation-Derived Waste Sampling and Disposal

IDW includes all equipment decontamination liquid, purged groundwater, and all soil from cores not provided for sampling. No decontamination liquids will be released to the ground or to surface waters. Decontamination water, soil, and groundwater will be placed in separate appropriate containers, such as 55-gallon drums. Containers will be consolidated into an area approved by the Park and covered. IDW containers will be staged within the CBR property. The final disposal facility will be selected by NPS, or by VHB with approval from NPS, based on waste acceptance policies, capacity, and pricing.

Soils collected with the hand-held drill during ISM sampling will be used to create the sample, and minimal waste is expected from these areas. Soil cores retrieved during drilling will be placed in a steel drum after they have been appropriately logged and sampled. Area 3 IDW will be collected in separate, dedicated drums. The debris landfill ISM results will be used to characterize this IDW. For drums containing IDW soils from Areas 1 and 2, one composite sample will be collected from a minimum of eight random locations and depths in each container for IDW characterization.

No decontamination liquids will be released to the ground or to surface waters. Water used for decontaminating equipment and water pumped from monitoring wells will be placed in drums or a fractionation tank. One sample per IDW water drum or fractionation tank will be collected for characterization.

IDW samples will be submitted to the laboratory and analyzed using the following method:

- TCLP: all IDW samples will be extracted by TCLP via EPA Method 1311 and analyzed using the methods specified above for RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), VOCs, SVOCs, and pesticides.

NPS shall be identified as the generator of wastes for the purpose of regulatory or policy compliance. A bill of lading (for non-hazardous wastes) or manifest (for hazardous wastes) will be prepared for each shipment of IDW and will be signed by the waste generator. Waste will be removed as soon as possible for disposal at an appropriate facility, based on the analytical results. All project waste operations will be conducted in accordance with applicable regulations and requirements, including state and federal regulations such as RCRA, Toxic Substances Control Act (TSCA), and Department of Transportation (DOT) regulations, as well as Virgin Islands-specific requirements. The shipping documents will also be signed by the driver prior to the waste leaving the Site; these documents will accompany all shipments of waste while in transit at all times. The certified disposal facility tickets will be collected by VHB and provided to NPS to maintain information related to these wastes, including all disposal analyses by waste type, manifests/bills of lading, and disposal facility weight tickets.

Non-soil and water waste, such as wrapping and excess PVC pipe, and non-hazardous debris generated during EE/CA activities will be placed in drums or roll-off boxes for disposal off-site at a licensed landfill.

5.4 Health and Safety

A HASP that covers all VHB employees is provided in Appendix 3. Each subcontractor who will be performing activities that could result in contact with or release of contamination is responsible for preparing a separate HASP that covers their own specific activities, and for providing staff who are appropriately trained in the Occupational Safety and Health Administration’s Hazardous Waste Operations and Emergency Response 1910.120 requirements. Safety at the Site is a top priority.

5.5 Preliminary Lead-Based Paint Investigation

Surface soil will be sampled and analyzed using discrete sampling techniques. The surface soil interval is 0-0.5 fbgs. Discrete surface soil samples will be collected from locations selected in the field based on observations made during reconnaissance of Site structures.

5.5.1 Soil Sampling Locations

Soil sampling locations will be identified during reconnaissance of Site structures based on visual evidence of potential impacts of lead-based paint to the environment (e.g. chipping paint, the presence of paint chips on the ground surface) and proximity of soil to painted surfaces (e.g. along building driplines). Due to the large number of structures on the property, sample locations will be selected to be representative of clusters of buildings that appear to be similar in age, construction, and/or condition. There are approximately 50 buildings, but VHB assumes that multiple clusters will have similar characteristics. VHB anticipates collecting 25 soil samples for lead.

5.5.2 Surface Soil Sampling Protocol

Surface soil will be sampled with the following procedure.

1. Clear vegetation and leaf litter from the ground surface at the sampling location.
2. Using a drill, trowel, or similar implement dig a small hole to approximately 0.5 fbgs and transfer soil to a laboratory-provided sample container.
3. Backfill sample hole with surrounding soil.
4. Decontaminate sampling implements between each location.

5.5.3 Surface Soil Field Measurements

VHB will record each soil sample location with a submeter GPS.

5.5.4 Soil Analytical Measurements/Methods

The laboratory will analyze soil samples for the following analyte and analytical method.

- Total metals by EPA Method 6020B: lead (VHB will instruct the laboratory to use 10 grams of soil, rather than 1 gram of soil, during the extraction).

5.6 Surface Soil Investigation

Surface soil will be sampled and analyzed using ISM techniques. The surface soil interval is 0-0.5 fbgs. Each DU is approximately 0.25 acres or less. Samples will be collected using a drill with an auger bit, which collects a cylindrical core sample. Three replicates will be collected from each DU for ISM processing and analysis, and one additional replicate will be collected for pH analysis without ISM processing.

5.6.1 Soil Sampling Locations

Following is a summary of the proposed sampling locations, which are also shown on Figure 8. ISM surface soil sample names include the prefix "IA-#" where "#" corresponds to the specific investigation area of the Site.

- Reference (Ref) locations. Two reference locations will be sampled: IA-Ref-01 is south of Area 1 and west of Area 2, at a similar elevation to or slightly higher than both areas; and IA-Ref-02 is northeast of Area 3.
- Area 1 locations are on the gravel terrace above the WWTP. A total of two DUs will be sampled in Area 1, one on the north side (IA-1-01), including the area the drums were observed in 2016, and one on the south side (IA-1-02).
- Area 2 locations are on grass or the forest floor adjacent to pavement or concrete. A total of five DUs will be sampled from Area 2: IA-2-01 through IA-2-05. IA-2-01 and IA-2-02 will be collected near the westernmost buildings, which are maintenance garages. IA-2-03 and IA-2-04 will be collected in the landscaping area. IA-2-05 will be collected from the vicinity of the ASTs and fuel pump.
- Area 3 locations are on the cleared surface of the debris landfill. A total of two DUs will be sampled from Area 3, one on the north side (IA-3-01) and another on the south side (IA-3-02).

In total, two reference and nine surface soil DUs are proposed.

5.6.2 Surface Soil Sampling Protocol

A measuring tape and GPS will be used to locate the boundaries of each surface soil DU. The boundaries of the DU will be marked using flagging tape, pin flags, or stakes. Markers will be removed after the GPS or licensed surveyor recordation. A description of the ISM sample collection area will be provided on the ISM soil sample collection record field form (Appendix 1).

At the two surface soil ISM reference locations, in advance of sampling, the DUs will be inspected and areas of potential anthropogenic contamination, such as vehicle trails, cigarette disposal areas, fire pits, or locations of observable dumping, will be avoided. The DU may be reshaped to avoid these areas (e.g., changed from a square to a rectangle) or moved to a nearby location with a similar elevation and lithological characteristics that are similar those at to the Site.

Each IA DU sample replicate will be composed of 40 increments collected using a systematic random approach (ITRC 2012).

A cordless drill with a small-diameter (approximately 0.75-inch) ship auger bit will be used to obtain an approximately cylindrical core from each increment location to a depth of 0-0.5 ft for surface soil. The technique is a modified version of the technique presented in the Hawaii Technical Guidance Manual Notes (HDOH 2011) and is described as follows.

5. Attach to a cordless drill a 0.75-inch drill bit with a minimum length of 8 inches for collection of 6-inch soil samples. Mark the 6 inch depth with paint and/or tape. Verify the markings between DUs because there is a high potential for wear when contacting soil.
6. Clear vegetation and leaf litter from the ground surface at the sampling location.
7. Keeping the drill perpendicular to the ground, advance the bit to the target depth. Soil will collect between the auger flights.
8. Pull the drill straight up and, keeping the bit vertical, transfer the soil directly into the sampling container. Use the drill to spin the bit quickly in the container to release the soil. If necessary, use a scoopula or stainless steel spoon to scrape the soil from the bit; the same instrument may be used for all increments within a decision unit.
9. Decontaminate the drill bit and change gloves between DUs.

All samples will be placed directly into the sampling container for each ISM replicate. A separate jar will be maintained for the pH sample from the fourth replicate.

Each small hole will be backfilled with surrounding soil and covered with leaf litter or grass (if present) to minimize the visibly disturbed area.

5.6.3 Surface Soil Field Measurements

If the shape of the ISM DU changed during sampling, a GPS will be used to record the revised DU boundaries.

5.6.4 Soil Analytical Measurements/Methods

Soil samples will be analyzed for the following analytes and analytical methods. ISM samples will be submitted to the laboratory for processing, which will include drying, disaggregating, sieving, and subsampling using the 2-Dimensional Slabcake method.

- Metals: antimony, arsenic, barium, beryllium, barium, cadmium, chromium (III and VI), copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.
- VOCs: in samples collected near the ASTs and fuel pump only (IA-2-05); a standard list of VOCs will be analyzed.

- SVOCs: 18 PAHs (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, dibenz(a,h)anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, pyrene, and phenanthrene).
- Pesticides: Organochlorine pesticides.
- pH: One sample from an additional (fourth) replicate at each DU will be analyzed for pH for the purpose of evaluating metals bioavailability in the risk assessments. This sample will not be processed using ISM laboratory techniques because the effects of processing on the pH results are unknown.

5.7 Debris Landfill Contents Investigation

VHB will attempt to determine the depth of the debris landfill materials and sample wastes to provide information with which to assess potential response actions. This part of the investigation will have two components: decision and estimation. The following subsections describe the proposed debris landfill sampling.

5.7.1 Debris Landfill Delineation and Sampling Locations

The GPR and EMI contractor will perform a survey of the landfill in five transects across the reported landfill debris area. The contractor will mark areas of buried anomalies using pin flags and VHB will record locations using a GPS. VHB and the contractor will discuss additional delineation requirements, such as defining pit extents, while in the field. VHB will select 10 locations for advancing soil cores within or at the edges of the landfill, depending on the delineation findings. The objectives will be to characterize the waste, and to gather information regarding the extent of contaminants that may be migrating out of the landfill.

VHB will use the delineation results to select the three reference soil core locations that are outside and not likely to have been affected by landfill contaminant releases, are in similar soil to that of the landfill, and at a similar elevation to the landfill. Because the area was used as a rock borrow pit, soil concentrations may be naturally higher in some metals associated with the bedrock; hence, the reference soils should have observable characteristics similar those at the landfill.

The debris landfill sample cores will have the prefix "SC." VHB will install 10 soil cores through pits identified as containing waste, if present, and in surrounding soil at the outside edges of the landfill. VHB will collect two samples per boring for analysis at depths corresponding to burrowing mammal receptors (0.5 to 3 fbgs) and utility workers (4 to 6 fbgs). VHB will collect one sample per boring of waste materials for hazardous waste characterization.

The debris landfill is located in Area 3. The DU for landfill debris contents is IB-3-01.

5.7.2 Debris Landfill Delineation and Sampling Protocol

The driller will use a drill rig with a small diameter core barrel to collect all debris landfill content samples. Borings will be advanced using a Geoprobe drill rig with a 2-inch diameter outer casing. The driller will collect continuous soil cores in butyrate or acetate liners during boring, and the system will produce relatively little waste soil compared to using an auger. The drilling method will provide continuous cores for geological observations and logging. A 4-ft long, 2-inch diameter core barrel with a liner will be used.

The driller will decontaminate sampling equipment before moving to and from the debris landfill and between each boring. VHB will lay out the sampling locations. The driller will complete borings in the landfill to the following maximum depth, whichever is encountered first:

- 1 foot below the bottom of observed waste
- Refusal
- 15 fbgs
- 1 ft below the water table

The core liners will be removed from the rod and cut open to evaluate the core and determine the depth of landfill contents and field VOC screening. To minimize VOC losses, a syringe-type soil sampler will be used to collect 1-gram soil plugs from one random depth in each sampling interval (0.5 to 3 fbgs and 4 to 6 fbgs) immediately upon opening the core. The approximately 5 gram VOC sample will be placed in 5-milliliters of methanol. The cores will be logged for geology, and then the syringe-type sampler will be used to collect additional soil for the remaining analytical parameters except for TCLP. At each coring location where waste is observed, additional plugs will be collected and placed in the TCLP containers.

VHB will place a pin flag or stake at the ground surface at the 13 coring locations (10 associated with the landfill and 3 reference borings) for the surveyor to record the ground elevation; the total depth of the core will be used to provide data for the debris landfill contents volume estimate.

5.7.3 Debris Landfill Contents Delineation and Sampling Field Measurements

A photoionization detector (PID) will be used to screen the breathing zone during drilling, and the PID will be used to screen cores, with measurements recorded every 1 ft along the core.

5.7.4 Debris Landfill Content Analytical Measurements/Methods

The soil cores associated with the landfill and the reference cores will be analyzed for the following COPCs.

- Total metals by EPA Methods 6020A and 7471A: antimony, arsenic, barium, beryllium, barium, cadmium, chromium III, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.
- PCB Aroclors by EPA Method 8082A in all samples.
- 18 PAHs by EPA Method 8270D (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, dibenz(a,h)anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, pyrene, and phenanthrene).
- Organochlorine pesticides by EPA Method 8081A.
- Total VOCs by EPA Method 8260C.
- pH.

VHB will analyze up to 10 samples of waste (a maximum of one sample per boring) for waste characterization parameters, including TCLP RCRA 8 metals, TCLP SVOCs, TCLP pesticides, and TCLP VOCs.

5.8 Groundwater Investigation

Groundwater monitoring wells will be installed both upgradient and downgradient of known or suspected sources of contamination to evaluate as many potential contaminant areas as possible. Wells will be screened across the water table. Well locations will also be arranged such that equipotential contours may be calculated and changes in contaminant transport chemistry along groundwater flow paths between source areas and discharge areas or buildings may be evaluated.

5.8.1 Groundwater Sampling Locations

Following is a summary of the proposed groundwater sampling locations, which are also shown on Figure 8. Locations are divided approximately by Site area.

- Reference (Ref) locations. Shallow monitoring wells will be installed at two reference locations, MW-Ref-01 is upgradient of Area 2 and MW-Ref-02 is upgradient/cross-gradient of Area 3.
- Area 2 monitoring well locations are intended to monitor two potential sources:

- Two wells, MW-2-01 and MW-2-02, will be installed downgradient of the former UST on the eastern side of Area 2. MW-1, the existing monitoring well immediately downgradient of the former UST, will also be sampled during this investigation.
- Two wells, MW-2-03 and MW-2-04, will be installed downgradient of the fuel pump and the ASTs, at the base of the hill next to the road.

- The Area 3 monitoring well location is at the base of the slope below the debris landfill, near the concession stands that service Honeymoon Beach.

In total, two reference and five Site monitoring wells will be installed. The existing monitoring well in Area 2 will also be sampled.

5.8.2 Groundwater Sampling Protocol

Monitoring Well Installation

Borings will be advanced using a Geoprobe drill rig with a 2-inch diameter or larger outer casing. This type of drill rig operates by using hydraulic power to push or hammer a small-diameter rod through the soil. Because the rod is pushed, it relies on soil displacement to advance, and cannot break through boulders or buried concrete. Continuous soil cores are captured in butyrate or acetate liners during boring, and the system produces relatively little waste soil compared to using an auger. Geoprobes are typically used to core to a maximum depth of approximately 60 feet in unconsolidated sediments. Because they are relatively small machines, there are few access restrictions for track-mounted Geoprobes. Previous investigations at the Site have successfully used Geoprobes for borings and well installation.

The drilling method will provide continuous cores for geological observations and logging. A 4-foot long, 2-inch diameter core barrel with a liner will be used. The liner will be removed from the rod and cut open to view for geologic logging, field VOC screening. Geologic descriptions will be recorded on Well Log field forms (Appendix 1) and will include observations of grain size, color (according to the Munsell chart), water content, and texture in accordance with VHB's SOP. After soil cores have been logged and any samples collected, soil will be placed in a drum for waste characterization before disposal (see Section 5.3).

It is unlikely that water will be injected during Geoprobe coring. However, water will be mixed with bentonite and concrete and injected during borehole abandonment or well grouting. Water will be stored in polyethylene tanks or similar, which will be filled at a location designated by NPS and CBR. A sample (called Drill Water) will be collected from the tank at the start of the investigation to evaluate the water that will be used in subsurface completions; one sample will be collected from each separate water source. If multiple tanks and pumps are used in series, a single sample will be collected after the water is passed through all of the tanks and pumps.

The approximate depth of the water table will be determined during drilling through observation of retrieved cores and measurement in previously installed wells using an electronic water level indicator. Once drilling has reached the targeted depth, the depth to the bottom of the boring will be measured with a weighted measuring tape. If necessary, filter sand will be used to fill the bottom of the boring until the desired depth of the bottom of the screen is reached. Bentonite chips or pellets may be added beneath the filter sand if the boring extends more than 2 to 3 feet beyond the desired target depth of the well screen bottom. Wells will be screened across the water table and completed to a depth of between approximately 5 and 10 fbgs, as needed to intercept the water table in high water and low water seasons, with 5-ft long screens. Shallow wells will be installed with the top of screen no less than 3 fbgs.

A 1.5-inch diameter pre-pack PVC well screen with 0.006-inch slots will be threaded to a 1.5-inch diameter PVC casing and placed in the boring. Screens, casing, and other well construction materials will be new, unused, and kept clean until they are placed in the borehole. Pre-pack well screens will be used to place a uniform sand pack around the well screen. Well screens will not be installed across confining units. Filter sand (#0 size or equivalent) will be placed in the annular space around the screen to 1 ft above the top of the screen. A minimum of a 1-ft thick layer of granular bentonite or bentonite chips will be placed above the top of the sand pack and hydrated with drilling water. A 0.5 ft thick drainage layer of sand will be placed above the bentonite. If there is additional open annular space, a tremie pipe will be used to fill it with a concrete/bentonite slurry to 0.5 fbgs.

A vent hole or slot will be cut near the top of the casing. A reference mark will be made on the top of the PVC casing for surveying and depth-to-groundwater measurements. A locking well cap will be placed on the well casing. Locks on the well cap and the protective casing will have identical, standard keys supplied by VHB. Copies of the keys will be provided to NPS and CBR personnel. Monitoring wells will be completed at the surface with a flush-mount road box embedded in concrete to prevent damage to the well.

A well completion diagram that documents relevant material quantities and placement depths will be prepared for each monitoring well installed. Blank monitoring well construction logs are included in Appendix 1.

Monitoring wells will be constructed in all of the borings discussed in this subsection. Borings not used for monitoring well installation will be abandoned by pumping a concrete/bentonite slurry from the bottom to the top of the boring using a tremie pipe. Bentonite chips or pellets may be used to fill annular spaces above the water table but must be hydrated immediately. Any excess grout will be disposed of in IDW drums. Abandoned borings will be checked 24 to 48 hours after slurry placement to determine if settling has occurred. If settling has occurred, bentonite chips or additional grout will be added to the hole to bring the level within 0.5 ft of the ground surface. After the bentonite and grout have cured and dried, native soil surrounding the hole will be swept into the hole to make a plane level with the surrounding area. No holes should be visible or sufficiently deep to present a trip hazard after abandonment.

Monitoring Well Development

Monitoring wells will be developed after installation. A surge block and inertial valve pump and peristaltic pump will be used to surge and purge the well while pumping at a rate much greater than would be used for sampling. Development will generally be continued until discharge water becomes clear quickly after surging. If water does not become clear after removal of a large volume of water relative to the recharge rate and well volume, development will be discontinued. The well development process will be documented on groundwater sampling or development forms for each well and piezometer (Appendix 1).

Hydraulic conductivity will be measured following well development and groundwater sampling, using slug tests as described in Section 5.7.3.

Water Level Measurements

To collect data for calculation of horizontal and vertical gradients, two synoptic water level rounds will be conducted during the investigation, after all wells have been installed. Water levels will be measured with an electronic water marker. The water level marker will be decontaminated between wells according to procedures described in Section 5.1.3. The synoptic round first will be performed after the effects of purging, well installation, and development are likely to have subsided, and the second will be performed after the groundwater sampling described below. Completion of the synoptic water level round will be completed in less than four hours, or sooner if it begins to rain during the activity. Precipitation for 24 hours prior to, and during, the synoptic rounds shall be determined using the closest available NOAA recording site.

Water Level Measurements

Monitoring wells will be sampled near the end of the field mobilization to allow the wells to remain undisturbed for a maximum length of time after development. Wells located upgradient of the Site (i.e., reference locations) will be sampled first to minimize potential cross-contamination.

Wells will be purged and sampled using low-flow methods in accordance with VHB's SOP. Because the depth to water is expected to be within the practical suction limit (approximately 25 feet below the top of casing), peristaltic pumps will be used for purging and sampling. Peristaltic pump tubing will be dedicated to each well. The tubing intake will be positioned at approximate midpoint between the bottom of screen and the measured surface of groundwater in the wells. The objective of this intake placement is to avoid or reduce formation water cascading down the inside of the screen before sample collection.

Field parameters, as described in Section 5.8.3, will be measured during low flow sampling to indicate when stable conditions have been achieved and sampling may occur.

Samples for VOC analysis will be collected first, followed by samples for PAHs, pesticides, metals, and PCBs. Sample containers will be sealed, placed in a cooler on ice, and shipped to the laboratory as described in Section 5.2.

Field duplicates and MS/MSDs are planned to be collected from the following two monitoring wells:

1. MW-1, duplicate called MW-101, also collect MW-1-MS and MW-1-MSD; and
2. MW-2-03, duplicate called MW-102, also collect MW-2-03-MS and MW-2-03-MSD.

If a listed well does not produce water at a sufficient rate for efficient collection of the QC samples, alternative locations for those samples will be chosen in the field. In addition, a trip blank will be included in each cooler containing samples for VOC analysis, and will be analyzed for VOCs. Trip blanks will be prepared by the laboratory and will accompany sample containers at all times

5.8.3 Groundwater Sampling Field Measurements

Well Development

An electronic water marker will be used to monitor drawdown during well development. A turbidity meter will be used to check turbidity measurements when the purge water becomes increasingly clear. If feasible, well development will continue until the turbidity reading is less than 10 Nephelometric Turbidity Units (NTU). If water does not become clear after removal of a large volume of water relative to the recharge rate and well volume, development will be discontinued, and a note will be made on the sampling forms.

PID Screening

PID screening of the well headspace will be performed immediately upon opening the well for sampling. The result will be recorded on the groundwater sampling field form.

Low Flow Sampling Parameter Monitoring

A multiparameter instrument will be used to measure standard field parameters (pH, temperature, specific conductance, oxidation-reduction potential (ORP), and dissolved oxygen) during purging. A turbidity meter will be used to collect turbidity measurements. The multiparameter instrument and turbidity meter will be calibrated daily before use and calibration information will be recorded on the multiparameter instrument calibration sheet and turbidity meter calibration sheet, respectively (Appendix 1). During purging, the field parameter measurements will be recorded on ground water monitoring well sample collection record forms (Appendix 1) at 5-minute intervals during purging. Samples will be collected after parameters have stabilized, with three consecutive readings within the following limits:

- Turbidity = <1 NTU or +/-10% for values above 1 NTU. Samples will not be filtered.
- DO = +/-10%
- Specific conductance =+/-3%
- Temperature = +/-0.2°C
- pH = +/- 0.1 units
- ORP = +/- 10 millivolts

Water Level Measurements

Water levels will be measured immediately prior to purging and sampling in each well. The measurement will be performed with an electronic water marker in accordance with VHB's SOP.

5.8.4 Groundwater Analytical Measurements/Methods

Groundwater samples will be analyzed for the following analytes and analytical methods.

- Metals by EPA Methods 6020A and 7470A: antimony, arsenic, barium, beryllium, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.
- VOCs by EPA Method 8260C: The full standard analytical laboratory list of VOCs.
- 18 PAHs by EPA Method 8270D (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, dibenz(a,h)anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, pyrene, and phenanthrene).
- Organochlorine pesticides by EPA Method 8081A.
- PCBs by EPA Method 8082A from monitoring wells near Area 3 (MW-Ref-02 and MW-3-01).

Standard field parameters will be measured in the field immediately before sample collection.

Collection of duplicates at a frequency of 10 percent is currently proposed, as detailed in Section 4.6.1.

6 Data Management

This section describes how data are managed from the point when it is generated through use and storage. Project data, communications, and other information will be stored by VHB in a format useable to project personnel for at least 10 years following the investigation.

6.1 Documentation Control Systems

6.1.1 Project Document Control System

The Contractor Project Manager will maintain and manage hard copies and/or electronic copies of all project related documents. Electronic copies of information relating to this project are maintained on the project network files, which are backed up once per day.

6.1.2 Data Recording

Data generated during this project will be captured electronically and entered by hand into bound field or laboratory logbooks or preprinted forms (Appendix 1). Computer generated laboratory data will be managed using the laboratory information management system (LIMS); the LIMS used by Eurofins TestAmerica are described in their QA documentation.

6.2 Data Quality Assurance Procedures

The VHB Field Team Leader and Project Manager will monitor the progress of sample collection to verify that samples are collected as planned. The list of planned samples will be compared to the list of samples collected and picked up each day to confirm nomenclature accuracy.

The laboratory must maintain a formal Quality Management Plan to which they adhere, and which addresses all data generating aspects of daily operations. All data generation processes will be reviewed and modified as needed to meet project objectives. Periodic audits of field operations will be performed to check that data collection, documentation, and QA/QC procedures are being followed.

Data generation processes will be reviewed and modified as needed to meet project objectives. Periodic desktop (i.e., not in-field) audits of field operations will be performed to check that data collection, documentation, and QA/QC procedures are being followed. Data entries created from hand-written notes will be QA checked by another person for accuracy.

6.2.1 Laboratory Data Transmittal

Laboratory data are managed by Eurofins TestAmerica's LIMS beginning with the sample receiving process. Eurofins TestAmerica is required to provide laboratory data reports (sample results, QC summary information, and supporting raw data) including electronic data deliverables (EDDs) within the turnaround times specified in Table 18.

6.2.2 Data Storage and Retrieval

Completed forms, logbooks, photographs, data packages, and electronic files will be transmitted regularly to the Contractor Project Manager. Eurofins TestAmerica will maintain copies of all documents it generates as well as backup files of all electronic data relating to the analysis of samples. All project data will be submitted to NPS at the end of the investigation.

7 Assessment and Oversight

This section describes the measures that will be employed to ensure that this SAP is implemented properly.

7.1 Assessment and Corrective Actions

The Chemistry Quality Assurance Officer/Data Validator and all VHB staff who are responsible for data control are specified in Table 16. VHB personnel and subcontractors will report to the Contractor Project Manager. The Contractor Project Manager is responsible for performing or coordinating the quality reviews specified in Table 16. The Contractor Project Manager is also responsible for ensuring that corrective actions are implemented if QA problems are identified during quality reviews.

7.1.1 Field Audit and Response Actions

A desktop (i.e., not in-field) field sampling audit will be performed during the first week of sampling by the Contractor Project Manager. The field sampling audit will include the following:

- a brief interview with field staff involved in sampling to determine their familiarity with the SAP requirements;
- a review of all field forms related to the sampling that was performed; and,
- a review of the chain-of-custody forms that were submitted with samples.

Results of the field sampling audit are intended to confirm that proper protocols are being followed, or to make improvements to the systems that are in-place. Audit findings may be communicated to the sampling team during the audit if immediate changes are necessary.

7.1.2 Laboratory Audit and Response Actions

No laboratory audit will be completed for this project. An audit of Eurofins TestAmerica-Canton was performed for another NPS project in June and July of 2016 by a professional chemist under subcontract to NPS through VHB, and data validators have intermittently reviewed Eurofins TestAmerica’s work since then.

7.2 Quality Assessment Reporting

The VHB Field Team Leader will be responsible for preparing daily reports documenting field activities, which will be reviewed by the Contractor Project Manager before being sent to NPS. The Laboratory Project Manager will be responsible for sending an e-mail acknowledging sample login to the Contractor Project Manager and Chemistry Quality Assurance Officer/Data Validator within a day of sample login. The Laboratory Project Manager will be responsible for producing the laboratory data package with EDD to the Contractor Project Manager within five weeks after the last sample was received. The Chemistry Quality Assurance Officer/Data Validator will be responsible for producing the validation summary report to the Contractor Project Manager within nine weeks following receipt of the last data package.

7.2.1 Data Verification

Table 21 lists data verification procedures that will be implemented during the investigation.

7.2.2 Data Validation

Table 22 lists data validation procedures that will be used to ensure the data meet the requirements detailed in Section 4.6.3.

7.3 Reconciliation with DQOs and Data Usability

The data usability assessment will be led by the Contractor Project Manager named in Table 16. The data usability assessment will be presented in the EE/CA Report and will proceed as follows:

- **Step 1.** Review the project's objectives and sampling design: Review the key outputs defined during systematic planning (i.e., DQOs) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.
- **Step 2.** Review the data verification and data validation outputs: Perform a review of the accuracy, precision, representativeness, and completeness of analytical results based on criteria specified in the analytical methods used. Review available QA reports, including the data verification and data validation reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.
- **Step 3.** Verify the assumptions of the selected statistical method: Verify whether underlying assumptions for selected statistical methods (as documented in the SAP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.
- **Step 4.** Implement the statistical method: Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing, consider the consequences for selecting the incorrect

alternative; for estimation projects, consider the tolerance for uncertainty in measurements.

- **Step 5.** Document data usability and draw conclusions: Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss data quality indicators. Assess the performance of the sampling design and identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report in as a narrative and/or in a table.

8 Investigation Outputs

This section describes VHB's reporting required at the end of the EE/CA investigation. Daily reports, as described in Section 5.2.3 and Section 8.1, also will be prepared.

8.1 Daily Reports

Following completion of each day of field work, a Daily Report will be submitted to the NPS Project Manager. The Daily Report will include the following information:

- A summary of the field work completed including dates and times that each activity was performed and personnel associated with each activity, including key and/or relevant observations.
- Deviations from the SAP, including deviations from SOPs.
- Captioned photographs of the fieldwork.
- A table listing samples collected and relative documentation (e.g., sample identification, collection date and time, location, depth intervals, etc.).

8.2 Field Activities Report

VHB will submit a Field Activities Report within 15 days of field work completion. Included in the Field Activities Report are:

- Summary of completed work
- Deviations from the SAP
- Status of IDW storage and disposition
- Completed field forms
- Daily logs
- Photographs of field activities

8.3 Draft EE/CA Report

The draft human health and ecological risk assessment reports will be submitted to NPS for review approximately eight weeks after the data validation report is received. A draft EE/CA Report will be submitted to NPS within 10 weeks of receipt of the data validation report. More than one draft version may be required. NPS will communicate the deadline for each draft report upon issuing comments. The Draft EE/CA Report will follow the NPS Environmental Contaminants Cleanup Division's EE/CA Report template.

The report will present analytical data graphically and in tabular form to support discussion of the results. The report will include discussions of remaining data gaps and uncertainty associated with the selected field approach and sampling results. A photographic log, laboratory data, field forms, and IDW disposal documentation will be provided as appendices.

8.4 Draft Final EE/CA Report

The draft EE/CA Report, including the risk assessment report appendices, will be revised based on comments provided by NPS and reissued as a draft final version.

Electronic files containing data from field activities will be forwarded with the draft final report deliverable, after all data validation and QA/QC activities are complete, and will include:

- Copies of the signed chain-of-custody forms in Adobe Portable Document Format (PDF)
- Sample location data in Excel
- Sample analysis results and laboratory reports in PDF
- Data Validation reports in PDF
- Field parameter data in PDF
- Site fieldwork photographs in .jpg format and a photographic log in PDF

8.5 Final EE/CA Report

If NPS determines that revisions to the Draft Final EE/CA Report are necessary, such revisions will be made to address NPS comments and a final revision will be submitted to NPS.

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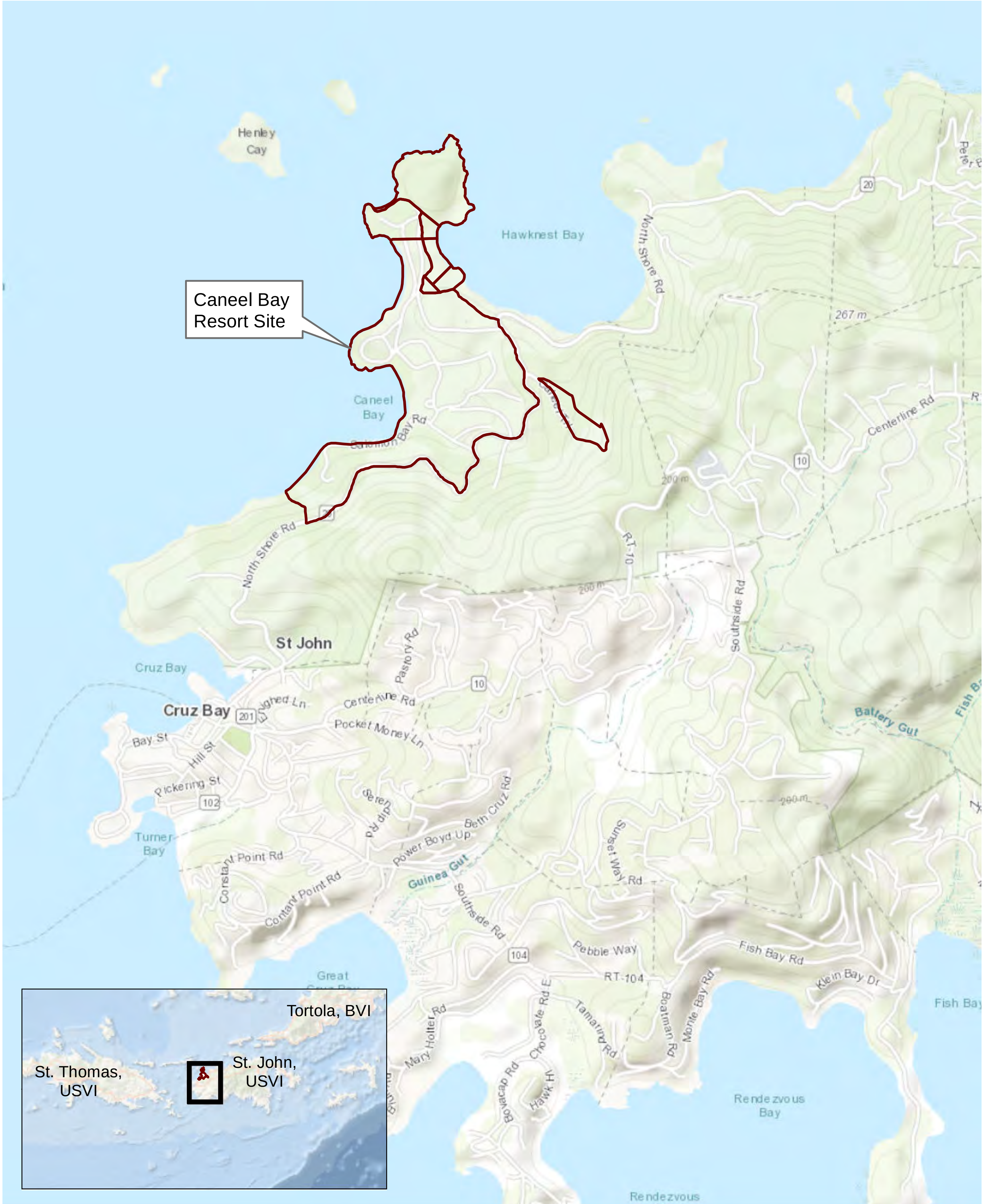
Figures

AR 001078

February 5, 2021 | **Figure 1**



\\vhb\gis\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Project\SAP\Figure 1 Site Location Map.mxd

0 500 1000 2000 Feet

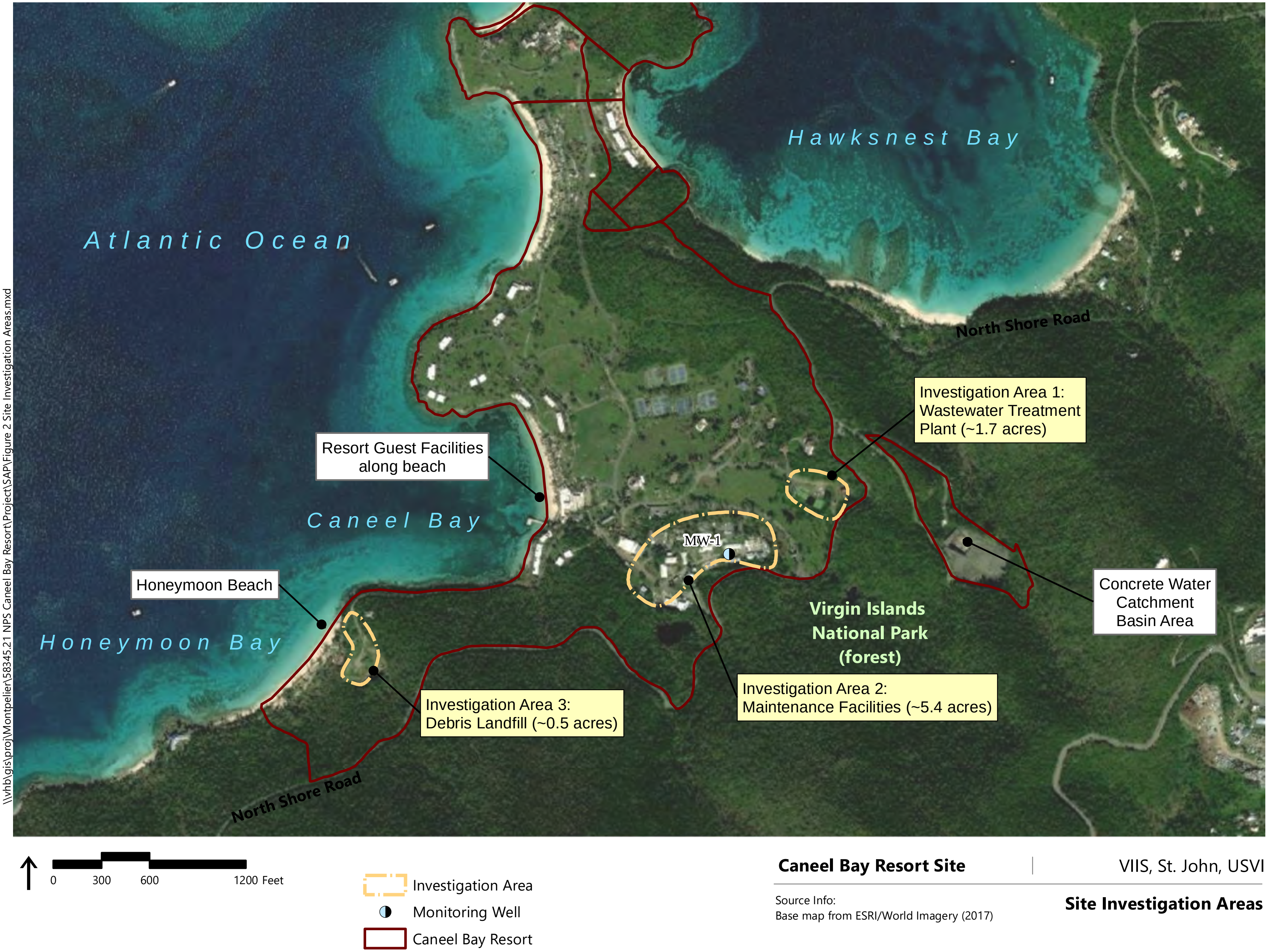
Caneel_Property

Caneel Bay Resort Site | St. John, USVI

Source Info:
Base map from ESRI/World Topo Map

Site Location Map

February 5, 2021 | **Figure 2**



\\vhb\gis\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Project\SAP\Figure 2 Site Investigation Areas.mxd

Caneel Bay Resort Site | VIIS, St. John, USVI

Site Investigation Areas

Source Info:
Base map from ESRI/World Imagery (2017)

Figure 3. September 15, 2016 Photoplates

Photoplate 1. Area 1: Southern side of gravel terrace above WWTP

Photoplate 2. Area 1: Northeastern side of gravel storage area above WWTP

Photoplate 3. Area 1: WWTP pump house

Photoplate 4. Area 2: Engineering/maintenance area, former UST area is left of the center golf cart.

Photoplate 5. Area 2: View to the west from the former UST area.

Photoplate 6. Area 2: The slope above (south of) the engineering and maintenance area.

Photoplate 7. Area 2: Gasoline (lower) and diesel (upper) tanks, fuel pump.

Photoplate 8. Area 2: Diesel tank and concrete slab to the northwest.

Photoplate 9. Area 2: Landscaping equipment maintenance building.

Photoplate 10. Area 2: Landscaping equipment yard.

Photoplate 11. Area 3: Landfill, view to the southwest.

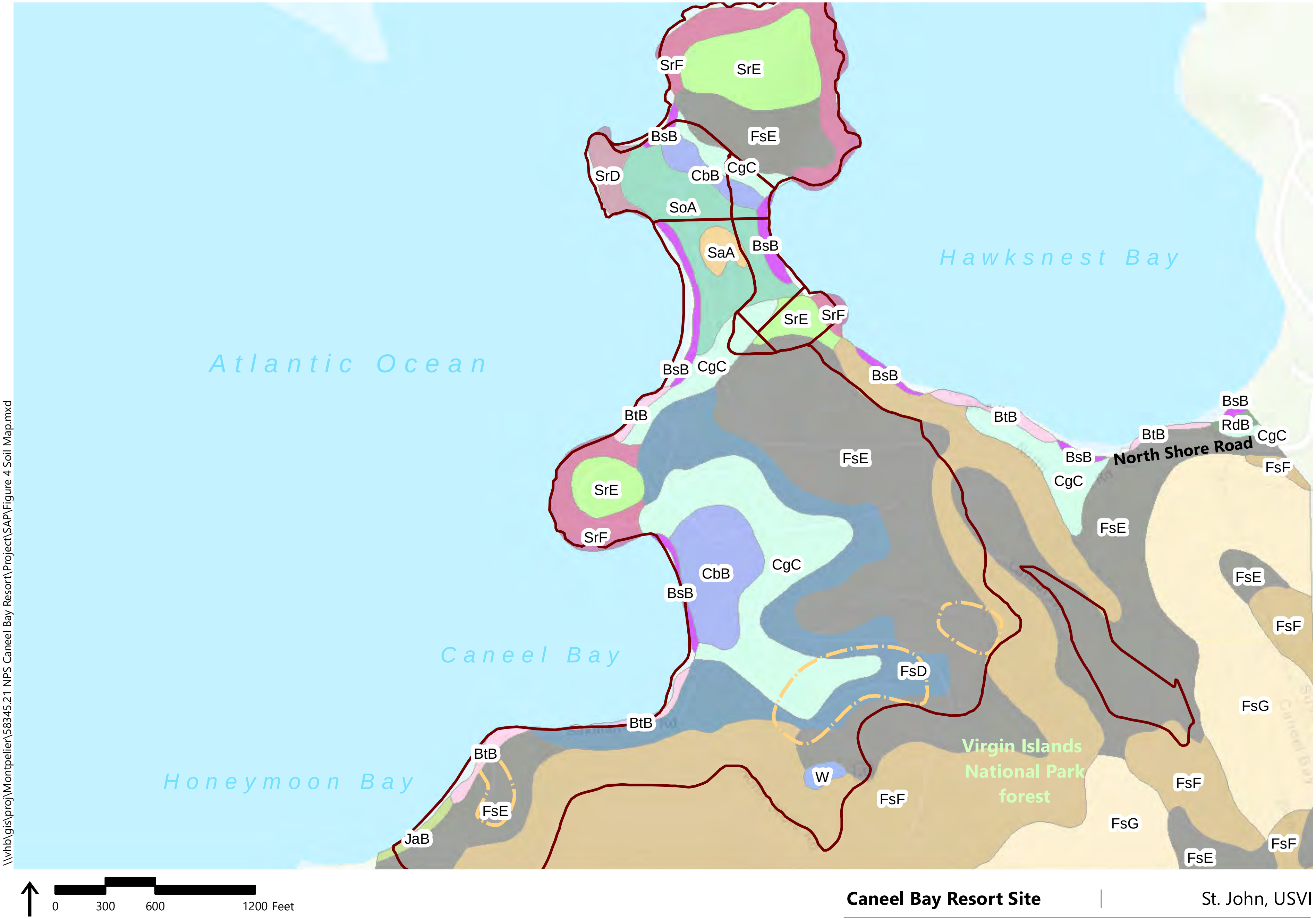
Photoplate 12. Area 3: Rock borrow pit east of the landfill.

Photoplate 13. Area 3: Western edge of the landfill.

Photoplate 14. Area 3: Canteen below the landfill (view towards landfill).

AR 001083

February 5, 2021 | **Figure 4**



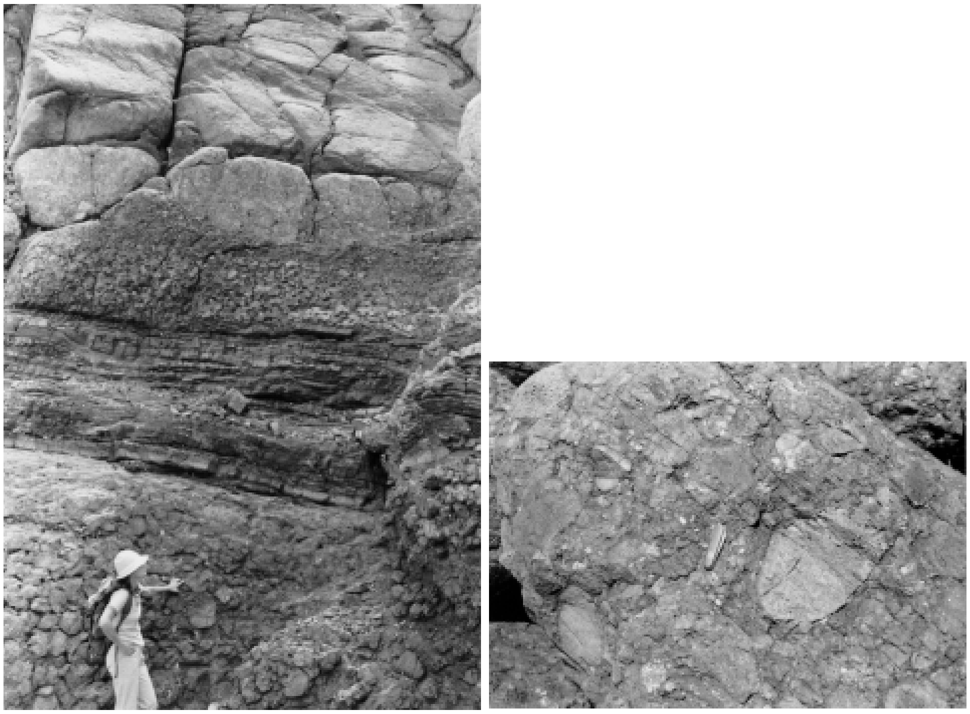
\\vhb\gis\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Project\SAP\Figure 4 Soil Map.mxd

- Caneel Bay Resort
- Investigation Area
- Beaches, sandy (BsB)
- Beaches, stony (BtB)
- Cinnamon Bay loam, 0-5% slope (CbB)
- Cinnamon Bay gravelly loam, 5-12% slope (CgC)
- Fredriksdal-Susannaberg (stony), 40-60% slope (FsD)
- Fredriksdal-Susannaberg (stony), 20-40% slope (FsE)
- Fredriksdal-Susannaberg (stony), 40-60% slope (FsF)
- Fredriksdal-Susannaberg (stony), 60-90% slope (FsG)
- Jaucas sand, 0-5% slope (JaB)
- Redhook stony sand, 0-5% slope (RdB)
- Salt flats, ponded (SaA)
- Solitude gravelly fine sandy loam, 0-2% slope (SoA)
- Southgate-Rock outcrop, 12-20% slope (SrD)
- Southgate-Rock outcrop, 20-40% slope (SrE)
- Southgate-Rock outcrop, 40-60% slope (SrF)
- Water (W)

Caneel Bay Resort Site | St. John, USVI

Source Info:
Base map from ESRI/World Imagery (2017)

Soil Map

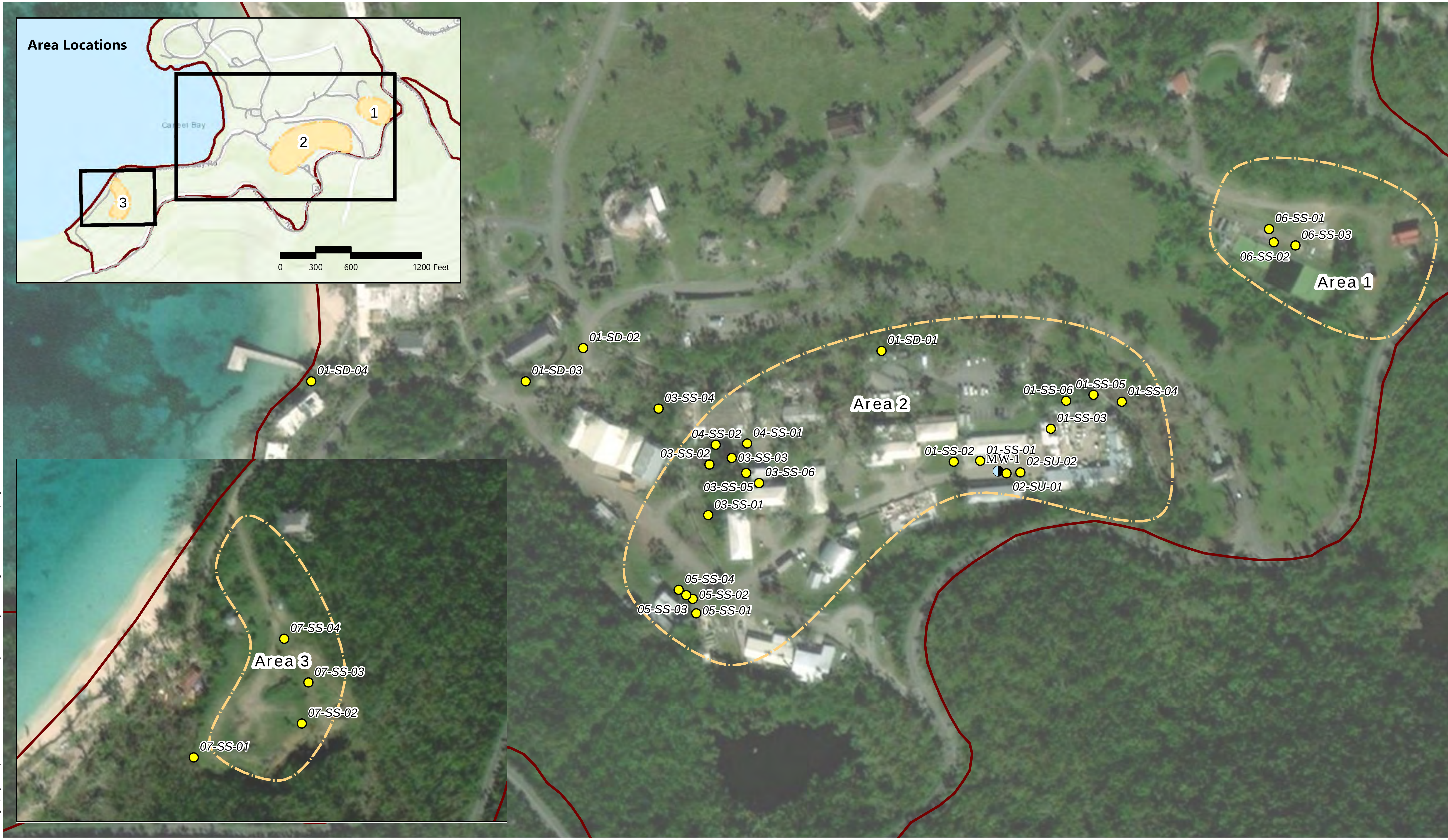


Volcanic conglomerate and thick graded beds of conglomerate and sandstone of the Louisenhoj Formation (USDA 2000)

Exposed rock wall at the southwestern edge of Area 3 (8 inch x 10 inch paper in foreground).

Figure 5. Geology Examples

February 5, 2021 | **Figure 6**



\\vhb\gis\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Project\SAP\Figure 6 Previous Sampling Locations.mxd

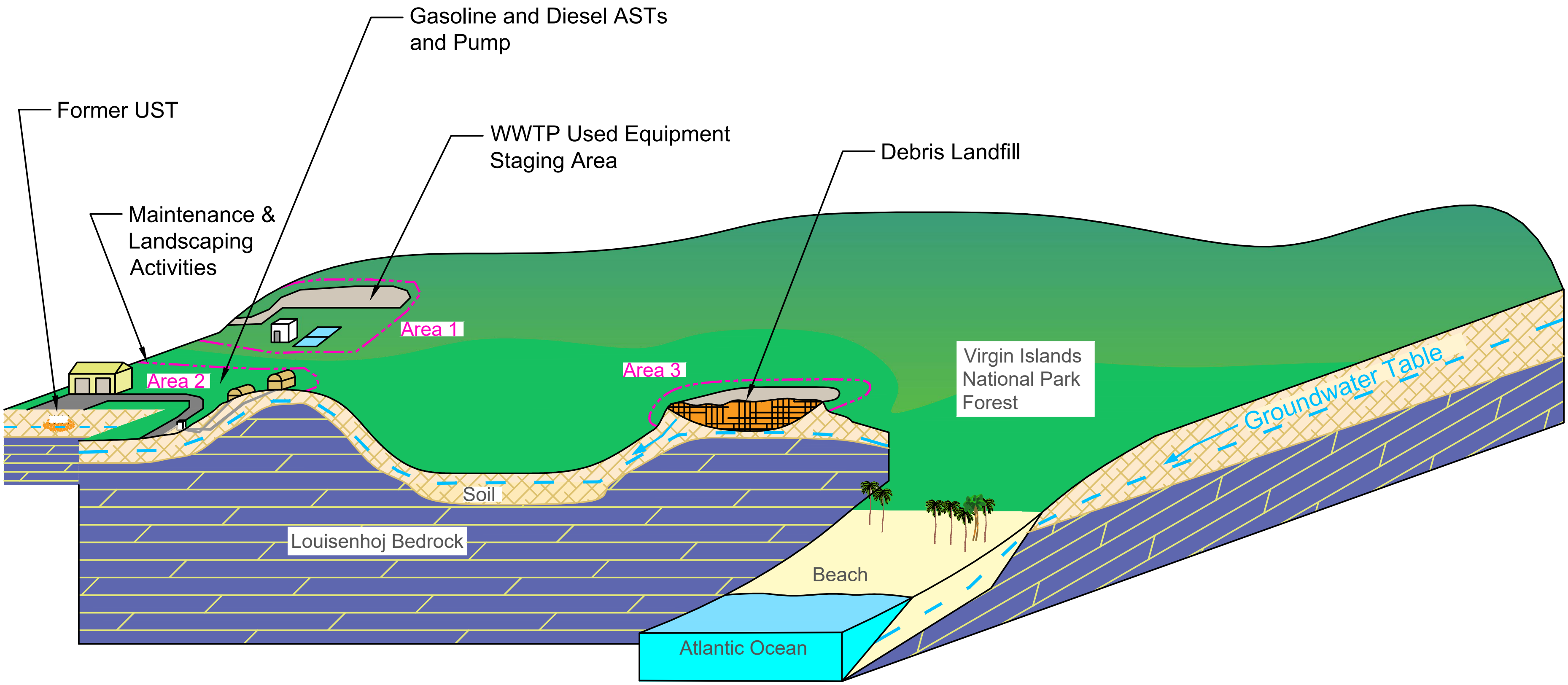
0 50 100 200 Feet

- Previous Soil Sample
- Monitoring Well
- Investigation Areas
- Caneel Bay Resort

Caneel Bay Resort Site | St. John, USVI

Source Info:
Base map from ESRI/World Imagery (2017).
Sampling locations from 2014 Barksdale & Associates Level 2 Report.

Previous Sampling Locations



Not to Scale

Caneel Bay Resort Site | St. John, USVI

Source Info:
Base map from ESRI/World Imagery (2017)

Conceptual Site Model

vhb February 5, 2021 | **Figure 8**

\\vhb\gis\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Project\SAP\Figure 8 Proposed Sampling Locations.mxd

0 50 100 200 Feet

- Proposed Well
- Monitoring Well
- Soil Core
- Soil Core Reference
- Potential Source
- ISM Surface Soil Decision Unit
- Investigation Areas
- Caneel Bay Resort

Note:
Soil core locations will be selected in the field based on the GPR and EMI survey results.

Caneel Bay Resort Site | St. John, USVI

Source Info:
Base map from ESRI/World Imagery (2017).
Sampling locations from 2014 Barksdale & Associates Level 2 Report.

Proposed Sampling Locations

Tables

List of Tables

TABLE 1 PROJECT ACTION LIMITS AND LABORATORY-SPECIFIC DETECTION/REPORTING LIMITS FOR SOIL

Analyte	CAS Number	Screening Levels			Project Soil Action Level	Achievable Laboratory Limits	
		Residential Regional Screening Level (Soil) (RSL)[1]	USVI DPNR Soil Cleanup Standard	NPS Soil Ecological Screening Value[2]		Limit of Quantitation (LOQ)	Method Detection Limit (MDL)
Metals (mg/kg) – EPA Methods 6020B & 7471B							
RCRA 8 Metals (all EPA 6020B except Mercury)							
Arsenic	7440-38-2	0.68	None	0.25	**0.25**	*1*	0.06
Barium	7440-39-3	1,500	None	17.2	**17**	1	0.289
Cadmium	7440-43-9	7	None	0.27	**0.27**	0.2	0.043
Chromium (Total)	16065-83-1	12,000	None	0.83	**1**	0.4	0.25
Lead	7439-92-1	400	None	0.94	**0.94**	0.2	0.0623
Mercury (EPA 7471B)	7439-97-6	1.1	None	0.013	**0.013**	*0.1*	*0.018*
Selenium	7782-49-2	39	None	0.331	**0.33**	*1*	0.12
Silver	7440-22-4	39	None	2	**2**	0.2	0.022
Other metals (all EPA 6020B)							
Antimony	7440-36-0	3.1	None	0.248	**0.248**	0.4	*0.125*
Beryllium	7440-41-7	16	None	2.42	**2.42**	0.2	0.047
Copper	7440-50-8	31	None	14	**14**	0.4	0.229
Nickel	7440-02-0	150	None	10	**10**	0.4	0.244
Thallium	7440-28-0	0.078	None	0.027	**0.027**	*0.2*	*0.048*
Zinc	7440-66-6	2,300	None	6.62	**6.62**	4	1.64
SVOCs - PAHs (µg/kg) - EPA Method 8270D							
1-Methylnaphthalene	90-12-0	18,000	200,000	No ESV	**18,000**	15	2.68
2-Methylnaphthalene	91-57-6	24,000	210,000	16,000	**16,000**	15	1.96
Acenaphthene	83-32-9	360,000	2,400,000	250	**250**	15	2.86
Acenaphthylene	208-96-8	None	1,800,000	120,000	**120,000**	15	4.01
Anthracene	120-12-7	1,800,000	21,000,000	6,800	**6,800**	15	2.41
Benzo(a)anthracene	56-55-3	1,100	None	730	**730**	15	3.41
Benzo(a)pyrene	50-32-8	110	100	1,980	**100**	15	9.34
Benzo(b)fluoranthene	205-99-2	1,100	None	18,000	**1,100**	15	6.50

Analyte	CAS Number	Screening Levels: Residential Regional Screening Level (Soil) (RSL)[1]	Screening Levels: USVI DPNR Soil Cleanup Standard	Screening Levels: NPS Soil Ecological Screening Value[2]	Project Soil Action Level	Achievable Laboratory Limits: Limit of Quantitation (LOQ)	Achievable Laboratory Limits: Method Detection Limit (MDL)
Benzo(g,h,i)perylene	191-24-2	None	2,500,000	25,000	**25,000**	15	7.10
Benzo(k)fluoranthene	207-08-9	11,000	None	71,000	**11,000**	15	6.93
Chrysene	218-01-9	110,000	None	3,100	**3,100**	15	1.49
Dibenzo(a,h)anthracene	53-70-3	110	None	14,000	**110**	15	6.92
Fluoranthene	206-44-0	240,000	3,200,000	10,000	**10,000**	15	4.45
Fluorene	86-73-7	240,000	2,600,000	3,700	**3,700**	15	2.74
Indeno(1,2,3-cd)pyrene	193-39-5	1,.100	None	71,000	**1,100**	15	7.36
Naphthalene	91-20-3	2,00	55,000	1,000	**1,000**	15	2.41
Phenanthrene	85-01-8	None	2,200,000	5,500	**5,500**	15	2.23
Pyrene	129-00-0	180,000	2,400,000	10,000	**10,000**	15	2.14
PCB Aroclors (µg/kg) – EPA Method 8082A							
PCB Aroclor-1016	12674-11-2	410	None	1,100	**410**	50	22
PCB Aroclor-1221	11104-28-2	200	None	No ESV	**200**	50	24
PCB Aroclor-1232	11141-16-5	170	None	No ESV	**170**	50	23
PCB Aroclor-1242	53469-21-9	230	None	41	**41**	*50*	*19*
PCB Aroclor-1248	12672-29-6	230	None	7.3	**7.3**	*50*	*24*
PCB Aroclor-1254	11097-69-1	120	None	41	**41**	*50*	*23*
PCB Aroclor-1260	11096-82-5	240	None	880	**240**	50	22
Organochlorine Pesticides (µg/kg) – EPA Method 8081B							
Aldrin	309-00-2	390	None	3.32	**3.32**	5	0.77
alpha-BHC	319-84-6	86	None	70	**70**	5	0.91
beta-BHC	319-85-7	300	None	3.98	**3.98**	*5*	*1.73*
delta-BHC	319-86-8	None	None	70	**70**	5	1.69
gamma-BHC (Lindane)	58-89-9	570	None	5	**5**	5	1.79
cis-Chlordane (alpha-Chlordane)	5103-71-9	None	None	270	**270**	5	1.5
gamma-Chlordane	5103-74-2	None	None	2,200	**2,200**	5	1.23
4,4'-DDD	72-54-8	190	None	2.0	**2.0**	*5*	*1.48*
4,4'-DDE	72-55-9	2,000	None	2	**2**	*5*	*1.51*

Analyte	CAS Number	Screening Levels: Residential Regional Screening Level (Soil) (RSL)[1]	Screening Levels: USVI DPNR Soil Cleanup Standard	Screening Levels: NPS Soil Ecological Screening Value[2]	Project Soil Action Level	Achievable Laboratory Limits: Limit of Quantitation (LOQ)	Achievable Laboratory Limits: Method Detection Limit (MDL)
4,4'-DDT	50-29-3	1,900	None	2	**2**	*5*	*1.13*
Dieldrin	60-57-1	34	None	4.5	**4.5**	*5*	*1.1*
Endosulfan I	959-98-8/115-29-7	47,000	None	640	**640**	5	1.2
Endosulfan II	33213-65-9	None	None	560	**560**	5	1.48
Endosulfan sulfate	1031-07-8	38,000	None	560	**560**	5	1.28
Endrin	72-20-8	1,900	None	1.4	**1.4**	*5*	*1.9*
Endrin aldehyde	7421-36-3	None	None	No ESV	**None**	5	1.31
Endrin ketone	53494-70-5	None	None	No ESV	**None**	5	0.89
Heptachlor	76-44-8	130	None	5.9	**5.9**	5	1.58
Heptachlor epoxide	1024-57-3	70	None	No ESV	**70**	5	1.44
Methoxychlor	72-43-5	32,000	None	5,100	**5,100**	10	6.56
Toxaphene	8001-35-2	490	None	4,100	**490**	100	25
Chlordane (technical)	12789-03-6	1,700	None	220	**220**	50	12
VOCs (µg/kg) – EPA Method 8260C							
1,1,1-Trichloroethane	71-55-6	810,000	None	260,000	**260,000**	250	78
1,1,2,2-Tetrachloroethane	79-34-5	600	None	No ESV	**600**	250	150
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	670	None	No ESV	**670**	250	67.0
1,1,2-Trichloroethane	79-00-5	150	None	No ESV	**150**	*250*	*57*
1,1-Dichloroethane	75-34-3	3,600	None	210,000	**3,600**	250	48
1,1-Dichloroethene	75-35-4	23,000	None	11,000	**11,000**	250	82
1,2,4-Trichlorobenzene	120-82-1	5,800	None	270	**270**	250	133
1,2-Dibromo-3-chloropropane	96-12-8	5.3	None	No ESV	**5.3**	*500*	*220*
1,2-Dichlorobenzene	95-50-1	180,000	None	920	**920**	250	120
1,2-Dichloroethane	107-06-2	460	500	850	**460**	250	47
1,2-Dichloropropane	78-87-5	1,600	None	700,000	**1,600**	250	37

Analyte	CAS Number	Screening Levels: Residential Regional Screening Level (Soil) (RSL)[1]	Screening Levels: USVI DPNR Soil Cleanup Standard	Screening Levels: NPS Soil Ecological Screening Value[2]	Project Soil Action Level	Achievable Laboratory Limits: Limit of Quantitation (LOQ)	Achievable Laboratory Limits: Method Detection Limit (MDL)
1,3-Dichlorobenzene	541-73-1	None	None	740	**740**	250	46
1,4-Dichlorobenzene	106-46-7	2,600	None	890	**890**	250	55
2-Butanone (MEK)	78-93-3	2,700,000	None	350,000	**350,000**	1,000	157
2-Hexanone	591-78-6	20,000	None	360	**360**	*1,000*	*263*
Methyl isobutyl ketone (MIBK)	108-10-1	3,300,000	None	9,700	**9,700**	1,000	238
Acetone	67-64-1	6,100,000	None	1,200	**1,200**	1,000	244
Benzene	71-43-2	1,200	1,200	24,000	**1,200**	250	42
Bromoform	75-25-2	19,000	None	No ESV	**19,000**	250	228
Bromomethane	74-83-9	680	None	No ESV	**680**	250	166
Carbon disulfide	75-15-0	77,000	None	810	**810**	250	108
Carbon tetrachloride	56-23-5	650	None	58,600	**650**	250	102
Chlorobenzene	108-90-7	28,000	None	2,400	**2,400**	250	35
Chlorodibromomethane	124-48-1	8,300	None	No ESV	**8,300**	250	117
Chloroethane	75-00-3	1,400,000	None	No ESV	**1,400,000**	250	150
Chloroform	67-66-3	320	None	8,000	**320**	250	54
Chloromethane	74-87-3	11,000	None	No ESV	**11,000**	250	66
cis-1,2-Dichloroethene	156-59-2	16,000	None	89,600	**16,000**	250	40
cis-1,3-Dichloropropene	10061-01-5	None	None	No ESV	**None**	250	124
Cyclohexane	110-82-7	650,000	None	No ESV	**650,000**	500	163
Dichlorodifluoromethane	75-71-8	8.7	None	No ESV	**8.7**	*250*	*53.0*
Dichlorobromomethane	75-27-4	0.29	None	No ESV	**0.29**	*250*	*28.0*
Ethyl benzene	100-41-4	5,800	1,500,000	No ESV	**5,800**	250	47
Ethylene dibromide	106-93-4	36	None	No ESV	**36**	*250*	*79*
Hexane	110-54-3	61,000	None	No ESV	**61,000**	250	114
Isopropylbenzene	98-82-8	190,000	None	No ESV	**190,000**	250	38
Methyl acetate	79-20-9	7,800,000	None	No ESV	**7,800,000**	1,250	168
Methylcyclohexane	108-87-2	None	None	No ESV	**None**	500	66

Analyte	CAS Number	Screening Levels			Project Soil Action Level	Achievable Laboratory Limits	
		Residential Regional Screening Level (Soil) (RSL)[1]	USVI DPNR Soil Cleanup Standard	NPS Soil Ecological Screening Value[2]		Limit of Quantitation (LOQ)	Method Detection Limit (MDL)
Methyl tert-butyl ether (MTBE)	1634-04-4	47,000	4,400,000	No ESV	**47,000**	250	37
Methylene Chloride (Dichloromethane)	75-09-2	35,000	None	2,600	**2,600**	500	383
Styrene	100-42-5	600,000	None	1,200	**1,200**	250	52
Tetrachloroethene	127-18-4	8,100	None	180	**180**	250	97
Tetrahydrofuran	109-99-9	1,800,000	None	No ESV	**1,800,000**	1,000	140
Toluene	108-88-3	490,000	None	23,000	**23,000**	250	240
trans-1,2-Dichloroethene	156-60-5	7,000	None	89,600	**7,000**	250	62
trans-1,3-Dichloropropene	10061-02-6	None	None	No ESV	**None**	250	105
Trichloroethene	79-01-6	410	None	1,387	**410**	250	143
Trichlorofluoromethane	75-69-4	2,300	None	52	**52**	*250*	*137*
Vinyl chloride	75-01-4	59	None	120	**59**	*250*	*123*
Xylenes, mp-		None	130,000	No ESV	**130,000**	Combined	Combined
Xylene, o-	95-47-6	65,000	130,000	4,162	**4,162**	Combined	Combined
Xylenes (total)	1330-20-7	58,000	130,000	1,400	**1,400**	500	91.0

[1] USEPA Regional Screening Levels (RSLs) Generic Tables - Target risk 1E-06, Target HQ 0.1 (May 2019).
[2] Lowest ESV across all NPS-approved sources.

TABLE 2 PROJECT ACTION LIMITS AND LABORATORY-SPECIFIC DETECTION/REPORTING LIMITS FOR GROUNDWATER

Analyte	CAS Number	Screening Levels					Project Groundwater Action Level	Achievable Laboratory Limits	
		Federal and Virgin Islands Maximum Contaminant Level (MCL)	Virgin Islands UST Ground Water Cleanup Level	Tap Water Residential Regional Screening Level (RSL)[1]	NPS Surface Water Ecological Screening Value[2]	Vapor Intrusion Screening Level Target Groundwater Concentration		Limit of Quantitation (LOQ)	Method Detection Limit (MDL)
Metals (µg/L) – EPA Methods 6020B & 7470A									
RCRA 8 Metals (all EPA 6020B except Mercury)									
Arsenic	7440-38-2	10	10	0.052	3.1	None	**0.052**	*2*	*0.68*
Barium	7440-39-3	2,000	None	380	3.9	None	**3.9**	2	0.746
Cadmium	7440-43-9	5	5	0.92	0.07	None	**0.07**	*0.5*	*0.151*
Chromium (Total)	16065-83-1	None	100	2,200	8.9	None	**8.9**	2	0.334
Lead	7439-92-1	15	15	15	0.92	None	**0.92**	0.5	0.071
Mercury (EPA 7470A)	7439-97-6	2	None	0.063	0.026	None	**0.026**	*0.20*	*0.079*
Selenium	7782-49-2	50	None	10	1	None	**1**	*1*	0.278
Silver	7440-22-4	None	None	9.4	0.067	None	**0.067**	*0.5*	*0.17*
Other metals (all EPA 6020B)									
Antimony	7440-36-0	6	None	0.78	30	None	**0.78**	*1*	0.406
Beryllium	7440-41-7	4	None	2.5	0.66	None	**0.66**	0.5	0.119
Copper	7440-50-8	1,300	None	80	0.23	None	**0.23**	*1*	*0.362*
Nickel	7440-02-0	None	None	39	5	None	**5**	1	0.604
Thallium	7440-28-0	2	None	0.02	0.03	None	**0.02**	*0.5*	*0.13*
Zinc	7440-66-6	None	None	600	30	None	**30**	10	6.18

SVOCs - PAHs (µg/L) – EPA Method 8270D-SIM									
1-Methylnaphthalene	90-12-0	None	28	1.1	No ESV	None	**1.1**	0.05	0.01
2-Methylnaphthalene	91-57-6	None	28	3.6	330	None	**3.6**	0.07	0.02
Acenaphthene	83-32-9	None	20	53	5.8	None	**5.8**	0.05	0.01
Acenaphthylene	208-96-8	None	210	None	4800	None	**None**	0.05	0.01
Anthracene	120-12-7	None	2100	180	0.012	None	**0.012**	*0.05*	0.01
Benzo(a)anthracene	56-55-3	None	0.05	0.03	0.018	None	**0.018**	*0.05*	0.01
Benzo(a)pyrene	50-32-8	0.2	0.2	0.025	0.014	None	**0.0140**	*0.05*	0.01
Benzo(b)fluoranthene	205-99-2	None	0.05	0.25	9	None	**0.050**	*0.05*	0.01
Benzo(g,h,i)perylene	191-24-2	None	210	None	7.6	None	**8**	0.05	0.01
Benzo(k)fluoranthene	207-08-9	None	0.5	2.5	0.0041	None	**0.00**	*0.05*	*0.01*
Chrysene	218-01-9	None	4.8	25	0.0018	None	**0.0**	*0.05*	*0.01*
Dibenzo(a,h)anthra-cene	53-70-3	None	0.005	0.025	0.0034	None	**0.0034**	*0.07*	*0.02*
Fluoranthene	206-44-0	None	280	80	0.04	None	**0.04**	*0.05*	0.01
Fluorene	86-73-7	None	280	29	3	None	**3**	0.05	0.01
Indeno(1,2,3-cd)pyrene	193-39-5	None	0.05	0.25	4.3	None	**0.050**	*0.05*	0.01
Naphthalene	91-20-3	None	14	0.12	1.1	None	**0.12**	0.07	0.03
Phenanthrene	85-01-8	None	210	None	0.4	None	**0.4**	0.07	0.03
Pyrene	129-00-0	None	210	12	0.025	None	**0.025**	*0.05*	0.01
PCB Aroclors (µg/L) – EPA Method 8082A									
PCB Aroclor-1016	12674-11-2	None	None	0.14	0.014	17	**0.01**	0.01	0.00476
PCB Aroclor-1221	11104-28-2	None	None	0.0047	0.014	0.53	**0.0047**	*0.01*	*0.00572*
PCB Aroclor-1232	11141-16-5	None	None	0.0047	0.014	0.16	**0.0047**	*0.01*	*0.00521*
PCB Aroclor-1242	53469-21-9	None	None	0.0078	0.014	None	**0.0078**	*0.01*	0.00356
PCB Aroclor-1248	12672-29-6	None	None	0.0078	0.014	0.27	**0.0078**	*0.01*	0.00299
PCB Aroclor-1254	11097-69-1	None	None	0.0078	0.014	None	**0.0078**	*0.01*	0.00456
PCB Aroclor-1260	11096-82-5	None	None	0.0078	0.014	0.36	**0.0078**	*0.01*	0.00392
Total PCBs	1336-36-3	0.5	None	None	0.014	None	**0.014**		

Organochlorine Pesticides (µg/L) – EPA Method 8081B									
4,4'-DDD	72-54-8	None	None	0.0063	0.011	None	**0.006**	0.0013	0.00534
4,4'-DDE	72-55-9	None	None	0.046	100	None	**0.05**	0.0013	0.00030
4,4'-DDT	50-29-3	None	None	0.23	0.001	None	**0.001**	*0.0013*	0.00030
Aldrin	309-00-2	None	None	0.00092	0.3	0.32	**0.00092**	*0.0013*	*0.00356*
alpha-BHC (alpha-Hexachlorocyclohexane)	319-84-6	None	None	0.0072	2.2	None	**0.0072**	0.0013	0.00024
beta-BHC (beta-Hexachlorocyclohexane)	319-85-7	None	None	0.025	2.2	None	**0.025**	0.0013	0.00037
Chlordane	54-74-9/ 12789-03-6	2	None	0.02	0.0043	None	**0.0043**	*0.0125*	*0.00726*
cis-Chlordane (alpha-Chlordane)	5103-71-9	None	None	None	0.0043	None	**0.0043**	0.0013	0.00037
delta-BHC (delta-Hexachlorocyclohexane)	319-86-8	None	None	None	2.2	None	**2.2**	0.0013	0.00064
Dieldrin	60-57-1	None	None	0.0018	0.056	None	**0.0018**	0.0013	0.00027
Endosulfan I	959-98-8/ 115-29-7	None	None	10	0.003	None	**0.003**	0.0013	0.00069
Endosulfan II	33213-65-9	None	None	None	0.003	None	**0.003**	0.0013	0.00032
Endosulfan sulfate	1031-07-8	None	None	11	0.003	None	**0.003**	0.0013	0.00064
Endrin	72-20-8	2	None	0.23	0.036	None	**0.036**	0.0013	0.00023
Endrin aldehyde	7421-36-3	None	None	None	0.036	None	**0.036**	0.0013	0.00052
Endrin ketone	53494-70-5	None	None	None	0.036	None	**0.036**	0.0013	0.00040
gamma-BHC (Lindane)	58-89-9	0.2	None	0.042	0.01	None	**0.01**	0.0013	0.00029
gamma-Chlordane	5103-74-2	None	None	None	0.0043	None	**None**	0.0013	0.00041
Heptachlor	76-44-8	0.4	None	0.0014	0.0038	None	**0.0014**	0.0013	0.00045
Heptachlor epoxide	1024-57-3	0.2	None	0.0014	0.0038	None	**0.0014**	0.0013	0.00034
Methoxychlor	72-43-5	40	None	3.7	0.019	None	**0.019**	0.0013	0.00078
Toxaphene	8001-35-2	3	None	0.071	0.0002	None	**0.0002**	*0.1000*	*0.04910*

VOCs (µg/L) – EPA Method 8260D									
1,1,1-Trichloroethane	71-55-6	200	None	800	11	None	**11**	0.5	0.06
1,1,2,2-Tetrachloroethane	79-34-5	None	None	0.076	610	None	**0.076**	*0.5*	0.07
1,1,2-Trichloroethane	79-00-5	5	None	0.041	1,200	None	**0.041**	*0.5*	*0.06*
1,1-Dichloroethane	75-34-3	None	None	2.8	47	None	**2.8**	0.5	0.07
1,1-Dichloroethene	75-35-4	7	None	28	25	None	**7**	0.5	0.06
1,2,4-Trichlorobenzene	120-82-1	70	None	0.4	24	None	**0.4**	*0.5*	0.06
1,2-Dibromo-3-chloropropane	96-12-8	0.2	None	0.00033	No ESV	None	**0.00033**	*0.5*	*0.1*
1,2-Dichlorobenzene	95-50-1	600	None	30	0.7	None	**0.7**	0.5	0.06
1,2-Dichloroethane	107-06-2	5	3	0.17	100	None	**0.17**	*0.5*	0.05
1,2-Dichloropropane	78-87-5	5	None	0.82	No ESV	None	**0.82**	0.5	0.06
1,3-Dichlorobenzene	541-73-1	None	None	None	71	None	**71**	0.5	0.06
1,4-Dichlorobenzene	106-46-7	75	None	0.48	15	None	**0.48**	*0.5*	0.07
2-Butanone (MEK)	78-93-3	None	None	560	7,200	None	**560**	5	0.6
2-Hexanone	591-78-6	None	None	3.8	99	None	**3.8**	*5*	0.6
Acetone	67-64-1	None	None	1,400	1,500	None	**1,400**	5	0.9
Benzene	71-43-2	5	1	0.46	46	None	**0.460**	*0.5*	0.05
Bromodichloromethane	75-27-4	80	None	0.13	No ESV	None	**0.13**	*0.5*	*0.5*
Bromoform	75-25-2	80	None	3.3	320	None	**3.3**	1	0.3
Bromomethane	74-83-9	None	None	0.75	1300	None	**0.75**	0.5	0.07
Carbon disulfide	75-15-0	None	None	81	0.92	None	**0.92**	*1*	0.06
Carbon tetrachloride	56-23-5	5	None	0.46	9.8	None	**0.46**	*0.5*	0.07
Chlorobenzene	108-90-7	100	None	7.8	1.3	None	**1.3**	0.5	0.06
Chloroethane	75-00-3	None	None	2,100	No ESV	None	**2,100**	0.5	0.07
Chloroform	67-66-3	80	None	0.22	1.8	None	**0.22**	*0.5*	0.09
Chloromethane	74-87-3	None	None	19	No ESV	None	**19**	0.5	0.06
cis-1,2-Dichloroethene	156-59-2	70	None	3.6	590	None	**3.6**	0.5	0.05
cis-1,3-Dichloropropene	10061-01-5	None	None	None	0.055	None	**0.055**	*0.5*	0.05
Cyclohexane	110-82-7	None	None	1,300	No ESV	None	**1,300**	0.5	0.05

Dibromochloromethane	124-48-1	80	None	0.87	No ESV	None	**0.87**	0.5	0.07
Dichloromethane	75-09-2	5	None	11	98.1	None	**5**	0.5	0.07
Diisopropyl ether (DIPE)	108-20-3	None	5	150	No ESV	None	**5**	0.5	0.05
Ethylbenzene	100-41-4	700	700	1.5	7.3	3.5	**1.5**	0.5	0.06
Ethylene dibromide	106-93-4	0.05	0.02	0.0075	No ESV	None	**0.0075**	0.5	0.06
Freon-11	75-69-4	None	None	520	No ESV	None	**520**	0.5	0.05
Freon-113	76-13-1	None	None	1,000	No ESV	None	**1,000**	0.5	0.06
Freon-12	75-71-8	None	None	20	No ESV	None	**20**	0.05	0.05
Isopropylbenzene	98-82-8	None	None	45	No ESV	None	**45**	0.5	0.05
Methyl acetate	79-20-9	None	None	2,000	No ESV	None	**2,000**	1	0.
Methyl isobutyl ketone (MIBK)	108-10-1	None	None	630	170	None	**170**	5	0.
Methyl tert-butyl ether (MTBE)	1634-04-4	None	None	14	10,000	None	**14**	0.5	0.05
Methylcyclohexane	108-87-2	None	None	None	No ESV	None	**None**	0.5	0.05
n-Hexane	110-54-3	None	None	150	No ESV	None	**150**	0.5	0.05
Styrene	100-42-5	100	None	120	72	930	**72**	0.5	0.05
Tertiary butyl alcohol	75-65-0	None	50	None	No ESV	None	**50**	10	1.1
Tetrachloroethene	127-18-4	5	None	4.1	50	None	**4.1**	0.5	0.06
Toluene	108-88-3	1,000	1,000	110	2	None	**2**	0.5	0.07
trans-1,2-Dichloroethene	156-60-5	100	None	6.8	590	None	**7**	0.5	0.06
trans-1,3-Dichloropropene	10061-02-6	None	None	None	0.055	None	**0.055**	*0.5*	*0.06*
Trichloroethene	79-01-6	5	None	0.28	21	None	**0.28**	*0.5*	0.06
Vinyl chloride	75-01-4	2	None	0.019	No ESV	None	**0.019**	*0.5*	*0.1*
Xylenes (unspecified)	1330-20-7	10,000	10,000	19	13	None	**13**	1	0.15

[1.] USEPA Regional Screening Level for target hazard quotients (THQ) of 0.1. [2] Lowest ESV across all NPS-approved sources.

TABLE 3 SUMMARY OF SOIL RESULTS – METALS

Site		Site 1 - Engineering & Maintenance												Site 2 - Former UST					
Sample Location ID		**01-SS-01**		**01-SS-02**		**01-SS-03**		**01-SS-04**		**01-SS-05**		**01-SS-06**		**02-SU-01**		**02-SU-02**		**02-SU-03 (02-SU-02 DUP)**	
Sample Date		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-13		2014-01-13		2014-01-13	
Depth (ft bgs)		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		5-6.5		5-7.0		5-7.0	
RCRA 8 Metals (Method 6010C)	**Action Level* (mg/kg)**																		
Arsenic	0.25		**7.8**		**2.6**		**5.7**		**19**		**15**		**42**		*NA*		*NA*		*NA*
Barium	17.2		**53.0**		**57**		**95**		**120**		**110**		**79**		*NA*		*NA*		*NA*
Cadmium	0.27	I	**0.46**	I	0.26	I	0.26		**2.1**	I	**0.48**		**1.1**		*NA*		*NA*		*NA*
Chromium	0.83		**32.0**		**33**		**39**		**76**		**52**		**74**		*NA*		*NA*		*NA*
Lead	0.94		**19.0**		**26**		**8**		**130**		**37**		**18**		**7.5**		**8.3**		**6.6**
Mercury (method 7471B)	0.013	V	**0.028**	V	**0.051**	V	**0.036**	V	**0.110**	V	**0.064**	V	**0.057**		*NA*		*NA*		*NA*
Selenium	0.331	UM	0.56	I	**0.74**	UM	0.5	UM	1.1	I	**0.62**	I	**0.63**		*NA*		*NA*		*NA*
Silver	2	UM	0.28	UM	0.25	UM	0.25	UM	0.55	UM	0.27	UM	0.27		*NA*		*NA*		*NA*

Site		Site 3 - Grounds & Landscaping Chemical Storage Sheds												Site 4 - Equip. Maint.			
Sample Location ID		**03-SS-01**		**03-SS-02**		**03-SS-03**		**03-SS-04**		**03-SS-05**		**03-SS-06**		**04-SS-01**		**04-SS-02**	
Sample Date		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-12		2014-01-12	
Depth (ft bgs)		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
RCRA 8 Metals (Method 6010C)	**Action Level* (mg/kg)**																
Arsenic	0.25		**1.1**		**15**		**2.5**		**4**		**1.6**		**30**		**4.9**		**4.6**
Barium	17.2		**36**		**58**		**42**		**59**		**42**		**41**		**40**		**34**
Cadmium	0.27	I	0.16	I	**0.4**	I	**0.39**	I	**0.47**	I	0.27		**0.61**	I	**0.5**	I	**0.4**
Chromium	0.83		**17**		**45**		**24**		**33**		**33**		**56**		**37**		**27**
Lead	0.94		**7.7**		**15**		**20**		**41**		**13**		**9.1**		**41**		**16**
Mercury (method 7471B)	0.013	UM	0.011		**0.019**	UM	0.011		**0.021**		**0.032**		**0.025**	V	**0.028**	V	**0.031**
Selenium	0.331		**1.6**	I	**0.51**	I	**0.57**	I	**0.68**	UM	0.43	UM	0.43	UM	0.55	I	**0.56**
Silver	2	UM	0.23	UM	0.2	UM	0.21	UM	0.25	I	0.23	I	0.26	UM	0.27	UM	0.23

	Site	Site 5 - Emergency Generator Building								Site 6 - Wastewater Treatment Plant					
	Sample Location ID	**05-SS-01**		**05-SS-02**		**05-SS-03**		**05-SS-04**		**06-SS-01**		**06-SS-02**		**06-SS-03**	
	Sample Date	2014-01-14		2014-01-14		2014-01-14		2014-01-14		2014-01-13		2014-01-13		2014-01-13	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
RCRA 8 Metals (Method 6010C)	**Action Level* (mg/kg)**														
Arsenic	0.25		**30**		**35**		**49**		**57**		**5.3**		**5.6**		**4**
Barium	17.2		**88**		**38**		**67**		**81**		**47**		**70**		**55**
Cadmium	0.27		**7.3**		**4.5**		**4.4**		**1.8**	I	**0.35**	I	**0.65**	I	**0.28**
Chromium	0.83		**90**		**68**		**60**		**37**		**45**		**71**		**63**
Lead	0.94		**180**		**100**		**83**		**59**		**14**		**23**		**19**
Mercury (method 7471B)	0.013		**0.083**		**0.34**		**0.026**		**0.022**		**0.03**		**0.27**	I	**0.017**
Selenium	0.331	I V	**1.1**	UM	**0.53**	UM	**0.48**	UM	**0.49**	I V	**0.77**	I V	**1**	UM	**0.48**
Silver	2		**3.5**		1.1	I	0.45	I	0.38	UM	0.23	I	0.62	UM	0.24

	Site	Site 7 - Debris Landfill									
	Sample Location ID	**07-SS-01**		**07-SS-02**		**07-SS-03**		**07-SS-04**		**07-SS-05 (07-SS-01 DUP)**	
	Sample Date	2014-01-15		2014-01-15		2014-01-15		2014-01-15		2014-01-15	
	Depth (ft bgs)	0-1.0		0-1.0		0-1.0		0-1.0		0-1.0	
RCRA 8 Metals (Method 6010C)	**Action Level* (mg/kg)**										
Arsenic	0.25		**0.8**		**5.8**		**4.3**		**2.1**		**0.7**
Barium	17.2		**80**		**79**		**58**		**72**		**51**
Cadmium	0.27	UM	0.1	I	**0.29**	I	**0.39**	I	0.25	UM	0.11
Chromium	0.83		**14**		**27**		**36**		**30**		**14**
Lead	0.94		**5.4**		**11**		**10**		**15**		**5.6**
Mercury (method 7471B)	0.013		**0.018**		**0.04**		**0.052**		**0.059**		**0.021**
Selenium	0.331	UM	**0.42**	UM	**0.55**	I V	**0.68**	I V	**0.82**	I V	**0.49**
Silver	2	UM	0.21	UM	0.27	UM	0.24	UM	0.21	UM	0.21

Notes:
UM = Compound was analyzed but not detected

Only results for compounds detected at the Site are shown

I = Value is between the laboratory MDL and the PQL
V = Analyte was detected at or above the MDL in both the sample and the associated method blank and the value of 10 times the blank value was equal to or greater than the associated sample value

*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.

Black cell = Result > Action Level
NA = No data available or not analyzed

TABLE 4 SUMMARY OF SOIL RESULTS – NONHALOGENATED ORGANICS

	Site	Site 1 - Engineering & Maintenance																			
	Sample Location ID	01-SS-01		01-SS-02		01-SS-03		01-SS-04		01-SS-05		01-SS-06		01-SD-01		01-SD-02		01-SD-03		01-SD-04	
	Sample Date	2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-13		2014-01-13		2014-01-13	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
Nonhalogenated Organics (Method 8015C)	**Action Level* (mg/kg)**																				
Gasoline Range Organics [C6-C10]	460	UM	0.061	UM	0.062	UM	0.059	UM	0.069	UM	0.065	UM	0.067	UM	0.086	UM	0.054	UM	0.055	UM	0.059
Diesel Range Organics [C10-C28]	460		370		27	I V	4		300	V	10	V	19	V	24		37	V	17	I V	4
Oil Range Organics [C28-C35]	460		350		33	I V	4		230	V	12	V	16		30		65		36	I V	3

	Site	Site 4 - Equip. Maint.				Site 5 - Emergency Generator Building								Site 6 - Wastewater Treatment Plant					
	Sample Location ID	04-SS-01		04-SS-02		05-SS-01		05-SS-02		05-SS-03		05-SS-04		06-SS-01		06-SS-02		06-SS-03	
	Sample Date	2014-01-12		2014-01-12		2014-01-14		2014-01-14		2014-01-14		2014-01-14		2014-01-13		2014-01-13		2014-01-13	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
Nonhalogenated Organics (Method 8015C)	**Action Level* (mg/kg)**																		
Gasoline Range Organics [C6-C10]	460	UM	0	I	0		*NA*		*NA*		*NA*		*NA*		*NA*		*NA*		*NA*
Diesel Range Organics [C10-C28]	460		*NA*		*NA*		310		**620**		98		**480**		*NA*		*NA*		*NA*
Oil Range Organics [C28-C35]	460		220		86		93		**590**		79		110		**4100**		52	I V	3.6

Notes:
UM = Compound was analyzed but not detected
I = Value is between the laboratory MDL and the PQL

Only results for compounds detected at the Site are shown

*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.

V = Analyte was detected at or above the MDL in both the sample and the associated method blank and the value of 10 times the blank value was equal to or greater than the associated sample value

Black cell = Result > Action Level
NA = No data available or not analyzed

TABLE 5 SUMMARY OF SOIL RESULTS – VOCS

	Site	Site 2 - Former UST					
	Sample Location ID	02-SU-01		02-SU-02		02-SU-03 (02-SU-02 DUP)	
	Sample Date	2014-01-13		2014-01-13		2014-01-13	
	Depth (ft bgs)	5-6.5		5-7.0		5-7.0	
VOC (Method 8260B)	**Action Level* (µg/kg)**						
Benzene	1,200	UM	0.61	UM	0.62	UM	0.61
Toluene	23,000	UM	0.88	UM	0.89	UM	0.87
Ethylbenzene	5,800	I	0.93	UM	0.77	UM	0.76
Xylenes, Total	1,400	UM	2.4	UM	2.4	UM	2.4

Notes:

UM = Compound was analyzed but not detected
I = Value is between the laboratory MDL and the PQL

Only results for compounds detected at the Site are shown
*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.
Black cell = Result > Action Level
NA = No data available or not analyzed

TABLE 6 SUMMARY OF SOIL RESULTS – PCBS

	Site	Site 1 - Engineering & Maintenance Area																			
	Sample Location ID	**01-SS-01**		**01-SS-02**		**01-SS-03**		**01-SS-04**		**01-SS-05**		**01-SS-06**		**01-SD-01**		**01-SD-02**		**01-SD-03**		**01-SD-04**	
	Sample Date	2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-13		2014-01-13		2014-01-13	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
PCBs (Method 8082A)	**Action Level* (µg/kg)**																				
PCB-1016	410	UM	2.8	UM	2.7	UM	2.9	UM	3.1	UM	2.8	UM	3.2	UM	4.1	UM	26.0	UM	2.7	UM	2.9
PCB-1221	200	UM	9.6	UM	9.2	UM	10.0	UM	11.0	UM	9.7	UM	11.0	UM	14.0	UM	90.0	UM	9.1	UM	9.8
PCB-1232	170	UM	10.0	UM	9.8	UM	11.0	UM	11.0	UM	10.0	UM	11.0	UM	15.0	UM	96.0	UM	9.7	UM	10.0
PCB-1242	41	UM	6.4	UM	6.1	UM	6.7	UM	7.1	UM	6.5	UM	7.2	UM	9.4	UM	60.0	UM	6.1	UM	6.6
PCB-1248	7.3	UM	2.1	UM	2.0	UM	2.2	UM	2.3	UM	2.1	UM	2.4	UM	3.1	UM	20.0	UM	2.0	UM	2.2
PCB-1254	41	UM	3.6	UM	3.4	UM	3.7	UM	4.0	UM	3.6	UM	4.0	UM	5.3	UM	34.0	UM	3.4	UM	3.7
PCB-1260	240	UM	3.9	UM	3.7	UM	4.1	UM	4.3	UM	3.9	UM	4.4	UM	5.7	UM	37.0	UM	3.7	UM	4.0

	Site	Site 6 - Wastewater Treatment Plant						Site 7 - Debris Landfill									
	Sample Location ID	**06-SS-01**		**06-SS-02**		**06-SS-03**		**07-SS-01**		**07-SS-02**		**07-SS-03**		**07-SS-04**		**07-SS-05 (07-SS-01 DUP)**	
	Sample Date	2014-01-13		2014-01-13		2014-01-13		2014-01-15		2014-01-15		2014-01-15		2014-01-15		2014-01-15	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-1.0		0-1.0		0-1.0		0-1.0		0-1.0	
PCBs (Method 8082A)	**Action Level* (µg/kg)**																
PCB-1016	410	UM	2.6	UM	4.0	UM	2.7	UM	2.4	UM	3.2	UM	2.8	UM	2.5	UM	2.4
PCB-1221	200	UM	8.8	UM	14.0	UM	9.2	UM	8.3	UM	11.0	UM	9.5	UM	8.6	UM	8.3
PCB-1232	170	UM	9.4	UM	15.0	UM	9.8	UM	8.8	UM	12.0	UM	10.0	UM	9.2	UM	8.8
PCB-1242	41	UM	5.9	UM	9.1	UM	6.1	UM	5.5	UM	7.4	UM	6.3	UM	5.7	UM	5.5
PCB-1248	7.3	UM	1.9	UM	3.0	UM	2.0	UM	1.8	UM	2.4	UM	2.1	UM	1.9	UM	1.8
PCB-1254	41	UM	3.3	UM	5.1	UM	3.4	UM	3.1	UM	4.1	UM	3.5	UM	3.2	UM	3.1
PCB-1260	240	UM	3.6	UM	5.6	UM	3.7	UM	3.4	UM	4.5		28		39	UM	3.4

Notes:

UM = Compound was analyzed but not detected

Only results for compounds detected at the Site are shown
*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.
Black cell = Result > Action Level
NA = No data available or not analyzed

TABLE 7 SUMMARY OF SOIL RESULTS – PAHS

	Site	**Site 1 - Engineering & Maintenance Area**																			
	Sample Location ID	**01-SS-01**		**01-SS-02**		**01-SS-03**		**01-SS-04**		**01-SS-05**		**01-SS-06**		**01-SD-01**		**01-SD-02**		**01-SD-03**		**01-SD-04**	
	Sample Date	2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-11		2014-01-13		2014-01-13		2014-01-13	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
SVOC (Method 8270D)	**Action Level* (µg/kg)**																				
1-Methylnaphthalene	18,000	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
2-Methylnaphthalene	16,000	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
Acenaphthene	250	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
Acenaphthylene	120,000	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
Anthracene	6,800	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
Benzo(a)anthracene	730	UM	64	UM	61	UM	13	I	81	UM	13	I	27	UM	95	UM	60	UM	61	UM	13
Benzo(a)pyrene	100	UM	64	UM	61	UM	13	I	**110**	UM	13	I	46	I	120	UM	60	UM	61	UM	13
Benzo(b)fluoranthene	1,100	UM	64	UM	61	UM	13	I	160	UM	13	I	72	I	**160**	UM	60	I	81	UM	13
Benzo(g,h,i)perylene	25,000	UM	64	UM	61	UM	13	I	110	UM	13	I	36	I	110	UM	60	UM	61	UM	13
Benzo(k)fluoranthene	11,000	UM	64	UM	61	UM	13	UM	72	UM	13	I	27	UM	95	UM	60	UM	61	UM	13
Chrysene	3,100	UM	64	UM	61	UM	13	UM	72	UM	13	I	33	UM	95	UM	60	UM	61	UM	13
Dibenz(a,h)anthracene	110	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
Fluoranthene	10,000	UM	64	UM	61	UM	13	I	280	UM	13	I	110	UM	95	UM	60	UM	61	UM	13
Fluorene	3,700	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
Indeno(1,2,3-cd)pyrene	1,100	UM	64	UM	61	UM	13	I	89	UM	13	I	31	UM	95	UM	60	UM	61	UM	13
Naphthalene	1,000	UM	64	UM	61	UM	13	UM	72	UM	13	UM	14	UM	95	UM	60	UM	61	UM	13
Phenanthrene	5,500	UM	64	UM	61	UM	13	I	170	UM	13	I	18	UM	95	UM	60	UM	61	UM	13
Pyrene	10,000	I	94	UM	61	UM	13	I	300	UM	13	I	110	UM	95	UM	60	UM	61	UM	13

	Site	Site 2 - Former UST						Site 4 - Equip. Maint.				Site 5 - Emergency Generator Building							
	Sample Location ID	02-SU-01		02-SU-02		02-SU-03 (02-SU-02 DUP)		04-SS-01		04-SS-02		05-SS-01		05-SS-02		05-SS-03		05-SS-04	
	Sample Date	2014-01-13		2014-01-13		2014-01-13		2014-01-12		2014-01-12		2014-01-14		2014-01-14		2014-01-14		2014-01-14	
	Depth (ft bgs)	5-6.5		5-7.0		5-7.0		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
SVOC (Method 8270D)	**Action Level* (µg/kg)**																		
1-Methylnaphthalene	18,000	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
2-Methylnaphthalene	16,000	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Acenaphthene	250	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Acenaphthylene	120,000	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Anthracene	6,800	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Benzo(a)anthracene	730	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Benzo(a)pyrene	100	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Benzo(b)fluoranthene	1,100	UM	61	UM	37	UM	37	UM	74	I	70	UM	67	UM	68	UM	64	UM	62
Benzo(g,h,i)perylene	25,000	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Benzo(k)fluoranthene	11,000	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Chrysene	3,100	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Dibenz(a,h)anthracene	110	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Fluoranthene	10,000	I	75	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Fluorene	3,700	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Indeno(1,2,3-cd)pyrene	1,100	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Naphthalene	1,000	UM J3	61	UM J3	37	UM J3	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Phenanthrene	5,500	UM	61	UM	37	UM	37	UM	74	UM	60	UM	67	UM	68	UM	64	UM	62
Pyrene	10,000	I	77	UM	37	UM	37	UM	74	UM	60	UM	67	I	83	UM	64	UM	62

	Site	Site 6 - WW Treatment Plant						Site 7 - Debris Landfill									
	Sample Location ID	06-SS-01		06-SS-02		06-SS-03		07-SS-01		07-SS-02		07-SS-03		07-SS-04		07-SS-05 (07-SS-01 (DUP))	
	Sample Date	2014-01-13		2014-01-13		2014-01-13		2014-01-15		2014-01-15		2014-01-15		2014-01-15		2014-01-15	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-1.0		0-1.0		0-1.0		0-1.0		0-1.0	
SVOC (Method 8270D)	**Action Level* (µg/kg)**																
1-Methylnaphthalene	18,000	UM	59	UM	36	UM	24	UM	22	UM	29	UM	25	UM	23	UM	11
2-Methylnaphthalene	16,000	UM	59	UM	36	UM	24	UM	22	UM	29	UM	25	UM	23	UM	11
Acenaphthene	250	UM	59	UM	36	I	65	UM	22	UM	29	UM	25	UM	23	UM	11
Acenaphthylene	120,000	UM	59	UM	36	UM	24	UM	22	UM	29	UM	25	UM	23	UM	11
Anthracene	6,800	UM	59	UM	36	I	120	UM	22	I	42	UM	25	I	31	UM	11
Benzo(a)anthracene	730	UM	59	UM	36	I	200	UM	22	I	240	I	52	I	110	UM	11
Benzo(a)pyrene	100	UM	59	I	49	I	**160**	UM	22	I	**210**	I	68	I	**110**	UM	11
Benzo(b)fluoranthene	1,100	UM	59	UM	36	I	200	UM	22	I	310	I	100	I	140	UM	11
Benzo(g,h,i)perylene	25,000	UM	59	UM	36	I	85	UM	22	I	140	I	53	I	63	UM	11
Benzo(k)fluoranthene	11,000	UM	59	UM	36	I	69	UM	22	I	100	UM	25	I	53	UM	11
Chrysene	3,100	UM	59	UM	36	I	170	UM	22	I	230	I	40	I	120	UM	11
Dibenz(a,h)anthracene	110	UM	59	UM	36	UM	24	UM	22	UM	29	UM	25	UM	23	UM	11
Fluoranthene	10,000	UM	59	I	62	I	430	UM	22	I	480	I	130	I	280	UM	11
Fluorene	3,700	UM	59	UM	36	I	41	UM	22	UM	29	UM	25	UM	23	UM	11
Indeno(1,2,3-cd)pyrene	1,100	UM	59	I	42	I	85	UM	22	I	130	I	51	I	60	UM	11
Naphthalene	1,000	UM	59	UM	36	UM	24	UM	22	UM	29	UM	25	UM	23	UM	11
Phenanthrene	5,500	UM	59	UM	36	I	410	UM	22	I	200	I	52	I	150	UM	11
Pyrene	10,000	I	66	I	80	I	360	UM	22	I	410	I	110	I	230	UM	11

Notes:

UM = Compound was analyzed but not detected

I = Value is between the laboratory MDL and the PQL

V = Analyte was detected at or above the MDL in both the sample and the associated method blank and the value of 10 times the blank value was equal to or greater than the associated sample value

Only results for compounds detected at the Site are shown

*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.

Black cell = Result > Action Level

NA = No data available or not analyzed

J3 = Estimated value; value may not be accurate. Spike recovery or RPD outside of criteria

TABLE 8 SUMMARY OF SOIL RESULTS - ORGANOCHLORINE PESTICIDES

	Site	Site 1 - Engineering & Maintenance								Site 3 - Grounds & Landscaping Chemical Storage Sheds											
	Sample Location ID	01-SD-01		01-SD-02		01-SD-03		01-SD-04		03-SS-01		03-SS-02		03-SS-03		03-SS-04		03-SS-05		03-SS-06	
	Sample Date	2014-01-11		2014-01-13		2014-01-13		2014-01-13		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
Organochlorine Pesticides (Method 8081B)	**Action Level* (µg/kg)**																				
4,4'-DDD	2.0		*NA*	UM	0.6	UM	0.61	UM	0.066	I	0.13		1	I	0.74	UM	0.33		1.1	UM	0.056
4,4'-DDE	2		*NA*	UM	0.49	UM	0.5	UM	0.054		**3.7**		**22**		**19**		**100**		**200**		**32**
4,4'-DDT	2		*NA*	UM	0.6	UM	0.61	UM	0.066		1.3		**12**		**2.8**		**6.6**		**22**		**9.8**
Aldrin	3.32		*NA*	UM	0.42	UM	0.42	UM	0.046	UM	0.06	I	0.19	I	0.33	UM	0.33	I	0.46	UM	0.056
alpha-BHC	70		*NA*	UM	0.6	UM	0.61	UM	0.066	UM	0.049	UM	0.044	UM	0.047	UM	0.27	UM	0.045	UM	0.046
beta-BHC	3.98		*NA*	UM	0.6	UM	0.61	UM	0.066	UM	0.06	UM	0.053	I	0.49	UM	0.33	UM	0.055	UM	0.056
delta-BHC	70		*NA*	UM	0.58	UM	0.59	UM	0.064	UM	0.042	UM	0.037	UM	0.04	UM	0.23	UM	0.038	UM	0.039
gamma-BHC (Lindane)	5		*NA*		**20**	UM	0.61	UM	0.066	UM	0.06	UM	0.053	UM	0.057	UM	0.33	UM	0.055		2.1
alpha-Chlordane	270		*NA*		16	I	5.9	UM	0.066	UM	0.06	UM	0.053		40	UM	0.33		69		13
gamma-Chlordane	2,200		*NA*	I	7.4	I	2.7	UM	0.066	UM	0.058	UM	0.052		23	UM	0.32		34		4.8
Dieldrin	4.5		*NA*	I	**8.2**	UM	0.61	UM	0.066	UM	0.06		1.3		**13**	UM	0.33		**26**		**24**
Endosulfan I	640		*NA*	UM	0.96	UM	0.97	UM	0.1	UM	0.096		14	UM	0.091	UM	0.53	UM	0.088	UM	0.09
Endosulfan II	560		*NA*	UM	0.5	UM	0.5	UM	0.054	UM	0.05		17		2.1	UM	0.27	UM	0.046		2.8
Endosulfan sulfate	560		*NA*	UM	1.6	UM	1.6	UM	0.17	UM	0.16		9.7		1.3	UM	0.86	UM	0.14		1.1
Endrin	1.4		*NA*	UM	0.47	UM	0.47	UM	0.051	I	0.79	UM	0.041	UM	0.044	UM	0.26	UM	0.043	UM	0.044
Endrin aldehyde	None		*NA*	UM	0.6	UM	0.61	UM	0.066	UM	0.06	UM	0.053	UM	0.057	UM	0.33	UM	0.055	UM	0.056
Endrin ketone	None		*NA*	UM	0.6	UM	0.61	UM	0.066	UM	0.06	UM	0.053	UM	0.057	UM	0.33	UM	0.055	UM	0.056
Heptachlor	59		*NA*	UM	0.6	UM	0.61	UM	0.066	UM	0.06	UM	0.053	UM	0.057	UM	0.33	I	0.65	UM	0.056
Heptachlor epoxide	70		*NA*	UM	0.6	UM	0.61	UM	0.066	UM	0.06	UM	0.053	UM	0.057	UM	0.33		1.8	UM	0.056
Methoxychlor	5,000		*NA*	UM	1.7	UM	1.8	UM	0.19	UM	0.17	UM	0.15	UM	0.16	UM	0.96	UM	0.16	UM	0.16
Toxaphene	490		*NA*	UM	100	UM	100	UM	11	UM	10	UM	9	UM	9.7	UM	56	UM	9.3	UM	9.6

Site	Site 7 - Debris Landfill

	Sample Location ID	07-SS-01		07-SS-02		07-SS-03		07-SS-04		07-SS-05 (07-SS-01 DUP)	
	Sample Date	2014-01-15		2014-01-15		2014-01-15		2014-01-15		2014-01-15	
	Depth (ft bgs)	0-1.0		0-1.0		0-1.0		0-1.0		0-1.0	
Organochlorine Pesticides (Method 8081B)	**Action Level* (µg/kg)**										
4,4'-DDD	2.0	I	0.12	UM	0.37	UM	0.32	I	1.4	UM	0.055
4,4'-DDE	2	I	0.65	I	**8.5**	I	**13**	I	**21**	UM	0.055
4,4'-DDT	2	I	0.49	I	1.6	I	**4.2**	I	**8.7**	UM	0.055
Aldrin	3.32	UM	0.055	UM	0.37	UM	0.32	UM	0.57	UM	0.055
alpha-BHC	70	UM	0.045	UM	0.3	UM	0.26	UM	0.47	UM	0.045
beta-BHC	3.98	UM	0.055	UM	0.37	UM	0.32	UM	0.57	UM	0.055
delta-BHC	70	UM	0.039	UM	0.26	UM	0.22	UM	0.4	UM	0.039
gamma-BHC (Lindane)	5	UM	0.055	UM	0.37	UM	0.32	UM	0.57	UM	0.055
alpha-Chlordane	270	UM	0.055	I	1.9	I	1.7	UM	0.57	UM	0.055
gamma-Chlordane	2,200	UM	0.053	I	0.88	I	0.65	UM	0.56	UM	0.054
Dieldrin	4.5	UM	0.55	I	1	I	0.59	I	1.2	UM	0.055
Endosulfan I	640	UM	0.088	UM	0.59	UM	0.41	UM	0.92	UM	0.088
Endosulfan II	560	UM	0.046	UM	0.31	UM	0.26	UM	0.48	UM	0.046
Endosulfan sulfate	560	UM	0.14	UM	0.96	UM	0.82	UM	1.5	UM	0.14
Endrin	1.4	UM	0.043	UM	0.29	UM	0.25	UM	0.45	UM	0.043
Endrin aldehyde	None	UM	0.055	UM	0.37	UM	0.32	UM	0.57	UM	0.055
Endrin ketone	None	UM	0.055	UM	0.37	UM	0.32	UM	0.57	UM	0.055
Heptachlor	59	UM	0.055	UM	0.37	UM	0.32	UM	0.57	UM	0.055
Heptachlor epoxide	70	UM	0.055	UM	0.37	UM	0.32	UM	0.57	UM	0.055
Methoxychlor	5,000	UM	0.16	UM	1.1	UM	0.92	UM	1.7	UM	0.16
Toxaphene	490	UM	9.4	UM	63	UM	54	UM	98	UM	9.4

Notes:
UM = Compound was analyzed but not detected
I = Value is between the laboratory MDL and the PQL

Only results for compounds detected at the Site are shown

*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.

V = Analyte was detected at or above the MDL in both the sample and the associated method blank and the value of 10 times the blank value was equal to or greater than the associated sample value
J3 = Estimated value; value may not be accurate. Spike recovery or RPD outside of criteria

Black cell = Result > Action Level
NA = No data available or not analyzed

TABLE 9 SUMMARY OF SOIL RESULTS - ORGANOPHOSPHOROUS PESTICIDES

	Site	Site 1 - Engineering & Maintenance						Site 3 - Grounds & Landscaping Chemical Storage Sheds											
	Sample Location ID	01-SD-02		01-SD-03		01-SD-04		03-SS-01		03-SS-02		03-SS-03		03-SS-04		03-SS-05		03-SS-06	
	Sample Date	2014-01-13		2014-01-13		2014-01-13		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
Organophosphorous Pesticides (Method 8141A)	**Action Level* (µg/kg)**																		
Bolstar	None	UM	24	UM	24	UM	8.6	UM	7.9	UM	7	UM	7.4	UM	8.7	UM	7.3	UM	7.4
Chlorpyrifos	6,300	UM	27	UM	27	UM	9.8	UM	9	UM	7.9	UM	8.4	UM	9.9	UM	8.3	UM	8.5
Coumaphos	None	UM	47	UM	48	UM	17	UM	16	UM	14	UM	15	UM	17	UM	14	UM	15
Diazinon	4,400	UM	54	UM	55	UM	20	UM	18	UM	16	UM	17	UM	20	UM	17	UM	17
Dichlorvos	1,900	UM	25	UM	25	UM	9	UM	8.3	UM	7.3	UM	7.7	UM	9.1	UM	7.6	UM	7.8
Disulfoton	250	UM	22	UM	23	UM	8.1	UM	7.5	UM	6.6	UM	7	UM	8.2	UM	6.9	UM	7
Ethoprop	None	UM	40	UM	40	UM	14	UM	13	UM	12	UM	12	UM	15	UM	12	UM	12
Fensulfothion	None	UM	40	UM	40	UM	14	UM	13	UM	12	UM	12	UM	15	UM	12	UM	12
Fenthion	None	UM	27	UM	28	UM	9.9	UM	9.1	UM	8.1	UM	8.5	UM	10	UM	8.4	UM	8.6
Methyl Parathion	1,600	UM	27	UM	28	UM	9.9	UM	9.1	UM	8.1	UM	8.2	UM	10	UM	8.4	UM	8.6
Mevinphos	None	UM	47	UM	48	UM	17	UM	16	UM	14	UM	15	UM	17	UM	14	UM	15
Phorate	1,300	UM	36	UM	37	UM	13	UM	12	UM	11	UM	11	UM	13	UM	11	UM	11
Ronnel	390,000	UM	27	UM	27	UM	9.7	UM	8.9	UM	7.8	UM	8.3	UM	9.8	UM	8.2	UM	8.3
Stirophos	None	UM	65	UM	66	UM	24	UM	22	UM	19	UM	20	UM	24	UM	20	UM	20
Terbutryn	200	UM	30	UM	30	UM	11	UM	10	UM	8.8	UM	9.3	UM	11	UM	9.2	UM	9.4
Tokuthion	None	UM	76	UM	77	UM	27	UM	25	UM	22	UM	24	UM	28	UM	23	UM	24
Dimethoate	14,000	UM	30	UM	30	UM	11	UM	9.9	UM	8.7	UM	9.2	UM	11	UM	9.1	UM	9.2
EPN	63	UM	29	UM	30	UM	11	UM	9.74	UM	8.6	UM	9.1	UM	11	UM	9	UM	9.1
Ethyl Parathion	38,000	UM	30	UM	31	UM	11	UM	10	UM	8.9	UM	9.4	UM	11	UM	9.3	UM	9.5
Malathion	130,000	UM	23	UM	23	UM	8.4	UM	7.7	I	9	UM	7.2	UM	8.5	UM	7.1		140
Sulfotepp	None	UM	24	UM	24	UM	8.6	UM	7.9	UM	7	UM	7.4	UM	8.7	UM	7.3	UM	7.4
Famphur	None	UM	31	UM	31	UM	11	UM	10	UM	9	UM	9.5	UM	11	UM	9.4	UM	9.6
Thionazin	None	UM	33	UM	34	UM	12	UM	11	UM	9.8	UM	10	UM	12	UM	10	UM	10

	Site	Site 7 - Debris Landfill									
	Sample Location ID	**07-SS-01**		**07-SS-02**		**07-SS-03**		**07-SS-04**		**07-SS-05 (07-SS-01 DUP)**	
	Sample Date	2014-01-15		2014-01-15		2014-01-15		2014-01-15		2014-01-15	
	Depth (ft bgs)	0-1.0		0-1.0		0-1.0		0-1.0		0-1.0	
Organophosphorous Pesticides (Method 8141A) (µg/kg)	**Action Level* (µg/kg)**										
Bolstar	None	UM	7.2	UM	9.7	UM	8.4	UM	7.6	UM	7.3
Chlorpyrifos	6,300	UM	8.2	UM	11	UM	9.5	UM	8.6	UM	8.2
Coumaphos	None	UM	14	UM	19	UM	17	UM	15	UM	14
Diazinon	4,400	UM	16	UM	22	UM	19	UM	17	UM	16
Dichlorvos	1,900	UM	7.6	UM	10	UM	8.8	UM	7.9	UM	7.6
Disulfoton	250	UM	6.8	UM	9.1	UM	7.9	UM	7.1	UM	6.8
Ethoprop	None	UM	12	UM	16	UM	14	UM	13	UM	12
Fensulfothion	None	UM	12	UM	16	UM	14	UM	13	UM	12
Fenthion	None	UM	8.3	UM	11	UM	9.7	UM	8.7	UM	8.3
Methyl Parathion	1,600	UM	8.3	UM	11	UM	9.7	UM	8.7	UM	8.3
Mevinphos	None	UM	14	UM	19	UM	17	UM	15	UM	14
Phorate	1,300	UM	11	UM	15	UM	13	UM	11	UM	11
Ronnel	390,000	UM	8.1	UM	11	UM	9.4	UM	8.5	UM	8.1
Stirophos	None	UM	20	UM	26	UM	23	UM	21	UM	20
Terbutryn	200	UM	9.1	UM	12	UM	11	UM	9.5	UM	9.1
Tokuthion	None	UM	23	UM	31	UM	27	UM	24	UM	23
Dimethoate	14,000	UM	9	UM	12	UM	10	UM	9.4	UM	9
EPN	63	UM	8.9	UM	12	UM	10	UM	9.3	UM	8.9
Ethyl Parathion	38,000	UM	9.2	UM	12	UM	11	UM	9.6	UM	9.2
Malathion	130,000	UM	7	UM	9.4	UM	8.1	UM	7.3	UM	7
Sulfotepp	None	UM	7.2	UM	9.7	UM	8.4	UM	7.6	UM	7.3
Famphur	None	UM	9.3	UM	13	UM	11	UM	9.7	UM	9.3
Thionazin	None	UM	10	UM	14	UM	12	UM	11	UM	10

Notes:
UM = Compound was analyzed but not detected
I = Value is between the laboratory MDL and the PQL

Only results for compounds detected at the Site are shown
*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.

V = Analyte was detected at or above the MDL in both the sample and the associated method blank and the value of 10 times the blank value was equal to or greater than the associated sample value

J3 = Estimated value; value may not be accurate. Spike recovery or RPD outside of criteria

Black cell = Result > Action Level

NA = No data available or not analyzed

TABLE 10 SUMMARY OF SOIL RESULTS - HERBICIDES

	Site	Site 1 - Engineering & Maintenance						Site 3 - Emerg Gen						Site 3 - Grounds & Landscaping Chemical Storage Sheds					
	Sample Location ID	01-SD-02		01-SD-03		01-SD-04		03-SS-01		03-SS-02		03-SS-03		03-SS-04		03-SS-05		03-SS-06	
	Sample Date	2014-01-13		2014-01-13		2014-01-13		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16		2014-01-16	
	Depth (ft bgs)	0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5		0-0.5	
Herbicides (Method 8151A) (µg/kg)	**Action Level* (µg/kg)**																		
2,4,5-T (Trichlorophenoxyacetic Acid, 2,4,5-)	63,000	UM	20	UM	8.2	UM	4.4	UM J3	4.1	UM	3.6	UM	3.9	UM	4.5	UM	3.8	UM J3	3.8
2,4-D (Dichlorophenoxy Acetic Acid, 2,4-)	70,000	UM	66	UM	27	UM	14	UM	13	UM	12	UM	12	UM	15	UM	12	UM	12
2,4-DB (Dichlorophenoxy)butyric Acid, 4-(2,4-))	190,000	UM	42	UM	17	UM	9.1	UM	8.4	UM	7.4	UM	7.9	UM	9.3	UM	7.8	UM	7.9
2,4,5-TP (Silvex)	110	UM	100	UM	41	UM	22	UM	20	UM	18	UM	19	UM	23	UM	19	UM	19
Dalapon	190,000	UM	430	UM	170	UM	92	UM	86	UM	75	UM	80	UM	94	UM	79	UM	80
Dicamba	190,000	UM	7.2	UM	2.9	UM	1.6	UM	1.4	UM	1.3	UM	1.4	UM	1.6	UM	1.3	UM	1.4
Dichlorprop	None	UM	20	UM	8	UM	4.3	UM	4	UM	3.5	UM	3.7	UM	4.4	UM	3.7	UM	3.7
Dinoseb	6,300	UM	26	UM	10	UM	5.6	UM	5.2	UM	4.5	UM	4.9	UM	5.7	UM	4.8	UM	4.8
MCPA	3,200	UM	5200	UM	2100	UM	1100	UM	1000	UM	910	UM	990	UM	1200	UM	960	UM	980
MCPP	6,300	UM	2400	UM	970	UM	520	UM	480	UM	420	UM	450	UM	530	UM	440	UM	450

Site		Site 7 - Debris Landfill									
Sample Location ID		07-SS-01		07-SS-02		07-SS-03		07-SS-04		07-SS-05 (07-SS-01 (DUP))	
	Sample Date	2014-01-15		2014-01-15		2014-01-15		2014-01-15		2014-01-15	
	Depth (ft bgs)	0-1.0		0-1.0		0-1.0		0-1.0		0-1.0	
Herbicides (Method 8151A) (µg/kg)	**Action Level* (µg/kg)**										
2,4,5-T (Trichlorophenoxyacetic Acid, 2,4,5-)	63,000	UM	3.8	UM	9.9	UM	8.6	UM	7.8	UM	7.4
2,4-D (Dichlorophenoxy Acetic Acid, 2,4-)	70,000	UM	12	UM	32	UM	28	UM	25	UM	24
2,4-DB (Dichlorophenoxy)butyric Acid, 4-(2,4-))	190,000	UM	7.7	UM	20	UM	18	UM	16	UM	15
2,4,5-TP (Silvex)	110	UM	19	UM	50	UM	43	UM	39	UM	37
Dalapon	190,000	UM	78	UM	210	UM	180	UM	160	UM	160
Dicamba	190,000	UM	1.3	UM	3.5	UM	3	UM	2.7	UM	2.6
Dichlorprop	None	UM	3.6	UM	9.6	UM	8.3	UM	7.5	UM	7.2
Dinoseb	6,300	UM	4.8	UM	13	UM	11	UM	9.8	UM	9.4
MCPA	3,200	UM	960	UM	2500	UM	2200	UM	2000	UM	1900
MCPP	6,300	UM	440	UM	1200	UM	1000	UM	910	UM	880

Notes:

UM = Compound was analyzed but not detected
I = Value is between the laboratory MDL and the PQL
V = Analyte was detected at or above the MDL in both the sample and the associated method blank and the value of 10 times the blank value was equal to or greater than the associated sample value

Only results for compounds detected at the Site are shown

*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.
Black cell = Result > Action Level
NA = No data available or not analyzed
J3 = Estimated value; value may not be accurate. Spike recovery or RPD outside of criteria

TABLE 11 SUMMARY OF GROUNDWATER RESULTS - METALS

	Sample Location ID	02-GW-01	
	Sample Date	2014-01-12	
	Depth (ft bgs)	5-7.5	
RCRA 8 Metals (Method 6010C)	**Action Level* (mg/L)**		
Lead	0.92	I	0.0043

Notes:

I = Value is between the laboratory MDL and the PQL
*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.

TABLE 11 SUMMARY OF GROUNDWATER RESULTS - VOCS

	Sample Location ID	**02-GW-01**	
	Sample Date	2014-01-12	
	Depth (ft bgs)	5-7.5	
VOC (Method 8260B)	**Action Level* (µg/L)**		
Benzene	0.46	I	**0.64**
Ethylbenzene	1.5		**49**
Toluene	2	I	0.72
Xylenes, Total	13	I	2

Notes:

I = Value is between the laboratory MDL and the PQL
*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.
Black cell = Result > Action Level

TABLE 13 SUMMARY OF GROUNDWATER RESULTS – PAHS

	Sample Location ID	02-GW-01	
	Sample Date	2014-01-12	
	Depth (ft bgs)	5-7.5	
SVOC (Method 8270D)	**Action Level* (µg/L)**		
Acenaphthene	6	I	0.91
Acenaphthylene	210	UM	0.17
Anthracene	0.012	I	**0.29**
Benzo(a)anthracene	0.018	UM	**0.18**
Benzo(a)pyrene	0.014	UM	**0.12**
Benzo(b)fluoranthene	0.050	UM	**0.15**
Benzo(ghi)perylene	8	UM	0.23
Benzo(k)fluoranthene	0.004	UM	**0.16**
Chrysene	0.002	UM	**0.19**
Dibenz(a,h)anthracene	None	UM	0.24
Fluoranthene	0.04	I	**0.68**
Fluorene	3	I	**6**
Indeno(1,2,3-cd)pyrene	0.05	UM	**0.22**
Naphthalene	0.12		**19**
Phenanthrene	0.40	I	**0.77**
Pyrene	0.025	I	**0.48**
1-Methylnaphthalene	1.1		**13**
2-Methylnaphthalene	3.6		**18**

Notes:
UM = Compound was analyzed but not detected
I = Value is between the laboratory MDL and the PQL
Only results for compounds detected at the Site are shown

*Action Levels lowest of Human Health and Ecological Screening Levels as described in report text.
Black cell = Result > Action Level

TABLE 14A SOIL SAMPLING LOCATIONS DETAILS

Sample ID	Location	Reason for Sampling
IA-1-01	Northern portion of gravel staging area above WWTP	Area historically used to store materials for disposal, including out-of-service mechanical equipment. Drums observed during 2016 RSE site visit (3E Consultants 2017).
IA-1-02	Southern portion of gravel staging area above WWTP	
IA-2-01	To the north and east of the of engineering & maintenance buildings.	Area historically used for equipment storage and maintenance. Level 2 investigation surface soil results exceed action levels for SVOCs and metals.
IA-2-02	To the north and west of the engineering warehouse.	
IA-2-03	To the east and northeast of the grounds and landscaping equipment maintenance building	Grass that may have been affected by runoff from maintenance area.
IA-2-04	To the south of the grounds and landscaping equipment maintenance building	Area historically used for landscaping chemical storage and equipment maintenance/storage. Soil staining observed in pole barn during 2016 RSE site visit (3E Consultants 2017). Level 2 investigation surface soil results exceed action levels for metals.
IA-2-05	Area around the diesel and gasoline ASTs, emergency generator building, and fuel pump	Area includes active diesel and gasoline ASTs, emergency generators, and fuel pumps. Multiple petroleum-related incidents reported in Level 1 assessment (Barksdale & Associates 2012). Level 2 investigation surface soil results exceed action levels for metals, TPH, and pesticides.
IA-3-01	Northern portion of debris landfill	Area historically used for disposal of "all types of wastes" from the resort (Barksdale & Associates 2014) and resort WWTP sludge (Barksdale & Associates 2012). Level 2 investigation surface soil results exceed action levels for metals, SVOCs, and pesticides.
IA-3-02	Southern portion of debris landfill	
IA-Ref-01	Reference area to south of WWTP	Area not believed to be contaminated by site activities. Area will be used to evaluate background concentrations.
IA-Ref-02	Reference area to the northeast of the debris landfill	Area not believed to be contaminated by site activities. Area will be used to evaluate background concentrations.

Sample ID	Location	Reason for Sampling
SC-03-01 through 10	Dependent on GPR and EMI findings, inside debris landfill waste and at boundaries	Area reported to be historical landfill. Samples may be in pits or on a grid pattern.
SC-Ref-01 though 03	Reference locations near debris landfill	Area not believed to be contaminated by site activities at similar elevation to debris landfill, and containing similar soil type as at landfill. If waste is encountered in a boring, the driller will abandon and move at least 10 feet away.
SC-Bldg-01 through 25	Discrete soil sample collected near dripline of a building that is representative of a single building or group of buildings similar in age and construction materials	Buildings constructed during the resort's operation may have been coated with lead-based paint. Paint chips and erosion can deposit lead in soils near the building, close to the dripline.

TABLE 14B GROUNDWATER SAMPLING LOCATIONS DETAILS

Sample ID	Location	Reason for Sampling
MW-1	Existing monitoring well to west of former UST	Proximity to former UST; presumed downgradient. Level 2 investigation groundwater results exceed action levels for VOCs and SVOCs.
MW-2-01	West of MW-1.	Presumed downgradient from MW-1 and MW-2-01.
MW-2-02	West of MW-1 and IA-2-02.	Presumed downgradient from MW-1 and IA-2-01/IA-2-02.
MW-2-03	Immediately northwest of fuel pump.	Proximity to fuel pump; presumed downgradient from IA-2-05 and emergency generator building.
MW-2-04	Northwest of MW-2-03.	Presumed downgradient from MW-2-03, IA-2-05, and fuel ASTs.
MW-3-01	Northwest of the debris landfill.	Presumed downgradient of the debris landfill.
MW-Ref-02	Northwestern corner of IA-Ref-02.	Presumed downgradient of IA-Ref-02. Sample will be used to evaluate background concentrations.

TABLE 15A SAMPLE TYPES AND TOTAL NUMBER OF CONTAINERS FOR SOIL

SAMPLE ID	MATRIX	DEPTH (fbgs)	TYPE	RCRA 8 and 13 PPL Metals	VOCs	Waste Char.	PCBs	SVOCs	Pesticides	pH (All Samples are Discrete)
Soil- ISM										
IA-1-01	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	0	3	3	1
IA-1-02	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	0	3	3	1
IA-2-01	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	0	3	3	1
IA-2-02	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	0	3	3	1
IA-2-03	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	0	3	3	1
IA-2-04	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	0	3	3	1
IA-2-05	Surface soil	0-0.5	ISM (Reps A to C)	3	3	0	0	3	3	1
IA-3-01	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	3	3	3	1
IA-3-02	Surface soil	0-0.5	ISM (Reps A to C); Mark B jar for MS/MSD	3	0	0	3	3	3	1
IA-Ref-01	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	3	3	3	1
IA-Ref-02	Surface soil	0-0.5	ISM (Reps A to C)	3	0	0	3	3	3	1
Total ISM containers				33	3	0	12	33	33	11

SAMPLE ID	MATRIX	DEPTH (fbgs)	TYPE	RCRA 8 and 13 PPL Metals	VOCs	Waste Char.*	PCBs	SVOCs	Pesticides	pH (all samples are Discrete)
Soil- Discrete										
SC-3-01	Soil core	0.5-3	Discrete, Mark for MS/MSD	1	1	0	1	1	1	1
SC-3-02	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-03	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-04	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-05	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-06	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-07	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-08	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-09	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-3-10	Soil core	0.5-3	Discrete	1	1	1	1	1	1	1
SC-101	Soil core	4-6	Discrete (Duplicate)	1	1	1	1	1	1	1
SC-Ref-01	Soil core	0.5-3	Discrete	1	1	0	1	1	1	1
SC-Ref-02	Soil core	0.5-3	Discrete	1	1	0	1	1	1	1
SC-Ref-03	Soil core	0.5-3	Discrete	1	1	0	1	1	1	1
SC-3-01	Soil core	4-6	Discrete, Mark for MS/MSD	1	1	0	1	1	1	1
SC-3-02	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-03	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-04	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-05	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-06	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-07	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-08	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-09	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-3-10	Soil core	4-6	Discrete	1	1	0	1	1	1	1

SAMPLE ID	MATRIX	DEPTH (fbgs)	TYPE	RCRA 8 and 13 PPL Metals	VOCs	Waste Char.*	PCBs	SVOCs	Pesticides	pH (all samples are Discrete)
SC-102 through SC-103	Soil core	4-6	Discrete (Duplicate)	2	2	0	2	2	2	2
SC-Ref-01	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-Ref-02	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-Ref-03	Soil core	4-6	Discrete	1	1	0	1	1	1	1
SC-Bldg-01 through SC-Bldg-25[2]	Discrete soil	0-0.5	Discrete (lead only), Mark 2 for MS/MSD	25	0	0	0	0	0	0
SC-Bldg-101	Discrete soil	0-0.5	Discrete (lead only)	1	0	0	0	0	0	0
SC-Bldg-102	Discrete soil	0-0.5	Discrete (lead only)	1	0	0	0	0	0	0
SC-104 through SC-106	Soil core	0-0.5	Discrete (lead only) (Duplicate)	3	0	0	0	0	0	0
Equipment blanks off sampling equipment	Water	None	Field QC	6	2	0	4	4	4	0
IDW-Soil	Soil	Container	Waste characterization	0	0	6	0	0	0	0
IDW-Water	Water	Container	Waste characterization	0	0	6	0	0	0	0
Total number of containers for discrete soil matrix, equipment blank water, soil IDW, and water IDW:				65	31	22	31	31	31	9

1 – Waste characterization samples will be analyzed by TCLP via EPA Method 1311 and analyzed using EPA Methods 6010 & 7470A for RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), and analytical methods specified above for TCLP-VOCs, TCLP-SVOCs, and TCLP-Pesticides. One sample per boring of waste from between 0.5 and 6 fbgs will be analyzed.

2 – SC-Bldg samples will be analyzed for lead only, not for all metals.

TABLE 15B SAMPLE TYPES AND TOTAL NUMBER OF CONTAINERS FOR GROUNDWATER

SAMPLE ID	MATRIX	DEPTH (fbs)	TYPE	13 PPL Metals	VOCs	PCBs	SVOCs	Pesticides
MW-1	Groundwater	Mid-screen	Low flow	1	1	0	1	1
MW-2-01	Groundwater	Mid-screen	Low flow	1	1	0	1	1
MW-2-02	Groundwater	Mid-screen	Low flow	1	1	0	1	1
MW-2-03	Groundwater	Mid-screen	Low flow	1	1	0	1	1
MW-2-04	Groundwater	Mid-screen	Low flow	1	1	0	1	1
MW-3-01	Groundwater	Mid-screen	Low flow	1	1	1	1	1
MW-Ref-01	Groundwater	Mid-screen	Low flow	1	1	0	1	1
MW-Ref-02	Groundwater	Mid-screen	Low flow	1	1	1	1	1
Field Duplicate: MW-103	Groundwater	Mid-screen	Field QC	1	1	0	1	1
Matrix Spike/Matrix Spike Duplicate/Matrix Dup at MW-3-01	Groundwater	Mid-screen	Lab QC (MS/MSD for organics & MS/MD for Metals)	1 [lab perform both MS & MD from one bottle]	2	2	2	2
Trip blank	Groundwater	N/A	Lab supplied	0	1	0	0	0
Total number of containers for groundwater matrix:				7	12	4	11	11

Notes: fbs = feet below surface QC = quality control
N/A = Not applicable

TABLE 16 PERSONNEL ROLES AND RESPONSIBILITIES

ORGANIZATION	PROJECT TITLE, NAME, AND CONTACT INFORMATION	RESPONSIBILITIES
National Park Service (NPS)	*Federal Government Lead* Kelly Kachurak kelly_kachurak@nps.gov	Approve changes to sampling and analysis plan (SAP) before implementation. Approve corrective actions for field work and/or laboratory work before implementation if actions will affect the data quality or usability. Review and approve the sampling report.
Department of the Interior (DOI)	*Legal Lead* Lois Wye lois_wye@sol.doi.gov	Provide an opinion on changes to the SAP, as necessary. Review and approve the sampling report.
VHB	*Cleanup Lead* Jonathan Ordway jordway@vhb.com	Discuss the need for corrective actions for field work and/or laboratory work with the Federal Government Lead and Legal Lead, as appropriate.
VHB	*Contractor Project Manager* Rhonda Kay rkay@vhb.com	Point of contact with NPS and DOI. Manage all project phases. Review daily reports and submit to the Federal Government Lead and Legal Lead. Determine the need for corrective action for laboratory issues in conjunction with the Laboratory Project Manager and Data Validator, as appropriate.
VHB	*Field Team Leader* Ben Deede bdeede@vhb.com	Prepare the and final sampling reports. Notify Cleanup Lead about minor changes to the SAP; prepare quality assurance project plan (QAPP) amendments for major changes. Lead the field work and document daily activities in field notes and a daily progress report. Maintain equipment calibration logs on-site. Notify Cleanup Lead where unforeseen circumstances require work stoppage and/or immediate corrective actions. Notify Cleanup Lead about the need for corrective action for field issues or analytical issues. Verify completeness of and file all field notes, daily progress reports, equipment calibration logs, chains of custody, shipping documents, corrective action forms,

ORGANIZATION	PROJECT TITLE, NAME, AND CONTACT INFORMATION	RESPONSIBILITIES
		laboratory reports, and other project-related correspondence electronically on the VHB server. Carry out corrective actions as directed by the Contractor Project Manager.
Eurofins TestAmerica, Inc.	*Laboratory Project Manager* Opal Johnson opaljohnson@testamericainc.com	Main point of contact at laboratory for all sample container ordering, shipping, sample receiving/logins, and chain of custody questions. Notify the Cleanup Lead of the need for corrective action for analytical issues. Provide the laboratory data package with electronic data deliverables within 4 weeks of sample receipt.
New Environmental Horizons, Inc. (NEH)	*Chemistry Quality Assurance Officer (QAO)/Data Validator* Susan Chapnick schapnick@neh-inc.com	Review project QAPP, field chain of custody and sample logins. Discuss the need for field or laboratory corrective action with the Cleanup Lead. Perform data validation, prepare the validation summary report, and approve the release of analytical data.

TABLE 17 STANDARD OPERATING PROCEDURES

TITLE, REVISION DATE AND/OR NUMBER	ORIGINATING ORGANIZATION[1]	MATRIX/ ANALYTICAL GROUP	EQUIPMENT TYPE	MODIFIED FOR PROJECT WORK?
Field SOPs				
SOP-JCO-007 Standard Operating Procedure for Chain of Custody Records, Rev 6/17	VHB	N/A	N/A	No
SOP-JCO-009 Standard Operating Procedure for Water Level Measurements, Rev. 12/99	VHB	N/A	Water level indicator	No
SOP-JCO-018 Standard Operating Procedure for Deviation from Protocols or Standard Operating Procedures and for Notation, Correction, and Documentation of Unforeseen Circumstances, Rev. 4/18	VHB	N/A	N/A	No
SOP-JCO-026 Standard Operating Procedure for Sampling of Organic and Inorganic Compounds, Rev. 4/18	VHB	N/A	N/A	No
SOP-JCO-027 Standard Operating Procedure for Decontamination of Field Equipment, Rev. 4/18	VHB	N/A	N/A	No
SOP-JCO-034 Standard Operating Procedure for Use of Field Log Books, Rev. 4/18	VHB	N/A	N/A	No
SOP-JCO-044 Standard Operating Procedure for Calibration and Operation of the MiniRAE 3000 Portable Handheld VOC Photo-Ionization Detector, Rev 9/13	VHB	N/A	PID	No
SOP-JCO-053 Standard Operating Procedure for Low Stress Groundwater Sampling of Monitoring Wells and Piezometers, Rev. 08/14	VHB	Groundwater	Pump	No

TITLE, REVISION DATE AND/OR NUMBER	ORIGINATING ORGANIZATION[1]	MATRIX/ ANALYTICAL GROUP	EQUIPMENT TYPE	MODIFIED FOR PROJECT WORK?
SOP-JCO-055 Standard Operating Procedure for Calibration and Use of the YSI Model 6210 XL, Rev. 09/12	VHB	Groundwater	YSI	No
Laboratory SOPs				
NC-OP-040: Soxhlet (Traditional) Extraction of Organic Compounds from Soils Based on Method SW846 3540C, Rev. 7, 6/09/20	Eurofins TestAmerica - Canton	Soil and GW / organics	N/A	No
NC-IP-010 Acid Digestion for Solid Samples, Rev. 9, 10/14/20	Eurofins TestAmerica-Canton	Soil / Metals	N/A	No - except for discrete soil Lead modify to 10-g
NC-IP-011 Acid Digestion for Aqueous Samples, Rev. 9, 04/30/20	Eurofins TestAmerica - Canton	TCLP Wastes / Metals except Mercury	N/A	No
NC-MS-018 GC/MS Analysis based on Methods 8270C, 8270D, and 8270E Rev. 8, 07/02/19	Eurofins TestAmerica - Canton	Soil / SVOCs	Gas Chromatograph/ Mass Spectrometer (GC/MS)	No
NC-MS-019 Determination of Volatile Organics by GC/MS based on Methods 8260A, 8260B, 8260C, and 8260D, Rev. 7, 6/25/19	Eurofins TestAmerica-Canton	Soil / VOCs	GC/MS	No
NC-MT-002 Inductively Coupled Plasma – Mass Spectrometry, Rev. 12, 12/07/20	Eurofins TestAmerica - Canton	Soil / all metals except Mercury	Inductively Coupled Plasma Mass Spectrometer (ICP-MS)	No
NC-MT-012 Inductively Coupled Plasma – Atomic Emission Spectroscopy, Spectrometric Method for Element Analysis, Rev. 12, 12/07/20	Eurofins TestAmerica - Canton	TCLP Wastes, Discrete Lead Soil / Metals except Mercury	Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES)	No

TITLE, REVISION DATE AND/OR NUMBER	ORIGINATING ORGANIZATION[1]	MATRIX/ ANALYTICAL GROUP	EQUIPMENT TYPE	MODIFIED FOR PROJECT WORK?
NC-MT-014 Preparation and Analysis of Mercury in Aqueous and Solid Samples by Cold Vapor Atomic Absorption Spectroscopy, Rev. 11, 12/07/20	Eurofins TestAmerica - Canton	Soil, TCLP Wastes/ Mercury	Cold Vapor Atomic Absorption Spectrophotometer (CVAA)	No
NC-OP-033 Toxicity Characteristic Leaching Procedure and Synthetic Precipitation Leaching Procedure, Rev. 8, 04/28/20	Eurofins TestAmerica - Canton	Soil/1311 (TCLP)	N/A	No
NC-OP-044 Soil Processing, Method: ASTM D6323-12, ITRC Guidance Document, Soil Fractionation Method for Michigan, Rev. 4, 1/13/21	Eurofins TestAmerica – Canton	Soil ISM	N/A	No
NC-OP-046 Subsampling, Method: ASTM D6323-12, Rev. 3, 6/18/19	Eurofins TestAmerica – Canton	Soil ISM	N/A	No
NC-WC-010 pH Electrometric Method, 7/30/19, Rev. 16	Eurofins TestAmerica – Canton	Soil / pH	Electrode	No
NC-GC-042 Gas Chromatographic Analysis of Pesticides Based on Methods 8081A and 8081B, Rev. 3, 10/29/20	Eurofins TestAmerica – Canton	Soil / Pesticides	Gas chromatograph with electron capture detector (GC-ECD)	No
NC-GC-045 Gas Chromatographic Analysis of PCBs Based on Methods 8082 and 8082A, Rev. 3, 8/31/20	Eurofins TestAmerica – Canton	Soil / PCB Aroclors	GC-ECD	No
PT-GC-005 Polychlorinated Biphenyls (PCBs) and PCBs as Congeners by GC/ECD, Rev. 12, 5/19/20	Eurofins TestAmerica - Pittsburgh	GW / PCBs	GC-ECD	No
PT-GC-006, Chlorinated Pesticides, Rev. 10, 8/16/19	Eurofins TestAmerica - Pittsburgh	GW / Pesticides	GC-ECD	No
PT-OP-001 Extraction of Organic Compounds from Waters, Rev. 21, 11/5/20	Eurofins TestAmerica - Pittsburgh	GW/ Organic compounds	N/A	No

TITLE, REVISION DATE AND/OR NUMBER	ORIGINATING ORGANIZATION[1]	MATRIX/ ANALYTICAL GROUP	EQUIPMENT TYPE	MODIFIED FOR PROJECT WORK?
T-MET-WI11933 Metals by Inductively Coupled Plasma Mass Spectrometry for SW-846 Methods 6020/ 6020A/ 6020B (aqueous, solid, tissue) and EPA 200.8 (Aqueous), Rev. 11,11/12/2020	Eurofins TestAmerica – Lancaster	GW / Metals except Mercury	ICP-MS	No
T-MET-WI11937 Sample Preparation of Leachates and Other Wastewater for Analysis of Total Metals by Inductively Coupled Plasma-Mass Spectrometer, Rev. 12, 01/19/2020	Eurofins TestAmerica – Lancaster	Water / Metals except Mercury	N/A	No
T-MET-WI7965 Mercury in Aqueous, Solid and Tissue Samples by EPA 7471A, 7471B, 7470A, and 245.1 Rev. 3,11/30/2020 by Cold Vapor AA	Eurofins TestAmerica – Lancaster	GW/ Mercury	CVAA	No
T-OE-SVOA-WI11432 Separatory Funnel Extraction by Method 3510C for BNAs in Wastewater, Rev. 17, 10/31/2020	Eurofins TestAmerica – Lancaster	GW/ SVOCs	N/A	No
T-SVOA- WI0005 Semi-Volatiles in Waters and Soils by Methods 8270C/D/E SIM and 625.1 SIM by GC/MS, Rev. 18, 07/07/2020	Eurofins TestAmerica – Lancaster	GW/ SVOCs	GC-MS-SIM	No
T-SVOA-WI9617 Semi-Volatile Organic Compounds by Method 8270D/E in Aqueous and Non-Aqueous Matrices using GC-MS, Rev. 12, 06/10/2020	Eurofins TestAmerica - Lancaster	GW/ SVOCs	GC-MS	No
T-VOA-WI8194 VOCs and GRO by GC/MS in Waters and Wastewaters by EPA 8260C/D, Rev. 9, 03/25/2020	Eurofins TestAmerica – Lancaster	GW/ VOCs	GC/MS	No

Notes

The cited Standard Operating Procedures (SOPs) are to be used for field work performed during this project. SOPs are proprietary, prepared for internal use only, and are not for distribution.

SM – Standard Methods for the Examination of Water and Wastewater, 23rd Ed., 2017.

EPA Methods reference: Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium (SW-846), Update V, Revision 8, July 2014.

ISM Processing Notes:

1. Non-soil and non-sediment debris, such as plant matter, rocks, shells of organisms, etc., should be removed by the field team and/or the lab before ISM preparation. If standing water is present in the sample upon receipt at the lab, the lab will fully homogenize the sample before ISM preparation. The lab should not decant or remove standing water.
2. Sample may be air-dried to remove moisture and facilitate sieving.
3. Milling is not recommended for organic contaminants and should not be performed for this project.
4. The lab will sieve the sample; generally, to <2mm particle size (#10 sieve) to exclude gravel and other large particles that may not have been removed in the field.
5. Multi-incremental sub-sampling, using the 2-D slabcake method as described in the ISM guidance section 6.2.2.7, will be performed to obtain the sub-samples for chemical preparation/extraction and analysis.

Discrete Soil Samples for Lead:

1. The lab will modify sample preparation to use 10-g initial weight rather than 1-g. Lab to modify amounts of digestion acids as proportionally appropriate. This modification is to improve sample data representativeness for lead in soil that may be heterogeneously distributed from/in lead paint chips.
2. Sample-specific LOQ for lead must be adjusted for the modified initial sample weight and reported, as for other soils, on a dry-weight basis.

All Soils – report on dry-weight basis.

TABLE 18 SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

ANALYTE/ANALYTE GROUP *	MATRIX	METHOD/(LABORATORY SOP[1])	CONTAINER(S) (NUMBER, SIZE & TYPE PER SAMPLE)	PRESERVATION	HOLDING TIME	DATA PACKAGE TURNAROUND
VOCs	Surface Soil ISM	8260C	8 x 60mL VOA-vials; 5 soil increments of 5 g each per vial	Methanol (MeOH)-preserved; soil:MeOH at 5g:5mL; ≤6 °C	14 days	3 weeks
Metals	Surface Soil ISM	6020A all Metals except Mercury 7471B Mercury	32-ounce (oz) glass or 1 gallon Ziploc bag for all analyses (1Kg sample size)	≤6 °C	180 days all Metals except Mercury; 28 days Mercury	3 weeks
PCB Aroclors	Surface Soil ISM	8082A			14 days / 40 days after extraction	3 weeks
SVOCs (PAHs)	Surface Soil ISM	8270D			14 days / 40 days after extraction	3 weeks
Organochlorine Pesticides	Surface Soil ISM	8081B			14 days / 40 days after extraction	3 weeks
pH	Surface & Subsurface Soil Discrete	9045D	4-oz glass	≤6 °C	ASAP	2 weeks

ANALYTE/ANALYTE GROUP *	MATRIX	METHOD/(LABORATORY SOP[1])	CONTAINER(S) (NUMBER, SIZE & TYPE PER SAMPLE)	PRESERVATION	HOLDING TIME	DATA PACKAGE TURNAROUND
VOCs	Soil – Discrete	8260C	2 @ 40-mL VOA vial with teflon-lined septa	1 unpreserved; 1 MeOH-preserved; soil:MeOH at 5g:5mL; ≤6 °C	14 days	3 weeks
PCB Aroclors SVOCs (PAHs) Pesticides	Soil – Discrete	8082A 8270D 8081B	8-oz glass	≤6 °C	14 days / 40 days after extraction	3 weeks
Metals	Soil – Discrete	6020A all Metals except Mercury 7471B Mercury	4-oz glass	≤6 °C	180 days all Metals except Mercury; 28 days Mercury	3 weeks
Lead	Soil – Discrete	6010C or 6020B	4-oz glass	≤6 °C	180 days	3 weeks
TCLP VOCs	IDW-Soil	1311 (TCLP), 8260C	4-oz glass jar filled with no headspace	≤6 °C	14 days	2 weeks
TCLP PAHs TCLP Metals TCLP Pesticides	IDW-Soil	1311 (TCLP), 8270, 6010C, 7470A, 8081B	8 oz glass	≤6 °C	N/A	2 weeks
VOCs	Groundwater & IDW-Water	8260C	3 @ 40 mL VOA vials	HCl to pH <2, ≤6 °C	14 days	2 weeks

ANALYTE/ANALYTE GROUP *	MATRIX	METHOD/(LABORATORY SOP[1])	CONTAINER(S) (NUMBER, SIZE & TYPE PER SAMPLE)	PRESERVATION	HOLDING TIME	DATA PACKAGE TURNAROUND
SVOCs	Groundwater & IDW-Water	8270D	2 @ 250 mL amber glass	≤6 °C	7 days/ 40 days after extraction	2 weeks
Metals	Groundwater & IDW-Water	6020B, 7470A	250 mL plastic	HNO_3 to pH <2, ≤6 °C	180 days for all Metals except Mercury; Mercury 28 days	2 weeks
Organochlorine Pesticides	Groundwater	8081B	2 @ 1 liter	≤6 °C	7 days / 40 days after extraction	2 weeks
PCBs	Groundwater	8082A	2 @ 1 liter	≤6 °C	40 days after extraction	2 weeks

Notes:
* = Laboratory accreditation expiration dates will be provided in each data package received. Accreditation certifications will be updated throughout the project.
[1] Laboratory SOPs are listed in Table 4. °C = degrees Celsius SOP = Laboratory standard operating procedure

Laboratory Information: TestAmerica-North Canton, 4101 Shuffel Street, NW, North Canton, OH 44720
Contact: Opal Johnson, Opal.Johnson@testamericainc.com, (330) 966-9279

TABLE 19 LABORATORY QUALITY CONTROL AND DATA VALIDATION CRITERIA

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA[1]
Matrix: All	Analytical Group: Metals (EPA Methods 6020B, 7470A, 7471B)				
Method Blank (MB)	Reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis.	One per sample preparation batch of up to 20 samples.	MB Target analytes < LOQ	Re-preparation and re-analysis of all samples associated with an unacceptable MB is required when reportable concentrations are determined in the samples.	Target analytes < LOQ. Associated sample results detected < MB levels may be negated (U) due to blank action.
Laboratory Control Sample (LCS)	Known value standard from a source other than the calibration standards. LCS must be matrix-matched, contain all analytes of interest and must be carried through the entire analytical procedure.	One per sample preparation batch up to 20 samples.	Aqueous Recovery within 80 – 120%; RPD ≤ 20%. Solid: Recovery within vendor control limits for solid SRM; RPD ≤ 20%.	Re-preparation and re-analysis of the batch.	Recovery 80-120% or vendor control limits for solid SRM; RPD ≤ 20%

[1] Data validation (DV) criteria are based on the USEPA *National Functional Guidelines for Inorganic Superfund Methods Data Review*, Office of Superfund Remediation and Technology Innovation (OSRTI), USEPA, OLEM 9355.0-135, USEPA-540-R-2017-001, January 2017 (NFG). For validation purposes, it is assumed the laboratory will perform calibration, maintenance and corrective actions per the specified method and laboratory method-specific SOPs. Professional judgement may be used during data validation, as allowed by the NFG, to take alternate DV actions based on cumulative QA/QC issues.

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA[1]
Matrix Spike & Matrix Duplicate ("MS" or "MD")	An MS is a field sample to which known concentrations of target analytes have been added. An MD or lab duplicate is a second aliquot of the same sample prepared and analyzed along with the sample and MS. The MS/MD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.	One MS/MD pair must be processed for every 20 samples of the same matrix.	MS recovery 75-125% except if the sample concentration is > 4x the spike level (spike swamped out) MD RPD ≤ 20%	Analyst shall determine if the MS is spiked properly. Recovery < 30%: re-digest and re-analyze associated sample(s). Otherwise, if LCS/LCSD is in-control, lab qualify data or narrate.	MS recovery 75-125% Soil sample/MD RPD ≤ 35% GW RPD ≤ 20%
Serial Dilution	Performed to determine whether significant physical or chemical interferences exist due to the sample matrix. Test is performed by running a sample at 5X analytical dilution.	One sample per batch up to 20 samples only required if MS recovery is outside control limits.	% difference ≤ 10% for samples concentration 50x the MDL.	Lab qualify data or narrate.	Soil: % difference ≤15% GW: % difference ≤10%
Field Duplicate (FD)	A FD will be collected as a duplicate discrete sample with a unique sample identification as a measure of precision and representativeness of the field collection process	One FD per 10 discrete samples	Soil: RPD ≤ 50% GW: RPD ≤ 30%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	Soil: RPD ≤ 50% GW: RPD ≤ 30% RPD criteria for results > 2 x LOQ; otherwise use professional judgment
Equipment Blank (EB)	Measure of potential field contamination	One per 20 samples	EB Targets< LOQ	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	EB Targets< LOQ

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA[1]
ISM Replicates A, B, C	Replicate ISM samples will be collected with a minimum of 40 increments each and a total of approximately 1Kg sediment each replicate to assess overall precision and representativeness of ISM sample results.	3 replicates to be collected / analyzed in each Decision Unit	RSD ≤ 50%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	RSD ≤ 50% for results > 2 x LOQ; otherwise use professional judgment

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix: All	Analytical Group: Organochlorine Pesticides (EPA 8081B)				
Method Blank (MB)	Reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis.	One per sample preparation batch of up to 20 samples.	MB Target analytes < LOQ	Re-preparation and re-analysis of all samples associated with an unacceptable MB is required when reportable concentrations are determined in the samples.	Target analytes < LOQ. Associated sample results detected < MB levels may be negated (U) due to blank action.
Laboratory Control Sample (LCS)	Known value standard from a source other than the calibration standards. LCS must contain all analytes of interest and must be carried through the entire analytical procedure.	One per sample preparation batch up to 20 samples.	Recovery within laboratory control limits and >10%; RPD ≤ 30%	If %Rec < 10%, Re-prepare and re-analyze the entire QC batch. Otherwise narrate issue.	Recovery within laboratory control limits and >10%, RPD ≤ 30%
Endrin/DDT Breakdown evaluation	To verify the accuracy for reporting of Endrin, Endrin Aldehyde, Endrin Ketone, 4,4′-DDT, 4,4′-DDE, and 4,4′-DDD	Daily prior to ICV or CCV and sample analyses	Breakdown ≤15% for Endrin and 4,4′-DDT	See SOP – perform maintenance on the GC injection system and column and then re-evaluate breakdown	Breakdown ≤ 15% for Endrin and 4,4′-DDT
Surrogates	Tetrachloro-m-xylene (TCMX) and Decachlorobiphenyl (DCB) used to assess accuracy in the matrices	Added to each sample and QC (MS/MD, LCS, MB) prior to extraction	Recovery 30-150% on both GC Columns	No action required if TMX and DCB are acceptable on one of the GC Columns or if dilution has caused the surrogates to be "diluted out". Otherwise, re-analyze or re-extract and re-analyze, if possible. Narrate issues if re-extraction and re-analysis not possible.	Lab limits; to be checked if recovery outside 30-150%

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix Spike & Matrix Duplicate ("MS" or "MD")	A MS is a field sample to which known concentrations of target analytes have been added. An MD or lab duplicate is a second aliquot of the same sample prepared and analyzed along with the sample and MS. The MS/MD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.	One MS/MD pair must be processed for every 20 samples of the same matrix.	Recovery within laboratory control limits and > 10%, Sample/MD RPD ≤ 30%	Recovery < 10%: re-prepare and re-analyze unspiked sample and MS/D, if possible. Otherwise, if LCS/LCSD is in-control, narrate issue	Recovery within laboratory control limits and > 10%, RPD ≤ 30%
Dual Column Precision	Evaluates accuracy for reporting of results.	Every detected result	RPD ≤ 40% for a detect between the 2 GC Columns	If RPD > 100%, dilute the extract and re-analyze. Qualify sample results appropriately (e.g., add "P" or "IP" to data) and narrate issue.	RPD ≤ 40%
Field Duplicate (FD)	A FD will be collected as a duplicate discrete sample with a unique sample identification as a measure of precision and representativeness of the field collection process	One FD per 10 discrete samples	Soil: RPD ≤ 50% GW: RPD ≤ 30%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	Soil: RPD ≤ 50% GW: RPD ≤ 30% RPD criteria for results > 2 x LOQ; otherwise use professional judgment
Equipment Blank (EB)	Measure of potential field contamination	One per 20 samples	EB Targets < LOQ	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	EB Targets < LOQ

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
ISM Replicates A, B, C	Replicate ISM samples will be collected with a minimum of 40 increments each and a total of approximately 1Kg sediment each replicate to assess overall precision and representativeness of ISM sample results.	3 replicates to be collected / analyzed in each Decision Unit	RSD ≤ 50%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	RSD ≤ 50% for results > 2 x LOQ; otherwise use professional judgment

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix: All	Analytical Group: PCB Aroclors (EPA 8082A)				
Method Blank (MB)	Reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis.	One per sample preparation batch of up to 20 samples.	MB Target analytes < LOQ	Re-preparation and re-analysis of all samples associated with an unacceptable MB is required when reportable concentrations are determined in the samples.	Target analytes < LOQ. Associated sample results detected < MB levels may be negated (U) due to blank action.
Laboratory Control Sample (LCS)	Known value standard from a source other than the calibration standards. LCS must contain all analytes of interest and must be carried through the entire analytical procedure.	One per sample preparation batch up to 20 samples.	Recovery within laboratory control limits and >10%; RPD ≤ 30%	Re-preparation and re-analysis of the entire QC batch.	Recovery within laboratory control limits and > 10%; RPD ≤ 30%
Surrogates	Tetrachloro-m-xylene (TCMX) and Decachlorobiphenyl (DCB) used to assess accuracy in the matrices	Added to each sample and QC (MS/MD, LCS, MB) prior to extraction	Recovery 30-150% on both GC Columns	No action required if TMX and DCB are acceptable on one of the GC Columns or if dilution has caused the surrogates to be "diluted out". Otherwise, re-analyze or re-extract and re-analyze, if possible. Narrate issues if re-extraction and re-analysis not possible.	Lab limits; to be checked if recovery outside 30-150%

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix Spike & Matrix Duplicate ("MS" or "MD")	An MS is a field sample to which known concentrations of target analytes have been added. An MD or lab duplicate is a second aliquot of the same sample prepared and analyzed along with the sample and MS. The MS/MD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.	One MS/MD pair must be processed for every 20 samples of the same matrix.	Recovery within laboratory control limits and > 10%, Sample/MD RPD ≤ 30%	Recovery < 10%: re-prepare and re-analyze unspiked sample and MS/MD, if possible, Otherwise, if LCS/LCSD is in-control, narrate issue.	Recovery within laboratory control limits and > 10%,, Sample/MD RPD ≤ 30%
Dual Column Precision	Evaluates accuracy for reporting of results.	Every detected result	RPD ≤ 40% for a detect between the 2 GC Columns	If RPD > 200%, dilute the extract and re-analyze. Qualify sample results appropriately (e.g., add "P" or "IP" to data) and narrate issue.	RPD ≤ 40%
Field Duplicate (FD)	A FD will be collected as a duplicate discrete sample with a unique sample identification as a measure of precision and representativeness of the field collection process	One FD per 10 discrete samples	Soil: RPD ≤ 50% GW: RPD ≤ 30%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	Soil: RPD ≤ 50% GW: RPD ≤ 30% RPD criteria for results > 2 x LOQ; otherwise use professional judgment
Equipment Blank (EB)	Measure of potential field contamination	One per 20 samples	EB Targets< LOQ	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	EB Targets< LOQ

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
ISM Replicates A, B, C	Replicate ISM samples will be collected with a minimum of 40 increments each and a total of approximately 1Kg sediment each replicate to assess overall precision and representativeness of ISM sample results.	3 replicates to be collected / analyzed in each Decision Unit	RSD ≤ 50%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	RSD ≤ 50% for results > 2 x LOQ; otherwise use professional judgment

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix: All	Analytical Group: VOCs (EPA 8260C)				
Method Blank (MB)	Reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis.	One per sample preparation batch of up to 20 samples.	MB Target analytes < LOQ	Re-analyze all samples associated with an unacceptable MB when reportable concentrations are determined in the samples.	Target analytes < LOQ. Associated sample results detected < MB levels may be negated (U) due to blank action.
Laboratory Control Sample (LCS)/LCS Duplicate (LCSD) (if performed)	Known value standard from a source other than the calibration standards. LCS must contain all analytes of interest and must be carried through the entire analytical procedure.	One per sample preparation batch up to 20 samples.	Recovery within 70 – 130%; RPD ≤ 20% (waters) and RPD ≤ 30% (soils).	Re- analyze entire QC batch.	Lab limits; check if recovery 70-130%; RPD ≤ 20% (waters) and RPD ≤ 30% (soils).
Surrogates	Minimum of 3 surrogates (VOC compounds that are not found in nature like Toluene-d8) added to every sample to evaluate the accuracy of the analysis	Added to each sample and QC (MS/MD, LCS/LCSD, MB) prior to analysis	Recovery 70-130%	If recovery < 70%, re-analyze sample, if possible. Narrate issues if re-analysis not possible	Recovery: 70-130%

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix Spike & Matrix Duplicate ("MS" or "MD")	An MS is a field sample to which known concentrations of target analytes have been added. An MD or lab duplicate is a second aliquot of the same sample prepared and analyzed along with the sample and MS. The MS/MD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.	One MS/MD pair must be processed for every 20 samples of the same matrix.	MS recovery 70-130% except if the sample concentration is > 4x the spike level (spike swamped out) Sample/MD RPD ≤ 20% (waters) and RPD ≤ 35% (soils)	Recovery < 10%: re-analyze sample and MS/ MD, if possible. Otherwise, if LCS/LCSD is in-control, narrate issue.	MS recovery 70-130% Sample/MD RPD ≤ 20% (waters) and RPD ≤ 35% (soils)%
Field Duplicate (FD)	A FD will be collected as a duplicate discrete sample with a unique sample identification as a measure of precision and representativeness of the field collection process	One FD per 10 discrete samples	Soil: RPD ≤ 50% GW: RPD ≤ 30%,	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	Soil: RPD ≤ 50% GW: RPD ≤ 30% RPD criteria for results > 2 x LOQ; otherwise use professional judgment
Equipment Blank (EB)	Measure of potential field contamination	One per 20 samples	EB Targets< LOQ	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	EB Targets < LOQ
ISM Replicates A, B, C	Replicate ISM samples will be collected with a minimum of 40 increments each and a total of approximately 1Kg sediment each replicate to assess overall precision and representativeness of ISM sample results.	3 replicates to be collected / analyzed in each Decision Unit	RSD ≤ 50%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	RSD ≤ 50% for results > 2 x LOQ; otherwise use professional judgment

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix: All	Analytical Group: PAHs (SVOC EPA Method 8270D)				
Method Blank (MB)	Reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis.	One per sample preparation batch of up to 20 samples.	MB Target analytes < LOQ	Re-preparation and re-analysis of all samples associated with an unacceptable MB is required when reportable concentrations are determined in the samples.	Target analytes < LOQ. Associated sample results detected < MB levels may be negated (U) due to blank action.
Laboratory Control Sample (LCS)/LCS Duplicate (LCSD) (if performed)	Known value standard from a source other than the calibration standards. LCS must contain all analytes of interest and must be carried through the entire analytical procedure.	One per sample preparation batch up to 20 samples.	Recovery within 40 – 140%; RPD ≤ 20%.	Re-preparation and re-analysis of the entire QC batch.	Recovery 40-140%; RPD ≤ 20%
Surrogates	Minimum of 3 surrogates (BN compounds that are not found in nature like Nitrobenzene-d5) added to every sample to evaluate the accuracy of the extraction and analysis	Added to each sample and QC (MS/MD, LCS/LCSD, MB) prior to extraction	Recovery 30-130%	If recovery < 30%, re-analyze or re-extract and re-analyze sample, if possible. Narrate issues if re-analysis not possible.	Recovery: 30-130%

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix Spike & Matrix Duplicate ("MS" or "MD")	An MS is a field sample to which known concentrations of target analytes have been added. An MD or lab duplicate is a second aliquot of the same sample prepared and analyzed along with the sample and MS. The MS/MD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.	One MS/MD pair must be processed for every 20 samples of the same matrix.	MS recovery 40-140% except if the sample concentration is > 4x the spike level (spike swamped out); RPD ≤ 20% (waters) and RPD ≤ 35% (soils)	Recovery < 10%: re-analyze or re-extract-reanalysis sample and MS/MD, if possible. Otherwise, if LCS/LCSD is in-control, narrate issue.	MS recovery 40-140% RPD ≤ 20% (waters) and RPD ≤ 35% (soils)
Field Duplicate (FD)	A FD will be collected as a duplicate discrete sample with a unique sample identification as a measure of precision and representativeness of the field collection process	One FD per 10 discrete samples	Soil: RPD ≤ 50% GW: RPD ≤ 30%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	Soil: RPD ≤ 50% GW: RPD ≤ 30% RPD criteria for results > 2 x LOQ; otherwise use professional judgment
Equipment Blank (EB)	Measure of potential field contamination	One per 20 samples	EB Targets < LOQ	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	EB Targets < LOQ
ISM Replicates A, B, C	Replicate ISM samples will be collected with a minimum of 40 increments each and a total of approximately 1Kg sediment each replicate to assess overall precision and representativeness of ISM sample results.	3 replicates to be collected / analyzed in each Decision Unit	RSD ≤ 50%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	RSD ≤ 50% for results > 2 x LOQ; otherwise use professional judgment

QUALITY CONTROL CHECK	EXPLANATION	RUN FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	DATA VALIDATION CRITERIA
Matrix: Sediment	Analytical Group: pH (EPA 9045D)				
Laboratory Control Samples (LCS) – pH 7 standard	Known value pH 7 standard reference material (SRM) to verify accuracy of probe/meter initial calibration.	Daily at beginning of sample analysis and every 10 samples	± 3% of true value for SRM	Re-analysis of field samples	± 3% of true value for SRM
Matrix Duplicate (MD)	An MD or lab duplicate is a second aliquot of the same sample prepared and analyzed along with the parent sample. The MD results are used to determine the effect of a matrix on the precision of the analytical process.	One MD must be processed for every 20 samples of the same matrix.	RPD ≤ 10%	Re-prepare and re-analyze. If still out, narrate noncompliance and lab qualify data.	RPD ≤ 10%
Field Duplicate (FD)	A FD will be collected as a duplicate discrete sample with a unique sample identification as a measure of precision and representativeness of the field collection process	One FD per 10 discrete samples	Soil: RPD ≤ 15% GW: RPD ≤ 10%	No lab corrective action unless reanalysis requested by project manager. Potential data usability issue.	Soil: RPD ≤ 15% GW: RPD ≤ 10%

TABLE 20 LABORATORY DATA DELIVERABLES

RECORD	Metals	VOCs, SVOCs, PCBs, Pesticides, and Herbicides	pH, Percent Solids
Narrative	x	x	x
Chain of custody	x	x	x
Sample Receipt Report	x	x	x
Summary results	x	x	x
Quality control (QC) summary results	x	x	x
Chromatograms/Spectra	N/A	x	N/A
Instrument raw data (all calibration reports, QC sample raw data, sample raw data for all analyses including dilutions and re-analyses, and preparation/extraction information)	x	x	x
Laboratory bench sheets/logs (all bench sheets must be included)	x	x	x
Electronic data deliverables	x	x	x

TABLE 21 DATA VERIFICATION PROCEDURES

ITEM/DESCRIPTION	VERIFICATION (COMPLETENESS)	VALIDATION (CONFORMANCE TO SPECIFICATIONS)
Planning Documents/Records		
1. Approved quality assurance project plan (QAPP)	x	
2. Contract	x	
3. Field standard operating procedures (SOPs)	x	
4. Laboratory SOPs	x	
Field Records		
5. Field logbooks	x	x
6. Equipment calibration records	x	x
7. Chain-of-custody forms	x	x
8. Sampling diagrams/surveys	x	x
9. Sediment description logs	x	x
10. Relevant correspondence	x	x
11. Deviations	x	x
12. Field corrective action reports	x	x
Analytical Data Package		
13. Cover sheet (laboratory identifying information)	x	x
14. Case narrative	x	x
15. Inter-laboratory chain-of-custody documents	x	x
16. Sample receipt records	x	x
17. Sample chronology (i.e., dates and times of receipt, prep, analysis)	x	x
18. Laboratory bench sheets and instrument logs	x	x
19. LOD/LOQ establishment and verification	x	x

ITEM/DESCRIPTION	VERIFICATION (COMPLETENESS)	VALIDATION (CONFORMANCE TO SPECIFICATIONS)
20. Standards traceability	x	x
21. Instrument calibration records	x	x
22. Definition of laboratory qualifiers	x	x
23. Results reporting forms	x	x

TABLE 22 DATA VALIDATION PROCEDURES

Data validator: New Environmental Horizons, Inc. (NEH)

Summary: All received data packages will be verified externally. Third-party validation will be performed by NEH according to the data validation procedures specified in the EPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use, USEPA National Functional Guidelines for Inorganic Superfund Methods Data Review, Office of Superfund Remediation and Technology Innovation (OSRTI), USEPA, OLEM 9355.0-135, USEPA-540-R-2017-001, January 2017 (NFG), the analytical methods, and the DQOs defined in this SAP/QAPP. Professional judgment will be applied as necessary and appropriate. Stage 3 validation will be conducted for the first SDG for ISM Soils for Metals, SVOCs, VOCs, PCB Aroclors, and Pesticides. For the remaining SDGs, a modified Stage 2B validation will be conducted (including calibration data but not including calculation checks). Stage 2B validation will be performed for all soil pH results.

Analytical Group/Method:	Metals, SVOCs, VOCs, PCB Aroclors, Pesticides, pH
Data deliverable requirements:	Table 20 (full lab data report as bookmarked pdf file and electronic data deliverable [EDD])
Analytical specifications:	Equipment calibration in standard operating procedures (SOPs) Table 18; Lab QA/QC & Measurement Performance Criteria (MPV) Table 19; LOQs Tables 1 & 2
Percent of data packages to be validated:	100
Measurement performance criteria (MPC):	Laboratory SOPs and Tables 1, 2, and 19
Percent of raw data reviewed:	Spot check of raw data for first data package
Percent of results to be recalculated:	One sample result and reporting level for first data package
Validation procedure:	Reference method and criteria presented in SOPs and Table 8. National Functional Guidelines may be consulted.
Validation code*:	S3VM for first SDG for Soil for Metals, SVOCs, VOCs, PCB Aroclors, and Pesticides; S2BVM for remaining SDGs for all media and analytes S2BVM for all pH data
Electronic validation program/version:	Equis compliant EDD

Validation Code*	Validation Label	Description/Reference
S1VE	Stage 1 Validation Electronic	
S1VM	Stage 1 Validation Manual	
S1VEM	Stage 1 Validation Electronic and Manual	
S2aVE	Stage 2A Validation Electronic	

Validation Code*	Validation Label	Description/Reference
S2aVM	Stage 2A Validation Manual	EPA 2009 Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use
S2aVEM	Stage 2A Validation Electronic and Manual	
S2bVE	Stage 2B Validation Electronic	
S2bVM	Stage 2B Validation Manual	
S2bVEM	Stage 2B Validation Electronic and Manual	
S3VE	Stage 3 Validation Electronic	
S3VM	Stage 3 Validation Manual	
S3VEM	Stage 3 Validation Electronic and Manual	
S4VE	Stage 4 Validation Electronic	
S4VM	Stage 4 Validation Manual	EPA 2009 Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use
S4VEM	Stage 4 Validation Electronic and Manual	
NV	Not Validated	

The following data qualifiers will be applied during data validation. Potential impacts on project-specific data quality objectives (DQOs) will be discussed in the data usability report.

Qualifier	Definition
U	The analyte was analyzed for but was not detected above the level of the reported sample-specific LOQ.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
NJ	The analyte has been "tentatively identified" or is "presumptively" present and the associated numerical value is the estimated concentration in the sample.
UJ	The analyte was not detected above the reported concentration. The reported quantitation limit QL is approximate and may be inaccurate or imprecise.
R	The sample result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

Appendix 1 – Field Forms

VHB
100 State Street, Suite 600
Montpelier, VT 05602

Phone: (802) 229-4600
Fax: (802) 229-5876
www.vhb.com

Water Level Measurement Record

Project Name: Caneel Bay Resort Site ________ Project #: 58345.21

Site Location: Virgin Islands National Park (VIIS) ________ Date: ________

Weather Conditions: ________ Time on Site: ________

Personnel: ________

Location	Time	Depth to Water (ft. btoc)	Observations
MW-1			

Project Name: CBR Site ____ Project #: 58345.21 Initials: ______ Date: ________

\\vhb\gbl\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Reports\2021-02 EECA Planning Documents\EECA SAP\Appendices\Appendix 1 - Field Forms\CBR Water Level Measurements.docx

CANEEL BAY RESORT SITE EE/CA INVESTIGATION
VIRGIN ISLANDS NATIONAL PARK
DAILY PROGRESS REPORT

Date:		**Time On-Site:**	
Job Activity:			
Weather:	Morning: °F; Afternoon: °F		

Personnel On Site

National Park Service (NPS)	**Representatives:**	Name	*Time on-site*
Respondent: Caneel Bay Resort (CBR)	**Representatives:**	Name	*Time on-site*
Contractor: VHB	**Representatives:**	Name	*Time on-site*
Oversight: ***Company name***	**Representatives:**	Name	*Time on-site*
Drilling or Excavation Subcontractor: ***Company name***	**Representatives:**	Name	

Subcontractor	**Activities**

Activities

Description of Activities:

1. *Summarize main activity that was performed according to the FSP.*
2. .....

Specific locations (e.g., borings installed, well names, sample names, etc.)

Other Oversight Activities/Discussions:

1. *Summarize other relevant discussions, inspections, decisions. For example, describe public interactions that occurred today.*

Problems/ Deviations /Resolution:

1. *Summarize deviations from the FSP, problems that may affect the schedule, and any resolutions.*

Quality Control:

List QA/QC sampling and calibrations performed.

Safety:

State when the safety briefing occurred. Describe any health and safety concerns or problems.

CANEEL BAY RESORT SITE EE/CA INVESTIGATION VIRGIN ISLANDS NATIONAL PARK *DAILY PROGRESS REPORT*		
Deliveries or shipping: List supplies, sampling equipment, roll-off bins delivered or shipped.		
Mobilization #	1 - Geological borings	Date this mobilization began: *Insert date* (## days ago)

\\vhb\gbl\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Reports\2021-02 EECA Planning Documents\EECA SAP\Appendices\Appendix 1 - Field Forms\Daily Log Field Form.docx

Insert Photos

Photo 1. *Photo caption*

Insert general Site map or aerial photo and mark general locations of work performed today.

VHB
100 State Street, Suite 600
Montpelier, VT 05602

Phone: (802) 229-4600
Fax: (802) 229-5876
www.vhb.com

Ground Water Monitoring Well Sample Collection Record

Well ID:________________

Project Name: Caneel Bay Resort Site   Project #: 58345.21   Date:________________

Site Location: Virgin Islands National Park   Sampler: ________________

Weather Conditions:________________________   Time on site:________________

1. WATER LEVEL DATA: (from TOC)

Description of measuring point (MP)________________Depth to water below MP (ft):____________

Total well depth (ft):__________Well diameter (in):________Length of water column in well (ft):__________

Gallons per foot[1]:________________Well volume (gal): __________ PID Headspace (ppmV):________

2. PURGING DATA: Method:________________________ Stabilized intake depth:________

Purge Volume @_______well volume:______________(gal) Purge Rate:__________(gpm)

Parameter equipment:________________________

Time	Depth (ft)	Volume Removed ( )	Flow Rate ( )	Temp (deg C)	Spec Cond (uS/cm)	Dissolved Oxygen (mg/L)	pH	ORP (mV)	Turb. (NTU)
		0	0	Start	----	----	----	----	----

Purge Water Disposal Method ________________ Comments (e.g. color / odor):________________

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100 State Street, Suite 600
Montpelier, VT 05602
Phone: (802) 229-4600
Fax: (802) 229-5876
www.vhb.com

Ground Water Monitoring Well Sample Collection Record

Well ID:________________ Date:___________

3. SAMPLE COLLECTION: Method:____ Sample Time:___________

Quantity	Container Type	Preservation	Analytical Method / Laboratory	Laboratory

Chain-of-Custody #: ____________________________________ **Shipper ID #:** __________________________

[1]well volumes for various diameters in gal./ft.

0.50" = 0.01	0.75" = 0.023	1.00" = 0.041	1.25" = 0.064	1.50" = 0.09
2.00" = 0.16	3.00" = 0.32	3.50" = 0.50	4.00" = 0.65	6.00" = 1.47

1 Gallon = 3.785 Liters

4. DEVELOPMENT INFORMATION:

Date developed: ________________________________ Personnel:_____________________________

Pumping Rate: _________________________________ Volume removed:_______________________

General drawdown/ well pumped dry? ____

Comments: Sample ID = ____

Time off site:__________________

VHB
100 State Street, Suite 600
Montpelier, VT 05602 USA
Phone: (802) 229-4600
Fax: (802) 229-5876
www.vhb.com

Ground Water Sampler Development Record

Location ID:____________

Project Name: Caneel Bay Resort Site Project #: 58345.21

Site Location: Virgin Islands National Park (VIIS) Personnel: ________ Date:________

Weather Conditions:________________ Time on Site:________

1. WATER LEVEL DATA:

Description of measuring point (MP)____________ Depth to water below MP (ft):________

Total well depth (ft):________ Well Dia.(in):______ Length of water column in well (ft):______

Gallons per foot[1]:________ Well volume (gal):______ Screen Interval (ft): ________

2. PURGING DATA: Method:____________ Development Depth Range:________

Purge Volume @______well volumes:______(L) (3.785 L/gal) Purge Rate:________(L/min)

Parameter equipment:________________________

Time	Water Depth (ft.)	volume removed ( )	Flow Rate ( )	Turb. (NTU)	Notes: (depth to bottom, color, odor, pump setting, etc.)

[1]well volumes for various diameters in gal./ft.

0.50" = 0.01	0.75" = 0.023	1.00" = 0.041	1.25" = 0.064	1.50" = 0.09
2.00" = 0.16	3.00" = 0.32	3.50" = 0.50	4.00" = 0.65	6.00" = 1.47

Project Number:__________________ Well Name:__________________ Date:___________ Personnel Initials: _________

[1]well volumes for various diameters in gal./ft.

0.50" = 0.01	0.75" = 0.023	1.00" = 0.041	1.25" = 0.064	1.50" = 0.09
2.00" = 0.16	3.00" = 0.32	3.50" = 0.50	4.00" = 0.65	6.00" = 1.47

Comments:

Time Off Site__________________

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100 State Street, Suite 600
Montpelier, VT 05602
Phone: (802) 229-4600
Fax: (802) 229-5876
www.VHB.com

Incremental Sampling Methodology (ISM) Sample Collection Record

Sample Decision Unit ID:__________________________ **Sample Medium:** ________________________

Project Name:____ Project #: ________

Site Location:_____________________________ Date:____________________

Weather Conditions:____ Time On-Site:_____________

Sampler: ____

1. SAMPLE LOCATION AND COLLECTION METHODOLOGY INFORMATION:

Description of decision unit location:____

Dimensions of decision unit: __________________________________Coordinate system:__________________________________

Planned GPS coordinates:

Increment collection method:__________________________________ Sample depth range:________________________

Approximate increment spacing:_______________________________ Total number of increments collected: ________________

2. SAMPLE INFORMATION:

Analysis Methods	**Field or fixed lab analysis**	**Type of container**	**Sample notes, observations, comments**
1. EPA 6020A, Lead, Antimony, Copper 2. Percent Moisture 3. EPA Method 1311, TCLP Volatiles, semivolatiles, metals including mercury, pesticides, and herbicides 4. EPA Method 1312, SPLP Lead, Antimony, Copper	Fixed	1 x 1 gallon Ziploc, No preservatives	

Original Name/Time: _______________________________________ pH Sample Name/Time: ____________________

Duplicate Name/Time: ______________________________________

Triplicate Name/Time: ______________________________________

General comments / notes:____

____

Lab Designation:__TestAmerica Canton, 4101 Shuffel Street NW, North Canton, OH 44720 (330)497-9396_________________

Chain of Custody #:____Shipper Tracking #:___________________________________

VHB
100 State Street, Suite 600
Montpelier, VT 05602

Phone: (802) 229-4600
Fax: (802) 229-5876
www.vhb.com

PID CALIBRATION SHEET				
Job Name: Caneel Bay Resort Site			Job #:58345.21	
Equipment ID:		Serial #		Lamp: _____eV
Brand of Standard				
Lot #				
Expiration Date				
Date	Time	Initials	100 ppm Isobutylene Value (ppm)	Site Background Value (ppm)

Project: 58345.21 NPS Caneel Bay Resort	Boring ID Number:	
Boring Location:	Elevation & Datum:	
Drilling Contractor:	Date Started:	Date Finished:
Drilling Method:	Total Depth:	Comments:
Drilling Equipment:	Depth to H2O:	
Sample Method:	Logged By:	

Depth (ft)	Recovery	Description: Name, color, moisture, structure, geologic interpretation Ground Surface	PID	Notes/Details/Comments

THE JOHNSON COMPANY, INC.
100 State Street, Suite 600
Montpelier, VT 05602

Phone: (802) 229-4600
Fax: (802) 229-5876
www.johnsonco.com

Soil Sample Collection Record

Soil Sample Location ID:__________________

Project Name:____ Project #: ________________

Site Location:____ Date:____________________

Weather Conditions:____ Time on Site:______________

Sampler: ____

1. SAMPLE LOCATION AND COLLECTION METHODOLOGY INFORMATION:

Description of soil sampling location:____

GPS coordinates of sampling location:__________________________Coordinate system:_________________________________

Sample collection method:____

Sample depth range (ft):____

2. SAMPLE INFORMATION:

Sample depth (ft)	Sample type (analyte(s))	Type of container	Collection time	Sample notes, observations, comments
	EPA 6020A, Lead, Antimony, Copper, Percent moisture	1 x 100 gram glass, unpreserved		

General comments / notes:____

____

Lab Designation:____

Chain of Custody #:____Shipper Tracking #:____________________________________

VHB
100 State Street, Suite 600
Montpelier, VT 05602

Phone: (802) 229-4600
Fax: (802) 229-5876
www.vhb.com

TURBIDITY METER CALIBRATION SHEET						
Job Name: Caneel Bay Resort Site						Job #: 58345.21
Equipment ID:						Serial #:
Brand of Standard						Comments
Lot #						
Expiration Date:						
Date	Time	Initials	15 NTU Value	100 NTU Value	750 NTU Value	

VHB
100 State Street, Suite 600
Montpelier, VT 05602

Phone: (802) 229-4600

www.VHB.com

YSI CALIBRATION SHEET

Job Name:					**Job # :**			**YSI #:**			**Serial #:**			
Brand of Standard			-----------	YSI	Oakton	Oakton	Oakton	Oakton	Oakton	YSI	YSI	YSI		Oakton
Lot #			-----------											
Expiration Date			-----------											
Date		Time	Initials	YSI Temp. - °C	Specific Cond. 1.413 ms/cm	Specific Cond. ms/cm	pH 7.00	pH 4.01	pH 10.00	ORP-Zobell Solution (200-275mV)	Barometric Pressure (mmHg)	100% D.O. (%)	100% D.O. (mg/L)	Zero O_2 Solution (mg/L)
Calibration														
End of Day Check														
Calibration														
End of Day Check														
Calibration														
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Calibration														
End of Day Check														
Calibration														
End of Day Check														

NIST Certified Thermometer Check (Date/Results): ____(must be completed at least once per year)

Notes: Calibration order is left to right on chart. The optimum pH mV range for pH7 is -70 to +70 after calibration.

Appendix 2 – Laboratory SOPs

Laboratory SOPs are available upon request.

Appendix 3 – Health and Safety Plan

SITE HEALTH AND SAFETY PLAN

COMPREHENSIVE SITE ASSESSMENT

Virgin Islands National Park

February 2021
Caneel Bay Resort Site
National Park Service

Prepared by

EMERGENCY PHONE NUMBERS / HOSPITAL LOCATION / MAP

EMERGENCY SERVICE	TELEPHONE
Ambulance	911 (From cell phone: 340-776-9110)
Hospital*	Myrah Keating Smith Community Health Center (340) 693-8900 St.Thomas Hospital: (340) 776-8311
Police	Emergency: 911 (From cell phone: 340-776-9110) Police St. John (Non-emergency): (340) 693-8880
Fire	Emergency: 911 (From cell phone: 340-776-9110) Fire and Emergency Medical Services Department (340) 776-6365
Poison Control Hotline	(800) 222-1222
Emergency Reportable Spill Notification	(800) 424-8802
Emergency Reportable Spill Notification St. Jon's Island	(340) 776-3497
VHB	
Incident Reporting Hotline	(844)-407-0011
Rhonda Kay, Project Manager	Office/Cell (802) 778-1277
Bob Osborne, Field Manager	Office (802) 778-1287; cell (802) 249-2630
CLIENT CONTACT	
Kelly Kachurak, Project Coordinator	Moblile (404) 883-0738
Nigel Fields, Park Superintendent and Site Contact	Office (340) 776-6201 ext. 240
OSHA: Call within 8 hours of a work-related death or inpatient hospitalization of three or more workers.	(800) 321-6742 (340) 773-1994

Virgin Islands Division of Occupational Safety and Health (VIDOSH)

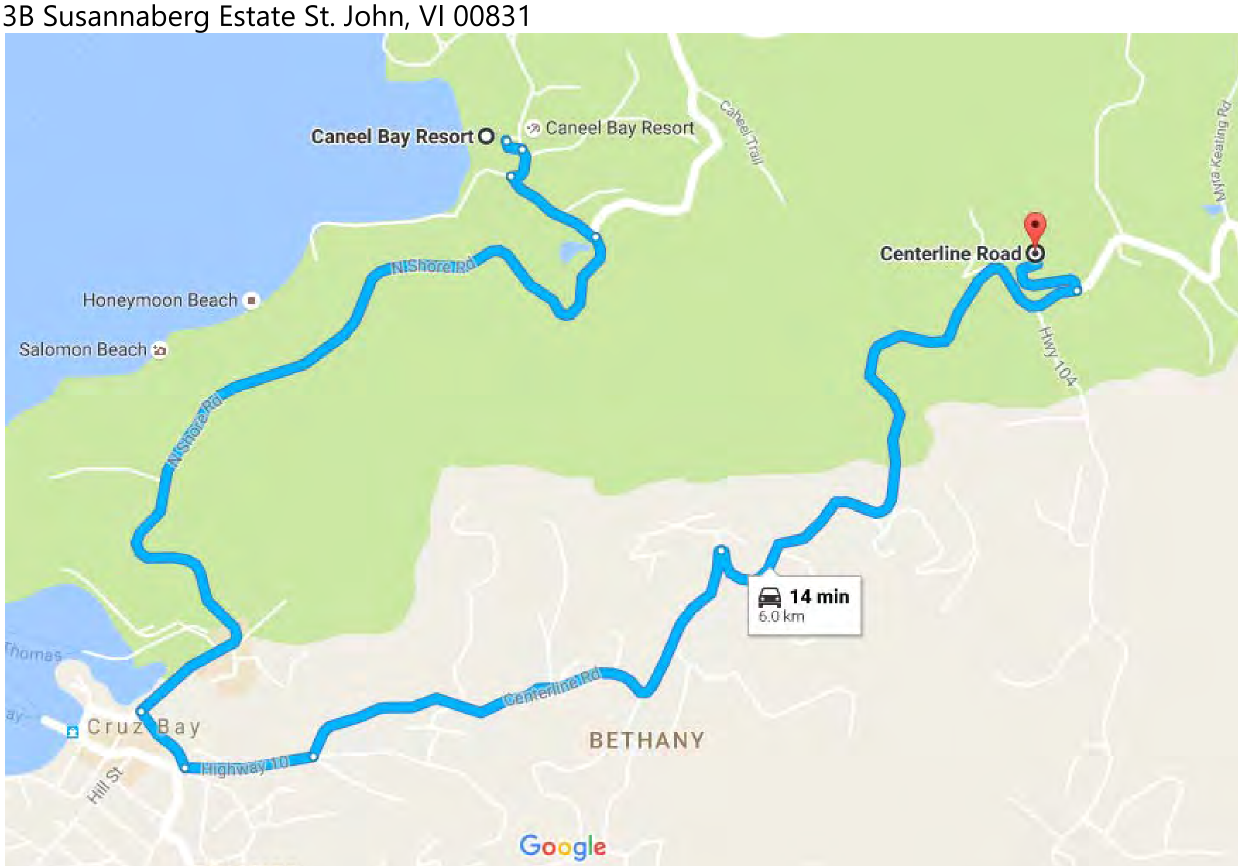
* Directions to Myrah Keating Smith Community Health Center:

Time: 12 to 15 minutes (much longer with traffic)
Telephone: (340) 693-8900

Directions from Caneel Bay Resorts

1. Drive South along Salomon Bay Rd, proceed for 0.2 miles
2. Turn right onto N. Shore Rd/Rte 20, proceed for 1.7 miles
3. In Cruz Bay turn left onto Centerline Rd/Rte 10 for 1.7 miles until destination arrives on the left

Myrah Keating Smith Community Health Center
3B Susannaberg Estate St. John, VI 00831



APPROVALS

By their signatures, the undersigned hereby certify that this Site-Specific Health and Safety Plan has been reviewed and approved for use at the Caneel Bay Resort Site on St. John, U.S. Virgin Islands.

Adopted by: ______________________ Date: February 1, 2021
Joel Behrsing
VHB Montpelier Safety and Health Representative
(802) 229-4600

Adopted by: ______________________ Date: February 1, 2021
Rhonda Kay
VHB Project Manager
(802) 778-1277

Adopted by: ______________________ Date: 2/5/2021
Bob Osborne
VHB Site Safety Officer
Office (802) 778-1287; cell (802) 249-2630

Prepared for:

National Park Service

Prepared by:

VHB. Montpelier, Vermont

\\vhb\gbl\proj\Montpelier\58345.21 NPS Caneel Bay Resort\Reports\2021-02 EECA Planning Documents\HASP\2021-02-01 Caneel Bay HASP FINAL.docx

SITE HEALTH AND SAFETY PLAN ACKNOWLEDGMENT FORM

I have read, understand, and will abide by the procedures set forth in this Site-Specific Health and Safety Plan and any Amendments thereto. I have been briefed of the contents of this plan and have been given sufficient opportunity to ask any questions that have arisen and have received answers that I believe are appropriate and complete.

Printed Name	Signature	Representing	Date
Ben Deede		VHB	February 4, 2021

By acknowledging the contents of this plan, individuals are recognizing the hazards present at the site and are indicating that they are willing to accept the jurisdiction of the appropriate site officials as well as the policies and procedures required to minimize exposure to potentially hazardous substances.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANSI	American National Standards Institute
ATSDR	Agency for Toxic Substances and Disease Registry
CACO	Cape Cod National Seashore
CBR	Caneel Bay Resort
CFR	Code of Federal Regulations
CSHR	Corporate Safety and Health Officer
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IDW	Investigation-Derived Waste
ISM	Incremental sampling methodology
µg/kg	micrograms per kilograms
mg/kg	milligrams per kilograms
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
OSHA	Occupational Safety and Health Administration
PM	Project Manager
PPE	Personal Protective Equipment
SDS	Safety Data Sheet
SSO	Site Safety Officer
VIIS	Virgin Islands National Park

1.0 BACKGROUND INFORMATION

1.1 PURPOSE

This site-specific Health and Safety Plan (HASP) is for use by VHB during implementation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Engineering Evaluation/ Cost Analysis (EE/CA) for the Caneel Bay Resort (CBR) Site (the Site). The Site is composed of three areas, as described below, at the Caneel Bay Resort, which is on the western side of the island of St. John, U.S. Virgin Islands. VHB is implementing the EE/CA on behalf of the National Park Service (NPS) because CBR is located within the Virgin Islands National Park (VIIS). CBR occupies approximately 150 acres, but the Site is limited to approximately 8 acres, in the following areas:

- Area 1, the gravel terrace above the wastewater treatment plant located east of the resort;
- Area 2, the engineering, landscaping, and maintenance area located just southeast of the main body of the resort; and
- Area 3, the landfill area located south of the resort near Honeymoon Beach.

This document establishes the health and safety procedures to minimize any potential risk to VHB personnel conducting field tasks at the Site and describes measures intended to minimize or eliminate investigation-related risks to others who may be in the vicinity of the Site, including Park visitors.

This HASP has been written to comply with the requirements of the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response standard (29 Code of Federal Regulations (CFR) 1910.120). All activities covered by this HASP must be performed in complete compliance with this HASP and with all applicable federal, state, and local safety and health regulations. Personnel covered by this HASP who cannot or will not comply will be excluded from site activities.

Any work-related or suspected work-related fatalities or inpatient hospitalization of three or more workers must be reported within 8 hours by telephone to OSHA at 1-800-321-6742 (or VIDOSH at (340) 773-1994).

1.2 SCOPE AND APPLICATION

The provisions of this HASP apply to all VHB personnel who potentially will be exposed to safety and/or health hazards related to activities described in this document. This document establishes safety and health procedures to minimize potential risk to VHB personnel overseeing EE/CA activities at the Site. This plan will be distributed to each VHB employee involved with field oversight. Each employee must review the HASP and sign the receipt and acceptance form, which is located at the beginning of this document. VHB personnel working on the Site are required to abide by the requirements of this HASP, including signing the document. VHB personnel, and all subcontractors and site visitors will be briefed on the relevant health and safety procedures, must attend safety briefings and meetings, and must comply with personal protective equipment requirements.

1.3 SUMMARY OF RISKS

The various risks associated with field tasks depend on activity and include:

- physical (working near heavy equipment, working on uneven terrain, heat stress, etc.)
- chemical (potential exposure to contaminants);
- biological (ticks, wildlife, plants, etc.); and
- environmental (storms, hurricanes, etc.).

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 ORGANIZATION/RESPONSIBILITIES

The implementation of this HASP at the Site will be the shared responsibility of the Project Manager (PM), Site Safety Officer (SSO), Corporate Safety and Health Officer (CSHO), and other staff participating in this field program. Contact information for the PM, CSHO, and SSO is provided in Table 2.1.

Table 2.1 Contact Information

Title	Name	Phone Number (VHB)	Cell Number	Email
Project Manager (PM)	Rhonda Kay	(802) 778-1277	(802) 778-1277	rkay@vhb.com
Site Safety Officer (SSO)	Bob Osborne	(802) 778-1287	(802) 249-2630	bosborne@vhb.com
Corporate Safety and Health Representative	Joel Behrsing	(802) 778-1265	(802) 272-8869	jbehrsing@vhb.com

2.1.1 *Project Manager*

The PM for the project is Rhonda Kay. The PM is responsible for overall safety and health issues related to this project. As such, the PM must ensure that the requirements of this HASP are implemented. The PM will be assisted by the SSO. The PM will provide NPS representatives with incident reports, progress reports, and other pertinent information.

2.1.2 *Site Safety Officer*

The SSO for the project is Bob Osborne. The SSO is responsible for implementing the requirements of this HASP and enforcing the requirements of this HASP once work begins. The SSO has the authority to immediately correct all situations where noncompliance with this HASP is noted and to immediately stop work in cases where an immediate danger is perceived. Some of the SSO's specific responsibilities include:

- Providing all appropriate employees with a copy of this HASP;

- Ensuring that all personnel to whom this HASP applies have completed the HASP acknowledgement form;
- Ensuring that all personnel to whom this HASP applies have attended a pre-entry briefing and any subsequent safety meetings that are conducted during the implementation of this program;
- Maintaining a high level of safety and health consciousness among VHB personnel and subcontractors;
- Informing the team of updates to Site conditions and the scope of Site work;
- Collecting current training certificates (see Attachment D);
- Procuring and distributing personal protective equipment (PPE) to VHB personnel, except for personal items such as boots and clothing;
- Verifying that all PPE and safety and health equipment used by VHB personnel is in good working order;
- Maintaining regular communications with the PM;
- Notifying the PM of all noncompliance situations and stopping work upon observing a dangerous situation;
- Preparing accident/incident investigation and near-miss reports;
- Coordinating the activities of all team subcontractors and ensuring that they are aware of the pertinent safety and health requirements for this project;
- Monitoring and controlling the safety performance of VHB personnel and subcontractors within the established restricted areas to ensure that required safety and health procedures are being followed;
- Conducting the pre-entry briefing and daily safety meetings for other VHB personnel;
- Initiating emergency response procedures in accordance with this HASP; and

- Meeting with NPS representatives to determine Site access issues, Site communications, Site accountability, and how to coordinate emergency evacuation procedures.

2.1.3 <u>Corporate Safety & Health Representative</u>

The CSHR, Joel Behrsing, is responsible for reviewing, interpreting, and approving of this HASP and all modifications. The PM or SSO may modify the HASP to include less stringent precautions only with the approval of the CSHR. Specific duties of the CSHR include:

- Reviewing and approving the HASP and any amendments;
- Advising the PM and SSO on matters relating to safety and health;
- Recommending appropriate PPE to protect team personnel and team subcontractors from potential Site hazards; and
- Conducting accident and near-miss investigations.

2.1.4 <u>Field Staff</u>

All team field personnel covered by this HASP are responsible for following the safety and health procedures specified in this HASP and for performing their work in a safe and responsible manner. Some of the specific responsibilities of the field personnel are as follows:

- Reading the HASP in its entirety before starting on-site work;
- Completing the HASP acknowledgement form before starting work;
- Attending the required pre-entry briefing (before on-site work) and all subsequent safety meetings conducted during the field program;
- Bringing forth any questions or concerns regarding the content of the HASP to the PM or the SSO before starting or continuing on-site work;
- Reporting all accidents, injuries, and illnesses, regardless of their severity, to the SSO; and
- Complying with the requirements of this HASP and the requests of the SSO.

2.1.5 Subcontractors and Suppliers

VHB has retained subcontractors to complete the requirements of the project. A description of these subcontractors and their responsibilities are presented below. All subcontractors are responsible for their own safety and adherence with regulatory and project-specific requirements. The roles of VHB subcontractors are as follows.

Conducting sub-surface utility clearance around proposed boring locations

On-Site Environmental, Inc. will provide sub-surface utility clearance of all soil borings and monitoring well locations using ground penetrating radar or similar technologies to determine that locations are free from underground features such as electrical, water, sewer and/or sanitary pipes and tanks.

Monitoring well installation and sub-surface soil coring

On-Site Environmental, Inc. will install monitoring wells in accordance with all State and local regulations for monitoring well construction. On-Site Environmental will advance soil borings to collect subsurface soil samples from the landfill.

2.1.6 Visitors

Authorized visitors (e.g., NPS representatives, CBR representatives, etc.) requiring entry to any work location on the Site will be directed to the VHB SSO who has the overall responsibility for safety and health. Visitors will be required to comply with VHB's requirements for Site entry.

3.0 SITE HISTORY

3.1 SITE LOCATION

The CBR property is located on the northwestern shore of St. John, U.S. Virgin Islands, in the VIIS. The property consists of nine land tracts totaling 150.32 acres. The property is located approximately 1 mile northeast of the town of Cruz Bay. The property consists of a large vacation resort with approximately 100 buildings and structures used for lodging, food services, recreation, docks, marinas, and maintenance services. CBR also maintains an approximately 1-acre debris landfill, which historically accepted sludge from its wastewater treatment plant, in the southwestern portion of the property. The resort property is adjacent to Caneel Bay on the Atlantic Ocean, to the west, and also includes several beaches and large areas of undeveloped woods.

3.2 HISTORICAL INFORMATION

CBR has a very long history of settlement but was first developed as a commercial resort in 1956. CBR was developed to provide an ecotourism experience, and the environmental impacts of the resort have been minimized by resort operators. Nonetheless, delivering services to a large number of people requires the use of petroleum products in vehicles, and other chemicals for cleaning and maintenance. In addition, CBR operates a wastewater treatment plant, and the treatment sludge was historically disposed of in an on-site debris landfill southwest of the resort buildings. Treatment sludge is now disposed of at the commercial landfill on St. Thomas. The areas to be investigated are considered “the Site” for the purposes of the EE/CA. The Site includes three areas, as shown on Figure 2: Area 1 - Wastewater Treatment Plant, where there was a used-equipment staging area on a gravel terrace above the Plant; Area 2 - Maintenance Facilities in which petroleum has been stored and used; and Area 3 - Debris Landfill. The Site covers approximately 8 acres within CBR. No areas of public or guest use have been identified as part of the Site.

3.3 NATURE AND EXTENT OF CONTAMINATION

Previous environmental investigations at the Site included a Level 1 and a Level 2 Pre-Acquisition Environmental Site Assessment (ESA; Barksdale &Associates 2012; Barksdale & Associates 2014). The ESAs revealed the following related to possible contamination of soil and groundwater at the Site:

- Historical petroleum releases from a former underground storage tank (UST), existing aboveground storage tanks (ASTs), and smaller containers located in separate storage areas
- Potential releases of pesticides and metals from storage areas and from general historical use.
- An approximately 1-acre debris landfill that has been in operation for approximately 50 years. The landfill is reported to have received organic wastes, including wastewater treatment sludge, in addition to metal and plastic debris.

Contaminants that were identified at the Site during the Level II ESA included polycyclic aromatic hydrocarbons (PAHs), metals, pesticides, petroleum-related volatile organic compounds (VOCs), and polychlorinated biphenyls (PCBs), which were found at the debris landfill only. Asbestos pipes were reported to be present within the maintenance area. A suspected asbestos pipe (6-inch-diameter) was sampled and analyzed for asbestos using Polarized Light Microscopy. The laboratory report indicated the sample contained approximately 30 percent asbestos. There have also been unverified claims that asbestos may have been buried in the debris landfill.

4.0 GENERAL SAFE WORK PRACTICES

The following are general safe work practices to be observed at all times:

- General
  - Each employee is responsible for his or her safety and health.
  - Each employee is responsible for his or her safety and health.
  - All personnel shall report all injuries and/or illnesses to the SSO regardless of the severity of injuries. If the SSO is the only VHB employee present at the Site, the SSO shall report all injuries and/or illnesses to the PM.
  - Personnel encountering a potentially hazardous environment (e.g., noticing strong vapors of unidentified substances) shall instruct all other on-site personnel to leave the Site and shall call the PM and CSHO for instruction. Personnel shall not re-enter the Site without proper protective clothing, and shall not work at the Site until the unknown substance is identified and characterized.
  - Personnel shall avoid any potentially dangerous environmental situations such as entering a confined space without proper supervision, training, and equipment.
  - The "buddy system" shall be used by personnel in the exclusion zone (See Section 7.1).
  - Visual, voice, or radio communications shall be maintained at all times. Wearing of headphones is strictly prohibited.
  - Unnecessary contact with contaminated surfaces, water, soils, and equipment shall be avoided whenever possible. Individuals shall not sit or place equipment on drums or containers.
  - Eating, drinking, and smoking are prohibited in exclusion and contamination reduction zones (see Section 7.1). Alcoholic beverages and illegal drugs are prohibited on the job site.
  - It is an expectation that workers will not be under the influence of alcohol or illegal drugs. If any individual suspects that another worker is under the influence of alcohol or any drugs that may impair their ability to work as required, they will report their observations to the PM. Anyone reporting to work under the influence of alcohol/or illegal drugs will not be allowed access to the site.

- Decontamination
  - Hands must be thoroughly washed upon leaving a decontamination area. Further, whenever decontamination procedures for outer garments are in effect, the entire body shall be thoroughly washed as soon as possible after the protective garment is removed.
  - All equipment must be decontaminated or discarded upon exiting the exclusion zone.

- Personal Protective Equipment
  - Personal protective equipment shall be required for all field personnel and may include, but is not limited to: a shirt, long pants, respiratory protection, hard hat, chemical resistant coveralls, boots, gloves, safety glasses, and ear protection, as specified in Section 6.2.
  - Failure to be part of a respiratory protection program shall preclude admission to any zone requiring respirator wear.
  - Employees are responsible for cleaning and maintaining the protective equipment issued to them. Any and all defects or failures of the equipment shall be reported immediately to the SSO.
- Heavy Equipment
  - All persons shall listen for and yield the right-of-way to construction equipment.
  - All equipment operators shall provide warning of movement and watch for personnel in their path.
  - Ground guides must be designated and in use as needed. Personnel working along roadways or near vehicle traffic must wear reflective vests.
- COVID-19 Pandemic
- Hazard: Potential Exposure. Various state and federal restrictions may apply as a result of their respective responses to the COVID-19 pandemic. VHB has adopted specific COVID-19 Field Work Protocols to provide guidance and protocols to support the completion of work in a safe manner. VHB's current protocols should viewed at the following link: https://vhb.sharepoint.com/sites/HealthSafetyDepartment/Shared Documents/Field Work.pdf?web=1.

5.0 POTENTIAL HAZARDS ASSOCIATED WITH WORKING AT THE SITE

This section presents an assessment of the suspected or known chemical, biological, and physical hazards that may be encountered during site activities.

5.1 FIELD TASKS

The field program will include performing the following field activities:

- Oversight of contractor performing utility clearance, ground penetrating radar survey, soil boring advancement, and monitoring well installation;
- Surface and subsurface soil sampling; and
- Developing and sampling monitoring wells.

5.2 CHEMICAL HAZARDS

Historical soil and groundwater sampling has indicated the presence of the following contaminants: total petroleum hydrocarbons (TPH), PAHs, organochlorine pesticides, benzene, ethylbenzene, selenium, arsenic, mercury, beryllium, and polychlorinated biphenyls (PCBs). The health effects of exposure to these substances have been summarized from the Agency for Toxic Substances and Disease Registry fact sheets, unless noted, as follows (ATSDR 2016).

- DDx compounds: DDT, DDE, and DDD are probable human carcinogens. High levels of DDT can affect the nervous system causing excitability, tremors and seizures. In women, DDE can cause a reduction in the duration of lactation and an increased chance of having a premature baby.
- TPH: TPH is a mixture of many different compounds. Exposure to TPH comes from many sources, including gasoline pumps, spilled oil, and chemicals used at home or work. Some TPH compounds can affect the nervous system and cause headaches and dizziness. Chemicals that occur in TPH compounds include benzene and PAHs, which are described in more details below.

- PAHs, including benzo(a)pyrene: Some PAHs, including benzo(a)pyrene, are likely carcinogens. Humans are exposed to PAHs by breathing air contaminated by wildfires or coal tar, or by eating foods that have been grilled. Some people who have had long-term exposes to PAHs have developed cancer.
- Organochlorine pesticides, including aldrin and dieldrin: Some organochlorine pesticides, including aldrin and dieldrin, are probable human carcinogens. Humans are exposed to organochlorine pesticides by eating contaminated foods, through contaminated air, surface water, or soil, or by living in homes that were once treated with aldrin or dieldrin to control termites. Some people who have ingested large amounts of aldrin or dieldrin suffer convulsions and die. Some workers exposed to moderate levels in the air for a long time had headaches, dizziness, irritability, vomiting, and uncontrolled muscle movements.
- Benzene: Benzene is a known human carcinogen. Breathing high levels of benzene in air can result in drowsiness, dizziness, and unconsciousness. Long-term exposure of lower level of benzene can affect bone marrow and cause anemia and leukemia.
- Ethylbenzene: Ethylbenzene is a possible human carcinogen. Breathing high levels of ethylbenzene in the air can cause eye and throat irritation and dizziness. Long-term exposure of lower level of ethylbenzene can cause kidney damage in animals.
- Selenium: Selenium is unlikely to be a human carcinogen. Humans are exposed to selenium in air, food, and water, or by working at or living near industries where selenium is used or by living in the vicinity of hazardous waste sites or coal burning plants. Selenium is a trace mineral needed in small amounts for good health, but exposure to much higher levels can result in neurological effects, brittle hair, and deformed nails. Occupational inhalation exposure to selenium vapors may cause dizziness, fatigue, irritation of the mucous membranes, and respiratory effects.
- Asbestos is a name given to a variety of naturally occurring minerals composed of hydrated, fibrous silicates that are crystalline in structure. Asbestos is virtually

indestructible, has good fiber bonding, is abrasion-resistant, is extremely resistant to heat and chemicals, will not broken down to other compounds and will remain virtually unchanged over long periods. The primary drawback with its use is the known association of severe health disorders with exposure to asbestos fibers including asbestosis, mesothelioma and lung cancer.

- Arsenic: Inorganic arsenic is a known carcinogen and ingesting very high levels can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet. Long-term exposures can cause darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. Skin contact may cause redness and swelling.
- Mercury: Mercury (specifically mercuric chloride and methylmercury) are possible human carcinogen. Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at high levels, may damage the brain, kidneys, and developing fetus. Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation. Inorganic mercury is a known carcinogen and ingesting very high levels can result in death.
- Beryllium: Beryllium is classified as a known human carcinogen because long-term exposure can increase the risk of developing lung cancer. Inhaling beryllium dust can permanently injure the lungs and cause a chronic lung condition called chronic beryllium disease. Beryllium is not typically harmful if ingested but contact with scraped skin can cause rashes or ulcers.
- PCBs: PCBs are classified as probable carcinogens. Exposures, through dermal contact, inhalation, and ingestion, to high concentrations of PCBs can result in chloracne and rashes and liver damage. Animals exposed to large doses of PCBs

experienced damage to the liver, stomach, thyroid gland, skin, the immune system, behavior, and reproduction.

5.3 PHYSICAL HAZARDS

Potential physical hazards are associated with any task performed during a field investigation, with varying levels of risk. Hazards related to the investigation are assessed in Attachment B, which includes the following field activities: 1) Collecting surface, subsurface, and soil samples (ISM and discrete) 2) Monitoring well development, groundwater sampling, and oversight 3) Equipment and personnel decontamination. Attachment C, the Activity Hazard Analyses, identifies the principal activities performed during each of these field tasks, lists specific potential safety and health hazards, and details recommended controls to avoid or address each hazard.

The activities identified in Attachment C are as follows.

Activity No. 1: Collecting surface soil samples (ISM)

Activity No. 2: Observing soil boring advancement and monitoring well installation, collecting soil samples from cores

Activity No. 3: Monitoring well development and groundwater sampling

Activity No. 4: Equipment and personnel decontamination

Attachment C identifies the following physical hazards and recommended controls specific to each task listed in the Attachment C tables as shown in Table 5.3.

Table 5.3. Physical Hazards

Physical Hazard	Activity No.			
	1	2	3	4
Impact	✓	✓		
Penetration	✓	✓	✓	
Compression (Rollover)	✓	✓		

Table 5.3. Physical Hazards

Physical Hazard	**Activity No.**			
	1	**2**	**3**	**4**
Operating on unstable surfaces	✓	✓	✓	
Slip, trip, and fall hazards	✓	✓	✓	✓
Working on steep terrain	✓	✓	✓	
Heat stress	✓	✓	✓	✓
Extreme weather	✓	✓	✓	✓
Exposure to natural hazards (i.e., sunburn, wildlife, insect bites/stings, poisonous plants, etc.)	✓	✓	✓	✓
Strains and back injury from lifting heavy objects	✓	✓	✓	✓
Cuts and lacerations	✓	✓	✓	✓
Electrical hazards			✓	
Eye injuries	✓	✓	✓	✓

In addition to the specific recommended controls listed in Attachment C, VHB employees shall use good judgment to assess and avoid potentially harmful situations. Measurable limits have been developed to help workers identify when physical hazards can present increased risk. These limits are described in the following subsections.

5.3.1 Heavy Equipment

Working around heavy equipment presents hazards such as physical injury and hearing loss. Heavy equipment that may operate at the Site includes a drill rig. Before any drilling begins, the drilling locations will be cleared for the presence of underground utilities such as gas, electricity, and water by On-Site Environmental, Inc. The location of all overhead power lines will be identified, and all equipment will be set up a safe distance from the utility lines. Site specific practices to reduce heavy equipment hazards include:

- Wearing high visibility vests, steel-toe boots, hard hats, and safety glasses;
- Using hearing protection when in the vicinity of any operating heavy equipment;

- When approaching equipment, make eye contact with the operator before entering the swing radius of equipment or passing in front of or behind running equipment

5.3.2 *Slips, Trips, and Falls*

The ground surface in work areas may be uneven or slippery, especially when wet. Employees should walk around, not over or on top of obstructions. When carrying equipment, a path should be identified that is clear of any obstructions. The work area should be maintained in a neat and clean condition to reduce the possibility of tripping when walking about the site. Specific practices to reduce slip, trip, and fall hazards include:

- Orderly placement of materials, tools, and equipment;
- Placement of trash receptacles with lids or dumpsters at appropriate locations for the disposal of miscellaneous rubbish;
- Prompt removal and secure storage of items that are not needed to perform the immediate task at hand; and
- Awareness on the part of all employees to walk around, not over or on, equipment that may be stored in the work area.

5.3.3 *Cuts and Lacerations*

Cuts and abrasions may occur as individuals move through trees and underbrush and contact thorny plants, sharp stones, etc. The risk of these injuries can be minimized by wearing appropriate clothes, gloves, and footwear. Eye injuries can be prevented by wearing safety glasses.

If knives or blades must be used, the following safety precautions are to be observed:

- Keep your free hand out of the way;
- Secure your work if cutting through thick material;

- Use only sharp blades; dull blades require more force that results in less knife control;
- Don't put your knife in your pocket;
- When cutting, cut away from the body;
- Use a retractable blade; and
- Wear leather or other suitable gloves when using knives or blades.

5.3.4 Back Safety

The manual moving and handling of materials poses a risk to workers in the form of muscle strains and injuries due to dropped containers. Use of proper techniques to lift and move heavy pieces of equipment is important to reduce the potential for back injury. The following precautions should be implemented when lifting or moving heavy objects:

- Use mechanical devices to move objects that are too heavy to be moved manually;
- If mechanical devices are not available, ask another person to assist you;
- Bend at the knees, not the waist;
- Do not twist while lifting;
- Bring the load as close to you as possible before lifting; and
- Be sure the path you are taking while carrying a heavy object is free of obstructions and slip, trip, and fall hazards.

5.3.5 Heat Stress

The planned field work will take place in the Caribbean where hot and humid conditions prevail; therefore, heat stress is anticipated to be of potential concern. In the event of inclement weather that poses a hazard to personnel, work will be postponed at the SSO's discretion.

Heat-related problems include heat rash, fainting, heat cramps, heat exhaustion, and heat stroke. Heat rash can occur when sweat isn't allowed to evaporate, leaving the skin wet and subject to irritation. Fainting may occur when blood pools in lower parts of the body and, as a result, does not return to the heart to be pumped to the brain. Heat-related fainting often occurs during activities that require standing erect and immobile in the heat for long periods of time. Heat cramps are painful spasms of the muscles due to excessive salt loss associated with profuse sweating. Heat exhaustion results from the loss of large amounts of fluid, and the excessive loss of salt from profuse sweating. The skin will be clammy and moist and the affected individual may exhibit giddiness, nausea, and headache.

Heat stroke occurs when the body's temperature regulation system has failed. The skin is hot, dry, red, and spotted. The affected person may be mentally confused and delirious. Convulsions could occur. Early recognition and treatment of heat stroke are the only means of preventing brain damage or death. A person exhibiting signs of heat stroke should be removed from the work area to a shaded area. The person should be soaked with water to promote evaporation. Fan the person's body to increase cooling.

Early symptoms of heat-related health problems include the following:

- Decline in task performance;
- Excessive fatigue;
- Un-coordination;
- Reduced vigilance;
- Decline in alertness;
- Muscle cramps;
- Unsteady walk; and
- Dizziness.

Susceptibility to heat stress increases due to:

- Lack of physical fitness;
- Obesity;
- Lack of acclimation;
- Drug (including some prescription drugs) or alcohol use;

- Increased age;
- Sunburn;
- Dehydration; and
- Infection.

People unaccustomed to heat are particularly susceptible to heat fatigue. Also, heat fatigue can come on suddenly for people not accustomed to wearing Level A, B, and C PPE. Sweating normally cools the body as moisture is removed from the skin by evaporation. However, the wearing of certain PPE, particularly chemical protective coveralls (e.g., Tyvek), reduces the body's ability to evaporate sweat and thereby regulate heat buildup. The body's efforts to maintain an acceptable temperature can therefore become significantly impaired by wearing PPE.

The following guidelines must be adhered to when working in hot environments.

- Establish work-rest cycles (short and frequent are more beneficial than long and seldom).
- Identify a shaded, cool rest area.
- Rotate personnel and job functions.
- Water intake should be equal to the sweat produced. Most workers exposed to hot conditions drink less fluid than needed because of an insufficient thirst. Do not depend on thirst to signal when and how much to drink. For an 8-hour workday, one half-gallon of fluids should be consumed.
- Eat lightly salted foods or drink salted drinks such as Gatorade to replace lost salt.
- Save strenuous tasks for non-peak heat hours such as the early morning or at night.
- Avoid double shifts and/or overtime.

Implementing and enforcing the above-mentioned measures will be the joint responsibility of the PM and SSO. Potable water will be available each day for the field team.

Site personnel should regularly monitor their heart rate as an indicator of heat strain by the following method. Check radial pulse rates by using fore-and middle fingers to apply light pressure to the pulse in the wrist for one minute at the beginning of each rest cycle. If the pulse rate exceeds 110 beats/minute, shorten the next work cycle by one-third and keep the rest period the same. If, after the next rest period, the pulse rate still exceeds 110 beats per minute, shorten the work cycle by one-third.

5.3.6 Other Adverse Conditions

The following other adverse conditions may present hazards during work:

- Rain, high winds
- Hurricanes
- Limited visibility from fog
- Electrical storm
- Fire

Whenever a worker determines that an adverse condition exists such that work cannot continue without creating unacceptable safety risks, he or she should quickly vacate the Site and proceed to the nearest safe shelter. If lightning is spotted within 5 miles of the Site, equipment should be immediately secured, and all workers should seek appropriate shelter. In the event of a hurricane warning, stop work and proceed to the nearest hurricane shelter. If field work is occurring during hurricane season (the beginning of June to the end of October) the SSO will identify the nearest hurricane shelter during morning safety briefings.

5.3.7 Ultraviolet Light Hazard

Skin and eye exposure to bright sunlight can cause sunburn. Sunglasses with ultraviolet (UV) A and B protection and sunscreen with an SPF factor of 15+ will be used when the UV index is known or expected to be 3 or greater. Note that the distribution, sale, and possession of sunscreens with oxybenzone, octocrylene, and octinoxate are prohibited under Virgin Islands law and should not be used.

5.4 BIOLOGICAL HAZARDS

Biological hazards are addressed with physical hazards in Attachment C. Specific plants, insects, and wildlife that may be encountered at the Site are described in the following subsections.

5.4.1 *Poisonous or Dangerous Plants*

Persons working on the site should be aware of the possible presence of poisonous or dangerous plants. The following table identifies poisonous or dangerous plants that may be present at the Site and the symptoms of, and remedy to, exposure.

Name	Identifying Information	Symptoms	Remedy	Photo
Christmas Bush	A small shrub that is found in open canopies and along trails. It has dark green leaves that can have a reddish hue. It resembles holly.	Burning, itching skin, swelling, irritation and rash that can last up to several weeks	Possible use of anti-itch creams or ointments	
Catch & Keep or Acacia retusa	A common weed that forms dense thickets of vine-like vegetation. Covered in hooked spines.	Barbed spines can penetrate skin causing dozens of cuts, irritation, redness, swelling and infection	Wash wound, apply antibiotic ointment or cream.	

Manchineel or Death Apple Tree (extremely toxic)	Found near and on coastal beaches, has shiny heart-shaped leaves with yellow veins and small green apple-like fruit.	Severe burning and blistering of the skin, temporary blindness	Wash with soap and water; if severe reaction, seek medical treatment	
Jump-Up-Cactus or Prickly pear	Common in dry forests, is covered by dozens of long, sharp, barbed spines and grows in dense low-growing clumps	Localized pain, inflammation, irritation and rash.	Remove spines carefully to alleviate pain	
Pencil Euphorbia or Milk Bush (extremely toxic)	A small shrub-like tree used as an ornamental plant. Distinguished by hundreds of bright green, pencil-thin cylindrical branches; it secretes a milky sap when cut or damaged	Skin irritation, sever rash and blisters, blindness	Wash affected area immediately with soap and water. Seek immediate medical attention for eye or mouth exposure.	
Jumbie Bean, Carb's Eye or Rosary (extremely toxic)	A slender vine commonly found in moist, well drained wooded areas, adjacent to clearings or disturbed areas and along roadsides. Has bright red seeds	Nausea, vomiting, convulsions, liver failure, death	If ingested seek medical attention immediately	

Casha or Acacia toruosa tree	Found in drier areas along the coastline, adjacent to trails or on hillsides. Common trees that can reach height of 30 feet and have dozens of spines along the branches.	Deep puncture wounds, redness, painful swelling, localized pain and infection	Wash wounds, apply antibiotic ointment or cream. If infection develops seek medical attention.	
Pinguin or False pineapple	Forms dense and impenetrable patches and thickets. Have long, slender, bright green leaves with spiny edges and tips.	Scratches, cuts and shallow puncture wounds	Wash wounds, apply antibiotic ointment or cream. If infection develops seek medical attention.	
Jimson Weed, Prickly Burr or Deadly Nightshade (extremely toxic)	Herbaceous, poisonous plants found along roadsides and disturbed areas. Distinguished by umbrella-shaped flowers and round prickly seed capsules. Can grow to height of 5 feet and prefers full sunlight.	If eaten, causes delirium, increased heart rate, rapid breathing, amnesia and death	Seek immediate medical attention	

Note: National Park Service, n.d. is the source for all descriptions and photographs unless otherwise noted

5.4.2 Insects

Biting and stinging insects, spiders, centipedes, and millipedes may be present at the Site. Insect repellant may be used as necessary. Multiple large spiders, such as the Giant Crab

Spider and Tarantulas, can be found in the park. While these spiders are formidable looking, their bite and venom are not seriously dangerous to humans. Dark and moist areas at the Site may harbor venomous spiders, including the black widow and brown recluse. The female black widow spider, which is responsible for almost all "medically important" bites, is about ½-inch long, not including the legs, and is "shiny jet black all over her body and legs except for a red pattern on the underside of the abdomen, which looks, in perfect specimens, like an hourglass" (UC IPM 2009). Bites from the spider are typically painless but symptoms start to appear within an hour. Flu-like symptoms may appear, as well as rigid stomach muscles, and "local, radiation, or regional" pain (UC IPM 2009). Medical attention should be sought immediately if bitten. A cold pack may be placed on the bite to relieve pain.

The brown recluse spider is small and has a dark violin-shaped marking on its head and three sets of eyes, not four. This spider cannot bite without counter pressure, but it can bite if trapped between a glove or other clothing and skin (CDC 2012a). Bites will initially hurt and then progress to a severe lesion in which the skin rots. See a doctor immediately if this occurs.

Drawing of black widow spider from www.calpoison.org

Photograph of brown recluse spider (Ohio State University, 2013)

Jack Spaniard wasps are common paper wasps on St. John that nests on plants and below underhangs of buildings and make no sound. The wasp has a rust-red head and thorax with a mostly black abdomen with a single yellow ring on the abdomen. If stung, scrape off the stinger (do not squeeze) with a credit card, and apply ice. Treat stings similar to a wasp or bee sting.

Photograph of Jack Spaniard Wasp
https://xpda.com/bugs/imagesets.aspx?tid=35714

Photograph of Jack Spaniard Wasp nest
https://xpda.com/bugs/imagesets.aspx?tid=35714

Mosquitoes on St. John can carry Dengue Fever or the Zika Virus Infection (Zika). Symptoms of Dengue Fever include a high fever and at least two of the following: headaches, pain behind the eyes, joint pain, and muscle/bone pain, skin rash, mild bleeding of the nose and gums/easy bruising, or low white cell count (CDC 2012b). Symptoms of Zika include fever, rash, headache, joint pain, red eyes, and muscle pain (CDC 2017). There is no vaccine or medicine for either illness. Field staff should use EPA-registered insect repellents containing DEET, picaridin, oil of lemon eucalyptus, or IR3535 on exposed skin and/or over clothing. Travelers returning to the Unites States from the US Virgin Islands should take steps to prevent mosquito bites for three weeks so that the Dengue and Zika viruses are not spread to uninfected mosquitoes (CDC 2016).

While not dangerous, sand-fleas and no-see-ums are a common annoyance on St. John. Scorpions can also be found on the island; while they are venomous they are not a danger to humans. Centipedes may be present at the Site. Centipedes have poisonous fangs; the bite of a large centipede will be painful but usually not dangerous to humans. Centipedes are active predators and can be found wherever prey is available, such as in litter, under rocks and barks, etc. Millipedes are also present on the island. Some millipedes emit an irritating liquid secretion to deter predators or if threatened or handled roughly by humans. Contact with the secretion can cause an allergic reaction in some people. Workers should check shoes and shake out clothing and linens to avoid encountering scorpions, spiders, centipedes and millipedes. Items such as clothing, towels, or bags that have come into contact with sand should not be brought into living quarters to avoid a sand-flea infestation.

5.4.3 *Wild and Feral Animals*

Wildlife or feral animals may be encountered at the Site. The most common wild animals in VIIS are the green iguana and the small Asian mongoose. Feral animals that may be encountered include goats, donkeys, dogs, cats, and hogs. Avoid physical contact and do not feed any wild or feral animals. If any animal approaches and cannot easily be deterred or is acting strange, leave the area immediately and use any available means to defend yourself to avoid being bitten.

5.4.4 *Venomous Snakes*

There are no venomous snakes in VIIS. However, it is possible that other non-venomous snakes could be encountered at the Site. If you or a colleague is bitten by a snake, wash the wound with soap and water and monitor the wound for infection. If an infection occurs seek medical treatment.

- Safety Tips: Wear shoes and heavy pants when walking and hiking in areas where snakes are likely found. Do not reach into rocky cracks, under logs, or large rocks. Even if a snake looks dead, do not touch it. A snake can bite up to one hour after its death. Do not get near or tease a snake. Snakes are shy creatures and generally will not attack unless bothered.

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 DIRECT READING INSTRUMENTATION

6.1.1 Instrument 1 – Photoionization Detector (PID)

A photoionization detector (PID) will be used to monitor the breathing zone by the SSO during drilling to determine the presence of VOCs. If monitoring indicates a PPE upgrade is necessary VHB employees will exit the exclusion zone and observe activities from a safe (upwind) distance. A sustained reading of 1 part per million (ppm) above background levels as indicated on the calibrated PID will be used as threshold for re-evaluation of Site work. At this level, all work will cease until the circumstances are evaluated in relation to the risk to human health of on-site workers. Engineering control or a HASP amendment may be needed to continue work. A sustained reading is defined as three consecutive readings (minimum 1-minute spacing) over a 15-minute interval.

6.2 PERSONAL PROTECTIVE EQUIPMENT

PPE will be selected to protect workers from the specific hazards they are likely to encounter on-site. In areas where the potential for contact with contaminants exists, Modified Level D PPE, as described below, will be worn unless visible dust is present and exposures cannot be controlled using physical means such as waiting for less wind or moving upwind of the source of dust.

6.3 CHEMICAL PROTECTIVE CLOTHING

PPE will be worn during all field activities to prevent on-site personnel from the safety hazards posed by the activities being performed. The following describes the PPE to be worn.

6.3.1 Level D

Level D attire affords no protection for the respiratory system and provides minimal skin protection. It is often considered to be the standard work uniform. It is not to be used when there is any chance of chemical exposure either through direct contact or inhalation.

A. Level D generally consists of the following equipment. Items marked with * are optional unless the stated conditions are present or likely.

1. Long pants and a shirt.
2. *Coveralls, as needed to protect clothing and skin from splashes, dust, or chemical contact hazards.
3. *Gloves: cut-resistant gloves are required when using knives or blades or working with power tools and machinery; chemically-resistant gloves are required when collecting samples, handling investigation-derived waste (IDW), or performing work with potential chemical contact hazards (e.g., nitrile for short exposure times of less than five minutes and Viton for longer exposure times).
4. Work Shoes; *chemical-resistant boots with steel or composite toe and shank (compliant with the American National Standards Institute (ANSI) Z41 standard), required when working with heavy machinery.
5. *Boots, outer, chemical-resistant (disposable).
6. *Safety glasses, chemical splash goggles or face shield, required when splash, dust, flying particles or other eye hazards are present.
7. *Hard hat (Type I or Type II compliant with ANSI Z89.1), required when overhead hazards are present.
8. *Hearing protection, required when excessive noise levels exist.
9. *Highly-Visible Traffic vest,
10. *Face Shield

B. Level D can be worn whenever the following conditions are met:

1. The atmosphere contains no known hazard.
2. Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.
3. Atmosphere contains at least 19.5% oxygen.

   VHB employees will use wetted techniques when collecting soil samples where asbestos may be present (i.e., in and around the landfill); this technique is defined by the addition of water mist at soil disturbance locations to ensure air fibers and dust are not lifted into the surrounding air.

6.3.2 Level C

Based on available contaminant concentration data from previous investigations and the expected locations and types of activities, it is not currently anticipated that Level C PPE will be necessary to perform field work. Level C PPE requires use of a respirator. On-site methods to control dust and other emissions will be used. Level C PPE upgrades will be performed if monitoring indicates that contaminant conditions cannot be controlled by other means.

6.4 OTHER PROTECTIVE EQUIPMENT

No additional protective equipment beyond that described above will be brought on-site by VHB personnel.

7.0 SITE CONTROL

7.1 WORK ZONES

To prevent both exposure of unprotected personnel and migration of contamination due to tracking by personnel or equipment, work areas and associated PPE requirements will be clearly identified. The SSO will designate work areas or zones as suggested in the "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (NIOSH, 1985). The areas surrounding each work area will be divided into three zones:

- Exclusion or "hot" zone;
- Contamination reduction zone (CRZ); and
- Support zone.

7.1.1 Exclusion Zone

Based on recent reported contaminant concentrations in groundwater, the establishment of an exclusion zone based on possible contaminant exposure is not warranted. However, for safety reasons the public will be kept from the immediate area where work is being performed (e.g., a 20-foot radius around the drill rig.)

7.1.2 Contamination Reduction Zones

A station will be established adjacent to the work area for the decontamination of tools that are in contact with the potentially contaminated groundwater or soil. Decontamination water will be collected in sealed 5-gallon buckets and transferred to a 55-gallon drum. Personnel will remove PPE and other disposable items and place them in a plastic bag before leaving the work area.

7.1.3 Support Zone

The support zone comprises the portion of the Site outside of the work area, to which public access is not controlled.

7.2 SITE COMMUNICATIONS

Cellular phones will be used to facilitate contact between team members, the SSO, and/or local emergency response personnel in the event of an emergency. Two-way radios may also be used on-site.

8.0 DECONTAMINATION

8.1 PERSONAL DECONTAMINATION

Proper decontamination is required of all personnel before leaving the site. Decontamination will occur within the contamination reduction zone. Disposable PPE will be removed and placed in garbage bags for disposal as solid waste. A sink with liquid soap, hand wipes, or similar decontamination facility, will be made available so employees can wash their hands before eating lunch or leaving the Site for the day.

8.2 EQUIPMENT DECONTAMINATION

Hand-held equipment will be decontaminated as needed. Decontamination will consist of a washing with a detergent such as Alconox and rinsing with distilled water. All decontamination water will be contained with other wastewater in drums or tanks.

8.3 INVESTIGATION-DERIVED WASTE HANDLING

Decontamination water and waste soil from soil borings will be considered contaminated and will be contained and transferred to drums or tanks with closed lids to prevent spillage. Drums will be temporarily stored on plastic in a designated drum storage area in the immediate vicinity of the Site and covered with plastic sheeting until disposal requirements and transportation can be arranged. Storage areas will be as discreet as possible to avoid creating an unattractive view to visitors.

9.0 EMERGENCY RESPONSE CONTINGENCY PLAN

9.1 PRE-EMERGENCY PLANNING

The purpose of the emergency response contingency plan is to ensure that, in the event of an emergency, personnel will have the information necessary to initiate a reasoned and rational response to the emergency without unnecessary delay. Potential emergencies include acute illness or injury, fire, explosion, or severe weather.

A fire extinguisher, first aid kit, and portable eye wash station will be kept on-site in accessible locations adjacent to the work area.

9.1.1 Employee Training

Employees will be informed of the emergency gathering location and evacuation routes and procedures and updated any time escape routes or procedures are modified or personnel assignments are changed.

9.1.2 Alarm Systems/Emergency Signals

An emergency communication system must be in effect at all times. When personnel are working in close proximity, direct verbal communication may suffice. Verbal communications must be supplemented any time voices cannot be clearly heard and any time a clear line-of-sight cannot be easily maintained between personnel because of distance, terrain, or other obstructions.

9.1.3 Escape Routes and Procedures

The escape route from each work area and emergency gathering location will be determined at the beginning of each day and communicated during the morning safety and health meeting.

9.2 PERSONNEL RESPONSIBILITIES

9.2.1 <u>General Roles and Responsibilities</u>

All on-site personnel are responsible for knowing the escape route from the Site and where to assemble after evacuation. The duties of all personnel in the event of an emergency are to communicate to the SSO that an emergency exists, respond appropriately to emergency signals, evacuate and secure the work area or emergency area, conduct any appropriate decontamination activities, render first aid, and call the emergency response service (911).

Personnel shall not engage in firefighting (beyond incipient stage with extinguishers) or hazardous materials cleanup (beyond cleanup of incidental releases or collection of contaminated PPE, etc.). Incidental releases are limited in quantity, exposure potential, or toxicity, and present minor safety or health hazards to employees in the immediate work area or those assigned to clean them up.

9.2.2 <u>Specific Personnel Responsibilities</u>

Specific personnel responsibilities for emergency response are summarized below.

<u>SSO:</u> The SSO is responsible for the initial response to an emergency situation. These duties include protection of employees, evacuating and securing the work area, ensuring protection of the public and the environment, ensuring appropriate decontamination procedures are implemented on all personnel, upgrading or downgrading the level of PPE, and notifying appropriate federal, state, and local agencies. The SSO is also responsible for determining the cause of the incident and recommending changes to prevent its reoccurrence. The SSO is responsible for ensuring that the features of the emergency response contingency plan are in place, personnel are appropriately trained and required safety and spill response equipment is maintained on the Site.

CSHO: Responsible for reviewing the emergency response contingency plan to ensure its compliance with appropriate regulations and company policy, and reviewing the adequacy of any emergency response after it is completed and making any corrective measures to the plan that may be necessary.

9.2.3 Rescue and Medical Duty Assignments

The phone numbers of local emergency responders, park contacts, local hospital, and VHB representatives are provided in the emergency reference sheet located in Section 13.0 and at the beginning of this HASP.

In the event an injury or illness requires more than first aid treatment, the SSO or his/her designee will accompany the injured person to the medical facility and will remain with the person until release or admittance is determined. The escort will relay all appropriate medical information to the CSHO.

9.3 COMMUNICATION

Every effort shall be made during an emergency to communicate in clear and concise terms. Notice of an emergency shall be communicated to personnel by a signal of three blasts from an air horn or vehicle horn. The SSO is responsible for providing personnel with the means for making this communication. The SSO will inform personnel of emergency communication signals during the pre-entry briefing and morning safety and health meetings.

9.4 EMERGENCY PROCEDURES

9.4.1 Fire or Explosion

In the event of a fire or explosion, call 911 immediately. Upon arrival of the emergency responders, advise the commanding officer of the location, nature, and identification of hazardous materials on-site. Only trained fire fighters should attempt to extinguish burning materials. Site personnel should not attempt to fight any fire unless properly trained and equipped to do so.

9.4.2 *Spills or Leaks of Hazardous Materials*

The materials susceptible to spillage that may be present on-site are as follows: water in temporary holding tanks. Hazardous materials will be stored in a designated area, isolated from vehicular traffic, and protected from the effects of weather. Measures to prevent spills or leaks include:

- all containers shall be clearly labeled or placarded as to their contents;
- a file of Safety Data Sheets (SDS) shall be maintained by the SSO for all materials introduced to the Site; and
- flammable or combustible liquids shall be stored separately, away from possible sources of ignition.

Spill Response Procedures

- *Training*: During the initial pre-entry briefing, employees will be informed of the potential hazards of the materials with which they work. The following spill procedures will also be presented at that time. Only Hazardous Waste Operations and Emergency Response (HAZWOPER)-trained personnel will assist in the clean-up procedure.
- *Initial response*: Upon observing a spill or leakage from a container, immediately step back to a safe distance and direct other employees away from the spill. Initial response actions will include the following:
  - Sources of ignition within 100 feet of the spill (including vehicle engines) will be de-energized;
  - All combustible materials (such as wood, paper, oil, etc.) will be removed from the spill area;
  - The PM and SSO will be advised immediately of the location, size, and nature of the spill, including the identity and/or source of the spilled material; and
  - Employees who have had contact with the spilled material will be decontaminated as needed.

- *Planning for Containment/Cleanup:* As conditions dictate, the SSO will determine the appropriate follow-up responses. These may include any combination of initiating containment/clean-up, requesting outside assistance, and notifying affected authorities. The SSO will be notified of the occurrence of any spill in a timely manner. Potentially applicable planning measures include:
  - The SSO will consult the SDS for the spilled material to determine the specific approach to containing the spill, including the PPE to be worn during response activities; and
  - The SSO will conduct air monitoring appropriate to the nature of the spilled material, to quantify exposure and detect flammable atmospheres and specify the required PPE for containment/cleanup activities.

- *Containment/Clean-up:* The following are examples of specific measures that may be used (in combination when necessary) to respond to a spill:
  - Upright or rotate containers to stop the flow of liquids. This step may be accomplished as soon as the spill or leak occurs, providing it is safe to do so;
  - Use sorbent pads, booms, or adjacent soil to dike or berm materials subject to flow and to solidify liquids;
  - Collect used/saturated sorbent pads, soil, or booms in drums; and
  - Collect contaminated tools and equipment for subsequent cleaning or disposal.

9.4.2.1 Restoration and Salvage of Spill Control Items

The disposal method for spill-affected materials will depend on the identity and characteristics of the spilled material. The SSO, in consultation with the PM, will determine the specific disposal method, along with any post clean-up verification sampling or restoration procedures.

Generally, if spill-affected materials such as PPE, sorbent pads and booms, contaminated soil, or collected spillage are determined or suspected to be hazardous waste, they will be collected and sealed in drums that will be appropriately labeled and shipped off-site as a Resource Conservation and Recovery Act (RCRA) hazardous waste.

10.0 TRAINING

10.1 MEDICAL MONITORING

All personnel performing activities covered by this HASP must be active participants in a medical monitoring program that complies with 29 CFR 1910.120(f). Each individual must have completed an annual surveillance examination within the last year (if exposure criteria are met) and an initial baseline examination prior to performing any work on the site covered by this HASP.

10.2 SAFETY AND HEALTH TRAINING

10.2.1 HAZWOPER

All personnel covered by this HASP must have completed the appropriate training requirements specified in 29 CFR 1910.120(e). Each individual must have completed an annual 8-hour refresher-training course and/or initial 40-hour training course not more than one year before performing any work covered by this HASP. Additionally, personnel must have completed at least three days of field training under the direction of a trained and experienced supervisor. Unless they are the sole representative of VHB on-site, the SSO must have completed an 8-hour HAZWOPER supervisor training course. Applicable clearance and credentials shall be documented for each VHB site worker on the form in Attachment D.

10.2.2 First Aid/CPR

The SSO will be trained in First Aid/CPR.

10.3 PRE-ENTRY BRIEFING

The SSO will conduct a pre-entry briefing to all personnel before Site activities begin. The HASP acknowledgement form must be signed by each VHB field employee before entry to the Site.

Specific topics that will be discussed during the pre-entry briefing include:

- Site history;
- Work scope;
- Potential hazards associated with contaminants of concern and how these potential hazards will be controlled;
- Air monitoring requirements and action limits;
- PPE and respiratory protection requirements;
- Potential physical hazards associated with implementing the scope of work;
- Emergency egress and hospital location/directions;
- Decontamination procedures; and
- Communication systems (e.g., emergency signals).

The HASP acknowledgement form will be signed at this meeting. Daily safety meetings will be conducted in the morning throughout the duration of the field portion of the project. Attendance of the safety meetings is mandatory for workers who are assembled at the Site.

11.0 ACCIDENT REPORTING

Any accident or injury to a VHB employee, subcontractor, or visitor must be reported by the worker to the SSO and/or the PM immediately and to the VHB Incident Reporting Hotline (844)-407-0011 . Injuries to subcontractors must be reported to the subcontractor's contact person immediately. The SSO will investigate as necessary to determine the cause of the incident and whether it was preventable. If the incident may have been preventable, the SSO will determine by what means future incidents of a similar nature can be avoided. The SSO will also investigate if applicable safety and health procedures were followed and whether required PPE was properly used. The SSO will complete the Accident Investigation Report Form (see Attachment C) and submit it to the PM who will review the form and interview the employee and/or SSO if necessary.

Any work-related or suspected work-related fatalities or inpatient hospitalization of three or more workers must be reported within 8 hours by telephone to OSHA at 1-800-321-6742.

12.0 MEDICAL SUPPORT

Potable water for eye washing and a first aid kit shall be maintained on-Site during field work. The location of this equipment will be communicated to all personnel during the pre-entry briefing. In the event of an emergency, the first point of contact will be 911, who will contact the appropriate emergency response teams.

The nearest **USVI Police station** is less than 1.8 miles from the Site.

Leander Jurgen Command Police Station Cruz Bay

St. John, VI 00830

Telephone (non-emergency): (340) 693-8880

The nearest **emergency health clinic** is 3.6 miles from the Site.

Myrah Keeting Smith Community Health Center

3B Susannaberg Estate

St. John, VI 00831

Telephone: (340) 693-8900

A summary of emergency contact telephone numbers is provided in the table below.

EMERGENCY PHONE NUMBERS / HOSPITAL LOCATION / MAP

EMERGENCY SERVICE	TELEPHONE
Ambulance	911 (From cell phone: 340-776-9110)
Hospital*	Myrah Keating Smith Community Health Center: (340) 693-8900 St. Thomas Hospital: (340) 776-8311
Police	Emergency: 911 (From cell phone: 340-776-9110) Police St. John (Non-emergency): (340) 693-8880
Fire	Emergency: 911 (From cell phone: 340-776-9110) Fire and Emergency Medical Services Department: (340) 776-6365
Poison Control Hotline	(800) 222-1222
Emergency Reportable Spill Notification	(800) 424-8802
Emergency Reportable Spill Notification St. John's Island	(340) 776-3497
VHB	
Incident Reporting Hotline	(844)-407-0011
Rhonda Kay, Project Manager	Office/Cell (802) 778-1277
Bob Osborne, Site Safety Officer	Office (802) 778-1287; cell (802) 249-2630
CLIENT CONTACT	
Kelly Kachurak, Project Coordinator	Cell (404) 883-0738
Nigel Fields, Park Superintendent and Site Contact	Office (340) 776-6201 ext. 240
OSHA: Call within 8 hours of a work-related death or inpatient hospitalization of three or more workers.	(800) 321-6742
Virgin Islands Division of Occupational Safety and Health (VIDOSH)	(340) 773-1994

13.0 MODIFICATION OR CHANGES TO THE HASP

The procedures in this HASP have been developed based on knowledge of previous investigations conducted at the Site and the proposed scope of work. Every effort has been made to address the physical and chemical hazards that may be encountered during the implementation of the proposed investigation. Should changes arise in the site conditions or scope of work, or if new information becomes available regarding potential on-site hazards, it may be necessary to issue an addendum to the HASP. HASP addenda must be reviewed and approved by the CSHR. Sign-off forms will accompany each addendum and must be signed by all personnel covered by the addendum.

14.0 REFERENCES

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FIGURES

ATTACHMENT A

SAFETY MEETING SIGN-IN SHEET

DAILY OR FIELD WORK INITIATION SAFETY MEETING ATTENDANCE FORM

Caneel Bay Resort Site

St John , U.S. Virgin Islands

Project #58345.21

Conducted by:		Date and Time Performed:	
Topics Discussed:	1.		
	2.		
	3.		
	4.		

Printed Name	Signature	Representing

ATTACHMENT B

HAZARD ASSESSMENT FORM

Date: 2/1/2021

Project Being Evaluated: Caneel Bay Resort Site EE/CA field work

Job Task Being Evaluated: Collecting surface soil samples (ISM)

Name of Person Conducting Assessment: Bob Osborne, Site Safety Officer; Ben Deede

Place a check mark (√) next to every category that could pose a hazard to employees working in this area. Identify the sources responsible for contributing to this hazard. Upon completion, rate each hazard category on a scale of 0-4. (0=no hazard, 1=slight hazard, 2=moderate hazard, 3=high hazard, 4=extreme hazard). **Note: Assignment of hazard rates may include numeric variation between the hazard scales. For example: a 1.5 rating would signify a hazard between slight and moderate.**

Category: √ **Impact** 1 **Hazard Rate**

Sources: (i.e., machinery or processes where any movement of tools, machine elements or particles could exist, or movement of personnel that could result in collision with stationary objects; sources of falling objects or potential for dropping objects)

1. Contact with vehicles moving around Site

Category: √ **Penetration** 1 **Hazard Rate**

Sources: (i.e., sources of falling objects or potential for dropping objects; sources of sharp objects which might pierce the feet or cut the hands)

1. Falling tree branches or other vegetation in wooded areas
2. ISM sampling tool (drill bit)
3. Cutting tools

Category: √ **Compression (rollover)** 1 **Hazard Rate**

Sources: (i.e., sources of rolling or pinching objects)

1. Hand-held drill could get caught in loose clothing

Category: √ **Chemical** 1 **Hazard Rate**

Sources: (i.e., types of chemicals utilized)

1. Contact with potentially contaminated soil.

Category: √ **Heat** 3 **Hazard Rate**

Sources: (i.e., sources of high temperature that could result in burns, eye injury, heat exhaustion, dehydration or ignition of protective equipment)

1. Heat stress or exhaustion may occur during field work

Category: √ **Harmful Dust** 2 **Hazard Rate**

Sources: (i.e., sources of harmful dusts)

1. Possible airborne dust from vehicles driving on unpaved surfaces or other soil disturbances
2. Possible asbestos-contaminated dust in soil cores at landfill

Category: ____ **Radiation** 0 **Hazard Rate**

Sources: (i.e., sources of light radiation including welding, brazing, cutting, furnaces, heat treating, high intensity lights, lasers, VDT, etc.)

1. ____________________

Category: √ **Electrical** 1 **Hazard Rate**

Sources: (i.e., sources of electrical hazards in relation to location of workers and the work performed)

1. Generators, monitoring equipment, and batteries

Category: √ **Motion** 2 **Hazard Rate**

Sources: (i.e., sources of repeated motions relative to frequency of activity, force, and duration)

1. Walking between locations, sometimes on steep terrain

2. Carrying tools or equipment between sampling locations
3. Repeated hand drill operation

Category: ____**Other: Surface water** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. ____

Category: ____**Other: Cold stress** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. ____

Category: √___**Other: Natural hazards** __2____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. Poisonous plants, venomous snakes, insects including ticks, wildlife
2. Extreme weather such as storms

Date: 2/1/2021

Project Being Evaluated: Caneel Bay Resort Site EE/CA field work

Job Task Being Evaluated: Utility clearance oversight, monitoring well installation oversight, and subsurface soil sampling and oversight

Name of Person Conducting Assessment: Bob Osborne, Site Safety Officer; Ben Deede

Place a check mark (√) next to every category that could pose a hazard to employees working in this area. Identify the sources responsible for contributing to this hazard. Upon completion, rate each hazard category on a scale of 0-4. (0=no hazard, 1=slight hazard, 2=moderate hazard, 3=high hazard, 4=extreme hazard). **Note: Assignment of hazard rates may include numeric variation between the hazard scales. For example: a 1.5 rating would signify a hazard between slight and moderate.**

Category: √ **Impact** 3 **Hazard Rate**

Sources: (i.e., machinery or processes where any movement of tools, machine elements or particles could exist, or movement of personnel that could result in collision with stationary objects; sources of falling objects or potential for dropping objects)

1. Drill rig and drill string
2. Mechanized heavy equipment moving around the drill rig
3. Tree branches knocked down by moving equipment

Category: √ **Penetration** 2 **Hazard Rate**

Sources: (i.e., sources of falling objects or potential for dropping objects; sources of sharp objects which might pierce the feet or cut the hands)

1. Falling tree branches or other vegetation in wooded areas
2. Cutting tools

Category: √ **Compression (rollover)** 2 **Hazard Rate**

Sources: (i.e., sources of rolling or pinching objects)

1. Drill rig operating on uneven terrain
2. Mechanized heavy equipment
3. Moving IDW drums manually or with mechanized machinery

Category: √ **Chemical** 2 **Hazard Rate**

Sources: (i.e., types of chemicals utilized)

1. Contact with soil cores or groundwater that contain chemical contamination

Category: √ **Heat** 3 **Hazard Rate**

Sources: (i.e., sources of high temperature that could result in burns, eye injury, heat exhaustion, dehydration or ignition of protective equipment)

1. Heat stress or exhaustion may occur during field work

Category: √ **Harmful Dust** 1 **Hazard Rate**

Sources: (i.e., sources of harmful dusts)

1. Possible airborne dust from vehicles driving on unpaved surfaces or other soil disturbances

Category: ____ **Radiation** 0 **Hazard Rate**

Sources: (i.e., sources of light radiation including welding, brazing, cutting, furnaces, heat treating, high intensity lights, lasers, VDT, etc.)

1. ____________________

Category: √ **Electrical** 1 **Hazard Rate**

Sources: (i.e., sources of electrical hazards in relation to location of workers and the work performed)

1. Generators, monitoring equipment, and batteries

Category: √___**Motion** __1____ **Hazard Rate**

Sources: (i.e., sources of repeated motions relative to frequency of activity, force, and duration)

1. Walking between drilling locations, sometimes on uneven terrain
2. Carrying tools or equipment between sampling locations

Category: _____**Other: Surface water** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. _____

Category: _____**Other: Cold stress** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. _____

Category: √___**Other: Natural hazards** __2____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. Poisonous plants, insects, and wildlife
2. Extreme weather such as storms

Date: 2/1/2021

Project Being Evaluated: Caneel Bay Resort Site EE/CA field work

Job Task Being Evaluated: Monitoring well development and groundwater sampling

Name of Person Conducting Assessment: Bob Osborne, Site Safety Officer; Ben Deede

Place a check mark (√) next to every category that could pose a hazard to employees working in this area. Identify the sources responsible for contributing to this hazard. Upon completion, rate each hazard category on a scale of 0-4. (0=no hazard, 1=slight hazard, 2=moderate hazard, 3=high hazard, 4=extreme hazard). **Note: Assignment of hazard rates may include numeric variation between the hazard scales. For example: a 1.5 rating would signify a hazard between slight and moderate.**

Category: √ **Impact** 1 **Hazard Rate**

Sources: (i.e., machinery or processes where any movement of tools, machine elements or particles could exist, or movement of personnel that could result in collision with stationary objects; sources of falling objects or potential for dropping objects)

1. Dropping sampling equipment and purge water

Category: √ **Penetration** 2 **Hazard Rate**

Sources: (i.e., sources of falling objects or potential for dropping objects; sources of sharp objects which might pierce the feet or cut the hands)

1. Falling Tree Branches
2. Cutting tools

Category: √ **Compression (rollover)** 2 **Hazard Rate**

Sources: (i.e., sources of rolling or pinching objects)

1. Moving IDW drums manually or with mechanized machinery

Category: √___**Chemical** __1____ **Hazard Rate**

Sources: (i.e., types of chemicals utilized)

1. Contact with contaminated groundwater or soil
2. Decontamination soap

Category: √___**Heat** __3____ **Hazard Rate**

Sources: (i.e., sources of high temperature that could result in burns, eye injury, heat exhaustion, dehydration or ignition of protective equipment)

1. Heat stress or exhaustion may occur during field work

Category: √___**Harmful Dust** __1____ **Hazard Rate**

Sources: (i.e., sources of harmful dusts)

1. Possible airborne dust from vehicles driving on unpaved surfaces or other soil disturbances
2. Possible asbestos-contaminated dust in soil cores at landfill.

Category: ____**Radiation** __0____ **Hazard Rate**

Sources: (i.e., sources of light radiation including welding, brazing, cutting, furnaces, heat treating, high intensity lights, lasers, VDT, etc.)

1. ______________________________

Category: √___**Electrical** __1____ **Hazard Rate**

Sources: (i.e., sources of electrical hazards in relation to location of workers and the work performed)

1. Monitoring and sampling equipment and batteries

Category: √___**Motion** __1____ **Hazard Rate**

Sources: (i.e., sources of repeated motions relative to frequency of activity, force, and duration)

1. Carrying tools, equipment, and purge water between drilling locations, most often uneven terrain
2. Repetitive motion associated with monitoring well development

Category: ____**Other: Surface water** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. ____

Category: ____**Other: Cold stress** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. ____

Category: √___**Other: Natural hazards** __2____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. Poisonous plants, insects, wildlife
2. Extreme weather such as storms

Date: 2/1/2021

Project Being Evaluated: Caneel Bay Resort Site EE/CA field work

Job Task Being Evaluated: Equipment and Personnel Decontamination

Name of Person Conducting Assessment: Bob Osborne, Site Safety Officer; Ben Deede

Place a check mark (√) next to every category that could pose a hazard to employees working in this area. Identify the sources responsible for contributing to this hazard. Upon completion, rate each hazard category on a scale of 0-4. (0=no hazard, 1=slight hazard, 2=moderate hazard, 3=high hazard, 4=extreme hazard). **Note: Assignment of hazard rates may include numeric variation between the hazard scales. For example: a 1.5 rating would signify a hazard between slight and moderate.**

Category: √ **Impact** 1 **Hazard Rate**

Sources: (i.e., machinery or processes where any movement of tools, machine elements or particles could exist, or movement of personnel that could result in collision with stationary objects; sources of falling objects or potential for dropping objects)

1. Dropping sampling equipment and purge water

Category: ____ **Penetration** 0 **Hazard Rate**

Sources: (i.e., sources of falling objects or potential for dropping objects; sources of sharp objects which might pierce the feet or cut the hands)

1. ________

Category: √ **Compression (rollover)** 2 **Hazard Rate**

Sources: (i.e., sources of rolling or pinching objects)

1. Moving IDW drums manually or with mechanized machinery

Category: √___**Chemical** __1____ **Hazard Rate**

Sources: (i.e., types of chemicals utilized)

1. Contact with contaminated groundwater, soil, or decontamination water

Category: √___**Heat** __3____ **Hazard Rate**

Sources: (i.e., sources of high temperature that could result in burns, eye injury, heat exhaustion, dehydration or ignition of protective equipment)

1. Heat stress or exhaustion may occur during field work

Category: √___**Harmful Dust** __1____ **Hazard Rate**

Sources: (i.e., sources of harmful dusts)

1. Possible airborne dust from vehicles driving on unpaved surfaces or other soil disturbance

Category: ____**Radiation** __0____ **Hazard Rate**

Sources: (i.e., sources of light radiation including welding, brazing, cutting, furnaces, heat treating, high intensity lights, lasers, VDT, etc.)

1. ____

Category: √___**Electrical** __1____ **Hazard Rate**

Sources: (i.e., sources of electrical hazards in relation to location of workers and the work performed)

1. Monitoring and sampling equipment and batteries

Category: √___**Motion** __1____ **Hazard Rate**

Sources: (i.e., sources of repeated motions relative to frequency of activity, force, and duration)

1. Carrying tools, equipment, and decontamination water between sampling locations an waste collection areas.

Category: ____**Other: Surface water** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. ______________________________

Category: ____**Other: Cold stress** __0____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. ____

Category: √___**Other: Natural hazards** __1____ **Hazard Rate**

Sources: (i.e., sources of other hazards that may be present requiring the use of PPE or special protective measures)

1. Poisonous plants, insects, wildlife
2. Extreme weather such as storms

ATTACHMENT C

ACTIVITY HAZARD ANALYSIS

Activity Hazard Analysis

Activity No. 1. Collecting surface, subsurface, and sediment samples (ISM and discrete) VHB/February 2021		
Principal Activities	Potential Safety/Health Hazards	Recommended Controls
Collecting samples using a hand drill (ISM)	*Chemical Hazards:*	
	1) Potential inhalation and/or contact exposure with contaminated sediment or soil cores	1) Use PPE during intrusive activities in source areas (modified Level D) to limit contact risk. Properly manage contaminated sediment and decontamination water. Review SDS for known or suspected chemicals of potential concern. Apply water mist to surface soil at the landfill during sample collection to suppress dust.
	Physical Hazards:	
	1) Operating on unstable surfaces	1) Clear debris and vegetation from areas to be traveled.
	2) Penetration	2) Ensure hand drill is safely operated. Operate hand drill only as intended. Exercise caution.
	3) Compression (rolling)	3) Keep loose clothing, including gloves, away from the drill bit while operating the handheld drill.
	4) Slip, trip, and fall hazards.	4) Use safe work practices and good housekeeping: keep work area free of slippery walking surfaces and keep tools and materials from underfoot. When carrying equipment, identify a path that is clear of obstructions or remove obstacles in advance. On steep or slippery slopes, carry lighter loads.
	5) Heat stress	5) Check temperatures and relative humidity forecasts and plan to monitor for heat stress, as appropriate. Wear appropriate clothing for conditions.
	6) Extreme weather (i.e., thunderstorms, high winds, snow and ice, etc.).	6) The Site Safety Officer will stop all site work during extreme weather that may risk the safety of workers. If lightning is reported or spotted within 5 miles of the Site, secure all equipment and seek appropriate shelter.
	7) Exposure to natural hazards (i.e., sunburn, wildlife, insect bites/stings, poisonous plants, etc.).	7) Wear appropriate clothing to minimize exposed skin. Be aware of wildlife, insect and poisonous plant hazards. Use sunscreen on areas that are not covered adequately by clothing. Use insect repellent in areas where ticks are prevalent and check for ticks frequently and soon after leaving the Site. Avoid contact with wild or stray animals.
	8) Cuts and lacerations	8) Wear eye protection when moving through trees and underbrush.
Equipment to be used	Inspection Requirements	Training Requirements
1) Hand drill	1) Check that tools are in good condition	1) No specific training required.
General: Review HASP and Activity Hazard Analysis; Hazardous Waste Operations and Emergency Response training per 29 CFR 1910.120; Initial site/task specific training; Project initiation safety meeting and optional daily safety meetings.		

Activity No. 2. Logging soils during soil boring and well installation VHB/February 2021		
Principal Activities	Potential Safety/Health Hazards	Recommended Controls
Screen and handle soils to observe and record visual and tactile information. Oversight of contractor activities. Sampling of IDW.	*Chemical Hazards:*	
	1) Potential inhalation and/or contact exposure to contaminated groundwater and soils.	1) Use PPE during intrusive activities in source areas (modified Level D) to limit contact risk. Monitor breathing zone air with a photoionization detector where volatile organic compounds are present or suspected. Properly manage contaminated groundwater, soils, and decontamination water. Review MSDS for known or suspected COCs.
	Physical Hazards:	
	1) Contacting overhead obstructions with the drilling equipment	1) Look for overhead obstructions. All portions of the drill rig in all configurations must remain a minimum of 10 feet from power lines rated 50kV or less. See OSHA 1926.550 for minimum setbacks from higher voltage lines. Cut overhanging branches that could interfere with the drill rig mast and winch.
	2) Contacting buried pipes/utilities	2) a) Inspect the ground for evidence of unmarked utilities or structures, such as manholes, valve covers, strips of repaired pavement, and fill pipes, and attempt to determine if a buried utility may be present. Use a metal detector, ground penetrating radar, or subcontracted utility locating service, if necessary. b) Consult the "Call Before You Dig" requirements for the location; premark and place the call in accordance with the state or local requirements. Do not drill within a zone defined by the width of the utility plus 18 inches on either side of the subsurface utility markings.
	3) Slip, trip, and fall hazards.	3) Use safe work practices and good housekeeping: keep work area free of slippery walking surfaces and keep tools and materials from underfoot. When carrying equipment, identify a path that is clear of obstructions or remove obstacles in advance.
	4) Entanglement in or being struck by drilling machinery	4) Stay a safe distance away from the drill rig while it is operating. Ask how far the tooling and drill string can swing away from the rig and stand outside this radius. Establish eye contact with the driller and wait until he tells you it is safe to approach. Stay clear of rotating augers and pinch points, such as cables or pulleys.
	5) Being struck by moving equipment	5) Wear a reflective safety vest and hard hat around heavy machinery. Pay attention to the backup signal and move out of the way if necessary. Use hand signals to alert operators to hazards they may not see such as overhead wires, posts, people, and items that may be obscured on the ground.

Activity No. 2. Logging soils during soil boring and well installation VHB/February 2021		
	6) Fire and explosion	6) Monitor for VOCs during drilling. Know the location of the fire extinguisher. Store portable containers of flammable liquids, including gasoline and diesel, at least 100 feet away from the drill rig. Turn off generators and vehicles before refueling. If a hole is covered overnight, carefully remove the cover and screen the hole with a multi-gas meter before drilling. Do not smoke in the general vicinity of any open holes.
	7) Hearing damage	7) If you must shout at someone 5 feet away to be heard, you require hearing protection. Working in close proximity to drill rigs may expose a person to noise levels that exceed the OSHA Permissible Exposure Limit (PEL) of 90 decibels for an 8-hour day. When working within 20 feet of power equipment, use ear muffs or properly-inserted ear plugs that have a minimum noise reduction rating (NRR) of 27 decibels.
	8) Heat stress	8) Check temperatures and relative humidity forecasts and plan to monitor for heat stress, as appropriate. Wear appropriate clothing for conditions.
	9) Extreme weather (i.e., thunderstorms, high winds, etc.).	9) The Site Safety and Health Officer will stop all site work during extreme weather that may risk the safety of workers. If lightning is reported or spotted within 5 miles of the Site, secure all equipment and seek appropriate shelter.
	10) Exposure to natural hazards (i.e., sunburn, wildlife, insect bites/stings, poisonous plants, etc.).	10) Wear appropriate clothing to minimize exposed skin. Be aware of wildlife, insect, and poisonous plant hazards. Use sunscreen on areas that are not covered adequately by clothing. Use insect repellent in areas where ticks are prevalent and check for ticks frequently. Avoid contact with wild or stray animals.
	11) Eye injuries	11) Wear eye protection when using chemicals that can injure your eyes. Pour water from buckets slowly to avoid splashing.

Equipment to be used	Inspection Requirements	Training Requirements
1) Vehicles	1) Inspect all equipment before use; refer to manufacturer's inspection requirements, if appropriate. Listen for a working backup signal on heavy equipment.	1) Valid operator's license for the class of vehicle.
2) Photoionization detector	2) Inspect and calibrate instrument daily when in use.	2) Training for operating and calibrating a photoionization detector.
3) Containers for waste soil and groundwater	3) Inspect containment vessel or structure before use for holes or weak areas.	3) No specific training required.

Activity No. 2. Logging soils during soil boring and well installation VHB/February 2021
General: Review HASP and Activity Hazard Analysis; Hazardous Waste Operations and Emergency Response training per 29 CFR 1910.120; Initial site/task specific training; Project initiation safety meeting and optional daily safety meetings.

Activity No. 3. Monitoring well development, groundwater sampling VHB/February 2021		
Principal Activities	Potential Safety/Health Hazards	Recommended Controls
Use a high-flow submersible pump or surge device to develop groundwater monitoring wells. Purge and collect groundwater samples from wells using low-flow sampling techniques. Transfer purge water and decontamination water to storage containers at the investigation derived waste storage area	*Chemical Hazards:*	
	1) Contact with contaminated groundwater or soil	1) Use PPE during intrusive activities in source areas (modified Level D) to limit contact risk. Properly manage contaminated sediment and decontamination water. Review SDS for known or suspected chemicals of potential concern.
	Physical Hazards:	
	1) Impact	1) Wear a reflective safety vest and hard hat around heavy machinery. Secure heavy items during transport such as monitoring equipment.
	2) Operating on unstable surfaces	2) Clear debris and vegetation from areas to be traveled.
	3) Penetration	3) Wear appropriate clothes, gloves, and footwear when using cutting tools, and wear eye protection when moving through trees and underbrush. When cutting, keep your body and free hand out of the way, use only sharp blades so you can reduce the force required, and secure thick material so it doesn't slip.
	4) Slip, trip, and fall hazards.	4) Use safe work practices and good housekeeping: keep work area free of slippery walking surfaces and keep tools and materials from underfoot. When carrying equipment, identify a path that is clear of obstructions or remove obstacles in advance. On steep or slippery slopes, carry lighter loads.
	5) Heat stress	5) Check temperatures and relative humidity forecasts and plan to monitor for heat stress, as appropriate. Wear appropriate clothing for conditions.
	6) Extreme weather (i.e., thunderstorms, high winds, etc.).	6) The Site Safety Officer will stop all site work during extreme weather that may risk the safety of workers. If lightning is reported or spotted within 5 miles of the Site, secure all equipment and seek appropriate shelter.
	7) Exposure to natural hazards (i.e., sunburn, wildlife, insect bites/stings, poisonous plants, etc.).	7) Wear appropriate clothing to minimize exposed skin. Be aware of wildlife, insect and poisonous plant hazards. Use sunscreen on areas that are not covered adequately by clothing. Use insect repellent in areas where ticks are prevalent and check for ticks frequently and soon after leaving the Site. Avoid contact with wild or stray animals.
	8) Cuts and lacerations	8) Wear eye protection when moving through trees and underbrush.
	Electrical Hazards:	
	1) Monitoring equipment and batteries	1) Check that sampling pumps have a grounded multi-contact plug and receptable. Always use a ground-fault circuit interrupter (GFCI) with and extension cord in potentially hazardous conditions such as wet environments or outside
Equipment to be used	Inspection Requirements	Training Requirements
1) Vehicles and site equipment:	1) Inspect all equipment before use; refer to manufacturer's inspection requirements, if	1) Valid operator's license for the class of vehicle.

Pickup trucks Portable generator Batteries Electric pumps and compressors Flexible extension cords Hand tools	appropriate. Inspect flexible extension cords daily. Test GFCI circuits before use.	
2) Photoionization detector, water level indicator, downhole submersible pump, multi-parameter probe, turbidimeter, and sampling tubing.	2) Inspect and calibrate instrument daily when in use.	2) Training for operating and calibrating equipment.
3) Pre-preserved sample containers	3) Check the laboratory cooler upon arrival for caps on pre-preserved bottles and vials that may not be tight, resulting in leaking acid.	3) No specific training required.
4) Containers for purge water	4) Inspect containment vessel or structure before use for holes or weak areas.	4) No specific training required.
General: Review HASP and Activity Hazard Analysis; Hazardous Waste Operations and Emergency Response training per 29 CFR 1910.120; Initial site/task specific training; Project initiation safety meeting and optional daily safety meetings.		

Activity No. 4. Equipment and personnel decontamination VHB/February 2021		
Principal Activities	Potential Safety/Health Hazards	Recommended Controls
Decontaminating equipment that comes in contact with contaminated media. Properly managing and disposing of PPE. Collecting, handling, and managing decontamination residuals.	*Chemical Hazards:*	
	1) Potential inhalation and/or contact exposure to contaminated sediment.	1) Use PPE during intrusive activities in source areas (modified Level D) to limit contact risk. Properly capture and manage decontamination water. Cover buckets of water before transporting them. Pour water from buckets slowly to avoid splashing. Cover drums and storage containers tightly when not in use. Practice good hygiene: wash hands before eating and remove contaminated sediment from exposed skin and clothing before entering vehicles or leaving the site.
	2) Skin or eye damage from caustic or concentrated cleaners	2) Read the label and use PPE as necessary. Wash and rinse skin and clothing that has contacted cleaning chemicals.
	Physical Hazards:	
	1) Slip, trip, and fall hazards.	1) Use safe work practices and good housekeeping: keep work area free of slippery walking surfaces and keep tools and materials from underfoot. When carrying equipment and buckets, identify a path that is clear of obstructions or remove obstacles in advance.
	2) Strains and back injury from lifting heavy objects	2) Use proper techniques when lifting or moving heavy objects: bend at the knees, do not twist, and keep the load as close as possible. Know your limitations and use assistance to lift loads heavier than you can handle; use mechanical devices if possible.
	3) Cuts and lacerations	3) Wear appropriate clothes, gloves, and footwear when using cutting tools, and wear eye protection when moving through trees and underbrush. When cutting, keep your body and free hand out of the way, use only sharp blades so you can reduce the force required, and secure thick material so it doesn't slip.
	4) Eye injuries	4) Wear eye protection when using chemicals that can injure your eyes. Pour water from buckets slowly to avoid splashing.
Equipment to be used	Inspection Requirements	Training Requirements
Hand tools	1) Inspect all equipment before use	1) No specific training required.
General: Review HASP and Activity Hazard Analysis; Hazardous Waste Operations and Emergency Response training per 29 CFR 1910.120; Initial site/task specific training; Project initiation safety meeting and optional daily safety meetings.		

ATTACHMENT D

ACCIDENT INVESTIGATION FORM

SSO'S ACCIDENT INVESTIGATION REPORT

Injured Employee ______________________________ Job Title ________________________

Date/Time of Accident ____

Location of Accident____

Witnesses to the Accident ____

Injury Incurred? Nature of Injury ____

____

Engaged in What Task When Injured? ____

____

____

Will Lost Time Occur? How Long? Date Lost Time Began_______________

Were Other Persons Involved/Injured? ____

How Did the Accident Occur?____

____

____

____

What Could Be Done to Prevent Recurrence of the Accident? __________________________

____

____

____

What Actions Have You Taken Thus Far to Prevent Recurrence? ________________________

____

____

____

SSO's Signature: ____________________________ Date: ____________________________

SSO's Printed Name: ___________________________

Note: If the space provided on this form is insufficient, provide additional information on a separate page and attach.

ATTACHMENT E

CURRENT TRAINING CERTIFICATES

Personnel Verification of Clearance/Credentials		
Employee Name	**Training Certifications (e.g., OSHA HAZWOPER, First Aid/CPR, etc.) (Type, Date)**	**Issues/ Concerns**
Bob Osborne	OSHA 8-Hour HAZWOPER Supervisor Training, 03/2/2020 Asbestos Awareness Training 01/27/2021	
Ben Deede	OSHA 8-Hour HAZWOPER Refresher, 09/10/2020 Asbestos Awareness Training 01/27/2020	

ATTACHMENT F

SAFETY AUDIT CHECKLIST

PROJECT MANAGER'S
SITE SAFETY AUDIT CHECKLIST

I. GENERAL INSTRUCTIONS

1. As a minimum answer all questions included in the general section by checking “yes”, “no” or “NA”
2. All questions with a ”no” answer must be supported by corrective action.
3. Safety areas specific to a particular site or project must be audited per site specific sections.
4. This audit is not defined as “Completed” until all noted corrective action is successfully implemented.
5. To print a copy of this audit checklist, select File, Print, Entire Workbook, OK.

II. TABLE OF CONTENTS

PROJECT MANAGER'S

SITE SAFETY AUDIT CHECKLIST

Project Name:	Date:		
Site Location:			
Auditor Name/Title:			
GENERAL SECTION	Yes	No	N/A
1. Is a site specific "Health & Safety Plan" current and readily available?			
2. Is the project site clean, sanitary and orderly?			
3. Are working/walking surfaces kept dry or measures taken to make them slip resistant?			
4. Are all work areas adequately illuminated?			
6. Is everyone on site registered in a central location?			
7. Is documentation available to verify daily safety meeting attendance for all personnel?			
8. Are first aid kits fully stocked and readily available?			
9. Are emergency phone numbers clearly visible and easily accessible?			
10. Is a map to the nearest hospital current and easily accessible?			
11.Are all workers within a work zone wearing the appropriate PPE?			
12. Is there an on site emergency procedure with signals and evacuation routes?			
13. Is there easy accessible working communication with off-site emergency personnel?			
14. Is there a procedure for decontamination and/or PPE disposal?			
15. Is fire equipment fully stocked, easily accessible and ready for use?			
17. Is there someone on site certified to perform CPR?			
18. Is there someone on site certified to perform First Aid?			
19. Is there a procedure in place to calibrate monitoring equipment?			
20. Are MSDS sheets for all materials on-site accessible to all workers? Common petroleum products excepted.			
21. Are all containers properly marked and labeled?			
22. Has the fire department been notified of on-site fire hazards and activities?			

23. Are fire extinguishers located near fire hazard areas?			
24. Are stairs and floor openings properly guarded?			
25. Have physical hazards specific to this site been identified, ex: wildlife, terrain, etc.			
26.Are workers aware of the hazards involved with various materials on site?			
27.Are caution labels and signs used to warn of hazardous substances?			
28.Are workers exposed to hazards of nearby traffic required to wear warning vests?			
29. Is appropriate foot protection required where risk of foot injury is prevalent?			
30.Are stairs/bridges for walkways provided over pipelines or similar hazards?			
31.Was the emergency response procedure discussed during the site safety orientation?			
32.Are all floor openings guarded by a guardrail or equivalent on all sides?			
33.Is required headroom provided where necessary?			
34.Are all exits kept free of obstructions?			

CORRECTIVE ACTION
Audit Section & Item Number: Corrective Action & date completed:
Audit Section & Item Number: Corrective Action & date completed:

PROJECT MANAGER'S

SITE SAFETY AUDIT CHECKLIST

SITE SPECIFIC	Yes	No	N/A
SECTION: MATERIAL HANDLING AND STORAGE			
1. Are materials on-site stored safely minimizing falling hazards and/or blockage of exits?			
2. Is there containment provided under hazardous material storage containers?			
3. Are drums / containers in good condition?			
4. Are compressed gas tanks stored secure and upright?			
5. Are cylinders protected from rain or snow?			
6. Are the cylinders capped when not in use?			
7. Are containers separated by dunnage sufficient to provide stability during movement?			
SECTION: EXCAVATION AND SHORING			
1. Have permits been acquired approving excavation work?			
2. Have all underground utilities been marked prior to excavating?			
3. Is there a Certified Excavation Competent Person on-site at all times during work hours?			
4. Are there ladders and / or ramps located at 50 ft intervals inside the excavation?			
5. Are there excavation spoils located at least 2-feet away from the edge of the excavation?			
6. Is there monitoring of the air within the excavation to identify dangerous conditions?			
7. Is equipment kept a safe distance away from the edge of the excavation?			
8. Are OSHA approved Trench Boxes used in the excavation?			
9. Are warning signs posted around the excavation?			
10.Is the excavation secured to prevent unauthorized access during non-working hours?			
11.Have procedures been followed to properly slope, shore and barricade the excavation?			
SECTION: DRILLING/SOIL PROBING			
1. All employees wearing appropriate PPE (hardhat, safety boots, gloves, hearing prot., safety glasses,)?			
2. Work areas and platforms free of materials, debris, and substances such as ice, grease or oil?			

3. All hand tools used for there intended purpose?			
4. All emergency shut-offs checked prior to beginning drilling operation?			
5. Before raising the mast (derrick) clear personnel from rear and sides of rig?			
6. Before raising the mast (derrick) check overhead clearance?			
7. Minimum set-back from overhead and underground utilities maintained?			
8. Is a safety device used when ascending or descending the derrick?			
9. Has the utility one-call clearance system been contacted?			
10. Are all underground utilities marked?			
11. All wire lines and fittings inspected for wear and abrasion prior to use?			
12. Is the cathead clean and free of rust, oil and grease?			
13. Is a clean, dry, sound cathead rope being used?			
14. Cathead rope properly handled (never wrap around a hand, wrist, arm, foot, etc...)?			
15. Proper cutting removal procedure followed?			
(never use hands or feet to move cuttings, never shovel or remove cuttings from rotating augers)			

CORRECTIVE ACTION
Audit Section & Item Number: Corrective Action & date completed:
Audit Section & Item Number: Corrective Action & date completed:
Audit Section & Item Number: Corrective Action & date completed:
Audit Section & Item Number: Corrective Action & date completed:

SITE SPECIFIC	Yes	No	N/A
SECTION: LADDERS AND SCAFFOLDING			
1. Are portable ladders tied, blocked or secured?			
2. Does ladder exceed maximum length?			
3. Are safety feet installed on all ladders?			
4. Are non-metal ladders used when conducting electrical work?			
5. Has scaffolding been inspected and tagged?			
6. Are all scaffolding braces in place and secured?			
7. Is platform planking in place and secured?			
8. Does the planking overlap a minimum of 12 inches?			
9. Does the planking extend over the end support between 16-18 inches?			
10.Does the scaffolding height exceed 4 times the base dimension or width?			
11.Is the platform planking secured from movement?			
12.Is fall protection used at heights greater than 6' in the absence of standard railing?			
13.Are toe boards utilized when performing work at elevated heights?			
14.Is the work area free of debris, snow, grease etc.?			
15.Are employees restricted from working on scaffolding during high winds?			
16.Are all pins in place and wheels locked?			
17.Are all ladders maintained in good condition			
18.Is there a 3' extension above the elevated surface when using a portable rung ladder?			
19.Is there an appropriate electrical caution label for metal ladders?			
SECTION: MOTOR VEHICLES AND HEAVY EQUIPMENT			
1. Are first aid kits, fire extinguishers and eye washes in all on-site vehicles?			
2. Do all vehicles have seat belts?			
3. Are workers using seat belts when operating vehicle?			
4. Are vehicles engines turned off prior to fueling?			

5. Are all vehicles and equipment in safe operating condition?			
6. Are vehicles in need of repair tagged out and reported to supervision?			
7. Does all heavy equipment have backup alarms?			
8. Does all heavy equipment have inspection logs, load chart and a fire extinguisher?			
9. Are operators practicing safe operating procedures?			
10.Does each operator have proper licensing to operate vehicles?			
11.Is there a safe distance between power lines and working vehicles?			
12.Are loads lower than the rated load for hoisting equipment?			

CORRECTIVE ACTION
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SITE SPECIFIC	Yes	No	N/A
SECTION: ELECTRICAL WORK			
1. Are the electrical tools in proper working condition?			
2. Are extension cords in proper working condition?			
3. Are all work areas protected by GFCI? Generators <4 KW are excepted.			
4. Are extension cords kept out of wet areas?			
5. Are cords taped or secured down in the walkways?			
6. Are the cords the correct gauge for the equipment?			
7. Is equipment and structures properly grounded?			
8. Are lines properly tagged as high & low voltage?			
9. Are terminal boxes covered?			
10.Are proper guards installed on tools?			
11.Are the permits or procedures on-site allowing for lock out/tag out?			
12.Are portable electrical tools grounded or of the double insulated type?			
13.Are multiple plug adapters prohibited?			
14.Are employees prohibited from working alone on energized equipment lines / equipment of 600V ?			
15.Are electrical enclosures provided with tight-fitting covers or plates?			
16.Are all electrical raceways and enclosures securely fastened in place?			
17.Are all disconnecting switches and circuit breakers labeled to indicate their use?			
18.Is the use of metal ladders prohibited for areas of potential contact with energized equipment?			
SECTION: WELDING AND CUTTING			
1. Has a hot work permit been obtained?			
2. Are fuel gas and oxygen separated by at least 20 feet in storage?			
3. Are work and electrode lead cables frequently inspected for wear and damage?			
4. Are flow gauges and regulators in good condition and removed when not in use?			

5. Are back flow check valves on oxy/acetylene?			
6. Are only trained personnel allowed to use welding equipment?			
7. Are welding machines properly grounded?			
8. Are welders and helpers using the correct PPE? (UV protection, spark, etc...)			
9. Are fire extinguishers provided in work area?			
10.Are compressed gas cylinders regularly examined for defects, deep rusting, or leakage?			
11.Are cylinders kept away from sources of heat?			
12.Are signs posted to read: DANGER-NO SMOKING, MATCHES OR OPENLIGHTS?			
13.Are regulators removed and valve-protection caps in place prior to moving cylinder?			
14.Are fire watches assigned in locations with a high potential for a serious fire could occur?			
15.Has the location where welding will occur been checked for adequate ventilation?			

CORRECTIVE ACTION
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Audit Section & Item Number: Corrective Action & date completed:

SITE SPECIFIC	Yes	No	N/A
SECTION: RESPIRATORY PROTECTION			
1. Are workers who use respiratory protection trained to use it?			
2. Are workers who use respiratory protection fit tested?			
4. Are replacement cartridges and respirators easily accessible to all workers?			
5. Does compressed breathing air meet CGA Grade "D" Medical Breathing Air requirements?			
6. Are 5-minute air escape packs properly maintained for emergency use?			
7. Are 5-minute air escape packs easily accessible to all workers?			
8. Are users of supplied air properly trained for use?			
SECTION: NOISE			
1. Has areas on site where continuous noise levels exceed 85dBA been identified?			
2. Are noise levels being recorded by a sound level meter, or octave band analyzer?			
3. Are specific controls being utilized to reduce or minimize exposure to noise?			
4. Is approved hearing protection equipment being properly utilized by workers?			
SECTION: FLAMMABLE AND COMBUSTIBLES			
1. Are covered metal waste cans used for oily or flammable waste?			
2. Are flammable materials safely dispensed, stored and disposed?			
3. Is proper storage practiced to minimize the risk of fire including spontaneous combustion?			
4. Are fuel gas and oxygen cylinders separated by appropriate distance when stored?			
5. Are appropriate fire extinguishers located 75' outside areas containing flammable liquids?			
6. Are appropriate fire extinguishers located within 10' of any inside storage area?			
7. Are "NO SMOKING" signs near areas containing flammable or combustible materials?			

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Audit Section & Item Number: Corrective Action & date completed:

ENVIRONMENTAL	Yes	No	N/A
SECTION: PERMITTING			
1. Are NPDES permits current and available?			
2. Have all discrete discharge points been identified and covered under the NPDES permit?			
3. Are vapor and water discharge monitoring reports readily available?			
4. Has NPDES sampling been conducted according to schedule and correct parameters analyzed?			
5. Have all permit exceedance requirements been complied with?			
6. Is proof of scheduled payment of permit fee maintained on file?			
SECTION: WASTE RECYCLE / MINIMIZATION / MANAGEMENT			
1. Have potential re-use, recycling and reclamation options been evaluated for waste disposal?			
2. Have all waste generated by the project been removed off site within 90 days?			
3. Has the PM received a copy of the waste disposal manifest that verifies facility acceptance?			
4. Has a copy of the completed waste disposal manifest been forwarded to the state agency?			

CORRECTIVE ACTION SECTION
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ATTACHMENT G

HEALTH EFFECTS OF CONTAMINANTS OF POTENTIAL CONCERN

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ARSENIC

CAS # 7440-38-2

Division of Toxicology and Environmental Medicine ToxFAQs™ **August 2007**

This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

❏ Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
❏ Arsenic cannot be destroyed in the environment. It can only change its form.
❏ Rain and snow remove arsenic dust particles from the air.
❏ Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
❏ Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

❏ Ingesting small amounts present in your food and water or breathing air containing arsenic.
❏ Breathing sawdust or burning smoke from wood treated with arsenic.
❏ Living in areas with unusually high natural levels of arsenic in rock.
❏ Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

ARSENIC
CAS # 7440-38-2

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How can arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce the risks of exposure to arsenic?

❏ If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.

❏ If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.

❏ If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

BENZENE

CAS # 71-43-2

Division of Toxicology and Environmental Medicine ToxFAQs™ **August 2007**

This fact sheet answers the most frequently asked health questions (FAQs) about benzene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Benzene is a widely used chemical formed from both natural processes and human activities. Breathing benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia. Benzene has been found in at least 1,000 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is benzene?

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and other synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include emissions from volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

What happens to benzene when it enters the environment?

❏ Industrial processes are the main source of benzene in the environment.
❏ Benzene can pass into the air from water and soil.
❏ It reacts with other chemicals in the air and breaks down within a few days.
❏ Benzene in the air can attach to rain or snow and be carried back down to the ground.
❏ It breaks down more slowly in water and soil, and can pass through the soil into underground water.
❏ Benzene does not build up in plants or animals.

How might I be exposed to benzene?

❏ Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions.
❏ Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents, can also be a source of exposure.
❏ Air around hazardous waste sites or gas stations will contain higher levels of benzene.
❏ Working in industries that make or use benzene.

How can benzene affect my health?

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term exposure is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries, but we do not know for certain that benzene caused the effects. It is not known whether benzene will affect fertility in men.

How likely is benzene to cause cancer?

Long-term exposure to high levels of benzene in the air can cause leukemia, particularly acute myelogenous leukemia, often referred to as AML. This is a cancer of the blood-forming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Research on Cancer (IARC) and the EPA have determined that benzene is carcinogenic to humans.

How can benzene affect children?

Children can be affected by benzene exposure in the same ways as adults. It is not known if children are more susceptible to benzene poisoning than adults.

Benzene can pass from the mother's blood to a fetus. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

How can families reduce the risks of exposure to benzene?

Benzene exposure can be reduced by limiting contact with gasoline and cigarette smoke. Families are encouraged not to smoke in their house, in enclosed environments, or near their children.

Is there a medical test to determine whether I've been exposed to benzene?

Several tests can show if you have been exposed to benzene. There is a test for measuring benzene in the breath; this test must be done shortly after exposure. Benzene can also be measured in the blood; however, since benzene disappears rapidly from the blood, this test is only useful for recent exposures.

In the body, benzene is converted to products called metabolites. Certain metabolites can be measured in the urine. The metabolite S-phenylmercapturic acid in urine is a sensitive indicator of benzene exposure. However, this test must be done shortly after exposure and is not a reliable indicator of how much benzene you have been exposed to, since the metabolites may be present in urine from other sources.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum permissible level of benzene in drinking water at 5 parts benzene per billion parts of water (5 ppb).

The Occupational Safety and Health Administration (OSHA) has set limits of 1 part benzene per million parts of workplace air (1 ppm) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Benzene (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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BERYLLIUM
CAS #7440-41-7

Division of Toxicology ToxFAQs™ **September 2002**

This fact sheet answers the most frequently asked health questions (FAQs) about beryllium. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: People working or living near beryllium industries have the greatest potential for exposure to beryllium. Lung damage has been observed in people exposed to high levels of beryllium in the air. About 1-15% of all people occupationally-exposed to beryllium in air become sensitive to beryllium and may develop chronic beryllium disease (CBD), an irreversible and sometimes fatal scarring of the lungs. CBD may be completely asymptomatic or begin with coughing, chest pain, shortness of breath, weakness, and/or fatigue. Beryllium has been found in at least 535 of the 1,613 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is beryllium?
Beryllium is a hard, grayish metal naturally found in mineral rocks, coal, soil, and volcanic dust. Beryllium ore is mined, and the beryllium is purified for use in nuclear weapons and reactors, aircraft and space vehicle structures, instruments, x-ray machines, and mirrors. Beryllium oxide is used to make speciality ceramics for electrical and high-technology applications. Beryllium alloys are used in automobiles, computers, sports equipment (golf clubs), and dental bridges.

What happens to beryllium when it enters the environment?
❑ Beryllium dust enters the air from burning coal and oil. This beryllium dust will eventually settle over the land and water.
❑ It enters water from erosion of rocks and soil, and from industrial waste. Some beryllium compounds will dissolve in water, but most stick to particles and settle to the bottom.
❑ Most beryllium in soil does not dissolve in water and remains bound to soil.
❑ Beryllium does not accumulate in the food chain.

How might I be exposed to beryllium?
❑ The general population is normally exposed to low levels of beryllium in air, food, and water.
❑ People working in industries where beryllium is mined, processed, machined, or converted into metal, alloys, and other chemicals may be exposed to high levels of beryllium. People living near these industries may also be exposed to higher than normal levels of beryllium in air.
❑ People living near uncontrolled hazardous waste sites may be exposed to higher than normal levels of beryllium.

How can beryllium affect my health?
Beryllium can be harmful if you breathe it. The effects depend on how much you are exposed to, for how long, and individual susceptibility. If beryllium air levels are high enough (greater than 1000 $\mu g/m^3$), an acute condition can result. This condition resembles pneumonia and is called acute beryllium disease Occupational and community air standards are effective in preventing acute lung damage.

Some exposed workers (1-15%) become sensitive to beryllium. These individuals may develop an inflammatory reaction in the respiratory system. This condition is called chronic beryllium disease (CBD), and can occur years after exposure to higher than normal levels of beryllium (greater than 0.2 $\mu g/m^3$). This disease can make you feel weak and tired, and can cause difficulty in breathing. It can also result in anorexia, weight loss, and may also lead to right side heart enlargement and heart disease in advanced cases. Some people who are sensitized to beryllium may not have any symptoms. The general population is unlikely to develop chronic beryllium disease because ambient air levels of beryllium are normally very low (0.00003-0.0002 ug/m^3).

Swallowing beryllium has not been reported to cause effects in humans because very little beryllium is absorbed from the stomach and intestines. Ulcers have been seen in dogs ingesting beryllium in the diet. Beryllium contact with skin that has been scraped or cut may cause rashes or ulcers.

How likely is beryllium to cause cancer?

Long term exposure to beryllium can increase the risk of developing lung cancer in people.

The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have determined that beryllium is a human carcinogen. The EPA has determined that beryllium is a probable human carcinogen. EPA has estimated that lifetime exposure to 0.04 ug/m^3 beryllium can result in a one in a thousand chance of developing cancer.

How can beryllium affect children?

It is likely that the health effects seen in children exposed to beryllium will be similar to the effects seen in adults. We do not know whether children differ from adults in their susceptibility to beryllium.

We do not know if exposure to beryllium will result in birth defects or other developmental effects in people. The studies on developmental effects in animals are not conclusive.

How can families reduce the risk of exposure to beryllium?

❑ Individuals working at facilities that use beryllium should make sure that contaminated clothing and objects are not brought home.

❑ Children should avoid playing in soils near uncontrolled hazardous waste sites where beryllium may have been discarded.

Is there a medical test to show whether I've been exposed to beryllium?

Beryllium can be measured in samples from your blood, urine, skin, or lungs. These tests are rarely done because they are not reliable measures of your exposure over time. Also, these tests do not show if you have become sensitized to beryllium.

Another test, the beryllium lymphocyte proliferation test (BeLPT), can help your doctor decide if you are sensitized to beryllium. This test is only done in a few specialized laboratories, but doctors familiar with the test can collect blood samples and send them for testing by overnight carrier. The BeLPT is most often done for people who work with beryllium. It is also useful for separating chronic beryllium disease from diagnoses that resemble it (for example, sarcoidosis). Depending on your exposure history, clinical findings, and test results, your doctor may also recommend additional specialized testing.

Has the federal government made recommendations to protect human health?

The EPA restricts the amount of beryllium that industries may release into the air to 0.01 ug/m^3, averaged over a 30-day period.

The Occupational Safety and Health Administration (OSHA) sets a limit of 2 ug/m^3 for an 8-hour work shift measured as a personal sample.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Toxicological Profile for Beryllium Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Ethylbenzene- ToxFAQs™

CAS # 100-41-4

This fact sheet answers the most frequently asked health questions (FAQs) about ethylbenzene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Ethylbenzene is a colorless liquid found in a number of products including gasoline and paints. Breathing very high levels can cause dizziness and throat and eye irritation. Breathing lower levels has resulted in hearing effects and kidney damage in animals. Ethylbenzene has been found in at least 829 of 1,699 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is ethylbenzene?

Ethylbenzene is a colorless, flammable liquid that smells like gasoline.

It is naturally found in coal tar and petroleum and is also found in manufactured products such as inks, pesticides, and paints.

Ethylbenzene is used primarily to make another chemical, styrene. Other uses include as a solvent, in fuels, and to make other chemicals.

What happens to ethylbenzene when it enters the environment?

- Ethylbenzene moves easily into the air from water and soil.
- It takes about 3 days for ethylbenzene to be broken down in air into other chemicals.
- In surface water, ethylbenzene breaks down by reacting with other chemicals found naturally in water.
- Ethylbenzene can move through soil into groundwater.
- In soil, it is broken down by bacteria.

How might I be exposed to ethylbenzene?

- If you live in a city or near many factories or heavily traveled highways, you may be exposed to ethylbenzene in air.
- Releases of ethylbenzene into the air occur from burning oil, gas, and coal and from industries using ethylbenzene.
- Ethylbenzene is not often found in drinking water. Higher levels may be found in residential drinking water wells near landfills, waste sites, or leaking underground fuel storage tanks.
- Exposure can occur if you work in an industry where ethylbenzene is used or made.
- Exposure can occur if you use products containing it, such as gasoline, carpet glues, varnishes, and paints.

How can ethylbenzene affect my health?

Exposure to high levels of ethylbenzene in air for short periods can cause eye and throat irritation. Exposure to higher levels can result in dizziness.

Irreversible damage to the inner ear and hearing has been observed in animals exposed to relatively low concentrations of ethylbenzene for several days to weeks.

Exposure to relatively low concentrations of ethylbenzene in air for several months to years causes kidney damage in animals.

How likely is ethylbenzene to cause cancer?

The International Agency for Research on Cancer (IARC) has determined that ethylbenzene is a possible human carcinogen.

Ethylbenzene

CAS # 100-41-4

How does ethylbenzene affect children?

There are no studies evaluating the effects of ethylbenzene exposure on children or immature animals. It is likely that children would have the same health effects as adults. We do not know whether children would be more sensitive than adults to the effects of ethylbenzene.

We do not know if ethylbenzene will cause birth defects in humans. Minor birth defects and low birth weight have occurred in newborn animals whose mothers were exposed to ethylbenzene in air during pregnancy.

How can families reduce the risk of exposure to ethylbenzene?

- Use adequate ventilation to reduce exposure to ethylbenzene vapors from consumer products such as gasoline, pesticides, varnishes and paints, and newly installed carpeting.
- Sometimes older children sniff household chemicals, including ethylbenzene, in an attempt to get high. Talk with your children about the dangers of sniffing chemicals.
- Household chemicals should be stored out of reach of children to prevent accidental poisoning. Always store household chemicals in their original containers; never store them in containers that children would find attractive to eat or drink from, such as old soda bottles. Gasoline should be stored in a gasoline can with a locked cap.

Is there a medical test to show whether I've been exposed to ethylbenzene?

Ethylbenzene is found in the blood, urine, breath, and some body tissues of exposed people. The most common way to test for ethylbenzene is in the urine. This test measures substances formed by the breakdown of ethylbenzene. Because these substances leave the body very quickly, this test needs to be done within a few hours after exposure occurs.

These tests can show you were exposed to ethylbenzene, but cannot predict the kind of health effects that might occur.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to ethylbenzene in drinking water at concentrations of 30 mg/L for 1 day or 3 mg/L for 10 days is not expected to cause any adverse effects in a child.

The EPA has determined that lifetime exposure to 0.7 mg/L ethylbenzene is not expected to cause any adverse effects.

The Occupational Health and Safety Administration (OSHA) has limited workers' exposure to an average of 100 ppm for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Toxicological Profile for Ethylbenzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Mercury - ToxFAQs™

CAS # 7439-97-6

This fact sheet answers the most frequently asked health questions (FAQs) about mercury. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at high levels, may damage the brain, kidneys, and developing fetus. This chemical has been found in at least 714 of 1,467 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is mercury?

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas.

Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make.

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, some dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

What happens to mercury when it enters the environment?

- Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants.
- It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity.
- Methylmercury may be formed in water and soil by small organisms called bacteria.
- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

How might I be exposed to mercury?

- Eating fish or shellfish contaminated with methylmercury.
- Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fossil fuels.
- Release of mercury from dental work and medical treatments.
- Breathing contaminated workplace air or skin contact during use in the workplace.
- Practicing rituals that include mercury.

How can mercury affect my health?

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

Mercury

CAS # 7439-97-6

How likely is mercury to cause cancer?

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney tumors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

How can mercury affect children?

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there, possibly causing damage to the developing nervous system. It can also pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Mercury's harmful effects that may affect the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

How can families reduce the risk of exposure to mercury?

Carefully handle and dispose of products that contain mercury, such as thermometers or fluorescent light bulbs. Do not vacuum up spilled mercury, because it will vaporize and increase exposure. If a large amount of mercury has been spilled, contact your health department. Teach children not to play with shiny, silver liquids.

Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children.

Pregnant women and children should keep away from rooms where liquid mercury has been used.

Learn about wildlife and fish advisories in your area from your public health or natural resources department.

Is there a medical test to determine whether I've been exposed to mercury?

Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Mercury in whole blood or in scalp hair is measured to determine exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2 parts of mercury per billion parts of drinking water (2 ppb).

The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part of methylmercury in a million parts of seafood (1 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic meter of workplace air (0.1 mg/m^3) and 0.05 mg/m^3 of metallic mercury vapor for 8-hour shifts and 40-hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

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POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

Agency for Toxic Substances and Disease Registry ToxFAQs September 1996

This fact sheet answers the most frequently asked health questions (FAQs) about polycyclic aromatic hydrocarbons (PAHs). For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing air contaminated by wild fires or coal tar, or by eating foods that have been grilled. PAHs have been found in at least 600 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are polycyclic aromatic hydrocarbons?

(Pronounced pŏl′ĭ-sī′klĭk ăr′ə-măt′ĭk hī′drə-kar′bənz)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

What happens to PAHs when they enter the environment?

- ❑ PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- ❑ PAHs can occur in air attached to dust particles.
- ❑ Some PAH particles can readily evaporate into the air from soil or surface waters.
- ❑ PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days to weeks.
- ❑ PAHs enter water through discharges from industrial and wastewater treatment plants.
- ❑ Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- ❑ Microorganisms can break down PAHs in soil or water after a period of weeks to months.
- ❑ In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- ❑ PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live.

How might I be exposed to PAHs?

- ❑ Breathing air containing PAHs in the workplace of coking, coal-tar, and asphalt production plants; smokehouses; and municipal trash incineration facilities.
- ❑ Breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts, asphalt roads, or agricultural burn smoke.
- ❑ Coming in contact with air, water, or soil near hazardous waste sites.
- ❑ Eating grilled or charred meats; contaminated cereals, flour, bread, vegetables, fruits, meats; and processed or pickled foods.
- ❑ Drinking contaminated water or cow's milk.

- Nursing infants of mothers living near hazardous waste sites may be exposed to PAHs through their mother's milk.

How can PAHs affect my health?

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people.

Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

How likely are PAHs to cause cancer?

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.

Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Is there a medical test to show whether I've been exposed to PAHs?

In the body, PAHs are changed into chemicals that can attach to substances within the body. There are special tests that can detect PAHs attached to these substances in body tissues or blood. However, these tests cannot tell whether any health effects will occur or find out the extent or source of your exposure to the PAHs. The tests aren't usually available in your doctor's office because special equipment is needed to conduct them.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 milligrams of PAHs per cubic meter of air (0.2 mg/m^3). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist that contains PAHs is 5 mg/m^3 averaged over an 8-hour exposure period.

The National Institute for Occupational Safety and Health (NIOSH) recommends that the average workplace air levels for coal tar products not exceed 0.1 mg/m^3 for a 10-hour workday, within a 40-hour workweek. There are other limits for workplace exposure for things that contain PAHs, such as coal, coal tar, and mineral oil.

Glossary

Carcinogen: A substance that can cause cancer.

Ingest: Take food or drink into your body.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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POLYCHLORINATED BIPHENYLS

Division of Toxicology ToxFAQs™ **February 2001**

This fact sheet answers the most frequently asked health questions (FAQs) about polychlorinated biphenyls. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Polychlorinated biphenyls (PCBs) are a mixture of individual chemicals which are no longer produced in the United States, but are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. PCBs have been found in at least 500 of the 1,598 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are polychlorinated biphenyls?

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

What happens to PCBs when they enter the environment?

❏ PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs.
❏ PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators.
❏ PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil.
❏ PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

How might I be exposed to PCBs?

❏ Using old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure.
❏ Eating contaminated food. The main dietary sources of PCBs are fish (especially sportfish caught in contaminated lakes or rivers), meat, and dairy products.
❏ Breathing air near hazardous waste sites and drinking contaminated well water.
❏ In the workplace during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials.

How can PCBs affect my health?

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs.

Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

How likely are PCBs to cause cancer?

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. The EPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans.

How can PCBs affect children?

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

How can families reduce the risk of exposure to PCBs?

❏ You and your children may be exposed to PCBs by eating fish or wildlife caught from contaminated locations. Certain states, Native American tribes, and U.S. territories have issued advisories to warn people about PCB-contaminated fish and fish-eating wildlife. You can reduce your family's exposure to PCBs by obeying these advisories.

❏ Children should be told not play with old appliances, electrical equipment, or transformers, since they may contain PCBs.

❏ Children should be discouraged from playing in the dirt near hazardous waste sites and in areas where there was a transformer fire. Children should also be discouraged from eating dirt and putting dirty hands, toys or other objects in their mouths, and should wash hands frequently.

❏ If you are exposed to PCBs in the workplace it is possible to carry them home on your clothes, body, or tools. If this is the case, you should shower and change clothing before leaving work, and your work clothes should be kept separate from other clothes and laundered separately.

Is there a medical test to show whether I've been exposed to PCBs?

Tests exist to measure levels of PCBs in your blood, body fat, and breast milk, but these are not routinely conducted. Most people normally have low levels of PCBs in their body because nearly everyone has been environmentally exposed to PCBs. The tests can show if your PCB levels are elevated, which would indicate past exposure to above-normal levels of PCBs, but cannot determine when or how long you were exposed or whether you will develop health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.0005 milligrams of PCBs per liter of drinking water (0.0005 mg/L). Discharges, spills or accidental releases of 1 pound or more of PCBs into the environment must be reported to the EPA. The Food and Drug Administration (FDA) requires that infant foods, eggs, milk and other dairy products, fish and shellfish, poultry and red meat contain no more than 0.2-3 parts of PCBs per million parts (0.2-3 ppm) of food. Many states have established fish and wildlife consumption advisories for PCBs.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html . ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Aldrin and Dieldrin- ToxFAQs™

CAS # 309-00-2 and 60-57-1

This fact sheet answers the most frequently asked health questions (FAQs) about aldrin and dieldrin. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to aldrin and dieldrin happens mostly from eating contaminated foods, such as root crops, fish, or seafood. Aldrin and dieldrin build up in the body after years of exposure and can affect the nervous system. Aldrin has been found in at least 207 of the 1,613 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA). Dieldrin has been found in at least 287 of the 1,613 sites.

What are aldrin and dieldrin?

Aldrin and dieldrin are insecticides with similar chemical structures. They are discussed together in this fact sheet because aldrin quickly breaks down to dieldrin in the body and in the environment. Pure aldrin and dieldrin are white powders with a mild chemical odor. The less pure commercial powders have a tan color. Neither substance occurs naturally in the environment.

From the 1950s until 1970, aldrin and dieldrin were widely used pesticides for crops like corn and cotton. Because of concerns about damage to the environment and potentially to human health, EPA banned all uses of aldrin and dieldrin in 1974, except to control termites. In 1987, EPA banned all uses.

What happens to aldrin and dieldrin when they enter the environment?

- Sunlight and bacteria change aldrin to dieldrin so that we mostly find dieldrin in the environment.
- They bind tightly to soil and slowly evaporate to the air.
- Dieldrin in soil and water breaks down very slowly.
- Plants take in and store aldrin and dieldrin from the soil.
- Aldrin rapidly changes to dieldrin in plants and animals.
- Dieldrin is stored in the fat and leaves the body very slowly.

How might I be exposed to aldrin or dieldrin?

- Dieldrin is everywhere in the environment, but at very low levels.
- Eating food like fish or shellfish from lakes or streams contaminated with either chemical, or contaminated root crops, dairy products, or meats.
- Air, surface water, or soil near waste sites may contain higher levels.
- Living in homes that were once treated with aldrin or dieldrin to control termites.

How can aldrin and dieldrin affect my health?

People who have intentionally or accidentally ingested large amounts of aldrin or dieldrin have suffered convulsions and some died. Health effects may also occur after a longer period of exposure to smaller amounts because these chemicals build up in the body.

Some workers exposed to moderate levels in the air for a long time had headaches, dizziness, irritability, vomiting, and uncontrolled muscle movements. Workers removed from the source of exposure rapidly recovered from most of these effects.

Animals exposed to high amounts of aldrin or dieldrin also had nervous system effects. In animals, oral exposure to lower levels for a long period also affected the liver and decreased their ability to fight infections. We do not know whether aldrin or dieldrin affect the ability of people to fight disease.

Studies in animals have given conflicting results about whether aldrin and dieldrin affect reproduction in male animals and whether these chemicals may damage the sperm. We do not know whether aldrin or dieldrin affect reproduction in humans.

Aldrin and Dieldrin

CAS # 309-00-2 and 60-57-1

How likely are aldrin and dieldrin to cause cancer?

There is no conclusive evidence that aldrin or dieldrin cause cancer in humans. Aldrin and dieldrin have shown to cause liver cancer in mice. The International Agency for Research on Cancer (IARC) has determined that aldrin and dieldrin are not classifiable as to human carcinogenicity. The EPA has determined that aldrin and dieldrin are probable human carcinogens.

How can aldrin and dieldrin affect children?

Children can be exposed to aldrin and dieldrin in the same way as adults. There are no known unique exposure pathways for children. Children who swallowed amounts of aldrin or dieldrin much larger than those found in the environment suffered convulsions and some died, as occurred in adults. However, we do not know whether children are more susceptible than adults to the effects of aldrin or dieldrin.

We do not know whether aldrin or dieldrin cause birth defects in humans. Pregnant animals that ingested aldrin or dieldrin had some babies with low birth weight and some with alterations in the skeleton. Dieldrin has been found in human breast milk, therefore, it can be passed to suckling infants.

How can families reduce their risk for exposure to aldrin and dieldrin?

- Since aldrin and dieldrin are no longer produced or used, exposure to these compounds will occur only from past usage.
- Because aldrin and dieldrin were applied to the basement of some homes for termite protection, before buying a home families should investigate what, if any, pesticides have been used within the home.

Is there a medical test to show whether I've been exposed to aldrin and dieldrin?

There are laboratory tests that can measure aldrin and dieldrin in your blood, urine, and body tissues. Because aldrin changes to dieldrin fairly quickly in the body, the test has to be done shortly after you are exposed to aldrin. Since dieldrin can stay in the body for months, measurements of dieldrin can be made much longer after exposure to either aldrin or dieldrin. The tests cannot tell you whether harmful health effects will occur. These tests are not routinely available at the doctor's office because they require special equipment.

Has the federal government made recommendations to protect human health?

The EPA limits the amount of aldrin and dieldrin that may be present in drinking water to 0.001 and 0.002 milligrams per liter (mg/L) of water, respectively, for protection against health effects other than cancer. The EPA has determined that a concentration of aldrin and dieldrin of 0.0002 mg/L in drinking water limits the lifetime risk of developing cancer from exposure to each compound to 1 in 10,000.

The Occupational Safety and Health Administration (OSHA) sets a maximum average of 0.25 milligrams of aldrin and dieldrin per cubic meter of air (0.25 mg/m^3) in the workplace during an 8-hour shift, 40 hour week. The National Institute for Occupational Safety and Health (NIOSH) also recommends a limit of 0.25 mg/m^3 for both compounds for up to a 10-hour work day, 40-hour week.

The Food and Drug Administration (FDA) regulates the residues of aldrin and dieldrin in raw foods. The allowable range is from 0 to 0.1 ppm, depending on the type of food product.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Toxicological Profile for Aldrin/Dieldrin. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

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SELENIUM

CAS # 7782-49-2

Division of Toxicology ToxFAQs™ **September 2003**

This fact sheet answers the most frequently asked health questions (FAQs) about selenium. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: People may be exposed to low levels of selenium daily through food and water. Selenium is a trace mineral needed in small amounts for good health, but exposure to much higher levels can result in neurological effects and brittle hair and deformed nails. Occupational inhalation exposure to selenium vapors may cause dizziness, fatigue, irritation of mucous membranes, and respiratory effects. This substance has been found in at least 508 of the 1,636 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is selenium?

Selenium is a naturally occurring mineral element that is distributed widely in nature in most rocks and soils. In its pure form, it exists as metallic gray to black hexagonal crystals, but in nature it is usually combined with sulfide or with silver, copper, lead, and nickel minerals. Most processed selenium is used in the electronics industry, but it is also used: as a nutritional supplement; in the glass industry; as a component of pigments in plastics, paints, enamels, inks, and rubber; in the preparation of pharmaceuticals; as a nutritional feed additive for poultry and livestock; in pesticide formulations; in rubber production; as an ingredient in antidandruff shampoos; and as a constituent of fungicides. Radioactive selenium is used in diagnostic medicine.

What happens to selenium when it enters the environment?

❑ Selenium occurs naturally in the environment and can be released by both natural and manufacturing processes.
❑ Selenium dust can enter the air from burning coal and oil. This selenium dust will eventually settle over the land and water.
❑ It also enters water from rocks and soil, and from agricultural and industrial waste. Some selenium compounds will dissolve in water, and some will settle to the bottom as particles.
❑ Insoluble forms of selenium will remain in soil, but soluble forms are very mobile and may enter surface water from soils.
❑ Selenium may accumulate up the food chain.

How might I be exposed to selenium?

❑ The general population is exposed to very low levels of selenium in air, food, and water. The majority of the daily intake comes from food.
❑ People working in or living near industries where selenium is produced, processed, or converted into commercial products may be exposed to higher levels of selenium in the air.
❑ People living in the vicinity of hazardous waste sites or coal burning plants may also be exposed to higher levels of selenium.

How can selenium affect my health?

Selenium has both beneficial and harmful effects. Low doses of selenium are needed to maintain good health. However, exposure to high levels can cause adverse health effects. Short-term oral exposure to high concentrations of selenium may cause nausea, vomiting, and diarrhea. Chronic oral exposure to high concentrations of selenium compounds can produce a disease called selenosis. The major signs of selenosis are hair loss, nail brittleness, and neurological abnormalities (such as numbness and other odd sensations in the extremities).

Brief exposures to high levels of elemental selenium or selenium dioxide in air can result in respiratory tract irritation, bronchitis, difficulty breathing, and stomach pains. Longer-term exposure to either of these air-borne forms can cause respiratory irritation, bronchial spasms, and coughing.

Levels of these forms of selenium that would be necessary to produce such effects are normally not seen outside of the workplace.

Animal studies have shown that very high amounts of selenium can affect sperm production and the female reproductive cycle. We do not know if similar effects would occur in humans.

How likely is selenium to cause cancer?

Studies of laboratory animals and people show that most selenium compounds probably do not cause cancer. In fact, studies in humans suggest that lower-than-normal selenium levels in the diet might increase the risk of cancer.

The International Agency for Research on Cancer (IARC) has determined that selenium and selenium compounds are not classifiable as to their carcinogenicity to humans.

The EPA has determined that one specific form of selenium, selenium sulfide, is a probable human carcinogen. Selenium sulfide is not present in foods and is a very different chemical from the organic and inorganic selenium compounds found in foods and in the environment.

How can selenium affect children?

It is likely that the health effects seen in children exposed to selenium will be similar to the effects seen in adults. However, one study found that children may be less susceptible to the health effects of selenium than adults.

Selenium compounds have not been shown to cause birth defects in humans or in other mammals.

How can families reduce the risk of exposure to selenium?

❏ Certain dietary supplements and shampoos contain selenium; these should be used according to the manufacturer's directions.

❏ Children living near waste sites that contain selenium or coal burning plants should be encouraged to wash their hands before eating and to avoid putting their unwashed hands in their mouths.

Is there a medical test to show whether I've been exposed to selenium?

Low levels of selenium are normally found in body tissues and urine. Blood and urine tests for selenium are most useful for people who have recently been exposed to high levels. Toenail clippings can be used to determine longer-term exposure. These tests are not usually available at your doctor's office, but your doctor can send the samples to a laboratory that can perform the tests. None of these tests, however, can predict whether you will experience any health effects.

Has the federal government made recommendations to protect human health?

The EPA restricts the amount of selenium allowed in public water supplies to 50 parts total selenium per billion parts of water (50 ppb).

The Occupational Safety and Health Administration (OSHA) sets a limit of 0.2 mg selenium/m^3 of workroom air for an 8-hour work shift.

ATSDR and the EPA have determined that 5 micrograms of selenium per kilogram of body weight taken daily would not be expected to cause any adverse health effects over a lifetime of such intake.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. Toxicological Profile for Selenium (Update) Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

TOTAL PETROLEUM HYDROCARBONS (TPH)

Agency for Toxic Substances and Disease Registry ToxFAQs **August 1999**

This fact sheet answers the most frequently asked health questions (FAQs) about total petroleum hydrocarbons (TPH). For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: TPH is a mixture of many different compounds. Everyone is exposed to TPH from many sources, including gasoline pumps, spilled oil on pavement, and chemicals used at home or work. Some TPH compounds can affect your nervous system, causing headaches and dizziness. TPH has been found in at least 23 of the 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are total petroleum hydrocarbons?

(Pronounced tōt′l pə-trō′lē-əm hī′drə-kär′bənz)

Total petroleum hydrocarbons (TPH) is a term used to describe a large family of several hundred chemical compounds that originally come from crude oil. Crude oil is used to make petroleum products, which can contaminate the environment. Because there are so many different chemicals in crude oil and in other petroleum products, it is not practical to measure each one separately. However, it is useful to measure the total amount of TPH at a site.

TPH is a mixture of chemicals, but they are all made mainly from hydrogen and carbon, called hydrocarbons. Scientists divide TPH into groups of petroleum hydrocarbons that act alike in soil or water. These groups are called petroleum hydrocarbon fractions. Each fraction contains many individual chemicals.

Some chemicals that may be found in TPH are hexane, jet fuels, mineral oils, benzene, toluene, xylenes, naphthalene, and fluorene, as well as other petroleum products and gasoline components. However, it is likely that samples of TPH will contain only some, or a mixture, of these chemicals.

What happens to TPH when it enters the environment?

- ❑ TPH may enter the environment through accidents, from industrial releases, or as byproducts from commercial or private uses.
- ❑ TPH may be released directly into water through spills or leaks.
- ❑ Some TPH fractions will float on the water and form surface films.
- ❑ Other TPH fractions will sink to the bottom sediments.
- ❑ Bacteria and microorganisms in the water may break down some of the TPH fractions.
- ❑ Some TPH fractions will move into the soil where they may stay for a long time.

How might I be exposed to TPH?

- ❑ Everyone is exposed to TPH from many sources.
- ❑ Breathing air at gasoline stations, using chemicals at home or work, or using certain pesticides.
- ❑ Drinking water contaminated with TPH.
- ❑ Working in occupations that use petroleum products.
- ❑ Living in an area near a spill or leak of petroleum products.
- ❑ Touching soil contaminated with TPH.

How can TPH affect my health?

Some of the TPH compounds can affect your central nervous system. One compound can cause headaches and dizziness at high levels in the air. Another compound can cause a nerve disorder called "peripheral neuropathy," consisting of numbness in the feet and legs. Other TPH compounds can cause effects on the blood, immune system, lungs, skin, and eyes.

Animal studies have shown effects on the lungs, central nervous system, liver, and kidney from exposure to TPH compounds. Some TPH compounds have also been shown to affect reproduction and the developing fetus in animals.

How likely is TPH to cause cancer?

The International Agency for Research on Cancer (IARC) has determined that one TPH compound (benzene) is carcinogenic to humans. IARC has determined that other TPH compounds (benzo[a]pyrene and gasoline) are probably and possibly carcinogenic to humans. Most of the other TPH compounds are considered not to be classifiable by IARC.

Is there a medical test to show whether I've been exposed to TPH?

There is no medical test that shows if you have been exposed to TPH. However, there are methods to determine if you have been exposed to some TPH compounds. Exposure to kerosene can be determined by its smell on the breath or clothing. Benzene can be measured in exhaled air and a breakdown product of benzene can be measured in urine. Other TPH compounds can be measured in blood, urine, breath, and some body tissues.

Has the federal government made recommendations to protect human health?

There are no regulations or advisories specific to TPH. The following are recommendations for some of the TPH fractions and compounds:

The EPA requires that spills or accidental releases into the environment of 10 pounds or more of benzene be reported to the EPA.

The Occupational Safety and Health Administration has set an exposure limit of 500 parts of petroleum distillates per million parts of air (500 ppm) for an 8-hour workday, 40-hour workweek.

Glossary

Carcinogenicity: Ability to cause cancer.

CAS: Chemical Abstracts Service.

Immune system: Body organs and cells that fight disease.

Pesticides: Chemicals used to kill pests.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for total petroleum hydrocarbons (TPH). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATTACHMENT H

HEAT STRESS GUIDANCE

Introduction

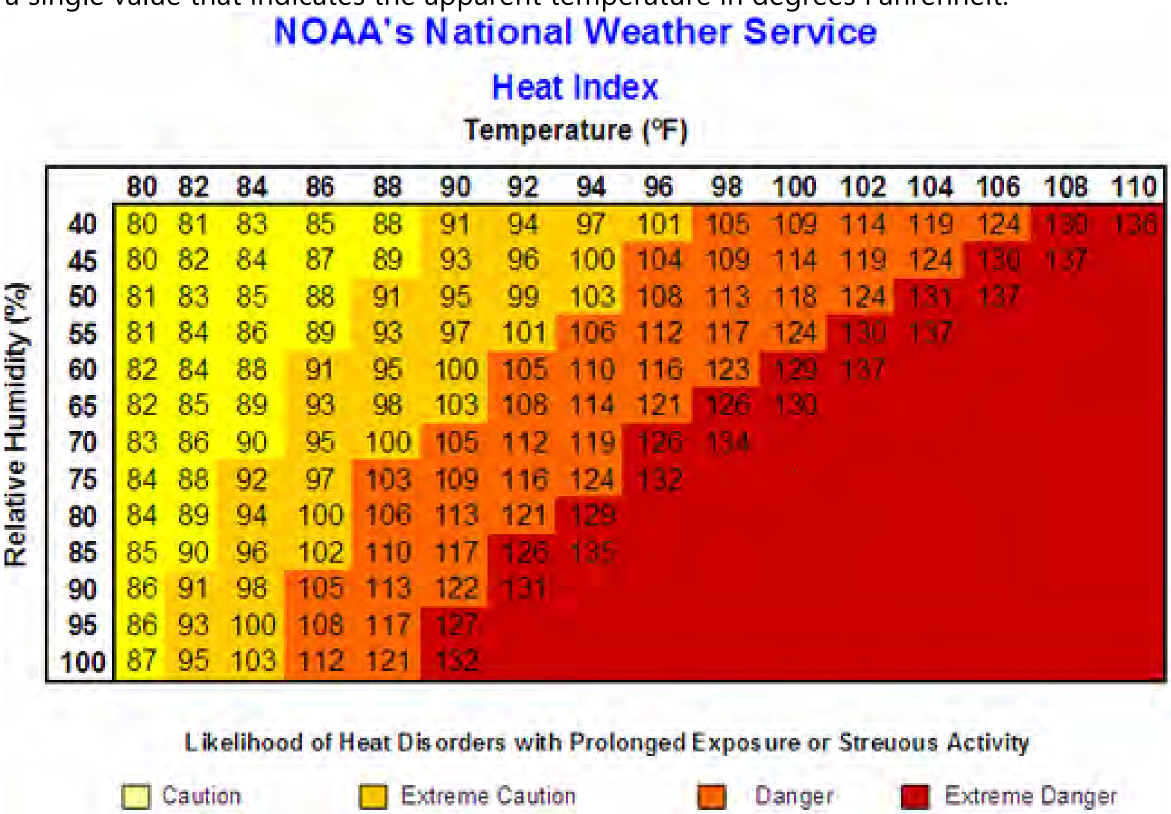
The Occupational Safety and Health Act (OSHA) does not have a specific standard that covers working in hot environments; however, under OSHA, employers have a duty to protect workers from recognized serious hazards in the workplace, including heat-related hazards.

Workers exposed to hot and humid conditions are at higher risk of heat-related illness. For people working in hot weather, both air temperature and humidity affect how hot they feel. The **"heat index"** is a single value that accounts for both temperature and humidity, since sweat does not readily evaporate and cool the skin. The higher the heat index, the hotter the weather feels.

The risk of heat-related illness increases as the heat index increases. Additional factors listed below increase the risk of heat-related illness:

- working in direct sunlight adds up to 15°F to the heat index;
- performing prolonged or strenuous work; and
- wearing heavy protective clothing or impermeable suits.

The Heat Index
The U.S. National Oceanographic and Atmospheric Administration (NOAA) developed the heat index system. The heat index combines both air temperature and relative humidity into a single value that indicates the apparent temperature in degrees Fahrenheit.



RH (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Using the Heat Index

The heat index can be used to help determine the risk of heat-related illness for outdoor workers, what actions are needed to protect workers, and when those actions are triggered. Heat index values are divided into four different color bands associated with four risk levels. A smart phone app is available at the Google Play Store, Apple App Store, or the OSHA website (https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html) that can be used by workers if cellular phone coverage is available at the work location. This phone app will calculate the heat index based on nearby weather station data and also provides links to relevant OSHA heat stress information and guidance.

Heat Index	Risk Level	Protective Measures
Less than 91°F	Lower (Caution)	Basic heat safety and planning
91°F to 103°F	Moderate	Implement precautions and heighten awareness
103°F to 115°F	High	Additional precautions to protect workers
Greater than 115°F	Very High to Extreme	Triggers even more aggressive protective measures

NOAA devised the heat index values for shaded conditions and light winds. **Full sunshine can increase heat index values by up to 15°F**. Strenuous work and the use of protective clothing also have an additive effect. As a result, the risk at a specific heat index could be higher than that listed in the table above if the work is in direct sunlight without a light breeze, or if work involves strenuous tasks or the use of protective clothing. Extra measures, including implementing precautions at the next risk level, are necessary under these circumstances.

Protective Measures Based on Heat Index

Heat Index	Risk Level	Protective Measures
<91°F	Lower (Caution)	Provide drinking water Ensure that adequate medical services are available Plan ahead for times when heat index is higher, including worker heat safety training Encourage workers to wear sunscreen Acclimatize workers **If workers must wear heavy protective clothing, perform strenuous activity or work in the direct sun, additional precautions are recommended.**

Heat Index	Risk Level	Protective Measures
91°F to 103°F	Moderate	In addition to the steps listed above: • Remind workers to drink water often (about 4 cups/hour)* • Review heat-related illness topics with workers: how to recognize heat-related illness, how to prevent it, and what to do if someone gets sick • Schedule frequent breaks in cool, shaded area • Acclimatize workers • Set up buddy system/instruct supervisors to watch workers for signs of heat-related illness **If workers must wear heavy protective clothing, perform strenuous activity or work in the direct sun, additional precautions are recommended to protect workers from heat-related illness.** • **Schedule activities at a time when the heat index is lower** • **Develop work/rest schedules** • **Monitor workers closely**
103°F to 115°F	High	In addition to the steps listed above: • Alert workers of high-risk conditions • Actively encourage workers to drink plenty of water (about 4 cups/hour)* • Limit physical exertion (e.g. use mechanical lifts) • Have a knowledgeable person at the worksite who is well-informed about heat-related illness and able to determine appropriate work/rest schedules • Establish and enforce work/rest schedules • Consider conducting physiological monitoring at the beginning of each rest period (e.g., pulse, temperature, etc) • Adjust work activities (e.g., reschedule work, pace/rotate jobs) • Use cooling techniques • Watch/communicate with workers at all times **When possible, reschedule activities to a time when the heat index is lower.**

Heat Index	Risk Level	Protective Measures
>115°F	Very High to Extreme	**Reschedule non-essential activity for days with a reduced heat index or to a time when the heat index is lower** **Move essential work tasks to the coolest part of the work shift; consider earlier start times, split shifts, or evening and night shifts. Strenuous work tasks and those requiring the use of heavy or non-breathable clothing or impermeable chemical protective clothing should not be conducted when the heat index is at or above 115°F.** If essential work must be done, in addition to the steps listed above: - Alert workers of extreme heat hazards - Establish water drinking schedule (about 4 cups/hour)* - Establish and enforce work/rest schedules - Conduct physiological monitoring at the beginning of each rest period (e.g., pulse, temperature, etc.) - Stop work if essential control methods are inadequate or unavailable

* Under most circumstances, fluid intake should not exceed 6 cups per hour or 12 quarts per day. This makes it particularly important to reduce work rates, reschedule work, or enforce work/rest schedules

Planning Checklists

Use the following checklists to prepare for hot weather and to make sure that appropriate precautions are in place.

Planning Ahead for Hot Weather

	Develop a list of hot weather supplies (e.g., water, shade devices, etc.). Estimate quantities that will be needed and decide who will be responsible for obtaining and transporting supplies and checking that supplies are not running low.
	Create emergency action plan for heat-related illnesses (who will provide first aid and emergency services, if necessary).
	Develop acclimatization schedule for new workers or workers returning from absences longer than one week.
	Identify methods for real-time access to important weather forecast and advisory information from the National Weather Service and ensure the information is available at outdoor work sites (e.g., laptop computer, cell phone, other internet-ready device, weather radio, etc.).
	Determine how weather information will be used to modify work schedules, increase the number of water and rest breaks, or cease work early if necessary.
	Train workers on the risks presented by hot weather, how to identify heat-related illnesses, and the steps that will be taken to reduce the risk.
	Plan to have a knowledgeable person on the worksite who can develop and enforce work/rest schedules and conduct physiological monitoring, when necessary, at high and very high/extreme risk levels for heat-related illness.

Daily Planning Checklist

Water	Is there plenty of fresh, cool drinking water located as close as possible to the workers?	
	Are water coolers refilled throughout the day? (Has someone been designated to check and make sure water is not running low?)	
Shade	Is shade or air conditioning available for breaks where workers can rest to recover?	
Training	Do workers know the:	
	Common signs and symptoms of heat-related illness?	
	Proper precautions to prevent heat-related illness?	
	Importance of acclimatization?	
	Importance of drinking water frequently (even when they are not thirsty)?	
	Steps to take if someone is having symptoms?	
Emergencies	Does everyone know who to notify if there is an emergency?	
	Can workers explain their location if they need to call an ambulance?	
	Does everyone know who will provide first aid?	
Knowledgeable Person	For high and very high/extreme heat index risk levels, is there a knowledgeable person at the worksite who is well-informed about heat-related illness and able to determine appropriate work/rest schedules and can conduct physiological monitoring as necessary?	
Physiological Monitoring	Are workers in the high or very high/extreme heat index risk levels being physiologically monitored as necessary?	
Worker Reminders	Drink water often	
	Rest in shade	
	Report heat-related symptoms early	

Responding to Heat-related Emergencies

If workers report or supervisors observe signs or symptoms of heat-related illness, stop activity immediately. While waiting for help, perform first aid as indicated in the table below. **HEAT STROKE IS A MEDICAL EMERGENCY. CALL 911 immediately if a worker shows any signs of heat stroke.**

Illness	Symptoms	First Aid*
Heat stroke	• Red, hot, dry skin or excessive sweating • Very high body temperature • Confusion • Seizures • Fainting	• **Call 911** While waiting for help: • Place worker in shady, cool area • Loosen clothing, remove outer clothing • Fan air on worker; cold packs in armpits • Wet worker with cool water; apply ice packs, cool compresses, or ice if available • Provide fluids (preferably water), as soon as possible • Stay with worker until help arrives
Heat exhaustion	• Cool, moist skin • Heavy sweating • Headache • Nausea or vomiting • Dizziness • Light headedness • Weakness • Thirst • Irritability • Fast heart beat	• Have worker sit or lie down in a cool, shady area • Give worker plenty of water or other cool beverages to drink • Cool worker with cold compresses/ice packs • Take to clinic or emergency room for medical evaluation or treatment if signs or symptoms worsen or do not improve within 60 minutes • Do not return to work that day
Heat cramps	• Muscle spasms • Pain • Usually in abdomen, arms, or legs	• Have worker rest in shady, cool area • Worker should drink water or other cool beverages • Wait a few hours before allowing worker to return to strenuous work • Have worker seek medical attention if cramps don't go away
Heat rash	• Clusters of red bumps on skin • Often appears on neck, upper chest, folds of skin	• Try to work in a cooler, less humid environment when possible • Keep the affected area dry

* Remember, if you are not a medical professional, use this information as a guide only to help workers in need.

Work/Rest Schedules

Work/rest cycles give the body an opportunity to get rid of excess heat, slow down the production of internal body heat, slow down the heart rate, and provide greater blood flow to the skin.

For the best protection from heat-related illness, workers should spend the rest periods of the cycle in a cool place, for example in a lightly air-conditioned room, trailer or vehicle, or if one is not available, then in full shade.

During the rest periods, workers may continue to perform mild or light work, such as completing paperwork, attending a meeting, or receiving training (e.g., instructions for upcoming work, or a tailgate safety talk).

When evaluating an appropriate work/rest schedule:

- Shorten work periods and increase rest periods:
    - As temperature rises;
    - As humidity increases;
    - When sun gets stronger;
    - When there is no air movement;
    - When protective clothing or gear is worn; or
    - For heavier work.
- Assign new and un-acclimated workers lighter work and longer rest periods. Monitor these workers more closely.

When possible, more frequent shorter periods of exposure to heat are better than fewer longer exposures. This means that the work/rest schedules are often based on 1-hour cycles and might call for a rest period of 15 minutes every hour during hot weather, but 45 minutes per hour when temperature and humidity are extreme.

Acclimatizing Workers

Workers become gradually acclimatized when exposed to hot conditions for several weeks. Physical changes in blood vessels and in sweating occur to dissipate heat more effectively. When the **heat index** is **high**, special precautions are needed to protect un-acclimatized workers while they adjust, particularly on the first few days of the job.

- Allow workers to get used to hot environments by gradually increasing exposure over at least a 5-day work period. Begin with 50% of the normal workload and time spent in the hot environment and then gradually build up to 100% by the fifth day.

- Implementing acclimatization activities is essential for new workers, workers who have been out sick or on vacation, and all workers during a heat wave.

If the fieldwork schedule and/or duration do not allow workers time to gradually acclimate, the workers must be monitored carefully and more frequently than acclimated workers for symptoms of heat-related illness. In addition, consider including physiological monitoring for un-acclimated workers at risk levels lower than for acclimated workers at the worksite.

Monitoring Workers at Risk of Heat-related Illness

When physiological monitoring is implemented based on the heat index (see Protective Measures Based on Heat Index table above), it should be performed at the beginning of each rest period as a minimum frequency for workers wearing normal work clothes. The frequency of physiological monitoring should be increased for workers wearing heavy or impermeable protective clothing or performing strenuous work in direct sunlight.

The National Institute for Occupational Safety and Health (NIOSH)/OSHA/United States Coast Guard (USCG)/United States Environmental Protection Agency (USEPA) Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities offers guidance for performing physiological monitoring of workers at hot worksites. This guidance document describes the following two options for worker monitoring to help manage the risk of heat-related illness:

- Heart rate: count the radial pulse during a 30-second period as early as possible in the rest period.
    - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.
    - If the heart rate still exceeds 110 beats per minute at the beginning of the next rest period, shorten the following work cycle by one-third.
- Body temperature: use an oral thermometer under the tongue or digital ear thermometer in the ear canal to measure body temperature at the beginning of each rest period (before drinking).
    - If body temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.
    - If body temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.
    - Do not permit a worker to wear a semi-permeable or impermeable garment when his/her body temperature exceeds 100.6°F (38.1°C).

Other physiological monitoring tools may be used at the worksite to augment the heart rate and body temperature monitoring methods described above (e.g., Hot Dot Body Temperature Alert Patch). The inclusion of additional physiological monitoring tools must be discussed with the Corporate Health and Safety Officer before they are implemented at the worksite. It is important to note that the use of some of these additional tools, such as the Hot Dot, does not replace required heart rate or body temperature monitoring at worksites.

Adapted from:

- NIOSH/OSHA/USCG/USEPA Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, Chapter 8 (1985); and
- http://osha.gov/SLTC/heatillness/heat_index/).