Naval Facilities Engineering Systems Command Southwest
Base Realignment and Closure
Program Management Office West
San Diego, CA

Final

Work Plan

Phase I Remedial Investigation for Per- and Polyfluoroalkyl Substances (PFAS) at Installation Restoration Program Site 6

Former Naval Station Treasure Island
San Francisco, California

April 2022

Approved for public release; distribution is unlimited

Naval Facilities Engineering Systems Command

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April 2022

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Multi-MACJV

FINAL

WORK PLAN

FOR

PHASE I REMEDIAL INVESTIGATION FOR PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) AT INSTALLATION RESTORATION SITE 6

FORMER NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

April 2022

Prepared for
United States Department of the Navy
Naval Facilities Engineering Systems Command Southwest
San Diego, California

Review and Approval

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Acronyms and Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
µg/L	microgram(s) per liter

AFFF	aqueous film-forming foam
APP	Accident Prevention Plan
AST	aboveground storage tank
ASTM	ASTM International
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry

BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BMP	best management practice
BRAC	Base Realignment and Closure
BW	body weight

C	chemical concentration
CADD	chronic average daily dose
Cal/EPA	California Environmental Protection Agency
Cal/OSHA	California Occupational Safety and Health Administration
Caltrans	California Department of Transportation
CAM	California Administrative Manual
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
COVID-19	Coronavirus Disease 2019
CR	contact rate
CSF	cancer slope factor
CSM	conceptual site model
CSO	Contractor Support Officer

DERP	Defense Environmental Restoration Program
DO	dissolved oxygen
DoD	United States Department of Defense

Acronyms and Abbreviations (continued)

DOL	United States Department of Labor
DON	United States Department of the Navy
DOT	United States Department of Transportation
DPT	direct-push technology
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
ED	exposure duration
EF	exposure frequency
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERRG	Engineer/Remediation Resources Group, Inc.
ET	exposure time
FS	Feasibility Study
HDPE	high-density polyethylene
HERO	Human and Ecological Risk Office
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
I	intake
IC	institutional control
ID	identification
IDW	investigation-derived waste
IR	Installation Restoration
ITRC	Interstate Technology & Regulatory Council
LADD	lifetime daily dose
LC/MS-MS	liquid chromatography and tandem mass spectrometry
LHA	lifetime health advisory
LRA	Local Redevelopment Agency
LUC	land use control
mg/kg	milligram(s) per kilogram

Acronyms and Abbreviations (continued)

mg/kg-day	milligram(s) per kilogram per day
mL/min	milliliter(s) per minute
MTRS	Meridian Township Range Section
Multi-MAC JV	Multi-MAC Joint Venture
mV	millivolt(s)
NAVFAC SW	Naval Facilities Engineering Systems Command Southwest
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NSTI	Naval Station Treasure Island
NTU	nephelometric turbidity unit(s)
OEA	Office of Economic Adjustment (DoD)
ORP	oxidation reduction potential
OSWER	Office of Solid Waste and Emergency Response
OWS	oil/water separator
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFC	perfluorinated compound
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PG	Professional Geologist
pH	potential of hydrogen
PLSS	Public Land Survey System
PMO	Program Management Office
POC	point of contact
PPE	personal protective equipment
PRC	PRC Environmental Management, Inc.
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RAGS	Risk Management Guidance for Superfund
RD	Remedial Design

Acronyms and Abbreviations (continued)

RfD	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RSL	regional screening level
RWQCB	California Regional Water Quality Control Board, San Francisco Bay Region
SAP	Sampling and Analysis Plan
SC	specific conductance
SERDP	*Strategic Environmental Research and Development Program*
SFPUC	San Francisco Public Utilities Commission
Shaw	Shaw Environmental, Inc.
SLERA	Screening-Level Ecological Risk Assessment
SSHP	Site Safety and Health Plan
TDS	total dissolved solids
TEQ	toxicity equivalency quotient
TI	Treasure Island
TIDA	Treasure Island Development Authority
TPH	total petroleum hydrocarbons
TtEMI	Tetra Tech EM Inc.
UCL	upper confidence limit
USA	Underground Service Alert
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USCS	Unified Soil Classification System
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound
WWTP	wastewater treatment plant
YBI	Yerba Buena Island

Executive Summary

This Work Plan describes the technical approach and activities for implementing the Phase I Remedial Investigation (RI) at Installation Restoration (IR) Site 6 (Former Fire Training School) at former Naval Station Treasure Island (NSTI), San Francisco, California (Figures 1 and 2). The RI will be conducted in two phases: onshore (Phase I) and offshore (Phase II). The soil and groundwater sampling activities described in this Work Plan constitute Phase I. A Phase II RI will be conducted after completion of the Phase I RI as needed. The soil and groundwater sampling activities described in this Work Plan comprise Phase I.

The Phase I RI at IR Site 6 consists of evaluations of (1) the nature and extent of per- and polyfluoroalkyl substances (PFAS) in soil and groundwater, and (2) potential risk to human health or the environment. This work is being performed for the Naval Facilities Engineering Systems Command Southwest (NAVFAC SW) Base Realignment and Closure (BRAC) Program Management Office (PMO) West under Contract Number N62470-19-D-4010, Task Order N6247320F5451.

IR Site 6 PFAS analytical data collected during previous investigations will be incorporated with the data collected during this Phase I RI to define the nature and extent of PFAS in soil and groundwater. The data will also be used in a human health assessment, and groundwater analytical data will be evaluated against appropriate ecological screening criteria to support the conclusions of the Phase I RI Report.

The Phase I activities for the RI include installation and development of 15 groundwater monitoring wells; collection of groundwater samples from the 15 new groundwater monitoring wells and 9 existing groundwater monitoring wells; collection of 90 soil samples from 45 discrete locations (including the 15 new well locations); a fate and transport evaluation of the tidal mixing zone; and proper disposal of investigation-derived waste (IDW).

At the conclusion of field activities, a Phase I RI Report will be prepared to document the results of the RI and the baseline human health risk assessment (HHRA) and an ecological screening evaluation.

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1.0 Introduction

This Work Plan describes the technical approach and activities for implementing a Remedial Investigation (RI) at Installation Restoration (IR) Site 6 (Former Fire Training School) at former Naval Station Treasure Island (NSTI), in San Francisco, California (Figure 1). As described in Section 1.1, the RI will be conducted in two phases, and this Work Plan presents the approach for the onshore (Phase I) portion of the RI. This work is being conducted by Multi-MAC Joint Venture (Multi-MAC JV), comprising Wood Environment & Infrastructure Solutions, Inc. and Nicklaus Engineering, Inc., on behalf of the Naval Facilities Engineering Systems Command Southwest (NAVFAC SW) Base Realignment and Closure (BRAC) Program Management Office (PMO) West under Contract Number N62470-19-D-4010, Task Order Number N6247320F5451.

This Work Plan was prepared in accordance with the applicable requirements of the United States Environmental Protection Agency (U.S. EPA) *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* (U.S. EPA, 1988). A site-specific Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) have been delivered under separate cover (Multi-MAC JV, 2020).

1.1 Objectives

The objectives of the RI are to determine whether per- and polyfluoroalkyl substances (PFAS) released to the environment from activities at IR Site 6 are migrating to the surface waters of San Francisco Bay, assess the nature and extent of PFAS in soil and groundwater, and determine whether PFAS in soil and groundwater present an unacceptable risk to site users and ecological receptors. The RI will be conducted in two phases: onshore (Phase I) and offshore (Phase II). The soil and groundwater sampling activities described in this Work Plan comprise Phase I. The Phase II RI will be scoped in a future Work Plan Addendum based on the results of Phase I.

To help meet the objectives, the Phase I RI presented in this Work Plan consists of collecting sufficient soil and groundwater analytical data at IR Site 6, the Former Fire Training School, to define the nature and extent of potential impacts by PFAS, performing a baseline Human Health Risk Assessment (HHRA) for current and future receptors, and evaluating groundwater analytical data against appropriate ecological screening criteria.

PFAS analytical data collected during previous investigations at IR Site 6 will be incorporated with the results from the Phase I RI to define the nature and extent of PFAS in soil and groundwater and conduct a baseline HHRA and an ecological risk assessment to support conclusions of the Phase I RI Report.

1.2 Regulatory Requirements

This Work Plan was prepared in accordance with the applicable requirements of the U.S. EPA guidance for conducting RIs under CERCLA (U.S. EPA,1988). The United States Department of the Navy (DON) is the owner of IR Site 6 and is the lead federal agency for CERCLA investigations, including this RI. The California Environmental Protection Agency Department of Toxic Substances Control (DTSC) is the lead state agency. Additionally, the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), California Department of Fish and Wildlife (CDFW), and Treasure Island Development Authority (TIDA) will provide support and input on the project.

PFAS have been identified by U.S. EPA as emerging chemicals of concern and are of environmental concern because of their persistence in the environment and in organisms, migration potential in aqueous systems (e.g., groundwater), historically ubiquitous use in commercial products, and possible adverse health effects at low levels of exposure. At this time, only three PFAS have U.S. EPA-derived toxicity values available to help understand potential health effects from exposure: perfluorobutanesulfonic acid (PFBS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS). On September 15, 2021, the United States Department of Defense (DoD) issued a memorandum for addressing PFAS in soil and groundwater within the Defense Environmental Restoration Program (DERP) under CERCLA (DoD, 2021). As indicated in the memorandum, screening levels for PFOA and PFOS were calculated using the U.S. EPA online calculator on April 6, 2018, and screening values for PFBS were derived from the U.S. EPA regional screening level (RSL) table (U.S. EPA, 2021). For groundwater, screening levels of 0.04 microgram per liter (µg/L) for PFOA, 0.04 µg/L for PFOS, and 0.6 µg/L for PFBS are used to evaluate impacts on groundwater. Screening levels of 0.13 milligram per kilogram (mg/kg) for PFOA, 0.13 mg/kg for PFOS, and 1.9 mg/kg for PFBS are used to evaluate impacts on soil (DoD, 2021).

In addition, on December 19, 2019, U.S. EPA published a guidance document for interim recommendations for addressing groundwater impacted with PFOA and/or PFOS. The guidance document also recommends that screening of sites be based on a target hazard quotient of 0.1 for PFOA or PFOS individually, which is currently 0.04 µg/L (i.e., site groundwater concentrations should be compared with one-tenth of the calculated tapwater RSL of 0.4 µg/L for PFOS or PFOA, which works out to 0.04 µg/L). The reason for selecting a target hazard quotient of 0.1 (i.e., one-tenth of the acceptable concentration for noncancer effects) is to protect against the possible co-occurrence in groundwater of multiple PFAS and other chemicals with similar or additive health effects. In addition, it recommends that the U.S. EPA lifetime health advisory (LHA) of

0.07 µg/L be used as the preliminary remediation goal for groundwater that is a current or potential source of drinking water where no state or tribal maximum contaminant level or other applicable or relevant and appropriate requirements are available or sufficiently protective (U.S. EPA, 2019). Groundwater at IR Site 6 is not currently a source of drinking water.

1.3 Work Plan Organization

This Work Plan is organized as follows:

- **Section 1.0, Introduction:** Presents the objective, identifies the regulatory agencies and regulatory requirements, and outlines the organization of the Phase I RI Work Plan.
- **Section 2.0, Background:** Describes the history, land use, previous investigations, and physical setting of the site.
- **Section 3.0, Conceptual Site Model:** Presents the sources of contamination and the current nature and extent, contaminant mechanisms of migration, potential receptors, and any uncertainties.
- **Section 4.0, Remedial Investigation Sampling Approach:** Discusses the investigation approach for the Phase I RI.
- **Section 5.0, Human Health Risk Assessment:** Presents the approach for the baseline HHRA that will be conducted as part of the Phase I RI.
- **Section 6.0, Ecological Risk Assessment:** Presents the approach for the ecological risk evaluation that will be conducted as part of the Phase I RI.
- **Section 7.0, Project Schedule and Reporting:** Presents the project schedule and a description of the Phase I RI Report.
- **Section 8.0, References:** Provides a list of sources used to develop this Work Plan.
- **Appendix A:** Sampling and Analysis Plan (SAP) for the IR Site 6 Phase I RI
- **Appendix B:** Contractor Quality Control Plan
- **Appendix C:** Waste Management Plan
- **Appendix D:** Responses to Agency Comments (to be included in the final version only)

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2.0 Background

Former NSTI is located in San Francisco Bay, midway between San Francisco and Oakland within the City and County of San Francisco. It consists of two adjacent islands: Yerba Buena Island (YBI) and the man-made Treasure Island (TI), connected by a causeway (Figure 1). The land mass of the northern island, TI, encompasses approximately 403 acres, and the land mass of the southern island, YBI, encompasses approximately 147 acres (NOREAS, Inc., 2019). Additionally, more than 527 acres of submerged lands within San Francisco Bay surrounding the two islands are also part of former NSTI (DON, 2020a).

2.1 Base History

TI was constructed on the Yerba Buena Shoals north and northwest of YBI from 1936 to 1937 under the direction of the United States Army Corps of Engineers (USACE). TI consists primarily of sediments dredged from San Francisco Bay that were placed within a retaining wall of rock and sand dikes. TI was originally constructed for the 1939 Golden Gate International Exposition World's Fair (NOREAS, Inc., 2019). The DON acquired it by condemnation in 1942 (Trevet, 2016).

The IR Site 6 former Fire Training School was used for nearly 50 years (1944 to 1992) for various firefighting training activities. The former Fire Training School at IR Site 6 included 10 buildings, 6 underground storage tanks (USTs) and 1 aboveground storage tank (AST) that were used to store fuel, and a central training yard. Training fires were ignited within various buildings and facilities in the central training yard (NOREAS, Inc., 2019). An aqueous film-forming foam (AFFF) Station was located in the northern boundary of the central training areas adjacent to the V-ditch collector trench (Harding Lawson Associates, 1987) (Figure 3).

2.1.1 Historical Land Use

Military activities in the area date back to 1866 when the United States Government took possession of YBI for defensive fortifications. YBI was occupied by the United States Department of the Army until 1896, when the DON assumed operations. YBI continued to function as a Naval Receiving Station until World War II, when naval operations were transferred to TI. In response to a DON request in 1941, the City of San Francisco leased TI to the DON for the duration of World War II. After World War II, the City and County of San Francisco agreed to trade the deed for NSTI to the DON in exchange for Government-owned land south of San Francisco, where the San Francisco International Airport was eventually built (Engineering/Remediation Resources Group, Inc. [ERRG], 2012). The island became a major naval facility, processing approximately 12,000 military personnel per day for service overseas and upon their return to the United States (Trevet, 2016). It was used primarily to provide training, administration, housing, and other support services to the United States Pacific Fleet. NSTI remained an active, fully operational DON facility until the 1990s. In 1993, the Defense BRAC Commission recommended closure of NSTI. The facility was subsequently closed on September 30, 1997 (NOREAS, Inc., 2019).

2.1.2 Current Land Use

The DoD Office of Economic Adjustment (OEA) designated San Francisco as the Local Redevelopment Authority (LRA) for former NSTI in May 1994. In 1997, the California State Legislature created a special reuse authority for former NSTI, transferring the LRA status from San Francisco to TIDA. TIDA is a state agency staffed by the San Francisco mayor’s office and is the entity responsible for planning the reuse and redevelopment of the former installation (Trevet, 2016). TIDA is a nonprofit, public benefit agency dedicated to the economic development of former NSTI. The authority is vested with the rights to administer Tidelands Trust property. TIDA is also responsible for administering vital municipal services to TI and YBI (TIDA, 2020). Former NSTI is now part of District 6 of the City and County of San Francisco (Villages at Treasure Island, 2020), and public utilities such as water, wastewater, and power are provided by the City of San Francisco Public Utilities Commission (SFPUC) (TIDA, 2020). The DON has transferred over 80 percent of the property at former NSTI to TIDA (DON, 2020a).

In addition to TIDA, there have been property transfers to federal entities. The United States Department of Labor (DOL) operates a Job Corps Center in the central portion of TI (Adanta, Inc., 2019). The United States Coast Guard (USCG), Sector San Francisco, operates on USCG-owned property on the southeastern portion of YBI, of which slightly more than half is submerged (DON, 2020a). The DON owned the property comprising the area beneath the San Francisco Bay Bridge on YBI until 2000, when the Federal Highway Administration obtained the bridge right-of-way and subsequently transferred it to the California Department of Transportation (Caltrans). All areas on YBI have been transferred out of DON control (Adanta, Inc., 2019).

Former NSTI also has a variety of commercial space suitable for office, media production, public storage, manufacturing, classroom and training, food service, special events, warehousing, and light industrial uses (TIDA, 2020). Other current uses of former NSTI include a daycare center, a YMCA facility, multiple sports fields, and a sailing center, as well as several parks, hiking trails, and scenic overlooks (Google Earth, 2020).

2.1.3 Future Planned Land Use

The proposed future uses of IR Site 6 include public open space for public services and civic and institutional uses, including a new wastewater treatment and recycled water plant and a 4- to 6-acre parcel that the SFPUC would use for renewable energy projects and above-ground and below-ground public infrastructure and utility systems. Improvements to the open space that surrounds and includes IR Site 6 could include new roads, hiking and walking trails, picnic areas, playgrounds, sports fields, a café and snack bar, and other public-park outdoor areas and recreational spaces (DON, 2014). There are no perennial surface water bodies at IR Site 6. Groundwater at IR Site 6 is not a potential source of drinking water (see Section 2.8), and no other uses of groundwater are planned at IR Site 6. Federal and state land use is expected to continue. The DON will retain certain parcels until they are transferred to TIDA (DON, 2020a). Future plans for lands adjacent to IR Site 6 may include development of stormwater wetlands (CE2-Kleinfelder JV, 2018).

The DON completed a remedial action for IR Site 6 in 2016 (CE2-Kleinfelder, 2018), including excavation and offsite disposal of impacted soil, groundwater monitoring, and use restrictions in the form of institutional controls (ICs). The existing ICs at IR Site 6 include prohibition of residential use of IR Site 6 (residential uses include constructing a residence, hospital for humans, or day care facility for children and growing produce for human consumption), implementation of approved contaminated soil and groundwater management plans for any future excavations at IR Site 6, and prohibition of alternation, disturbance, or removal of any component of the remedial action. These restrictions are described in the Final Land Use Control (LUC) Remedial Design (RD) (CE2-Kleinfelder, 2018).

2.2 IR Site 6 Description

IR Site 6 is in the northeastern portion of former NSTI. The site was used from 1944 to 1992 for various firefighting training activities. The Former Fire Training School at IR Site 6 included 10 buildings, 6 USTs, 1 known AST, and a central training yard. Training fires were ignited within various buildings and facilities in the central training yard. Most of IR Site 6 is presently unpaved because recent remedial actions have removed most of the paving at the site (DON, 2020b). The site features present during the operational period of the training school are presented on Figures 2 and 3.

IR Site 6 also included a vehicle parking area, forklift parking area, hazardous materials storage area, hazardous waste storage area, and storage area for former training structures. All buildings were demolished and removed from the site in 1993. The site is currently secured by chain-link fencing. The former parking and storage area are also secured with fencing (DON, 2020b).

2.3 Topography

Former NSTI is topographically flat, ranging from 12 to 15 feet above the mean lower low water level (NOREAS, Inc., 2019). The soil at former NSTI consists primarily of sand dredged from San Francisco Bay and the Sacramento-San Joaquin Delta and is retained by a perimeter of rock and sand dikes. All land above sea level and extending to a depth of approximately 10 to 50 feet below sea level is composed of fill. Surface runoff on paved areas flows into onsite storm catch basins and drains directly into San Francisco Bay (Figure 3). Runoff on unpaved areas infiltrates through the soil (TIDA, 2020).

2.4 Climate

The climate in the area of former NSTI can be defined as "Mediterranean with cool summers." In fact, both the winter temperatures and the rainfall pattern are typical of the Mediterranean climate, but summers are unusually cool because the cold current that flows along the coast of California and causes fog in San Francisco Bay and functions as a natural air conditioner for the city and the surrounding areas (Climates to Travel, 2020).

Records indicate that the temperatures in the former NSTI area (San Francisco, California) range from an average low of 46 degrees Fahrenheit (°F) in December and January to a high of 70°F in September. Annual rainfall averages 24 inches with monthly totals ranging from 0 inches in the summer (July) to 4.56 inches in the winter (December). The prevailing winds of the San Francisco Bay Area are from a westerly direction. Winds are approximately 4 miles per hour; June is the windiest month each year with an average of 6 miles per hour. Heavy fogs occur on an average of 21 days per year (The Weather Company, 2020).

2.5 Geology

TI was constructed from sandy sediments dredged from San Francisco Bay and placed within a retaining wall of rock and sand dikes. Dredging and construction of the island, directed by the USACE, began in 1936 and was completed in 1937. The island was constructed on the Yerba Buena Shoals, a spit of sand that extended north and northwest of naturally occurring YBI (NOREAS, Inc., 2019). The regional geologic map of former NSTI is presented on Figure 4.

Subsurface materials at TI can be divided into the following four geologic units, listed from youngest (shallowest) to oldest (deepest) (NOREAS, Inc., 2019):

- Fill and Shoal Sands (dredged sand fill and Yerba Buena Shoal sands)
- Younger Bay Mud
- Older Bay Mud
- Franciscan Assemblage

The cross-sections showing the geological units present at former NSTI are presented on Figures 5 and 6.

2.5.1 Fill and Shoal Sands

Dredged sediments used to construct TI consisted primarily of fine- to coarse-grained sand with lesser amounts of silt, clay, and gravel. The dredged sand included some shell fragments and clay nodules. The clay nodules were derived from clay beds within the sediment, excavated by dredging, and rounded as they passed through the delivery pipeline. Thin beds of clay occasionally developed as finer materials in the dredged sand fill settled out during fill operations (NOREAS, Inc., 2019).

2.5.2 Younger Bay Mud

Underlying the Yerba Buena Shoal and fill sands are Younger Bay Mud sediments of marine origin that consist of soft to stiff, olive-gray silty clay and clay with interbedded sand and silt layers in some areas. Younger Bay Mud sediments range from approximately 10 to 120 feet thick. These sediments are thinnest on the eastern portion of the island and thicken toward the northwestern portion of the island (NOREAS, Inc., 2019).

2.5.3 Older Bay Mud

Underlying the Younger Bay Mud sediments are the Older Bay Mud sediments, which consist of stiff to very stiff, sandy and silty clays that extend to the Franciscan Assemblage bedrock. The Older Bay Mud sediments that range from approximately 20 to 170 feet thick are thinnest on the southern portion of the island and thicken toward the northern portion of the island (NOREAS, Inc., 2019).

2.5.4 Franciscan Assemblage

Underlying the Older Bay Mud sediments is bedrock of the Franciscan Assemblage, which consists of interbedded shales and sandstone. Observations from borings that penetrated bedrock on the northwestern portion of TI indicate that the estimated depth to the Franciscan Assemblage ranges from 150 to 320 feet below ground surface (bgs). Depths are shallowest on the southern portion of the island and deepest toward the northern portion of the island (Geomatrix Consultants, Inc., 1990).

2.6 Hydrology

Watersheds in the San Francisco Bay Area range from large ones such as the Alameda Creek watershed, which encompasses 700 square miles and includes two counties and seven cities, to small watersheds such as the 1.1-square-mile Codornices Creek watershed along the Berkeley/Albany border. All of the San Francisco Bay Area watersheds ultimately drain to San Francisco Bay, or in coastal areas to the Pacific Ocean (RWQCB, 2018).

Former NSTI receives no surface water from any watershed, and any unevaporated precipitation ultimately drains to San Francisco Bay, via either surface runoff or groundwater.

Drinking water for former NSTI is obtained from the SFPUC via a pipeline attached to the Bay Bridge. SFPUC obtains water from the Hetch Hetchy Regional Water System. Most of this water comes from Hetch Hetchy Reservoir; the rest comes from local surface reservoirs in Alameda and San Mateo Counties, and beginning in early 2017, from groundwater pumped from the Westside Basin Aquifer (SFPUC, 2020).

2.7 Hydrogeology

The dredged material and shoal sands used to construct TI act as an unconfined water bearing zone with an average depth to the water table of 5.6 feet bgs. Perched groundwater may exist locally above the shallow water table because of the presence of silt and clay lenses. Groundwater recharge occurs primarily from infiltration of precipitation, with some contribution from landscape irrigation. Shallow groundwater flow is generally radial from the center of the island toward the shoreline with low gradients. Tidal fluctuations influence the groundwater gradient at locations within 200 to 250 feet of the shoreline (Figure 7).

Groundwater has been encountered on YBI in both the colluvium and the fill. The Franciscan Assemblage bedrock is relatively impervious, with the exception of localized fracturing. As a result, the bedrock generally serves as a boundary to groundwater flow. The volume of groundwater available in bedrock is negligible. Groundwater recharge primarily occurs from infiltration of precipitation with some contribution from landscape irrigation.

Former NSTI lies within several hydrogeological stratigraphic units. The portion of the island north of the Bay Bridge lies in the Bay Water hydrogeological unit, and the portion of the island south of the Bay Bridge south lies within the Bay Channel hydrogeological unit. Additionally, a search for United States Geological Survey (USGS) or Public Land Survey System (PLSS) Meridian Township Range Section (MTRS) well locations indicated that no wells are within a 1-mile buffer zone surrounding the island.

2.8 Groundwater Quality and Beneficial Uses

Groundwater within the areas of investigation under the Basewide Groundwater Monitoring Program has been identified as brackish, and because of the small volume of fresh groundwater available, potentially prone to saltwater intrusion (Shaw Environmental, Inc., 2004).

Groundwater at former NSTI is not suitable as a potential source of drinking water pursuant to California State Water Resources Control Board Resolution 88-63 and RWQCB Resolution No. 89-39 (RWQCB, 2001).

2.9 Biological Resources

TI is an engineered island and contains little natural habitat for wildlife. Habitat types are landscaped and developed areas. The limited habitat for wildlife is due to the developed and landscaped surface of TI. Much of the vegetation consists of introduced species, including trees such as blue gum eucalyptus, Monterey pine, and Monterey cypress. There are no freshwater, wetland habitats, or salt marshes on TI. The predominant aquatic habitat around TI is subtidal, with an unconsolidated mud bottom substrate. There is a limited intertidal habitat, consisting of concrete riprap and dock and pier pilings, along most of the shoreline surrounding TI. No rare or endangered terrestrial floral or faunal species are known to inhabit or visit the island on a regular basis (DON, 2003).

2.10 Physical Offshore Environment

The hydrodynamics of sediment movement and deposition in San Francisco Bay are affected by the interaction of tides, winds, freshwater inflow, and configuration of the sediment surface (USGS, 1990). San Francisco Bay comprises several embayments, including a deeper central region (Central Bay) and shallow regions (Suisan Bay, San Pedro Bay, and South Bay). Former NSTI is situated within the Central Bay region, where water is approximately 20 feet deep (Conomos, 1985). The morphology and bathymetry of the bay allow for a tidally driven exchange of water among the different embayments.

The tides are mixed semidiurnally with two lows and two highs approximately every 24 hours. These tides also affect biological productivity in intertidal and subtidal sediments by moving and mixing water and associated organisms and varying the height of the water column above the bay floor (Nichols and Pamatmat, 1988). Salinity ranges from approximately 30 parts per thousands in the Central Bay during summer to approximately 18 parts per thousand in the winter (rainy season).

The sediments in the bay consist of primarily alluvia deposits of Older Bay Mud Formation, Sand Deposits, and Younger Bay Mud Formation from the bottom to the surface. The Older Bay Mud Formation is composed of firm clay with some silts, sand, and gravel. The Sand Deposits consist of localized units of fine sand graded into a sandy silt and clayey sand. The Sand Deposits sediment is not always overlain by the Younger Bay Mud. The Younger Bay Mud overlying the Sand Deposits consists of soft, plastic, silty clay, clayey silt with minor organic material, and clayey fine sand (USACE, 1979).

The sediment deposition in San Francisco Bay is a dynamic process that depends on the accumulation process, particle size, and energy gradient. Suspended and bedload materials are generally transported from high-energy areas to low-energy areas. A USACE report of net bathymetric changes from 1955 to 1990 indicates that the shorelines along the northern (location of IR Site 6), eastern, and southern regions of former NSTI are net depositional areas, and the western shoreline is a net erosional area (U.S. EPA, 1996).

2.11 Previous Investigations

The soil and groundwater at IR Site 6 have been characterized under numerous investigations and studies completed since 1986. Table 2-1 summarizes these investigations.

The previous investigations that are relevant to the PFAS RI include the following:

- Treasure Island Tidal Studies were conducted in 1995 and 2002 (PRC Environmental Management, Inc. [PRC], 1995; Tetra Tech EM Inc. [TtEMI], 2002).
- An RI/Feasibility Study (FS) was conducted in 2012 (ERRG, 2012).
- Soil sampling for PFAS was conducted during a pre-remedial design investigation (CE2-Kleinfelder Joint Venture, 2018) at IR Site 6 in July 2015 (Figure 8). Soil analytical results for PFAS are summarized in Table 2-2.

- A remedial action for IR Site 6 was conducted from May through October 2016, and the Final Remedial Action Completion Report was completed in February 2018 (CE2-Kleinfelder Joint Venture, 2018; DON, 2020b). This remedial action did not target PFAS-impacted soil at IR Site 6.
- Groundwater samples from IR Site 6 were analyzed for PFAS as part of the annual basewide groundwater monitoring program in May and December 2017, and April and September 2020 (Figure 9) (NOREAS, Inc., 2019; DON, 2020c). Groundwater analytical results for PFAS are summarized in Table 2-3.

3.0 Conceptual Site Model

The conceptual site model (CSM) is a comprehensive representation of the site that documents the potential for exposure to contaminants under current and future land uses based on potential sources, release mechanisms, migration routes, receptors, and exposure pathways. The preliminary CSM is used to understand potential sources of impacts, migration pathways, and human and ecological receptors and is presented in Table 3-1 and Figure 10. The CSM will be updated with information collected during this Phase I RI and presented in the Phase I RI Report (Section 7.0).

3.1 Nature and Extent of PFAS

The environmental impacts on IR Site 6 from activities at the Former Fire Training School were identified in soil and groundwater in previous investigations, as discussed in Section 2.11. Historical sampling locations for PFAS are shown on Figures 8 and 9. The nature and extent of PFAS detected in soil and groundwater are discussed in this section.

Soil

Soil sampling for PFAS was conducted at IR Site 6 in July 2015. Only PFOA and PFOS were analyzed because these were the only PFAS with screening levels at the time of sampling. The following summarizes the results of the soil investigation for PFAS:

- The DoD has established soil screening criteria of 0.13 mg/kg for PFOA, 0.13 mg/kg for PFOS, and 1.9 mg/kg for PFBS (DoD, 2021).
- Soil samples were collected from depths ranging from 0.5 foot to 5.5 feet bgs, with most of the samples collected from depths of 2 to 4 feet bgs.
- PFOA was detected in 8 of the 11 soil samples. PFOA concentrations ranged from not detected to 0.0574 mg/kg, and were all below the screening criterion of 0.13 mg/kg.
- PFOS was detected in 5 of the 11 soil samples. PFOS concentrations ranged from not detected to 1.240 mg/kg. All five soil samples contained detected PFOS at concentrations above the screening criterion of 0.13 mg/kg.

Soil analytical results for PFAS are summarized in Table 2-2, and sampling locations are presented in Figure 8.

Groundwater

Groundwater has been sampled for PFAS from three monitoring wells at IR Site 6 as part of the annual basewide groundwater monitoring program conducted in May 2017, from all nine existing monitoring wells in December 2017 and April 2020, and from nine existing wells and 13 Hydropunch locations in September 2020 (NOREAS, Inc., 2019; DON, 2020c). The results of these sampling events indicated that PFAS were present in the site groundwater, summarized as follows:

- The DoD has established soil groundwater screening criteria of 0.04 µg/L for PFOA, 0.04 µg/L for PFOS, and 0.6 µg/L for PFBS for evaluation of PFAS at DoD BRAC installations (DoD, 2021).
- PFOA was detected in 48 of 49 samples at concentrations ranging from 0.0057 µg/L to 7.32 µg/L. A total of 37 of 49 reported PFOA results exceeded the DoD screening level of 0.04 µg/L.
- PFOS was detected in 48 of 49 samples at concentrations ranging from 0.042 µg/L to 30 µg/L. All 48 reported PFOS results exceeded the DoD screening level of 0.04 µg/L.
- PFBS was detected 45 of 49 samples at concentrations ranging from 0.0058 µg/L to 0.17 µg/L. None of the PFBS results exceeded the screening criteria of 0.6 µg/L.

Groundwater analytical results for PFAS are summarized in Table 2-3, and groundwater sampling locations are presented in Figure 9.

Note that although the DoD screening criteria are based on protection of drinking water uses, such use of groundwater does not occur at former NSTI.

3.2 Site Physical Characteristics

The physical characteristics and environmental setting of IR Site 6 are detailed in Section 2.0. IR Site 6 encompasses 4.54 acres of asphalt, concrete, and unpaved open space. All buildings have been removed, and the site is currently vacant, closed to the public, and secured by a fence to restrict access. IR Site 6 is relatively flat, with ground surface elevations ranging from approximately 9 to 11 feet above mean sea level. Surface runoff flows into onsite storm catch basins and drains directly into San Francisco Bay. These storm drains have vertical elevations from 5.5 to 7.8 feet above mean sea level, or approximately from 2.4 to 3 feet bgs.

IR Site 6 is underlain by dredged fill and shoal deposits consisting of fine- to coarse-grained sand, with varying proportions of shell fragments, silt, and clay (Figures 5 and 6). Groundwater occurs under unconfined conditions at an average depth of approximately 4.5 to 6 feet bgs. The direction of local groundwater flow is north-northeast toward San Francisco Bay at an average gradient of 0.002 foot per foot (Figure 7). Groundwater at IR Site 6 is tidally influenced up to 250 feet from the shoreline (PRC, 1995; TtEMI, 2002). As discussed previously, groundwater at former NSTI is not a potential drinking water source.

3.3 Sources of Impacts and Potential Release Mechanisms

The most prevalent PFAS-containing chemicals used at DON installations were related to historical formulations of AFFF used for firefighting. Evidence showing the initial use of PFAS-containing AFFF at DON installations includes the Military Specification for AFFF (MIL-F-24385) issued in 1969 and the DON's Qualified Products List from 1970 that included the 3M Company's AFFF formulation. Starting in the 1970s, the DON has used AFFF containing PFAS in fire-training exercises, in suppression of aircraft and other vehicle fires, and in aircraft hangar fire suppression systems at many of its installations across the United States (DoD, 2017; Interstate Technology & Regulatory Council [ITRC], 2020). The exact date that AFFF use began at former NSTI was not documented but is assumed to have been in the early 1970s. Despite industry efforts to reduce the use of PFAS, some PFAS are still required as an integral component of AFFF by the current Military Specification (ITRC, 2020). However, use of AFFF and any potential subsequent release of PFAS at IR Site 6 ceased with the end of training activities in 1992.

PFAS may have been released to the environment at former NSTI IR Site 6 because of use of AFFF during the following activities:

- Fire-training exercises at burn pits or structures
- Firefighting vehicle testing
- Improper filling and leakage from storage tanks and the AFFF Station (see Figure 3) or from firefighting trucks

The release areas of PFAS from AFFF include the former burn areas and suspected former burn pit at the northwestern corner of the site, the helicopter training area and portable aircraft area, the central fire training yard, and the concrete-lined collector trench used to convey wastewater runoff from fire training exercises to the sumps, surge pit, and oil/water separators (OWSs) on the eastern corner of the site (Figures 3 and 10). IR Site 6 was used for nearly 50 years (1944 to 1992) for firefighting training activities. Training fires were ignited within the helicopter training area and a portable aircraft area along the northern portion of the concrete pad, as well as within four former buildings (240 through 243) in the central training yard. These former buildings and portions of the burn pits and concrete-lined trench have been removed during previous remedial actions onsite. Wastewater and unburned gasoline and diesel were collected in a concrete-lined collector trench (installed in approximately 1949) situated around the perimeter of the training school yard and through gravity flow passed through onsite OWSs. The OWSs were used to treat the wastewater by removing floating petroleum products. Wastewater potentially containing PFAS generated and treated at the site was discharged to the wastewater treatment plant (WWTP). The waste diesel and gasoline fuels were disposed of at an off-base location. These former buildings and portion of the burn pits and concrete-lined trench were removed during previous remedial actions onsite.

The potential medium that could be affected by runoff containing PFAS is surface soil. Surface runoff was captured by the collector trenches and routed to the OWSs and WWTP east of IR Site 6. Although approximately 50 percent of IR Site 6 has been excavated and subsequently backfilled with clean fill during previous remedial actions, as shown on Figure 2, a portion of the site where AFFF-related training activities occurred during the operational period of IR Site 6 represents a release area. It is not anticipated that PFAS will be detected in the clean fill; however, the clean fill may be included as part of the exposure area considered in the risk assessment for PFAS if the clean fill occurs within the targeted soil sampling intervals. Secondary release mechanisms from surface soil include infiltration into subsurface soil and groundwater. PFAS have been reported in subsurface groundwater and soil at IR Site 6, as shown on Figures 8 and 9.

3.4 Potentially Affected Media Migration Pathways

Contaminant fate refers to the physical and chemical processes that affect contaminant movement through the different media, including soil, groundwater, sediment, and surface water, at IR Site 6. Many mechanisms can affect the fate and transport of PFAS in these media, including the compounds' physical and chemical properties and the physical, geologic, geochemical, climatic, and hydraulic conditions of the site. Most PFAS, and particularly PFOS and PFOA, are stable in environmental media because they are resistant to environmental degradation processes, such as biodegradation, photolysis, and hydrolysis. In water, no degradation has yet been demonstrated, and migration is strongly influenced by advection, dispersion, and sorption to particulate matter. Some PFAS are known to potentially bioaccumulate through the food chain (ITRC, 2020). PFAS occur widely in biota, specifically in plants, invertebrates, fish, and humans, through bioaccumulation processes (Houde et al., 2011). PFAS concentrations in biota are influenced by carbon chain length, uptake and elimination of both PFAS and their precursors, and biotransformation rates of PFAS precursors; therefore, concentrations of PFAS observed in biota at one location may not reflect concentrations in other environmental media (ITRC, 2020).

The solubility of the contaminant significantly influences its potential movement from the point of release. PFAS, particularly PFOA and PFOS, are highly soluble in water, and surface releases of AFFF could migrate in the underlying soil and subsequently migrate with precipitation recharge vertically through the unsaturated zone to the groundwater table. PFAS are also affected by multiple partitioning mechanisms, including hydrophobic, lipophobic, and interfacial behaviors, leading to their occurrence at the soil/water, water/air, or water/non-aqueous-phase-liquid interfaces. Longer-chain PFAS sorb more strongly to the organic carbon fraction of soil and sediment than do shorter-chain PFAS (ITRC, 2020). These compounds are also less volatile than typical organic groundwater contaminants, and transformation of certain PFAS (e.g., fluorotelomer-derived precursors) may form more persistent compounds (e.g., PFOA) under ambient conditions.

AFFF sources are poorly understood but have been documented as sometimes increasing with depth due to leaching (Agency for Toxic Substances and Disease Registry [ATSDR], 2018). In a study that evaluated surface soils at a depth interval of 0–1 foot bgs against deeper soils, concentrations of even the long-chain PFAS displayed sometimes similar, increasing or decreasing concentrations with depth in a manner that is not necessarily predictable (Anderson et al., 2016). Studies on ambient distribution of PFAS in soils have documented trends of higher surface concentrations only when comparing samples from the upper 3 feet bgs with those from deeper depths (Brusseau et al., 2020).

Another important factor in evaluating the mechanisms of contaminant fate and transport is the source strength. No available records document the amount, specific formulations, and concentrations (e.g., 3 or 6 percent) of the formulations of AFFF used at IR Site 6 during the site's operational history. Therefore, the original strength of the source cannot be evaluated. However, with additional characterization data collected during the Phase I RI, the remaining source strength may be estimated. In addition, even though a substantial portion of the shallow soil at the site has been sampled and subjected to several removal actions, PFAS were not part of the analyte list, so a reliable current vertical and horizontal distribution of PFAS cannot be assessed using historical data. Without information on source strength and distribution, it is not possible to calculate a reliable mass estimate for the site.

Because the primary mechanism for PFAS transport within the subsurface soil is gravity, the lateral extent of the PFAS concentrations in vadose soil should be consistent with that of the PFAS release area. However, if PFAS are present, it is possible for the lateral extent of PFAS to expand along that preferential pathway. Stormwater, sewer, and/or water utility trenches could serve as pathways for lateral migration of PFAS in the subsurface. Although the burn area was lined with asphalt and a shallow “L”-shaped concrete-lined V-ditch collector trench surrounding the firefighting training was used to collect and convey wastewater runoff to sump pits and OWSs for oil recovery prior to discharge to the WWTP (Harding Lawson Associates, 1987) (Figures 3 and 10), PFAS have been detected in the soil within the training area and in groundwater within and downgradient of the training area.

Groundwater movement also provides a vector for lateral PFAS transport through the subsurface through advection and dispersion in groundwater, and by tidal forces nearshore. Groundwater flows primarily to north-northeast toward San Francisco Bay at IR Site 6. Additionally, the identified PFAS groundwater plume lies within the influence of tidal oscillations from the bay. A basewide tidal influence study performed in 1995 indicated that water table fluctuations at IR Site 6 can be detected approximately 30 feet to 250 feet from San Francisco Bay depending on tide stage (PRC, 1995). A subsequent basewide tidal mixing zone study in 2001 estimated that physical mixing of surface water and groundwater took place over distances that ranged from 60 to 150 feet inland from the mean lower low water line of former NSTI; however, no data were collected at IR Site 6 (TtEMI, 2002).

3.5 Potential Receptors and Exposure Pathways

IR Site 6 is currently not used on a consistent basis by humans, with only occasional site visits by DON personnel and DON contractors. IR Site 6 is currently fenced and consists of bare ground and paved areas.

3.5.1 Human Receptors and Exposure Pathways

IR Site 6 is currently covered with asphalt, concrete, and unpaved open space. All buildings have been removed, and the site is currently vacant and secured. However, unoccupied Building 461 is directly adjacent to IR Site 6 and is underlain by the PFAS plume. Access to the site is restricted, and the site is not open for public use. The partial presence of pavement and concrete limits contact with PFAS potentially remaining in soil. Potential current human receptors at IR Site 6 include infrequent outdoor workers/construction workers (i.e., DON contractors) and site visitors. Potential receptors nearshore include recreational visitors that could be exposed to nearshore water and sediment (impacts currently unknown).

The planned future use of the site is as an open space and recreational area. The development plan also indicates that an approximately 0.9-acre area in the southeastern portion of IR Site 6 will be used for public services and institutional purposes to support the replacement of the existing WWTP (TIDA, 2011). Potential future human receptors at former IR Site 6 include construction workers and recreational visitors. Potential exposure media identified for the construction worker include soil and groundwater. Potential exposure media for recreational visitors are soil, nearshore water, sediment, and fish/shellfish (impacts currently unknown). Exposure pathways may include direct contact (incidental ingestion and dermal contact) with these media and ingestion of fish or shellfish. Access to the site is currently restricted, and the site is not open for public use.

Hypothetical future user includes residents, which may be exposed to soil, and may also be recreationally exposed to sediment, surface water, or fish or shellfish consumption pathway. This exposure scenario is considered hypothetical because of existing land use controls and the planned future use.

3.5.2 Ecological Receptors and Exposure Pathways

No rare or endangered terrestrial floral or faunal species are known to inhabit or visit the island on a regular basis (DON, 2003). The existing urbanized habitat types are landscaped and developed areas. The existing natural habitat for wildlife is minimal because of the developed and landscaped surface of TI. Much of the vegetation consists of introduced species, including trees such as blue gum eucalyptus, Monterey pine, and Monterey cypress. There are no freshwater water bodies, wetland habitats, or salt marshes on TI. The predominant aquatic habitat around TI is subtidal, with unconsolidated mud bottom substrate. There is limited intertidal habitat, consisting of concrete riprap and dock and pier pilings along most of the shoreline surrounding TI.

Benthic invertebrates and aquatic (water-column) organisms may be directly exposed to PFAS (if present) nearshore and downgradient of IR Site 6. Additionally, aquatic-dependent birds and mammals may be potentially exposed to PFAS (if present) through incidental ingestion of sediment, pore water, or surface water and through ingestion of impacted prey items exposed to impacted sediment or water nearshore of IR Site 6.

Several water-dependent special-status species, including the California least tern (*Sterna antillarum browni*) and California brown pelican (*Pelecanus occidentalis*), feed throughout the region and have been observed near former NSTI (TtEMI, 2003).

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4.0 Remedial Investigation Sampling Approach

This section describes general site activities and requirements for the fieldwork planned for the Phase I RI. Field sampling and analysis will be conducted in accordance with the project SAP presented in Appendix A. The Phase I RI activities include the following:

- Installation of 30 shallow soil borings and 15 new monitoring wells (total of 45 sampling locations)
- Collection of 90 soil samples from the 45 locations (including the 15 new groundwater monitoring wells)
- Development of 15 new groundwater monitoring wells, and sampling of 9 existing and 15 new groundwater monitoring wells for PFAS
- A fate and transport evaluation of the tidal mixing zone
- Disposal of investigation-derived waste (IDW) following all federal, state, and local regulations

All samples will be submitted to a laboratory certified by the DoD and State of California Environmental Laboratory Accreditation Program for PFAS analysis of 18 PFAS (DON, 2020e). The 18 PFAS are included in U.S. EPA Method 537.1 and will be analyzed using liquid chromatography and tandem mass spectrometry (LC/MS-MS) compliant with DoD Quality Systems Manual (QSM), version 5.3 (DoD, 2019). The laboratory analytical results will be presented in the Phase I RI Report, along with the data validation report. A total of 90 soil samples and 24 groundwater samples, plus all required quality assurance (QA)/quality control (QC) samples, will be collected and submitted for laboratory analysis. Additionally, the tidal influences on IR Site 6 groundwater and potential mixing of groundwater and brackish water from San Francisco Bay will be evaluated. The sampling location rationale for all media is presented in Table 4-1.

4.1 Preparation Activities

Preparation for fieldwork includes acquisition of services, equipment, and permits; logistical coordination; and mobilization. Subcontractor services to be procured include geophysical utility clearance, professional surveying, drilling, laboratory analytical services, and data validation. An area of IR Site 6 will be designated the laydown area to store well materials and soil bins and serve as the designated decontamination area for the field activities as needed. The drillers responsible for well installation and direct-push injections must be licensed in California and will hold a C-57 Well Drilling Contractors License. Well installation, soil sampling, and groundwater monitoring must be overseen by a California Professional Engineer (PE) or Professional Geologist (PG). Potable water for well installation and other activities may also be required if an onsite source is not available.

The Multi-MAC JV team is dedicated to providing a safe work environment and has developed Coronavirus Disease 2019 (COVID-19) procedures to ensure the health and safety of all employees and visitors to the site. These procedures conform to the new California Occupational Safety and Health Administration (CalOSHA) standard in Title 8 California Code of Regulation (CCR) Section 3205 COVID-19 Prevention and are presented in detail in the APP/SSHP prepared for this project (Multi-MAC JV, 2020). These procedures will be updated, if necessary, to be in accordance with state of California regulations at the time of field mobilization.

4.1.1 Permitting and Notification

Under CERCLA-regulated cleanups, no federal, state, or local permits are required for onsite investigations. To comply with the substantive requirements, Multi-MAC JV will notify the San Francisco Department of Public Health, Environmental Health Section, prior to drilling soil borings and installing groundwater monitoring wells.

Site activities will be coordinated with the base Resident Officer in Charge of Construction (ROICC), the DON Remedial Project Manager (RPM), and the BRAC Contractor Support Office (CSO) representative. DTSC, RWQCB, and TIDA will be notified when the Multi-MAC JV team mobilizes to the field and updated regularly about the field activities.

4.1.2 Utility Clearance

Underground Service Alert (USA) North 811 will be notified at least 72 hours prior to intrusive activities and will issue ticket that must be maintained onsite during all subsurface activities. The ticket will identify potential utilities in the areas of investigation and will allow representatives of each utility to access the site or review institutional documents to evaluate the presence of their specific utility within the site boundary. Prior to notification, each area of investigation will be identified with white paint, stakes, and/or flagging. Typically, a representative from each utility will then mark the approximate location of the utility on the ground or mark no conflict at the site. Sampling locations within 5 feet of subsurface utilities or 25 feet of overhead power lines will be moved approximately 10 feet from their proposed locations. Moving the sampling location more than 10 feet will require notifying USA North 811 to identify utilities in the new location. If a sampling location is offset because of underground utilities or other unforeseen obstructions, that change will be documented in the field forms and in the

Phase I RI Report. In addition, an independent utility locator service will be used to ensure that each boring location is clear of underground utilities.

4.1.3 Mobilization and Site Setup

Multi-MAC JV will mobilize to the site to prepare the site for the field effort. Site preparation activities include installation of signage, receipt of portable restroom and wash facilities, preparation of heavy equipment and IDW staging areas, and installation of best management practices (BMPs). Storage for the equipment and IDW associated with field activities will be maintained onsite at the laydown area to be identified prior to the start of field activities. All wastes will be removed from the site within 90 days and will be transported via a licensed transporter. Temporary facilities expected onsite include portable toilets and wash stations. These temporary facilities will have sufficient containment and will be removed at the completion of the project. Equipment storage, fueling activities, and staging activities will be performed only within the site limits.

Prior to conducting intrusive activities within IR Site 6, the Multi-MAC JV site supervisor or designee will establish each of the new proposed drilling locations on the ground with white marking paint and/or lath stakes, as appropriate. Multi-MAC JV will work with the former NSTI ROICC to establish and identify appropriate laydown areas for all equipment, materials, and vehicles required to implement the field tasks. A temporary fence will be installed, and the area will be used as a support zone for the storage of materials and equipment during the RI. In addition, the storage area for IDW will also be designated through coordination with the DON RPM and former NSTI ROICC. The IDW storage area may be the same as the laydown area.

Sampling activities and required QC measures regarding contractors performing work at IR Site 6 will be coordinated by Multi-MAC JV and the DON RPM prior to initiating the field sampling activities. Daily discussions with the field team leader, the quality officer (if required), and the field team staff will take place prior to any sampling activities. These meetings will entail a discussion of assignments for the field team, including the boring locations and analytical groups to be entered on the chain-of-custody record for the day.

4.2 Soil Sampling Procedures and Analytical Parameters

The overall objective of sampling is to further delineate the nature and extent of PFAS occurrence at IR Site 6. The locations, depths, and number of soil borings will focus on potential former source areas and activities. They will provide sufficient spatial coverage of IR Site 6, taking into consideration the locations of prior excavation and remediation activities.

4.2.1 Soil Sampling

A total of 30 shallow soil borings will be drilled to a maximum depth of 6 to 8 feet bgs with two soil samples collected per boring. In addition, two soil samples will be collected per boring during drilling of the 15 monitoring wells (see Section 4.3 for information on monitoring well drilling and installation). Therefore, soil samples will be collected from 45 locations. The soil samples from the soil borings and during drilling of the monitoring wells will be collected from depths of 0–2 feet bgs and approximately 4–6 feet bgs (soil/groundwater interface). The soil sampling depth rationale for each soil boring and the monitoring wells is presented in Table 4-1, and the proposed soil boring and monitoring well locations are presented in Figure 11.

Soil samples will be collected from the depth interval from 0–2 feet bgs to be consistent with and to make best use of existing prior data (collected from the interval from 0–2 feet bgs) for PFAS in soils at IR Site 6 to meet the requirements of the baseline HHRA. Samples will be collected during utility clearance using a decontaminated stainless-steel hand auger. The discrete soil sample will be collected from the grab sampler and placed directly into the sample containers. Soil samples will not be homogenized because of the tendency of PFAS to adhere to sampling equipment.

To collect the soil sample just above the soil/groundwater interface (i.e., within the capillary fringe above the water table), a sample core will be obtained from a depth of approximately 4–6 feet bgs; the actual depth may vary based on field conditions at the time of sampling. To collect a sample that is representative of the capillary fringe, field personnel under the direction of a PG will use field observations of the soil moisture content of the sample core in accordance with the ASTM International (ASTM) D2488-17 Visual-Manual Method (based on the Unified Soil Classification System [USCS]). In addition, the depth to groundwater measured in nearby monitoring wells (if available), and if possible measured in the soil boring itself, may be used to help assess the depth of the capillary fringe.

Because of their shallow depth and the requirement to hand clear borings to a depth of 5 feet bgs (for utilities), the samples from the depth interval of 4–6 feet will be collected using hand auger and/or manual slide hammer sampler (lined with a clean sample tube) if possible. However, if it is not feasible to collect any soil samples at depths below 5 feet bgs using manual equipment, then those samples will be collected using powered drilling equipment. The drilling method for monitoring wells is described in Section 4.3. For the shallow soil borings, a direct-push technology (DPT) drill rig will be mobilized to collect those samples. On a DPT drill rig, hydraulic rams are used to push the sampler to desired depth, and then the tip of the sampler is retracted to the top of the sampler to expose the hollow sample core to the undisturbed soils below the sampler barrel. The sampler is then pushed to the bottom of the interval to be sampled, allowing relatively undisturbed soil to enter the sampler. The soil sample is collected in a series of clean sample tubes that line the solid sampler barrel. The full sample barrel is then withdrawn to the surface and the sample tubes removed from the sampler; the selected sample interval will be cut from the sample tube and sealed with plastic end caps only (no Teflon sheeting is to be used).

A total of 90 discrete soil samples (and any accompanying equipment blanks and field blanks) will be collected during the soil sampling from the 45 sampling locations for evaluation of the distribution of PFAS in soil. All soil samples will be labeled with a unique identification number, sampling date and time, and other relevant sampling data, as described in the SAP (Appendix A), and will be placed on ice in an insulated cooler under chain-of-custody protocols for transportation to the laboratory.

Representative soil samples will also be collected for geochemical analysis to support the fate and transport evaluation of PFAS in the soil at IR Site 6, as described in Section 3.0 and the SAP (Appendix A). Fate and transport of PFAS can be affected by carbon content in the soil (particularly longer-chain PFAS), potential of hydrogen (pH), redox potential, and ionic charge. For instance, downward leaching of PFAS in unsaturated soils can occur during precipitation and irrigation that would promote dissolution of soil bound mass and transport the PFAS chemical to groundwater. The leaching potential is a function of both media properties (such as pH, redox potential, and increased partitioning with organic-rich soils) and PFAS structural properties (such as ionic charge and PFAS molecule chain length) (ITRC, 2020). PFAS can sorb to organic carbon, positively charged mineral surfaces, and oil by hydrophobic and electrostatic interactions. Low pH (increased hydrogen ion activity) and high calcium ion activity tend to promote sorption. For PFOS, anions in solution may compete with PFOS for electrostatic adsorption to positive surfaces (i.e., electrical double layer effect); however, anions in solution may also reduce repulsion of PFOS molecules, forcing them to pack together on weak positive to negative surfaces (National Ground Water Association Press, 2017). PFOS tends to exist as dissolved species in low-salinity water (i.e., freshwater), but is sorbed to sediment in high-salinity water (e.g., in seawater) (Weiss et al., 2015). Therefore, the geochemical analyses will include moisture content, grain size, vertical hydraulic conductivity, effective porosity, soil pH, total organic carbon, and anion and cation exchange capacity for the fate and transport evaluation. The proposed sampling locations for the geochemical samples are shown on Figure 11.

4.2.2 Soil Sampling Decontamination Procedures

All soil sampling equipment, DPT equipment, and rods will be decontaminated thoroughly prior to initiating any site work, between each sampling location, and upon completion of the sampling program. All reusable sampling equipment will be decontaminated prior to use at each sampling location to minimize the potential for contaminant migration or cross-contamination. Equipment decontamination areas will be placed within or adjacent to the assessment area, as designated by supervising field personnel.

General sampling equipment decontamination will be conducted in accordance with the following procedures:

(1) Potable water and nonphosphate detergent (i.e., Liquinox) wash (using brushes)

(2) Potable water rinse

(3) PFAS-free laboratory-grade distilled or deionized water rinse

(4) Air dry and storage on clean plastic until used

Decontamination liquids will be managed as described in Section 4.6.

4.2.3 Laboratory Analysis

A total of 90 discrete soil samples (and any accompanying equipment blanks and field blanks) will be collected during the soil sampling from the 45 sampling locations. The soil samples will be submitted to the laboratory to be analyzed for the following:

- PFAS will be analyzed using LC/MS-MS compliant with DoD QSM Version 5.3 (DoD, 2019), or latest update upon analysis.

In addition, 14 soil samples will be collected for geochemical analysis as described in Section 4.2.1. The locations of geochemical samples are selected to provide coverage across IR Site 6. The samples selected for geochemical analysis are listed in Table 4-1. The samples will be submitted to the laboratory to be analyzed for the following:

- Moisture content (ASTM D2216 or equivalent)
- Dry density (ASTM D2937 or equivalent)
- Total organic carbon (Walkley-Black)
- pH (ASTM D4972 or equivalent)
- Cation exchange capacity (ASTM D7503 or equivalent)
- Anion exchange capacity (ASTM D7503 or equivalent)
- Particle size analysis (ASTM D422 or equivalent)
- Specific gravity (ASTM D854 or equivalent)

A total of 11 of the 14 soil samples will be submitted to the laboratory to be analyzed for the following:

- Effective porosity (California State Water Resources Control Board)
- Saturated hydraulic conductivity (ASTM D5084)

4.3 Well Installation and Groundwater Sampling

A total of 15 new groundwater monitoring wells will be installed to augment the existing groundwater monitoring well network of 9 wells at the site (Figure 12). During drilling of the monitoring wells, two soil samples will be collected per boring from depth intervals of 0–2 feet bgs and approximately 4–6 feet bgs (at the capillary fringe) as discussed in Section 4.2.1. Most of the existing groundwater data indicate exceedances of the DoD screening criteria by one or more orders of magnitude, with some of the highest concentrations at locations toward the shoreward side of IR Site 6.

4.3.1 Groundwater Monitoring Well Installation and Sampling

Groundwater monitoring wells will be installed using hollow-stem auger drilling techniques. The monitoring wells will be installed inside of approximately 8-inch-diameter borings. The monitoring wells will be advanced to a depth of approximately 15.5 feet bgs and screened across the water table. The final well design can be adjusted relative to the measured static depth to groundwater, so that the final well design will allow for collection of a representative groundwater sample from the depth of potential water-bearing sand and gravel layers observed in the boring. The soil borings will then be completed as monitoring wells using 2-inch-diameter, schedule 40 polyvinyl chloride (PVC) well casing with 10 feet of 0.010-inch slotted well screen. Each groundwater monitoring well will be drilled to a total depth 15.5 feet, with the bottom of screen set to 15 feet bgs and the top of screen set at 5 feet bgs (total of 10 feet of screen). The remainder of the well casing will consist of Schedule 40 PVC blank casing with flush-threaded joints. The bottom of each screen will be completed with a 6-inch, flush-threaded end cap. A sand pack consisting of #2/12 sand will be installed to a depth approximately 2 feet above the top of the well screen. A 1-foot bentonite seal will then be installed and hydrated above the top of the filter pack. The remainder of the well annulus will be filled with neat cement/bentonite grout. Soil cuttings will be stored and disposed of in accordance with Section 4.6.

4.3.1.1 Surface Completion

Following well installation, a maximum 12-inch-diameter, flush-mounted, traffic-rated well case will be installed in a 3-foot by 3-foot concrete surface well pad. In addition, four bollards will be installed at each new groundwater monitoring well for protection from vehicle traffic.

4.3.1.2 Well Development

The development procedure will include first measuring the depth to groundwater in the well and then calculating the volume of water within the well casing. Gentle bailing will be used to remove sand and fine material that may have accumulated in the well and will continue until sand content has been removed. After most of the sand has been removed, the well will be surged. Surging should be followed by additional bailing to remove sand and fine materials that may have entered the well during this effort. The well will then be bailed and/or pumped to remove a minimum of three casing volumes of groundwater. Indicator parameters for pH, temperature, turbidity, and electrical conductivity will be monitored until they stabilize within 10 percent, or a maximum of 12 saturated well volumes have been removed (these volumes are in addition to removing the equivalent volume of any added potable water during well installation), at which time development will be considered complete. The purge volumes, indicator parameters, and estimated recharge rates will be recorded on the field forms in the field logbook during well development. For the purpose of well development, the well will be considered stabilized when three consecutive readings of the indicator parameters are within 10 percent. A licensed California PG will oversee well development and decide when well development is complete.

Development water will be placed into 55-gallon drums approved by the United States Department of Transportation (DOT) and moved to the laydown storage area pending receipt of the well sampling analytical results. The drums will be labeled as pending receipt of the laboratory analytical report. Well development will start no sooner than 24 hours after well installation.

4.3.1.3 Well Survey

The groundwater monitoring well location, top of casing elevation, and elevation of the well pad or ground surface for each well will be surveyed by a State of California Registered Land Surveyor. The well survey will also include the existing wells to be used as the monitoring network to ensure that elevation data for all wells are comparable.

4.3.1.4 Groundwater Sampling

Groundwater sampling of the 15 new and 9 existing groundwater monitoring wells at IR Site 6 will begin a minimum of 72 hours after completion of well development in the new wells and will use the low-flow sampling method. The low-flow method is used to remove stagnant water that may be present in the well so that a representative sample of the water-bearing zone can be collected. Sections 4.3.1.5 through 4.3.1.8 describe additional groundwater sampling methodology. Because PFAS can be found in a number of consumer products, the following precautions will be taken during sample collection to avoid inadvertent sample contamination. These precautions should be discussed at the readiness review meeting prior to the start of the field sampling. The field crew should be reminded of these precautions each day before the start of sampling:

- Post-it Notes should not be used at any time during sample handling or mobilization/demobilization.
- Products containing Teflon will not be used during sample handling or mobilization/ demobilization.
- Samples should be collected in 250-milliliter high-density polyethylene (HDPE) bottles (2 bottles per sample) with unlined (no Teflon) polyethylene screw caps and should not be field filtered as required by the laboratory. At the laboratory, turbid samples or those containing sediment should be centrifuged or allowed to settle prior to subsampling supernatant to begin sample processing. There should be no filtration by the laboratory. If filtration is needed, glass fiber filters, not nylon or plastic, should be used and the bottle should be rinsed with methanol.
- Personnel involved with sample collection and handling should avoid wearing new clothing (e.g., at least six washings since purchase).
- Personnel involved with sample collection and handling should not wear water-resistant clothing immediately prior to or during sample collection.
- Personnel involved with sample collection and handling should not wear Tyvek suits.
- Personnel involved with sample collection and handling should wear nitrile gloves at all times while collecting and handling samples.
- Many food and snack products are packaged in wrappers treated with perfluorinated compounds (PFCs) and PFAS. Therefore, hands will be thoroughly washed after handling fast food, carryout food, or snacks.

- Sampling personnel must not possess prewrapped food or snacks (such as candy bars, microwave popcorn, etc.) during sampling.
- Blue Ice must not be used to cool samples or be used in sample coolers.

4.3.1.5 Water Level Measurement

Prior to purging each groundwater monitoring well, the water level will be recorded using a water level meter in 0.01-foot increments relative to a permanently marked survey point located at the top of the well casing. Well caps will be removed at least one-half hour before measuring water levels to allow wells to sufficiently vent any accumulated air pressure and allow the water levels to equilibrate. During purging of each monitoring well, water level measurements will continue to be recorded to evaluate compliance with the low-flow water level drawdown criteria. A sustainable purge rate will be used, and the drawdown, purge rate, and any other relevant parameters will be documented in the field logbook. To maintain consistent data, water levels will be measured using the same surveyed measurement point during each measurement. The water level meter will be decontaminated prior to use at each sampling location. These measurements will be recorded on the well purging-field water quality measurements form (Appendix A, Attachment 5).

4.3.1.6 Groundwater Sampling Decontamination Procedures

The submersible pump, if used, and water level measurement probe will be decontaminated prior to use in each monitoring well. The submersible pump and water level measurement probe will be washed with a scrub brush in tap water containing a non-phosphate detergent, such as Alconox, followed by a tap water rinse and a second rinse in deionized water. The submersible pump will also be run during each decontamination step to decontaminate interior surfaces of the pump prior to sampling each well. The submersible pump and water level measurement probe will be allowed to air dry prior to use. The decontamination water will be containerized for disposal. An equipment blank will be collected from the submersible pump by pumping deionized water through the submersible pump into the appropriate sample containers supplied by the laboratory. Equipment blanks will be collected daily if a sampling device is used that requires decontamination between samples, and each blank sample will be analyzed for the PFAS analytes. One field blank sample will be collected from the water used for the second rinse in the decontamination procedure. The field blank sample will be analyzed for the PFAS analytes.

If a peristaltic pump is used, decontamination of the pump will not be required because only the tubing will touch the groundwater; however, the tubing must be replaced before sampling each well. One equipment blank will be collected by running deionized water through the disposable PFAS-free tubing used for sampling of site groundwater.

4.3.1.7 Well Purging Activities

Groundwater samples will be collected from each monitoring well using a portable peristaltic pump and PFAS-free tubing. Wells will be purged at a maximum rate of 500 milliliters per minute (mL/min; the low-flow sampling method) to minimize turbidity.

Low-flow purging minimizes stress on the groundwater system by decreasing drawdown caused by pumping. Pumping at a low flow rate effectively isolates the screened interval from the overlying (stagnant) casing water, thereby sampling water from the screened interval only. The overall goal of low-flow purging is to produce a drawdown of less than 0.3 foot. If it is not possible maintain less than 0.3 foot drawdown during low-flow purging, the low-flow method will not be an appropriate sampling method, and an alternative sampling method will have to be implemented.

Before groundwater sample collection, water quality indicator parameters will be monitored and recorded to assess the stabilization and quality of the formation water. The pH, temperature, specific conductance (SC), oxidation reduction potential (ORP), dissolved oxygen (DO), total dissolved solids (TDS), and turbidity levels will be monitored. The pH, specific conductance, ORP, DO, and temperature parameters will be measured using a multiparameter meter with flow-through cell. Turbidity may be measured with a separate portable turbidity meter.

Stabilization is achieved after indicator parameters have met the following criteria:

- pH – Three successive readings within ±0.1 pH units
- Specific conductance – Three successive readings within ±3 percent
- ORP – Three successive readings within ±10 millivolts (mV)
- DO – Three successive readings within ±10 percent
- Turbidity – Less than 5 nephelometric turbidity units (NTU)

Stabilization parameters will be recorded on the low-flow well purging-field water quality measurements form (Appendix A, Attachment 5) and in the field logbook. Wells will be purged until groundwater parameters stabilize, the well pumps dry, or three well volumes have been removed. If water quality indicator parameters have not stabilized after 2 hours of purging, the sample will be collected, and the lack of stabilization will be documented in the field logbook.

4.3.1.8 Groundwater Sample Collection

Groundwater samples will be collected by directing the discharge from the sampling pump into the appropriate laboratory prepared and preserved sampling containers (see SAP Worksheet #19 [Appendix A]). To prevent cross-contamination, samplers will wear a new pair of disposable nitrile gloves during collection of each sample, and they will collect the samples directly into the sample containers from the pump discharge tubing, not through the flow-through cell.

The maximum purge rate when filling sample containers for the PFAS analytes will be 100 mL/min. The following sequence will be used to collect groundwater samples for laboratory analysis using a submersible pump and the low-flow sampling technique:

(1) Maintain laminar flow throughout the sample tubing and flow-through cell; keep all lines and the cell completely filled and air-free during parameter measurement and sampling.

(2) Collect groundwater samples when field-measured water quality parameters are stabilized. To prevent cross-contamination, samplers will wear a new pair of disposable nitrile gloves during the collection of each sample, and they will collect the samples directly into the sample containers from the pump discharge tubing, not through the flow-through cell.

(3) Collect the groundwater samples in the volumes required by the laboratory and in containers provided by the laboratory, as specified above and in the SAP.

(4) Record sample information on the accompanying chain-of-custody records completely, correctly, and consistently with the sample labels. Then, store the samples in a cooler with ice to a temperature of approximately less than or equal to 6 degrees Celsius (ºC), not frozen.

All samples will be identified, recorded, and handled in accordance with the sample custody requirements provided in SAP Worksheet #27 (Appendix A). The groundwater samples will be placed in 250-milliliter HDPE bottles (two bottles per sample) for PFAS analysis. The bottles from each well will be labeled immediately and double-bagged together in resealable plastic bags to prevent cross-contamination from other groundwater samples.

4.3.2 Laboratory Analysis

A total of 27 groundwater samples (24 primary samples and 3 duplicate samples) and any accompanying equipment blanks and/or field blanks will be collected during the groundwater sampling event. The groundwater samples will be submitted to the laboratory to be analyzed for PFAS using method LC/MS-MS compliant with DoD QSM, version 5.3 (DoD, 2019) or latest version at time of analysis.

4.4 Sample Packaging and Shipment

The samples will be packed with shock-absorbent materials, such as bubble wrap, to prevent movement or breakage of the sample containers during transport. Prior to shipping, the sample cooler will be filled with fresh wet ice that will be double bagged in resealable bags to meet temperature requirements of less than or equal to 6ºC. A temperature blank will accompany each cooler to be measured by the laboratory upon receipt. Cooler drain spouts (if present) will be taped from the inside and outside of the cooler to prevent leakage. The SAP (Appendix A) describes sample handling and custody requirements in greater detail. The samples will be shipped to SGS Orlando as described in SAP Worksheet #30 (Appendix A).

A chain-of-custody form (Appendix A, Attachment 5) will be placed in a resealable bag and inserted into the cooler, which will then be sealed with packaging tape. The cooler containing the environmental samples will be picked up by a laboratory courier or arrangements will be made to have the cooler delivered to the laboratory by an overnight delivery service. If an overnight delivery service is used, the package will be scheduled for priority overnight service to ensure that the temperature preservative requirement is not exceeded. Saturday deliveries will be coordinated with the laboratory.

4.5 Tidal Influence Study

Hydraulic communication between site groundwater and San Francisco Bay will be re-evaluated using the existing and planned monitoring wells to assess the magnitude of potential transport of PFAS-impacted groundwater into the bay (Figure 12). Large surface water bodies such as San Francisco Bay can have a significant impact on migration of contaminants in groundwater through tidal forces. These tidal forces in nearshore groundwater interact with groundwater discharge and variable-density flow to form a complex and dynamic flow regime that will require additional evaluation.

4.5.1 Summary of Previous Tidal Studies

The previous basewide tidal studies at IR Site 6 concluded that the site is influenced by tidal effects. The 1995 basewide tidal influence study indicated that tidal influence and flow reversal could be possible at IR Site 6 as far as 300 to 375 feet from the bay (PRC, 1995). The 2000–2001 basewide tidal mixing zone study estimated that physical mixing of surface water and groundwater took place over distances that ranged from 60 to 150 feet inland from the mean lower low water line of former NSTI; however, no data were collected at IR Site 6 (TtEMI, 2002). These previous studies did not include a comprehensive evaluation of geochemistry and potential gradient reversal in the IR Site 6 area in proximity to the bay where new monitoring wells have been installed after the 2001 study.

Additionally, groundwater gradient reversals and tidal fluctuations/mixing processes were found to inhibit the migration of chemicals from the UST 240 source area to the bay (ERRG, 2012) and were confirmed by the 2010 Data Gaps Investigation, which indicated that total petroleum hydrocarbons (TPH) and ethylbenzene were not present in groundwater at concentrations of concern in proximity to San Francisco Bay (ERRG, 2010). Note that petroleum hydrocarbons have different transport and biodegradation characteristics than PFAS.

4.5.2 IR Site 6 Tidal Influence and Mixing Zone Evaluation

Hydraulic communication, specific to IR Site 6, between fresh groundwater from the island and saline bay water will be established by conducting a 2-week groundwater elevation and salinity study to capture the hydrogeological and geochemical effects during multiple tidal cycles, as follows:

- Multiparameter transducers will be installed at 12 wells at IR Site 6 and 1 surface water (bay) location to monitor for barometric pressure, water level change, and salinity (Figure 12). The wells that will be included in the study listed in Table 4-1.
- Groundwater elevation, barometric pressure, and salinity will be recorded at approximately 10-minute intervals for the duration of the study.
- All wells used in the study will be screened through the top of the first water-bearing zone, from a depth of approximately 5–15 feet bgs. The screened interval may be adjusted in the field so that the top of the screen is above the water table.

The study will be conducted during the dry season (non-raining) to represent 6 of the 12 months of the year and preferably during the period of maximum tidal amplitude, when tidal effects on the groundwater are expected to be greatest (i.e., the period when the tidal cycle has the greatest difference between low and high tides, thus representing a seasonal low and high tide levels within the study period). In San Francisco Bay, such extreme tidal fluctuations are predicted to occur at least once each month according to National Oceanic and Atmospheric Administration [NOAA] Tide Predictions).

The transport of PFAS in the tidal mixing zone will be evaluated using empirical data (e.g., water elevation and salinity) measured in selected monitoring wells and in San Francisco Bay. This evaluation will summarize the measured tidal effects (e.g., tidal efficiencies), groundwater geochemistry, and groundwater flow paths during high-, low- and mid-tide groundwater elevations. The study will also evaluate the changes in groundwater gradients and groundwater flow directions and the potential fate and transport and/or mass flux of PFAS from the release area to the bay throughout several tidal cycles.

The proposed tidal study consists of installing a series of hydraulic pressure and water quality transducers in selected monitoring wells screened across the water table and along the flow of groundwater from the source area(s) to San Francisco Bay (southwest to northeast). The data obtained from the pressure/water quality transducers will be used to evaluate the transmissivity/hydraulic conductivity of the water-bearing zone (shoal sands from dredging used as fill for IR Site 6 and former NSTI). Groundwater elevation over time in each well will be measured, and the time lag and/or stage ratio (well stage compared to the bay) will be computed and be used to estimate aquifer properties such as transmissivity and hydraulic diffusivity. The stage ratio and time lag methods produce more representative hydraulic properties of the site. Pressure transducers (In-Situ™ Aqua Troll 600 Multiparameter Sonde or equivalent) will be deployed in approximately four to six wells along the flow path of groundwater from the source area(s) to San Francisco Bay (Figure 12). One transducer will be placed in San Francisco Bay. Each pressure transducer will be capable of measuring pressure (groundwater elevation), pH/ORP, SC, salinity, density, DO, and temperature. The pressure transducers will be placed in the specified wells for approximately 2 weeks. The transducer data will be downloaded 2 to 3 days following deployment as a check that the transducers are collecting data and are operational.

Additionally, variation in geochemical parameters (SC, temperature, pH/ORP, and DO) will be monitored over several tidal cycles to determine areas of tidal mixing zone and areas of fresh (non-tidally mixed) groundwater.

The results of the study will provide data to estimate the net, mean groundwater gradient, and apparent direction of flow of groundwater across the site and to indicate the relative degree of hydraulic communication of groundwater with the bay.

4.6 Investigation-Derived Waste Management

IDW generated during well installation and groundwater sampling activities will include personal protection equipment (PPE), soil cuttings, development and purge water, and decontamination fluids. Development water, purge water, and decontamination water from drilling and sampling activities will be placed into DOT-approved 55-gallon drums and moved to the secured designated IDW storage area. Soil cuttings may be placed in a soil bin with a lid or DOT-approved 55-gallon drums.

Each drum (and/or soil bin) will be labeled with the following information:

- DON RPM (or designated point of contact [POC]) name and contact information
- Date collected

- General locations (location identifiers [IDs]) from which materials were collected
- Contents (soil or water)

All soil cuttings, purge water, and decontamination fluids generated during the RI field activities will be containerized in soil bins or 55-gallon drums approved by the DOT and placed inside a secondary containment area for storage at a designated IDW storage area. One composite sample will be collected from the soil bins, and one composite sample will be collected from drums containing development and purge water. The samples will be submitted to the laboratory for waste characterization analysis. The waste characterization samples will be submitted to the laboratory for the following analyses:

- Volatile organic compounds (VOCs) using U.S. EPA Method 8260B
- TPH as diesel and motor oil by U.S. EPA Method 8015D
- PFAS by LC/MS-MS Compliant with DoD QSM 5.3 Table B-15 or latest version at time of analysis
- California Administrative Manual (CAM) 17 metals (soil only) by U.S. EPA Methods 6010B//7471A

The results from the waste characterization samples will be used to create separate waste profiles for the designated disposal facilities for all soil and groundwater IDW generated at IR Site 6 during field sampling activities.

It is anticipated that IDW from the well installation and soil sampling activities will be considered nonhazardous. However, until analytical results are available, the drums will be labeled as “Pending Analysis.” Once analytical results are available, the IDW will be evaluated for hazardous potential content, and the appropriate label will be applied to the drums.

Based on the laboratory analytical results of the groundwater samples, a waste profile will be created that classifies the waste and is signed by the generating facility (or designated representative), acknowledging the classification. All soil, groundwater, and decontamination water will be transferred to the disposal facility under the waste profile generated for IR Site 6. A waste manifest will be generated from the waste profile and will be signed again by the generating facility (or designated representative) at the time the waste is readied for transport. The subcontracted waste transportation company will also sign the waste manifest, accepting the load and removes the waste from the generating facility’s property. When the waste arrives at the final disposal facility, the waste manifest will be signed by the final disposal facility, authorizing the acceptance of the waste. A copy of the waste manifest will be provided to the generating facility as proof of acceptance. The corrective action contractor will also retain a copy of the waste manifest as part of the official project files and will include a copy in the project report to the client.

On June 30, 2018, U.S. EPA established a national system for tracking hazardous waste shipments electronically (called “e-Manifest”), allowing U.S. EPA to accept electronic manifests in addition to the existing paper manifests. e-Manifest will be used to track hazardous wastes from cradle to grave electronically. Users can view, create, and sign electronic manifest forms electronically. e-Manifest also allows generator and disposal site managers to manage and approve the forms electronically. U.S. EPA encourages the use of electronic submittals, although the statute allows optional use of paper manifests. Whenever possible, the corrective action contractor should attempt to use the e-Manifest system as it becomes more widely adopted by generators, transporters, and disposal facilities.

Nonhazardous waste shipments will be tracked via standard paper manifests that are signed and dated by the waste generator, transporter, and disposal facility to track the movement of the wastes from the site to the final disposal facility. Copies of the standard manifests will be maintained by the generator, transporter, disposal facility, and corrective action contractor. The corrective action contractor will include the records of the shipments in project reporting, if required. Solid waste generated during sampling activities, such as PPE and miscellaneous trash, will be disposed of as nonregulated solid waste.

4.7 Site Restoration and Demobilization

Site restoration includes backfilling soil borings prior to final demobilization from the site.

Following collection of all soil samples from a boring, the boring will be backfilled with granulated bentonite from total depth to the surface and the surface of each boring will be covered with native soils. A wooden stake will be placed in the ground at the boring location following backfill, and the boring identification will be marked on the stake for survey.

Final demobilization from the site will occur once all field activities have been completed. Prior to final demobilization, a site walk with a DON representative will be conducted to ensure that site conditions have been restored to the extent possible and that no waste or materials are left onsite without proper permission.

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5.0 Human Health Risk Assessment

A baseline HHRA will be prepared for onshore exposures at IR Site 6 and will be documented in the Phase I RI Report. The baseline HHRA will be conducted in accordance with CERCLA requirements and applicable U.S. EPA, DON, and DTSC guidance. The baseline HHRA will be conducted for PFOS, PFOA, and PFBS and added to risks from previously identified COCs remaining onsite.

5.1 Overview of the Risk Assessment Methodologies

The baseline HHRA will be performed in a manner consistent with and/or in consideration of *U.S. EPA Risk Assessment Guidance for Superfund Volume I – Parts A through F* (U.S. EPA, 1989, 1991a, 1991b, 1992, 2001a, 2001b, 2004, 2009). In accordance with U.S. EPA guidance, the baseline HHRA will include the following four steps:

- Data Evaluation
- Exposure Assessment
- Dose-Response Assessment
- Risk Characterization

The State of California does consider site-specific HHRAs in remedial decision-making; therefore, its associated guidance will be considered in the baseline HHRA. The primary DTSC guidance for conducting baseline human health risk assessments has been rescinded. However, DTSC does have available screening-level risk assessment guidance (DTSC, 2015, 2018, 2019a) that will be used, as appropriate, in conjunction with U.S. EPA guidance and consistent with DON risk assessment guidance (DON, 2008) and other related DoD guidance (Tri-Services Environmental Risk Assessment Workgroup, 2009).

5.2 Data Evaluation

The data evaluation step includes compiling the available data sets: soil and groundwater analytical data from Phase I RI and data from previously collected soil samples still onsite. PFAS data will be limited to PFOS, PFOA, and PFBS because they are the only PFAS chemicals with available USEPA toxicity data. Previous validated PFAS data include the following:

- Soil data collected in July 2015 (see Table 2-1)

- Groundwater data collected in May and December 2017 and April and September 2020 (see Table 2-2)

The baseline HHRA will also evaluate residual concentrations where legacy chemicals remain in on-base media following remedial actions and are co-located with PFOS, PFOA, and PFBS. The process for evaluating data for legacy chemicals includes the following steps:

- Review of previous site investigation documentation, remediation reports, and database files for legacy data, which are likely to include dioxin toxicity equivalency quotient (TEQ) in soil, as well as VOCs and metals
- Evaluation of non-PFAS data to identify whether they are still representative of site conditions (i.e., subsequent remediation is not likely to have removed the contamination represented)
- Evaluation of current depths of the previous samples based on the added clean fill
- Evaluation of the records of testing of the imported fill to confirm that the fill contains no legacy chemicals
- Review of the CSM to determine whether additional exposure pathways require evaluation to provide cumulative risk estimate for PFAS and non-PFAS contaminants (i.e., whether inhalation pathways may need to be evaluated to provide an estimate of total risks)

Compiled analytical results and statistical summaries will be included in the baseline HHRA. All validated analytical data will be evaluated for usability in the baseline HHRA consistent with U.S. EPA guidance (U.S. EPA, 1992).

Soil data summary tables will be prepared for two depth intervals (0–2 feet bgs and 0-6 feet bgs); the interval from 0–6 feet is the anticipated depth to groundwater, and will include the range of detections, range of reporting limits for nondetections, number of samples, frequency of detection, location of the maximum detected concentration, and relevant screening levels. Data for field sample/field duplicate pairs will be resolved prior to calculating summary statistics with the maximum detection of each chemical selected to represent a field sample/field duplicate pair. In the case of nondetections for both the field sample and field duplicate results for a given chemical, the lower reporting limit will be selected to represent the field sample/field duplicate pair.

Data summaries for soil and groundwater (depth of less than 10 feet bgs) will be provided for one terrestrial exposure area.

Data that are selected for use in the baseline HHRA will be compiled and summarized to support the selection of contaminants of potential concern (COPCs) that will be carried through the baseline HHRA.

5.3 Selection of Contaminants of Potential Concern

PFOS, PFOA, and/or PFBS will be identified as COPCs if they are detected in at least one soil sample. Other PFAS chemicals currently lack available tiered toxicity criteria and therefore will not be evaluated for consideration as COPCs. This topic is discussed further in the uncertainty section.

If exposure areas for legacy chemicals remaining in on-base media following remedial actions overlap with exposure areas for PFOS, PFOA, and PFBS, the baseline HHRA will also evaluate residual concentrations. Following the same approach as PFAS, all legacy chemicals that are detected in at least one sample will be identified as COPCs.

COPCs for each media evaluated will be selected as described in Sections 5.3.1 and 5.3.2.

5.3.1 Soil

Chemicals in soil will be analyzed for PFAS. Analytical data for the surface (0–2 feet bgs) and combined surface and subsurface (0–6 feet bgs) will be compiled in data summary tables. Identification of COPCs will be based on whether PFOS, PFOA, and PFBS are detected in at least one soil sample. No risk-based toxicity screening will be conducted to select COPCs. Because PFOS, PFOA, and PFBS have been previously detected in soil, all three chemicals will be selected as COPCs.

Surface and subsurface soils are defined as follows for the purposes of the baseline HHRA:

- Surface soils are represented by samples collected from a depth from 0–2 feet bgs, where 2 feet represents the deepest end-depth interval, as explained in Section 4.2.1. This data set will be used to evaluate potential current/future exposures associated with the current site configuration, assuming little or no redevelopment and minimal disturbance of deeper (subsurface) soils.
- Subsurface soils that could become surface soils in the future are represented by soil samples collected from a depth from 0–6 feet bgs, where 6 feet bgs represents the deepest end-depth. This data set will be used to evaluate potential future exposures associated with possible intrusive development, where future regrading or excavation may redistribute subsurface soils to the surface.

5.3.2 Groundwater

Groundwater samples collected from monitoring wells will be analyzed for PFAS during the Phase I RI. Three PFAS (PFOS, PFOA, and PFBS) have been previously detected in groundwater monitoring wells and will be selected as COPCs in groundwater.

5.4 Exposure Assessment

The purpose of the exposure assessment is to estimate the magnitude and frequency of potential human exposure to COPCs present in media of interest at each exposure area. The first step in the exposure assessment process is determining potential receptors (i.e., people who may contact the impacted environmental media of interest). Exposure points and/or exposure areas are also identified during the exposure assessment. Potential exposure scenarios and appropriate environmental media and exposure pathways for current and potential future site uses are then identified. The doses (or average daily intakes for oral and dermal routes) and exposures (average daily exposures for the inhalation route) are calculated using exposure point concentrations (EPCs) and the receptor exposure parameters. This baseline HHRA onshore receptors will consider separately the potential exposure of receptors to soil and groundwater.

5.4.1 Site Setting

IR Site 6 is currently vacant. Onshore fishing activities have been observed by various stakeholders throughout former NSTI and in the general vicinity of IR Site 6. Groundwater is not suitable as a potential source of drinking water and therefore no potable use scenarios are considered. As discussed in Section 2.1.3, the existing restrictions on the use of the site are in place to prevent future residential site use.

5.4.2 Identification of Potential Exposure Scenarios

Relevant exposure routes for the onshore receptors RI are incidental ingestion and dermal contact with soil and incidental ingestion of groundwater. The inhalation exposure pathway will not be quantitatively assessed for PFAS because of the absence of currently recommended toxicity values by U.S. EPA, and dermal contact with PFAS in groundwater will not be quantitatively evaluated because of the limited dermal absorption of PFAS in water through human skin. The uncertainty related to the inhalation and dermal contact with groundwater pathways is discussed further in the uncertainty discussion.

Based on current and potential future land use, the onshore baseline HHRA will consider the following receptors and exposure pathways, as shown in the preliminary exposure CSM on Figure 13:

- Soil will be evaluated for direct contact pathways for recreational visitors and construction workers. Direct contact pathways for hypothetical future residents will also be evaluated for informational purposes, although existing ICs at IR Site 6 prohibit future residential use, as documented in Section 2.1.3. PFOS was detected at concentrations above the residential screening level of 0.13 mg/kg in five samples at depths from 2–4 feet bgs.
- Groundwater (depth of less than 10 feet bgs) will be evaluated for direct contact pathways for construction workers
- Evaluation of the recreational visitor exposure to surface water and sediment and consideration of the fish/shellfish consumption pathway will be described in a next phase of the RI.

Although background ambient surface water concentrations will not be measured as part of the onshore sampling effort, ambient concentrations in water are available for San Francisco Bay and may be discussed for comparison. Surface water ambient concentrations are available from the following publications:

- Sanchez-Soberon et al. 2020. *Multi-box mass balance model of PFOA and PFOS in different regions of San Francisco Bay*. Chemosphere 252, Article 126454.
- Sedlak et al. 2018. *Per and Polyfluoroalkyl Substances (PFAS) in San Francisco Bay: Synthesis and Strategy*. San Francisco Estuary Institute Contribution No. 867. San Francisco Estuary Institute: Richmond, CA.
- Sedlak et al. 2017. *Per- and polyfluoroalkyl substances (PFASs) in San Francisco Bay wildlife: Temporal trends, exposure pathways, and notable presence of precursor compounds*. Chemosphere 185: 1217-1226.

5.4.3 Exposure Points

Potential exposure points are identified on the basis of current and anticipated future population activity patterns and the relationship of the activities to the presence of impacted media. A location is identified as an exposure point if a human might contact (e.g., ingest) an impacted medium (e.g., surface soil) at that location. Exposure points will be further refined upon receipt of the full data set; however, currently one exposure point is anticipated per medium.

IR Site 6 will be evaluated as a single terrestrial exposure unit. Hot spots are not anticipated because of the small site size and surface dispersal. Exposure points are anticipated to include one onshore soil and groundwater exposure area.

5.4.4 Exposure Point Concentrations

EPCs will be calculated for each COPC in each medium and will be used to estimate exposures for each receptor:

- EPCs will be calculated for the soil exposure area (surface soil and combined surface and subsurface soil will be evaluated separately) as the lower of the 95 percent upper confidence limit (UCL) on the mean (calculated using U.S. EPA ProUCL software [U.S. EPA, 2016]), as appropriate, and the maximum detected concentration. Soil exposures for surface soil (0–2 feet bgs) will be considered for recreational visitors and hypothetical residents, and combined surface soil and subsurface soil (0–6 feet bgs) will be evaluated for all receptors (assuming future excavation and reworking/regrading of the site).
- EPCs will be calculated for the groundwater exposure area as the lower of the 95 percent UCLs on the mean (calculated using U.S. EPA ProUCL software [U.S. EPA, 2016]), as appropriate, and the maximum detected concentration per medium. The EPC estimation will also consider the U.S. EPA Supplemental Guidance for determining groundwater EPCs (U.S. EPA, 2014a).

5.4.5 Chemical Intake Estimates

Estimates of exposure are based on the EPCs, scenario-specific assumptions, and intake parameters. Exposure estimates (intakes) will be calculated for a reasonable maximum exposure (RME) scenario for each receptor and exposure pathway. The exposure parameters for each receptor will be selected to represent the RME scenario. The RME represents the highest exposure reasonably expected to occur and is calculated using the EPC and the RME exposure parameters. The exposure parameter values will be U.S. EPA-recommended default exposure parameters (e.g., body weight, soil ingestion rate, frequency of exposure, duration of exposure) that will be obtained from *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. Attachment 1. Recommended Default Exposure Factors* (U.S. EPA, 2014b). If California-specific exposure parameters differ, values recommended in DTSC Human and Ecological Risk Office (HERO) HHRA Note 1 (DTSC, 2019b) will be used for the California risk calculations.

For each receptor, the exposure (or dose) will be estimated for each chemical via each exposure pathway by which the receptor is assumed to be exposed. Exposure dose equations combine the estimates of chemical concentration in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose. The exposure dose or daily intake is defined as the amount of COPC taken into the receptor and is expressed in units of milligrams of COPC per kilogram of body weight per day (mg/kg-day). The generic equations for calculating chemical intake are as follows (U.S. EPA, 1989, 2009, 2014b):

$$Intake\ (oral\ or\ dermal) = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

where:

I = Intake: the amount of chemical at the exchange boundary from oral or dermal exposure (mg/kg-day for oral and dermal exposure)

C = Chemical concentration for the exposure medium: the EPC (e.g., mg/kg for soil)

CR = Contact rate: the amount of impacted medium contacted orally or dermally per unit of time or event – may be the ingestion rate or dermal contact rate (e.g., milligrams per day for the ingestion rate of soil). The contact rate is not applicable for inhalation exposures

ET = Exposure time: number of hours the exposure occurs (hours per day) – the exposure time is applicable only for inhalation exposures

EF = Exposure frequency: how often the exposure occurs (days per year)

ED = Exposure duration: the number of years in which a receptor comes in contact with the impacted medium (years)

BW = Body weight: the average body weight of the receptor over the exposure period (kilograms) – applicable only for oral and dermal exposures

AT = Averaging time: the period over which exposure is averaged (days for oral and dermal exposures; hours for inhalation exposures). For carcinogens, the averaging time is 25,550 days (oral and dermal exposures), and 613,200 hours (inhalation exposures) on the basis of a lifetime exposure of 70 years, which represents the average United States life expectancy. For noncarcinogens, the averaging time is equal to the ED expressed in days (ED × 365 days/year) for oral and dermal exposures, and in hours (ED × 365 days/year × 24 hours/day) for inhalation exposures.

The specific equations used to calculate doses/intakes for soil and groundwater are provided in Table 5-1 and Table 5-2, respectively. These tables identify the exposure profiles for each of the receptors, including proposed exposure parameter values used to calculate the daily intake calculations for each of the receptors and exposure pathways. The current exposure assumptions are consistent with previous exposure assumptions applied at the site, but not identical because of updates to references from both DTSC and U.S. EPA.

5.5 Toxicity Assessment

The purpose of the toxicity assessment (dose-response assessment) is to identify the types of adverse health effects a chemical may potentially cause and to define the relationship between the dose of a chemical and the likelihood or magnitude of an adverse effect (response) (U.S. EPA, 1989). Adverse effects are classified by U.S. EPA as potentially carcinogenic or noncarcinogenic (i.e., potential health effects other than cancer). Dose-response values for potentially carcinogenic effects are called cancer slope factors (CSFs), and those for noncarcinogenic effects are called reference doses (RfDs). Dose-response relationships are defined by U.S. EPA for oral and inhalation exposure. Oral toxicity values are also used to assess dermal exposures, but with appropriate adjustments. Combining the results of the dose-response assessment with information on the magnitude of potential human exposure provides an estimate of potential risk.

U.S. EPA guidance regarding the hierarchy of sources of human health dose-response values in the baseline HHRA will be followed in selecting dose-response values (U.S. EPA, 2003). The following hierarchy of sources for dose-response values from *Human Health Toxicity Values in Superfund Risk Assessments* (Office of Solid Waste and Emergency Response [OSWER] No. 9285.7–53, December 2003; U.S. EPA, 2003) will be used in identifying dose-response values for the CERCLA-compliant portion of the baseline HHRA. This section includes a discussion of the basis of the toxicity values selected, including their purpose for context.

The U.S. EPA toxicity criteria-based risk assessment will rely on DoD-accepted toxicological data, which currently include reference doses for PFOS, PFOA, and PFBS, and the oral cancer slope factor for PFOA. Additional toxicological data will be included in the risk assessment if compliant with the hierarchy of toxicity values defined in DoD Instruction 4715.18 and OSWER Directive 9285.7-53 (Human Health Toxicity Values in Superfund Risk Assessments [U.S. EPA, 2003]).

The current PFAS toxicity values for use in the baseline HHRA are as follows (these will be used unless other DoD-approved values become available prior to completion of the draft baseline HHRA):

- RfD for PFOS/PFOA (together or individually) – 2.0 x 10^{-5} mg/kg-day

- RfD for PFBS – 3.0×10^{-4} mg/kg-day
- CSF for PFOA – 0.07 $(\text{mg/kg-day})^{-1}$

Additional toxicological data for non-PFAS chemicals if included, will be selected and included in the risk assessment, if compliant with the hierarchy of toxicity values as defined in OSWER Directive 9285.7-53 (Human Health Toxicity Values in Superfund Risk Assessments [U.S. EPA, 2003]).

It is acknowledged that the regulatory environment regarding PFAS is continually changing. Therefore, adoption of additional toxicity criteria associated with PFAS issued at the federal and/or state level will be considered during the development of the RI Report.

Toxicity information will be summarized in the report in detailed tabular format. No toxicity values will be derived from primary literature.

5.6 Risk Characterization

For each potential exposure pathway considered in the baseline HHRA, health risks will be characterized into a potential carcinogenic risk and a potential noncarcinogenic hazard for each (U.S. EPA, 1989, 1991c). The total risk and hazard index (HI) will be compared with U.S. EPA and state regulatory thresholds.

The guidance states, "*where cumulative carcinogenic risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the noncancer HQ is less than 1, action generally is not warranted unless there are adverse environmental impacts.*" In addition, the California Environmental Protection Agency (Cal/EPA) has stated that 1×10^{-6} is considered as the point of departure for risk management decisions. For this reason, the range of 10^{-4} to 10^{-6} is referred to as the "risk management range" in the baseline HHRA, and action may be taken to address those calculated risks that are from 10^{-4} to 10^{-6}.

The cancer risk and HI will be calculated using EPCs, exposure parameters, and toxicity information discussed in Section 5.6 and presented in U.S. EPA *Risk Assessment Guidance for Superfund (RAGS) Part D* (U.S. EPA, 2001b). Calculated cancer risks and noncancer HIs will be included in appendices to the baseline HHRA. In addition, risk summary tables will be prepared to include medium-specific and cumulative receptor cancer risks and noncancer hazards for each medium/receptor combination. This baseline HHRA will focus on PFOS, PFOA, and PFBS and will consider cumulative risk from other historical site impacts where relevant.

Sections 5.6.1 and 5.6.2 describe the approach for characterization for carcinogenic and noncarcinogenic risks.

5.6.1 Carcinogenic Risk Characterization

The purpose of carcinogenic risk characterization is to estimate the upper-bound likelihood, over and above the background cancer rate, that a receptor will develop cancer in his or her lifetime as a result of exposure to a chemical in environmental media at the site. This likelihood is a function of the dose of a chemical and CSF for that chemical. The excess lifetime cancer risk (ELCR) is the likelihood over and above the background cancer rate. The risk value is expressed as a probability (e.g., $1\text{x}10^{-6}$ or 1 in 1 million).

The relationship between the ELCR and the lifetime average daily dose (LADD) of a chemical may be expressed as:

$$\text{ELCR} = \text{LADD (mg/kg-day)} \times \text{CSF (mg/kg-day)}^{-1}$$

This equation is typically used to calculate the ELCR in a baseline HHRA. The product of the CSF and the LADD is unitless and provides an upper-bound estimate of the potential carcinogenic risk associated with a receptor's exposure to that chemical via that pathway.

The potential carcinogenic risk for each exposure pathway is calculated for each receptor. In current regulatory risk assessments, it is assumed that cancer risks are additive. Risk estimates from different exposure pathways are summed to estimate the total site potential cancer risk for each receptor. The sum of the cancer risk estimates for each receptor will be compared with the U.S. EPA generally acceptable risk management range of 1×10^{-4} to 1×10^{-6}. In the *National Oil and Hazardous Substances Pollution Contingency Plan (NCP)*, U.S. EPA defined general remedial action goals for sites on the National Priorities List (Title 40 of the Code of Federal Regulations [CFR], Section 300.430). The goals include a range for residual cancer risk, which is "*an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}, or 1 in 10,000 to 1 in 1,000,000*." The goals established in the NCP are applied once a decision to remediate a site has been made. A subsequent U.S. EPA directive (U.S. EPA, 1991c) provides additional guidance on the role of the baseline HHRA in supporting risk management decisions, and in particular evaluating whether a response action is necessary. Carcinogenic risks that exceed the Cal/EPA point of departure of 1×10^{-6} will also be identified.

5.6.2 Noncarcinogenic Hazard Characterization

The potential for exposure to a chemical resulting in potentially adverse noncarcinogenic health effects will be estimated for each receptor by comparing the chronic average daily dose (CADD) for each COPC with the RfD for that COPC. The resulting ratio, which is unitless, is the hazard quotient (HQ) for that chemical. The HQ is calculated using the following equation:

$$HQ = \frac{CADD(mg/kg-day)}{RfD(mg/kg-day)}$$

When the HQ is less than or equal to 1, the RfD has not been exceeded, and no adverse noncarcinogenic effects are expected. If the HQ is greater than 1, there may be a potential for adverse noncarcinogenic health effects to occur; however, the magnitude of the HQ is not directly equated to a probability or effect level.

Summing the HQs for each individual chemical identifies the total HI for each exposure pathway. Furthermore, the total site HI is calculated for each potential receptor by summing the HIs for each pathway associated with the receptor. Where the total site HI is greater than 1 for any receptor, a more detailed evaluation of potential noncarcinogenic effects based on specific health or target endpoints (e.g., liver effects, neurotoxicity) may be performed, if appropriate for PFAS (U.S. EPA, 1989). The target HI is 1 on a per-target endpoint basis.

5.7 Uncertainty Analysis

The risk characterization that will be documented in the Phase I RI Report will include an uncertainty analysis. Uncertainty and variability are inherent in exposure assessment, toxicity values, and risk characterization. U.S. EPA guidance (U.S. EPA, 1989) states (emphasis from the original): "*There are several categories of uncertainties associated with risk assessments. One is the initial selection of substances used to characterize exposures and risk on the basis of the sampling data and available toxicity information. Other sources of uncertainty are inherent in the toxicity values for each substance used to characterize risk. Additional uncertainties are inherent in the exposure assessment for individual substances and individual exposures. These uncertainties are usually driven by uncertainty in the chemical monitoring data and the models used to estimate exposure concentrations in the absence of monitoring data, but can also be driven by population intake parameters. Finally, additional uncertainties are incorporated in the risk characterization when exposures to several substances across multiple pathways are summed.*"

Regulatory risk assessment methodology requires that conservative assumptions be made throughout the risk assessment to ensure that public health is protected. The assumptions that introduce the greatest amount of uncertainty in this onshore baseline HHRA will be discussed in the uncertainty analysis section of the Phase I RI Report. Assumptions will be discussed in qualitative terms because, for most of the assumptions, there is not enough information to assign a numerical value that can be factored into the calculation of risk to the uncertainty. Uncertainties involved in data evaluation (Section 5.3) include assumptions regarding the decision of selection of sampling points as EPCs and selection of COPCs on the basis of screening. In the exposure assessment (Section 5.4), uncertainties exist in the selection of receptors and assumptions concerning rates of ingestion, frequency and duration of exposure, and bioavailability of the chemicals in the medium. Specific uncertainties regarding the exposure pathways relevant to PFAS will be discussed. Assumptions regarding exposure scenarios will also be discussed, including the existing ICs prohibiting future residential use, as documented in Section 2.1.3. Typically, when limited information is available to establish these assumptions, a health-protective estimate of potential exposure is employed. In the dose-response assessment (Section 5.5), uncertainties are involved in animal-to-human extrapolations, high-to-low-dose extrapolations, and the specific models used to develop dose-response values. Specific uncertainties regarding the limited number of PFAS for which toxicity values are available will be discussed. The risk characterization (Section 5.6) includes uncertainties in the evaluation of potential exposure to multiple chemicals, the combination of upper-bound exposure estimates with upper-bound toxicity estimates, and the risk to sensitive populations. Each of the uncertainties involved in the different baseline HHRA steps will be discussed in the RI Report.

The surface soil sampling depth interval of 0–2 feet was selected for consistency with existing data. Some uncertainty may be associated with the use of soil sampling results from the depth interval of 0–2 feet bgs to estimate health risks from exposure to surface soil. In general, the preferred depth interval for evaluating surface soil exposure is 0–0.5 foot bgs rather than 0–2 feet bgs. The uncertainty analysis of the HHRA qualitatively evaluates the likelihood that the use of a depth of 0–2 feet bgs to represent surface soil may result in an underestimate of health risks for surface soil. Although the PFAS detected in site soil (PFOS and PFOA) may be adsorbed to high organic surface soil, they are also soluble, unlike many inorganic metals, and will migrate vertically with infiltration/rainwater. The potential underestimation of exposure to surface soil is likely compensated for by biasing sample locations toward likely release areas (i.e., former burn areas and AFFF wastewater conveyance systems), which is unlikely to replicate actual exposure patterns, and the use of conservative exposure assumptions. It is also noted that extensive excavation and backfilling with clean fill have occurred onsite. Sampling will take place within the clean fill that represents the likely exposure depth intervals (0–6 feet bgs), and as a result, the planned sampling will characterize fill emplaced following the remedial action, and this decision would represent concentrations that are a mixture of fill and PFAS-containing original source material. The potential unavoidable bias of including these samples in the HHRA will be considered in the uncertainty analysis.

6.0 Ecological Risk Assessment

PFAS encompass a heterogeneous group of more than 5,000 chemicals. For most PFAS, data suitable for assessing risks to the environment, such as toxicity thresholds, effects, and bioaccumulation and elimination rates, are lacking. This knowledge gap provides challenges for assessing risks from PFAS on the environment. However, the body of knowledge for this group of chemicals is expanding, and sufficient toxicity data and bioaccumulation and elimination rates are available to assess risks from several individual PFAS compounds, including PFOS and PFOA, which are two PFAS most commonly encountered.

6.1 Regulatory Framework

An Ecological Risk Assessment (ERA) will be conducted at IR Site 6 using a tiered approach consistent with ERA guidance documents from the DON and U.S. EPA CERCLA, and DTSC ecological risk assessment guidance documents, including the following:

- *Navy Guidance for Conducting Ecological Risk Assessments* (DON, 2004)
- *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments* (U.S. EPA, 1997)
- *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998)
- T*he Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments, ECO Update* (U.S. EPA, 2001c)
- *ECO Updates published from 1991 through 2008* (U.S. EPA 1991–2008)
- California DTSC (DTSC, 1996a, 1996b et seq.)

Documents related to screening the ecological risks of PFAS concentrations developed by the DoD Strategic Environmental Research and Development Program *(*SERDP*)* will also be considered:

- *A Framework for Assessing Bioaccumulation and Exposure Risks of PFAS in Threatened and Endangered Species* (ER18-1502) (Gobas et al., 2020)
- *Guidance for Assessing Ecological Risks of PFAS to Threatened and Endangered Species* (ER18-1614) (Conder et al., 2020)
- *Approach for Assessing PFAS Risk to Threatened and Endangered Species* (ER18-1653) (Divine et al., 2020)

Although some of these PFAS-specific documents were written to address risks to threatened and endangered species, they provide frameworks and technical support that can also apply to common species.

Under U.S. EPA and DON guidance, an ERA is carried out in a two-tiered approach:

- Tier I – Screening-Level Ecological Risk Assessment (SLERA)
- Tier II – Baseline Ecological Risk Assessment (BERA)

The Tier I SLERA includes the first two of the eight steps in an ecological risk assessment identified in the ERAGS (U.S. EPA, 1997; DON, 2004; DTSC, 1996a, 1996b). The first step (Step 1) is the Screening-Level Problem Formulation and Ecological Effects Evaluation. The second step (Step 2) is the Screening-Level Exposure and Risk Calculation. The Tier II BERA, if required, evaluates contaminants in greater detail and in the context of site-specific factors. The Tier II BERA begins with Step 3A, which is a refinement of risk estimates using more realistic assumptions than what were applied in the SLERA. If Step 3A indicates unacceptable risks, further evaluation may be recommended.

6.2 Groundwater Exposure Pathway Assessment

TI is a man-made island. The land surface at IR Site 6 has been developed so that there is no undisturbed terrestrial habitat. As a result of this site condition, terrestrial ecological exposure pathways are incomplete and do not require further ecological assessment.

The pathway for transport of PFAS from IR Site 6 into San Francisco Bay sediment and surface water via groundwater transport may be complete. However, Phase I RI is an onshore investigation of soil and groundwater; no offshore data will be collected during the Phase I RI.

Therefore, following completion of the Phase I RI fieldwork, an Exposure Pathway Assessment will be conducted to assess whether discharge of PFAS in groundwater into the nearshore area comprises a complete exposure pathway for marine receptors, including marine plants, benthic invertebrates (e.g., sand worms, bivalves, crustaceans, annelids, etc.), fish, shoreline birds, and marine mammals, and to assess whether receptors could be adversely affected.

The Groundwater Exposure Pathway Assessment will compare concentrations of PFAS in groundwater from monitoring wells nearest the shoreline to ecological target values:

- *Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites*. Project ER18-1614 (Conder et al., 2020)
- *Approach for Assessing PFAS Risks to Threatened and Endangered Species*. Project ER18-1653 (Divine et al., 2020)

These sources provide values that are protective of direct contact for plants, invertebrates, and fish for use in marine environments in the United States. Additional technical documents may be considered as sources of benchmarks as they become available.

If PFAS are not detected in shoreline groundwater, exposure pathways to aquatic receptors in the bay will be considered incomplete. If PFAS are detected in shoreline groundwater at concentrations less than ecological target values (see Worksheet #11 and Table 11-1 of the SAP, Appendix A), exposure pathways will be considered complete, but with an unlikelihood of adverse effects. However, PFAS concentrations that are greater than screening benchmarks will be found to indicate that exposure pathways are complete, and that the likelihood of adverse effects to the marine community cannot be ruled out. The findings of the Groundwater Exposure Pathway Assessment will be used to determine whether additional sampling is required in a Phase II RI and will help to guide the analyses, media, numbers, and locations of Phase II RI samples. The findings of the Groundwater Exposure Pathway Assessment will be used to develop a subsequent Tier I SLERA.

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7.0 Project Schedule and Reporting

The schedule for this project is provided as Figure 14. The field activities are scheduled for spring 2022, pending timely review and approval of the Phase I RI Work Plan.

Following completion of Phase I RI sampling, the soil and groundwater sample results will be presented in an Onshore RI Report. The Phase I RI Report will also include a baseline HHRA for upland exposure and an ecological screening evaluation. As data are collected during Phase I RI, they will be presented and discussed with stakeholders during PFAS Technical Working Group meetings. These meetings are scheduled for the second Wednesday of each month and will hopefully allow for an expedient transition to Phase II RI sampling activities (offshore).

The Phase I RI Report prepared by Multi-MAC JV will describe the scope and objectives of the project, fieldwork performed, rationale, data analyzed, QA/QC procedures, and conclusions and recommendations. At a minimum, the Phase I RI report will include the following:

- Background information regarding previous investigations at IR Site 6
- Presentation of laboratory analytical results for Phase I RI soil and groundwater samples, in tabular format, figures (as appropriate), and complete laboratory/validation reports in an appendix
- Figures showing new and existing wells and soil boring locations, baseline groundwater concentrations and contours, and groundwater flow direction
- Summary tables of water level measurements and geochemical parameters of the soil
- Summary of the results of the baseline HHRA (Phase I RI sampling), the ecological screening level risk evaluation
- Results of the geochemical analysis and tidal study to evaluate the potential transport of PFAS at IR Site 6 to San Francisco Bay
- Appendices with copies of applicable permits, access agreements, standalone reports such as the baseline HHRA and the ERA, and fieldwork documentation such as boring logs and sampling forms
- Documentation of the disposition of the soil, groundwater, purge, and decontamination water generated during this investigation
- Conclusions and recommendations for any actions that may be necessary to complete the assessment of PFAS compounds released at IR Site 6

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Figures

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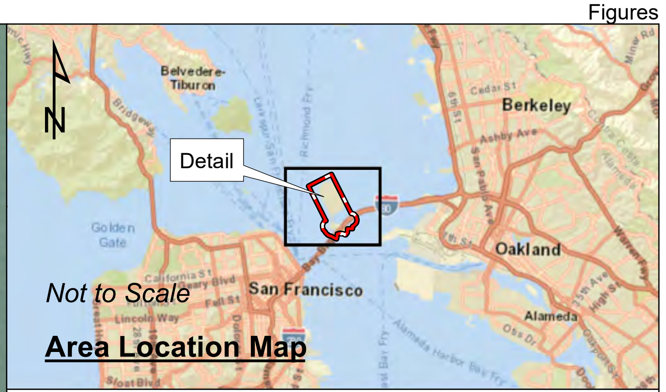

Area Location Map

Legend

🟦 IRP Site 6 Location

🟥 Former Naval Station Treasure Island Boundary

Notes:
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances

Basemap Source: ESRI Online Streaming Service 2021

1 Inch = 0.25 Miles

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Location Map

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

FIGURE

1

Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig01_TI_Site6_SiteLocation.mxd

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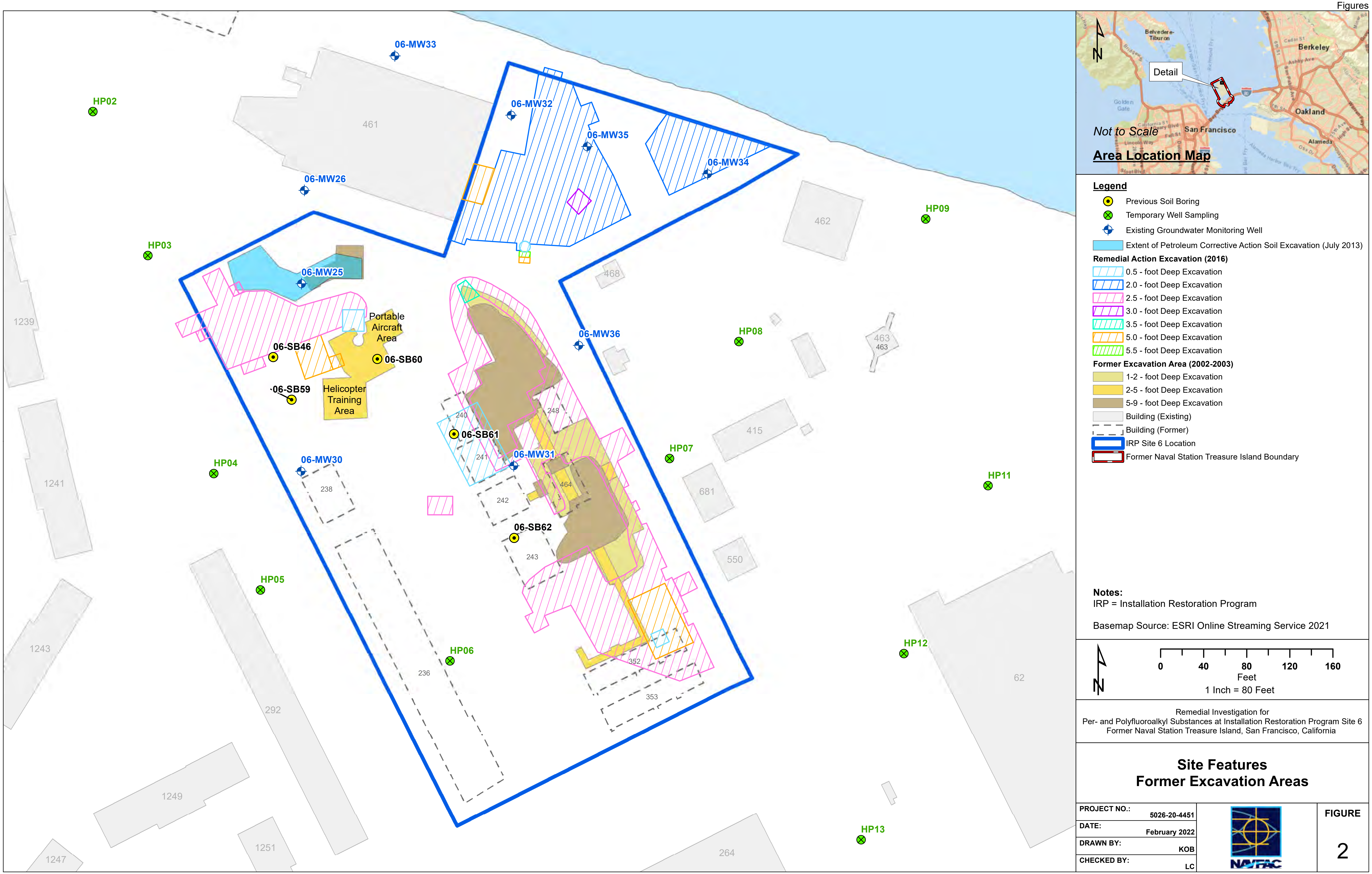

Legend

- ⊙ Previous Soil Boring
- ⊗ Temporary Well Sampling
- ⊕ Existing Groundwater Monitoring Well
- ▭ Extent of Petroleum Corrective Action Soil Excavation (July 2013)

Remedial Action Excavation (2016)

- ▨ 0.5 - foot Deep Excavation
- ▨ 2.0 - foot Deep Excavation
- ▨ 2.5 - foot Deep Excavation
- ▨ 3.0 - foot Deep Excavation
- ▨ 3.5 - foot Deep Excavation
- ▨ 5.0 - foot Deep Excavation
- ▨ 5.5 - foot Deep Excavation

Former Excavation Area (2002-2003)

- ■ 1-2 - foot Deep Excavation
- ■ 2-5 - foot Deep Excavation
- ■ 5-9 - foot Deep Excavation
- ▭ Building (Existing)
- ▭ Building (Former)
- ▭ IRP Site 6 Location
- ▭ Former Naval Station Treasure Island Boundary

Notes:
IRP = Installation Restoration Program

Basemap Source: ESRI Online Streaming Service 2021

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Site Features
Former Excavation Areas

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

FIGURE
2

Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig02_TI_Site6_FormerExcavations.mxd

Date: 1/31/2022

Figure-5

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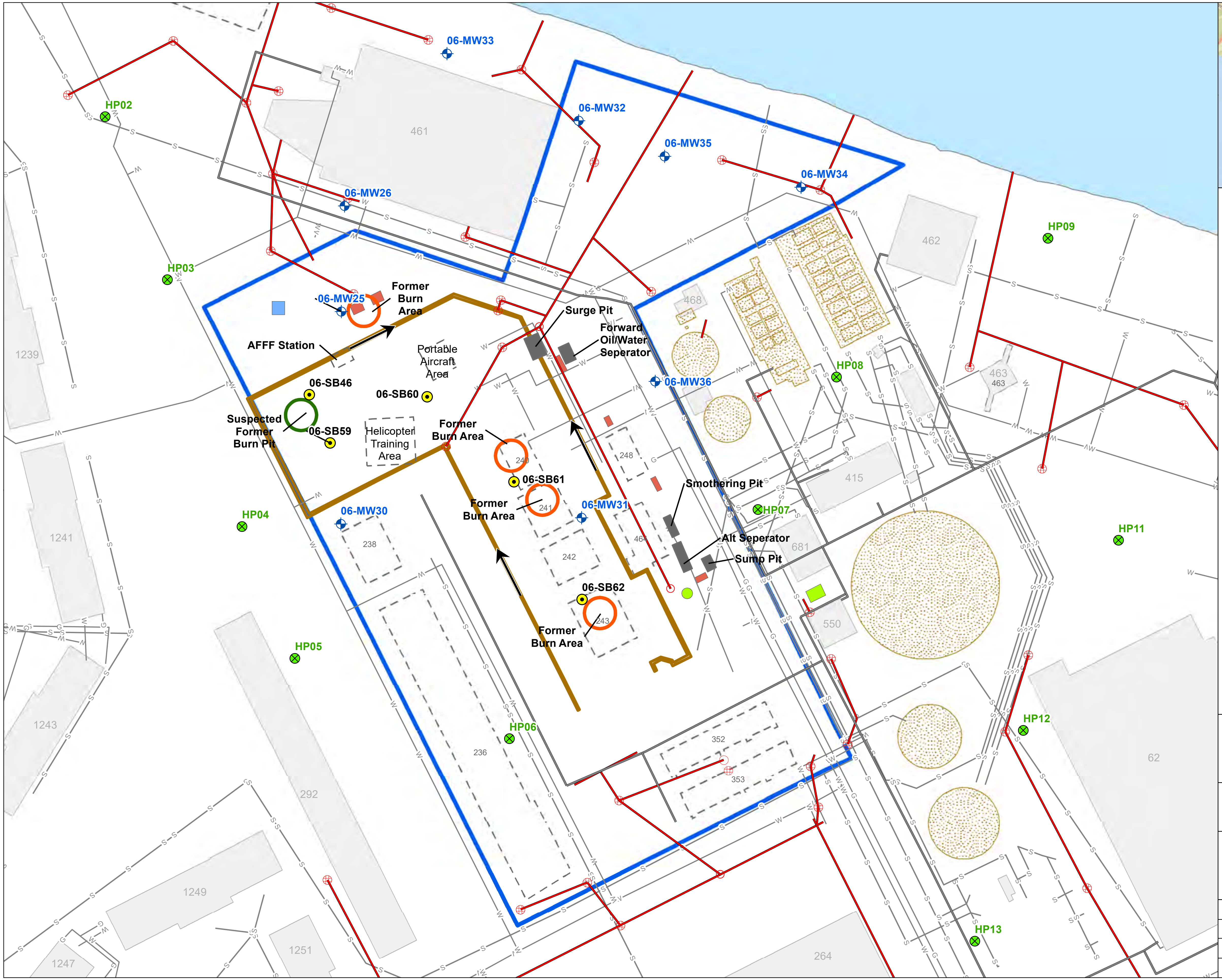

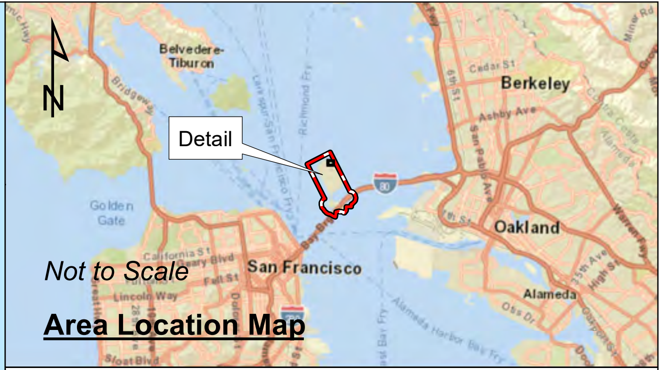

Not to Scale

Area Location Map

Legend

- ● Previous Soil Boring
- ⊗ Temporary Well Sampling
- ⊕ Existing Groundwater Monitoring Well
- ⊕ Stormwater Catch Basin
- ○ Manhole
- Stormwater Line
- Steam Line
- W Water Line
- S Sewer Line
- G Gas Line
- Collector Trench
- → Direction of AFFF Wastewater Flow
- ■ Oil/Water Seperator System Component
- 🟩 Removed AST
- 🟥 Removed UST
- 🟦 Suspected AST
- ▭ Former Burn Area
- ▭ Suspected Former Burn Pit
- ▨ Wastewater Treatment Plant
- ▭ Building (Existing)
- ▭ Building (Former)
- ▭ IRP Site 6 Location
- ▭ Former Naval Station Treasure Island Boundary

Notes:

AFFF = Aqueous Fire Fighting Foam
AST = Aboveground Storage Tank
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances
UST = Underground Storage Tank

Basemap Source: ESRI Online Streaming Service 2021

N

0 40 80 120 160
Feet
1 Inch = 80 Feet

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Site Features
Utilities

PROJECT NO.: 5026-20-4451
DATE: February 2022
DRAWN BY: KOB
CHECKED BY: LC

NAVFAC

FIGURE
3

Date: 1/31/2022
Path: D:\FilesFromWork\5026-204451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig03_TI_Site6_Utilities.mxd

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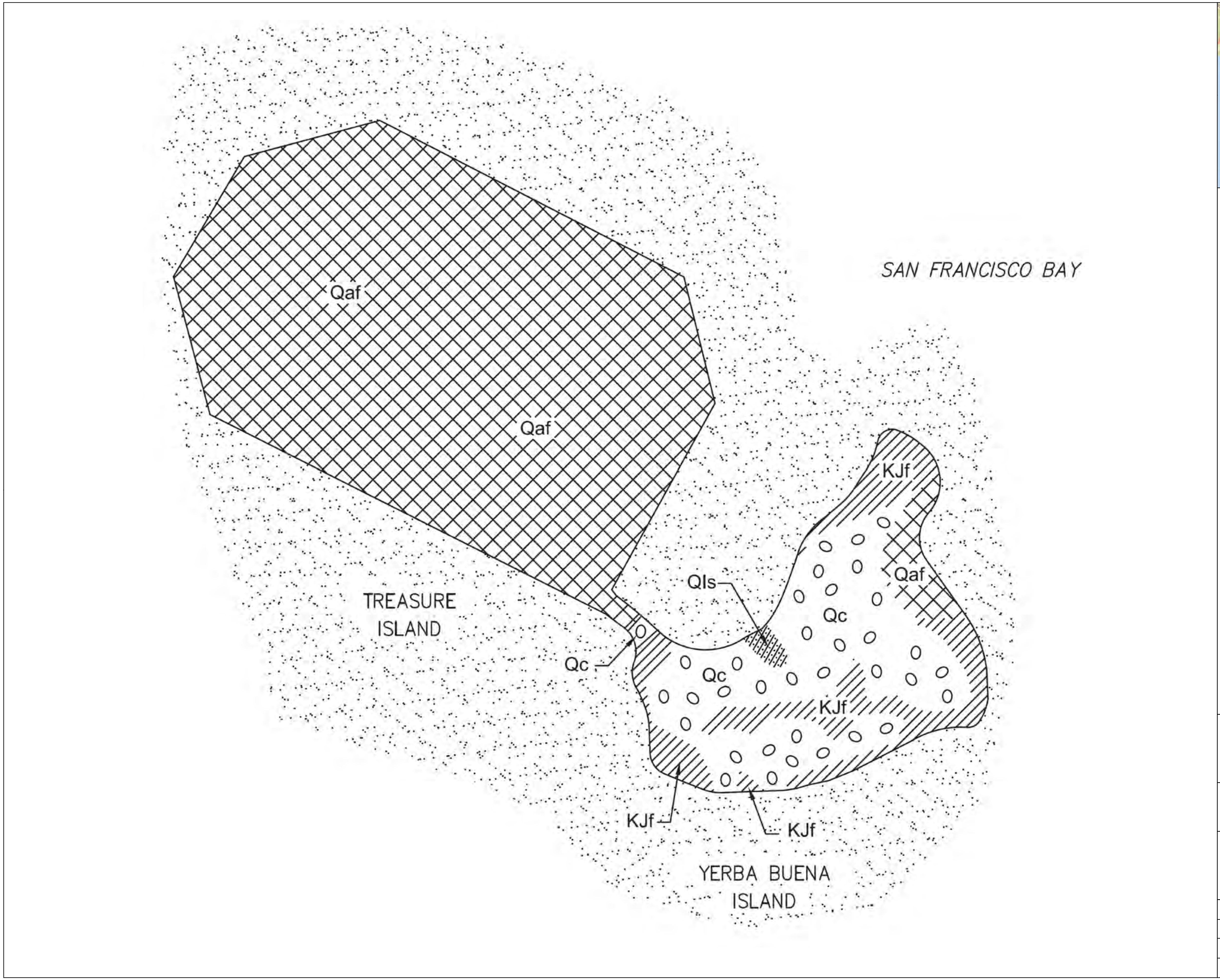

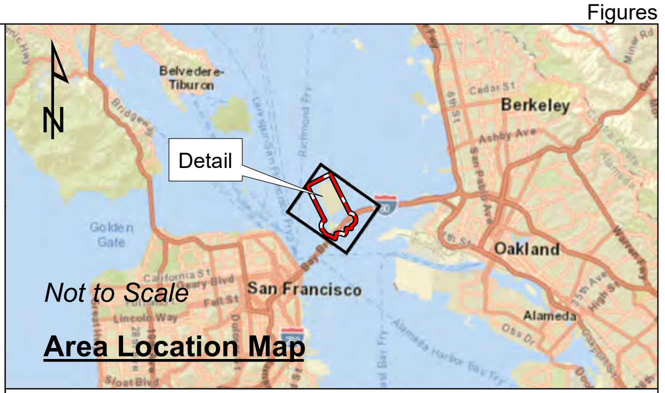

Legend

Qls	LANDSLIDE DEBRIS
Qaf	ARTIFICIAL FILL (SAND, CLAY OR MISCELLANEOUS REFUSE)
Qc	COLLUVIUM/EOLIAN SANDS (SAND WITH MINOR SANDY SILT, CLAY, AND GRAVEL INTERBEDS)
KJf	FRANCISCAN ASSEMBLAGE (SANDSTONE AND SHALE)
	SAN FRANCISCO BAY

SOURCE:
FINAL GROUNDWATER STATUS REPORT, SUMMARY OF GROUNDWATER MONITORING, MARCH THROUGH OCTOBER 2000, NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA
TETRA TECH EM INC. (TtEMI, 2002c)
COMPILED FROM:
DAMES AND MOORE (1988)
BLAKE AND OTHERS (1974)
RADBRUCH (1957)

Notes:
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances

Reference: ERRG 2011

Basemap Source: ESRI Online Streaming Service 2021

0 500 1,000 1,500 2,000
Feet
1 Inch = 1,000 Feet

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Generalized Regional Geologic Map

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

NAVFAC

FIGURE
4

Date: 1/31/2022 Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig04_TI_Site6_GeoRegional.mxd

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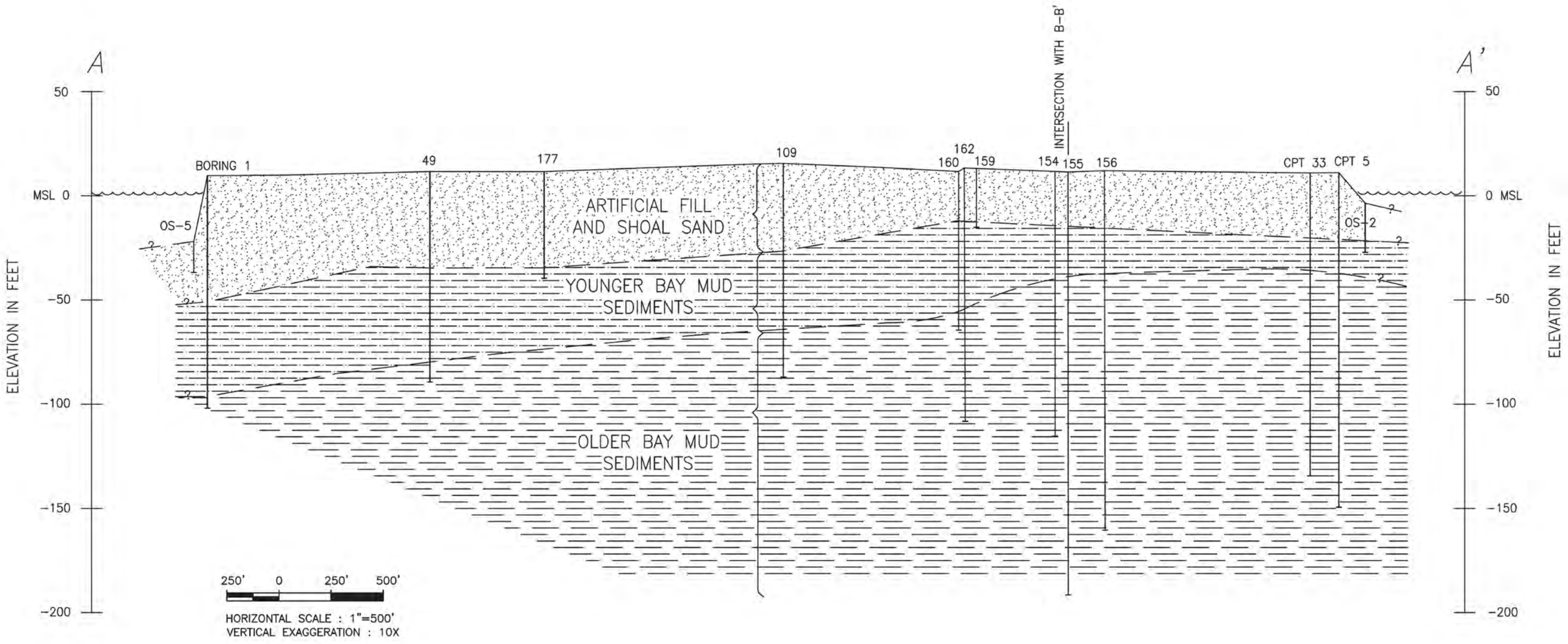

HORIZONTAL SCALE : 1"=500'
VERTICAL EXAGGERATION : 10X

LEGEND:

▨	ARTIFICIAL FILL AND SHOAL SANDS (Predominantly fine- to medium-grained sand and silty sands)
☰	YOUNGER BAY MUD SEDIMENTS (Predominantly soft to stiff clay, silty clay, or sandy clay with some silty sands and clayey sands)
☷	OLDER BAY MUD SEDIMENTS (Predominantly stiff to very stiff clay, silty clay, or sandy clay with some silty sands and clayey sands)
—?— —	LITHOLOGIC CONTACT (dashed where inferred, queried where uncertain)
49	SOIL BORING OR CONE PENETROMETER TEST (CPT)

NOTES:

1. CROSS SECTION SOURCE FROM CROSS SECTION A-A' (TtEMI, 2002c).
2. CROSS SECTION MODIFIED FROM CROSS SECTION M-M' (GEOMATRIX, 1990).
3. THE NUMBER OVER EACH SOIL BORING/CPT CORRESPONDS TO A SPECIFIC BORING INDEX NUMBER (GEOMATRIX, 1990).
4. THIS CROSS SECTION REPRESENTS ONE INTERPRETATION BASED ON AVAILABLE DATA; OTHER INTERPRETATIONS ARE POSSIBLE.

LOCATION MAP
NTS

Reference: ERRG 2011

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Geologic Cross Section A-A'

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

NAVFAC

FIGURE
5

Date: 1/31/2022 Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig05_TI_Site6_Geo_A-A.mxd

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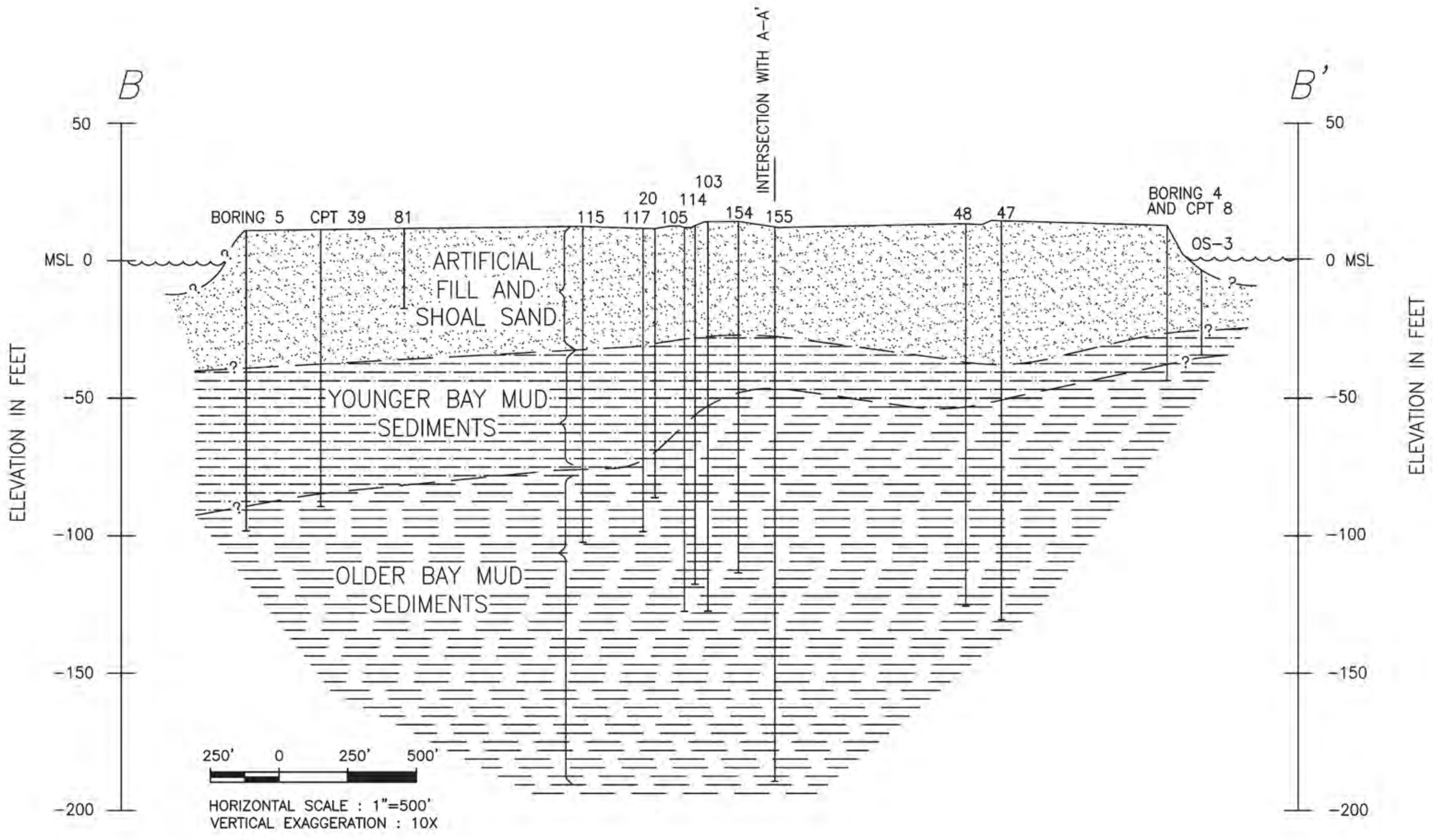

LEGEND:

▨ ARTIFICIAL FILL AND SHOAL SANDS
(Predominantly fine– to medium–grained sand and silty sands)

☰ YOUNGER BAY MUD SEDIMENTS
(Predominantly soft to stiff clay, or sandy clay
with some silty sands and clayey sands)

☰ OLDER BAY MUD SEDIMENTS
(Predominantly stiff to very stiff clay, silty clay, or sandy
clay with some silty sands and clayey sands)

—?— — LITHOLOGIC CONTACT (dashed where inferred, queried where uncertain)

81 | SOIL BORING OR CONE PENETROMETER TEST (CPT)

NOTES:

1. CROSS SECTION SOURCE FROM CROSS SECTION A–A' (TtEMI, 2002c).
2. CROSS SECTION MODIFIED FROM CROSS SECTION P–P' (GEOMATRIX, 1990).
3. THE NUMBER OVER EACH SOIL BORING/CPT CORRESPONDS TO A SPECIFIC BORING INDEX NUMBER (GEOMATRIX, 1990).
4. THIS CROSS SECTION REPRESENTS ONE INTERPRETATION BASED ON AVAILABLE DATA; OTHER INTERPRETATIONS ARE POSSIBLE.

LOCATION MAP
NTS

Reference: ERRG 2011

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Geologic Cross Section B-B'

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

FIGURE
6

Path: D:\FilesFromWork\5026-20-4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig06_TI_Site6_Geo_B-B.mxd

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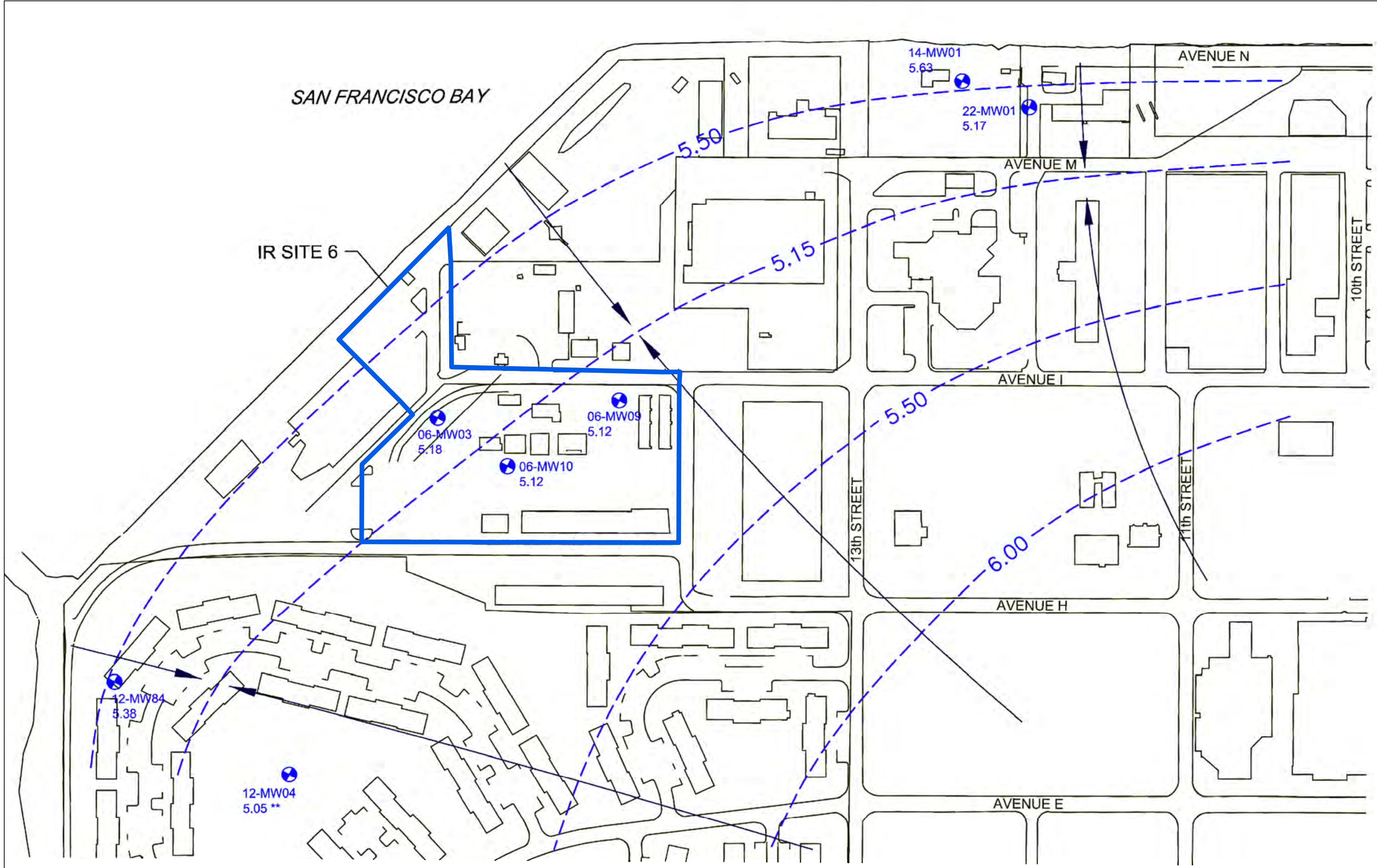

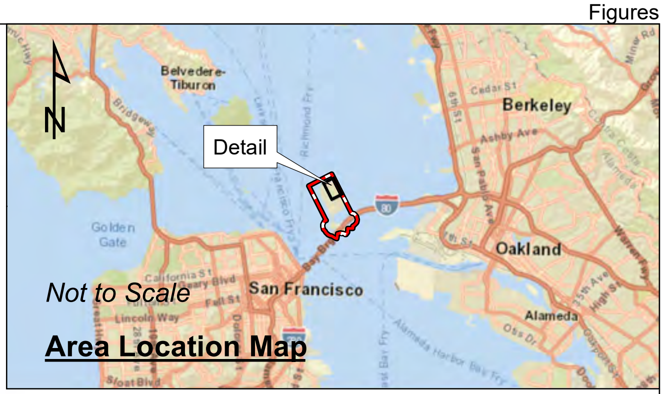

Reference: ERRG 2011

LEGEND:

06-MW09 5.12 ⊕ MONITORING WELL AND GROUNDWATER ELEVATION IN FEET

5.50 – – – ESTIMATED GROUNDWATER ELEVATION CONTOUR

← INFERRED GROUNDWATER FLOW DIRECTION

═ ROAD

▭ BUILDING

NOTES:

1. ELEVATIONS ARE IN FEET ABOVE THE TREASURE ISLAND MEAN LOWER LOW WATER DATUM.
2. WATER LEVEL DATA COLLECTED AT HIGH TIDE AUGUST 3, 1995.

** VALUE ESTIMATED FROM AUGUST 1, 1995 DATA.

SOURCE:

PHASE IIA REMEDIAL INVESTIGATION TIDAL INFLUENCE STUDY, SUMMARY OF RESULTS
NAVAL STATION TREASURE ISLAND SAN FRANCISCO, CALIFORNIA
(PRC,1995)

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Groundwater Elevations Contour Map
August 1995 Tidal Study

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

FIGURE

7

Path: D:\FilesFromWork\5026-20-4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig07_TI_Site6_Soil_HistoricTidal.mxd

Date: 1/31/2022

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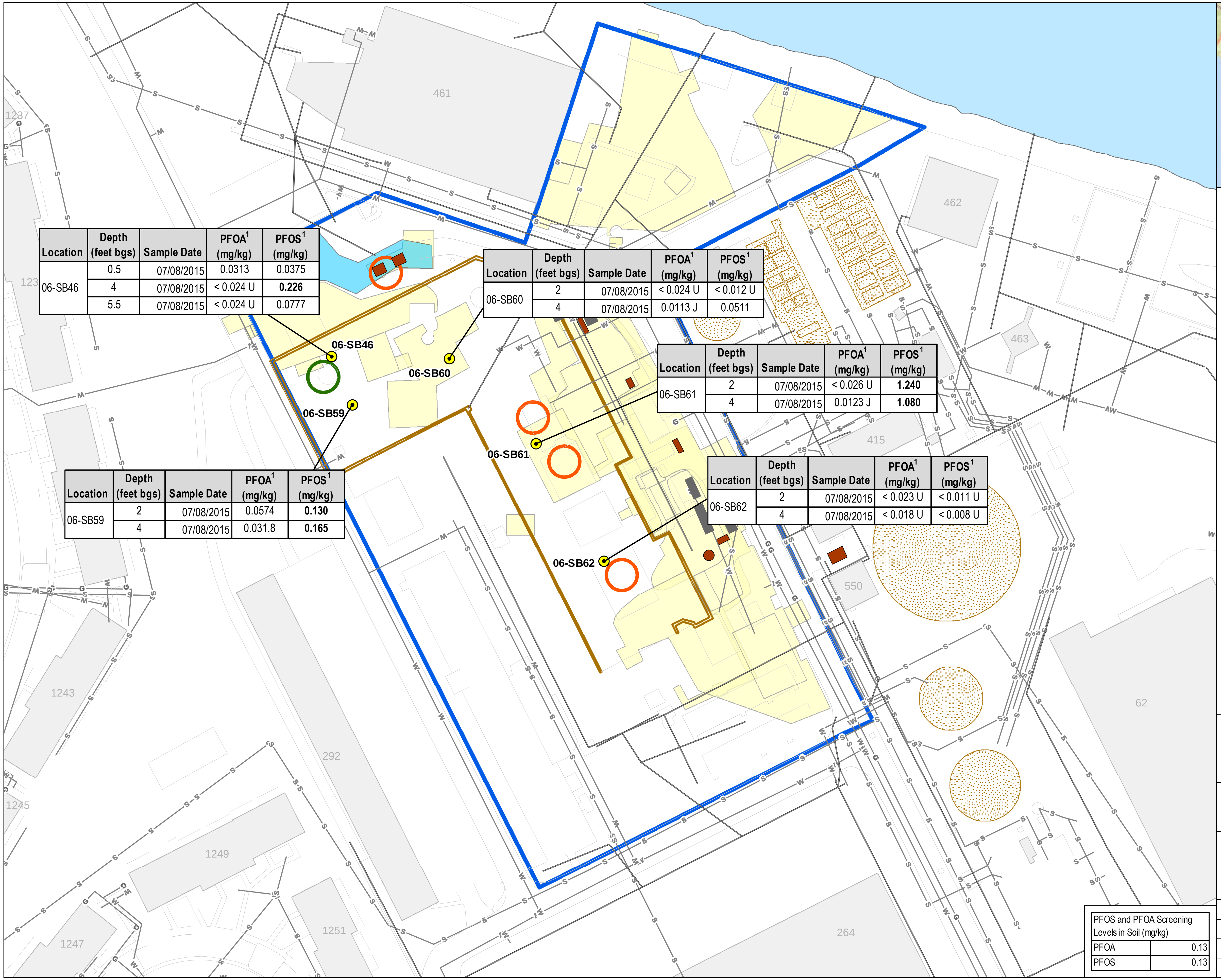


Location	Depth (feet bgs)	Sample Date	PFOA[1] (mg/kg)	PFOS[1] (mg/kg)
06-SB46	0.5	07/08/2015	0.0313	0.0375
	4	07/08/2015	< 0.024 U	**0.226**
	5.5	07/08/2015	< 0.024 U	0.0777

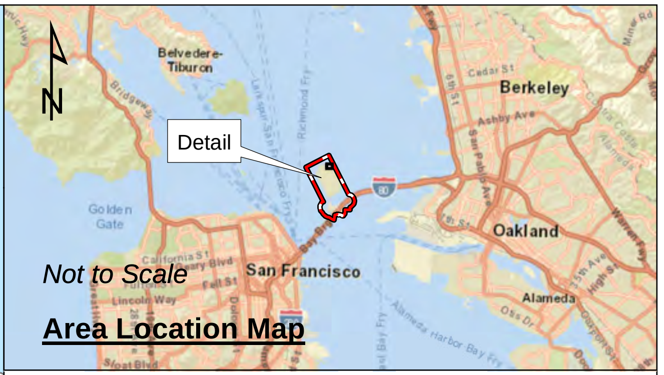
Location	Depth (feet bgs)	Sample Date	PFOA[1] (mg/kg)	PFOS[1] (mg/kg)
06-SB60	2	07/08/2015	< 0.024 U	< 0.012 U
	4	07/08/2015	0.0113 J	0.0511

Location	Depth (feet bgs)	Sample Date	PFOA[1] (mg/kg)	PFOS[1] (mg/kg)
06-SB61	2	07/08/2015	< 0.026 U	**1.240**
	4	07/08/2015	0.0123 J	**1.080**

Location	Depth (feet bgs)	Sample Date	PFOA[1] (mg/kg)	PFOS[1] (mg/kg)
06-SB59	2	07/08/2015	0.0574	**0.130**
	4	07/08/2015	0.031.8	**0.165**

Location	Depth (feet bgs)	Sample Date	PFOA[1] (mg/kg)	PFOS[1] (mg/kg)
06-SB62	2	07/08/2015	< 0.023 U	< 0.011 U
	4	07/08/2015	< 0.018 U	< 0.008 U

PFOS and PFOA Screening Levels in Soil (mg/kg)	
PFOA	0.13
PFOS	0.13



Not to Scale

Area Location Map

Legend

●	Previous Soil Boring
—	Utilities
—	Collector Trench
■	Oil/Water Seperator System Component
○	Former Burn Area
○	Suspected Former Burn Pit
■	Former Excavation
■	Extent of Petroleum Corrective Action Soil Excavation (July 2013)
■	Former Tanks (AST/UST)
▨	Wastewater Treatment Plant
■	Building
▭	IRP Site 6 Location
▭	Treasure Island Boundary

Notes:

Bold = exceeds screening criteria

[1] Only PFOS and PFOA were analyzed as these were the only PFAS with screening levels established at the time of sampling. Department of Defense . 2021. Memorandum on Investigating Per- and Polyfluoroalkyl Substances with the Department of Defense Cleanup Program, Residential Scenario Screening Levels. September 15.

AST = Aboveground Storage Tank
bgs = below grouind surface
IRP = Installation Restoration Program
J = Value is estimated between the Detection Limit (Method Detection Limit) and the Limit of Detection (Reporting Limit)
mg/kg = milligrams per kilogram
PFAS = per- and polyfluorinated substances
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
U = Chemical not detected at or above indicated limit of detection value
UST = Underground Storage Tank

Basemap Source: ESRI Online Streaming Service 2021

N
0 40 80 120 160
Feet
1 Inch = 80 Feet

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Previous Soil Sampling Results

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

NAVFAC

FIGURE
8

Path: D:\FilesFromWork\5026-204451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig08_TI_Site6_Soil_Historic.mxd

Date: 1/31/2022

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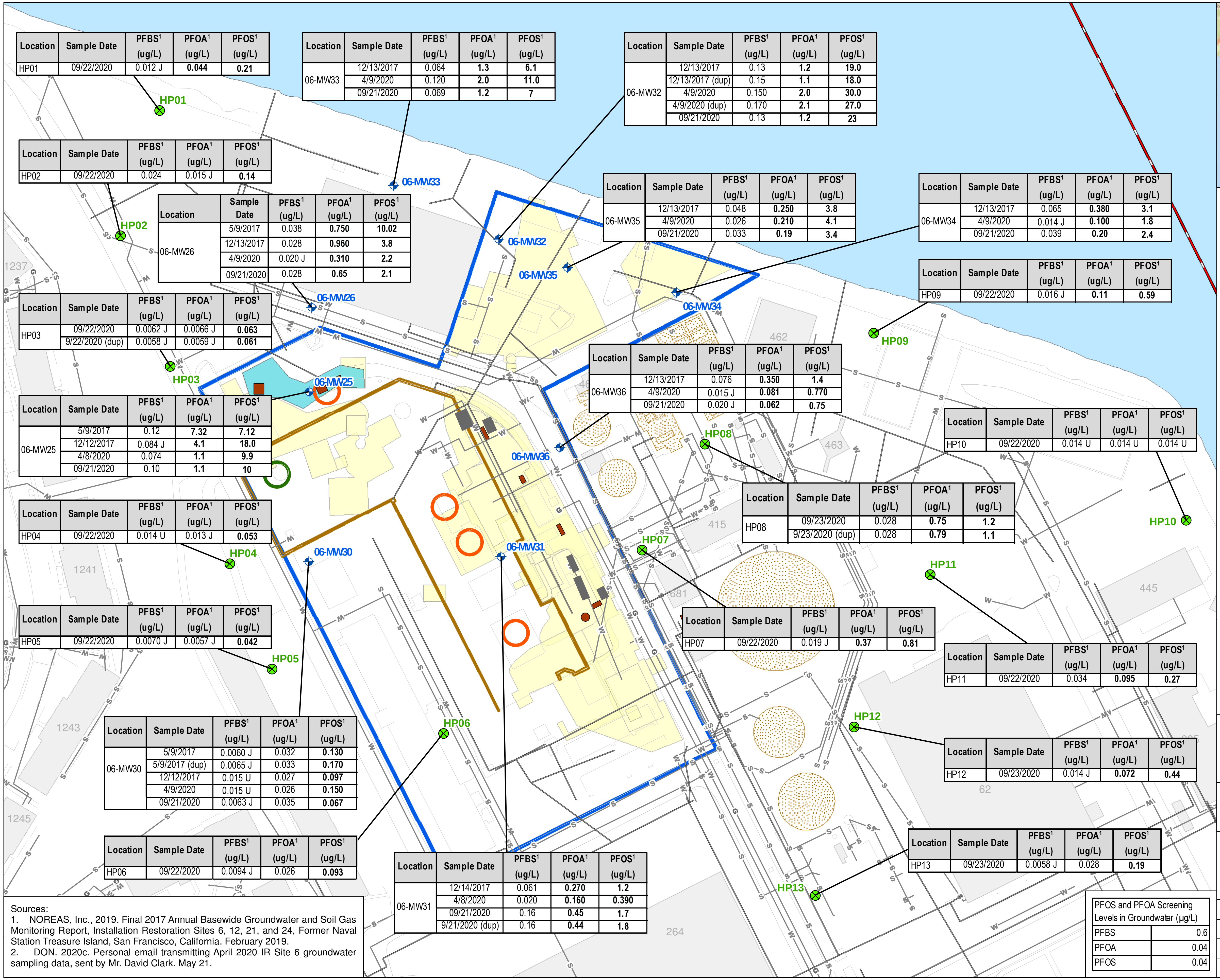


Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP01	09/22/2020	0.012 J	**0.044**	**0.21**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW33	12/13/2017	0.064	**1.3**	**6.1**
	4/9/2020	0.120	**2.0**	**11.0**
	09/21/2020	0.069	**1.2**	**7**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW32	12/13/2017	0.13	**1.2**	**19.0**
	12/13/2017 (dup)	0.15	**1.1**	**18.0**
	4/9/2020	0.150	**2.0**	**30.0**
	4/9/2020 (dup)	0.170	**2.1**	**27.0**
	09/21/2020	0.13	**1.2**	**23**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP02	09/22/2020	0.024	0.015 J	**0.14**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW26	5/9/2017	0.038	**0.750**	**10.02**
	12/13/2017	0.028	**0.960**	**3.8**
	4/9/2020	0.020 J	**0.310**	**2.2**
	09/21/2020	0.028	**0.65**	**2.1**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW35	12/13/2017	0.048	**0.250**	**3.8**
	4/9/2020	0.026	**0.210**	**4.1**
	09/21/2020	0.033	**0.19**	**3.4**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW34	12/13/2017	0.065	**0.380**	**3.1**
	4/9/2020	0.014 J	**0.100**	**1.8**
	09/21/2020	0.039	**0.20**	**2.4**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP09	09/22/2020	0.016 J	**0.11**	**0.59**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP03	09/22/2020	0.0062 J	0.0066 J	**0.063**
	9/22/2020 (dup)	0.0058 J	0.0059 J	**0.061**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW36	12/13/2017	0.076	**0.350**	**1.4**
	4/9/2020	0.015 J	**0.081**	**0.770**
	09/21/2020	0.020 J	**0.062**	**0.75**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW25	5/9/2017	0.12	**7.32**	**7.12**
	12/12/2017	0.084 J	**4.1**	**18.0**
	4/8/2020	0.074	**1.1**	**9.9**
	09/21/2020	0.10	**1.1**	**10**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP10	09/22/2020	0.014 U	0.014 U	0.014 U

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP08	09/23/2020	0.028	**0.75**	**1.2**
	9/23/2020 (dup)	0.028	**0.79**	**1.1**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP04	09/22/2020	0.014 U	0.013 J	**0.053**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP07	09/22/2020	0.019 J	**0.37**	**0.81**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP05	09/22/2020	0.0070 J	0.0057 J	**0.042**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP11	09/22/2020	0.034	**0.095**	**0.27**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW30	5/9/2017	0.0060 J	0.032	**0.130**
	5/9/2017 (dup)	0.0065 J	0.033	**0.170**
	12/12/2017	0.015 U	0.027	**0.097**
	4/9/2020	0.015 U	0.026	**0.150**
	09/21/2020	0.0063 J	0.035	**0.067**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP12	09/23/2020	0.014 J	**0.072**	**0.44**

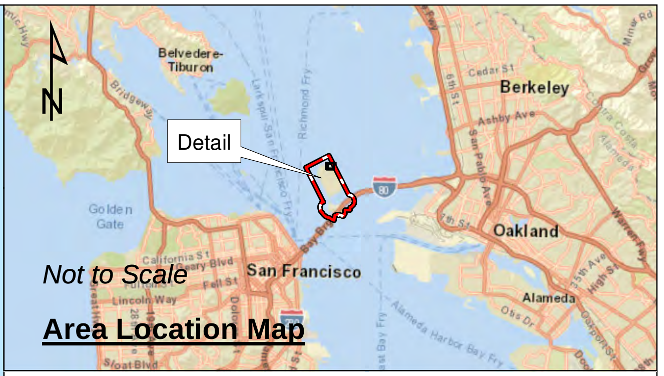
Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP13	09/23/2020	0.0058 J	0.028	**0.19**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
HP06	09/22/2020	0.0094 J	0.026	**0.093**

Location	Sample Date	PFBS[1] (ug/L)	PFOA[1] (ug/L)	PFOS[1] (ug/L)
06-MW31	12/14/2017	0.061	**0.270**	**1.2**
	4/8/2020	0.020	**0.160**	**0.390**
	09/21/2020	0.16	**0.45**	**1.7**
	9/21/2020 (dup)	0.16	**0.44**	**1.8**

Sources:
1. NOREAS, Inc., 2019. Final 2017 Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California. February 2019.
2. DON. 2020c. Personal email transmitting April 2020 IR Site 6 groundwater sampling data, sent by Mr. David Clark. May 21.

PFOS and PFOA Screening Levels in Groundwater (µg/L)	
PFBS	0.6
PFOA	0.04
PFOS	0.04



Not to Scale

Area Location Map

Legend

- ⊗ Temporary Well Sampling
- ⊕ Existing Groundwater Monitoring Well
- — Utilities
- — Collector Trench
- ■ Oil/Water Separator System Component
- ○ Former Burn Area
- ○ Suspected Former Burn Pit
- ■ Former Excavation
- ■ Extent of Petroleum Corrective Action Soil Excavation (July 2013)
- ■ Former Tanks (AST/UST)
- ▨ Wastewater Treatment Plant
- ■ Building
- ▭ IRP Site 6 Location
- ▭ Former Naval Station Treasure Island Boundary

Notes:
Bold = exceeded screening criteria
[1] Screening criteria for groundwater sample results follows Department of Defense . 2021. Memorandum on Investigating Per- and Polyfluoroalkyl Substances with the Department of Defense Cleanup Program, Residential Scenario Screening Levels. September 15.

-- = not analyzed
µg/L = microgram(s) per liter
AST = Aboveground Storage Tank
dup = field duplicate sample
IRP = Installation Restoration Program
J = Value is estimated between the Detection Limit (Method Detection Limit) and the Limit of Detection (Reporting Limit)
PFAS = per- and polyfluorinated substances
PFBS = perfluorobutanesulfonic acid;
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
U = analyte not reported at or above the method detection limit.
UST = Underground Storage Tank

Basemap Source: ESRI Online Streaming Service 2021

N
0 50 100 150 200
Feet
1 Inch = 100 Feet

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Previous Groundwater Sampling Results

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

FIGURE

9

Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig09_TI_Site6_GW_Historic.mxd

Date: 1/31/2022

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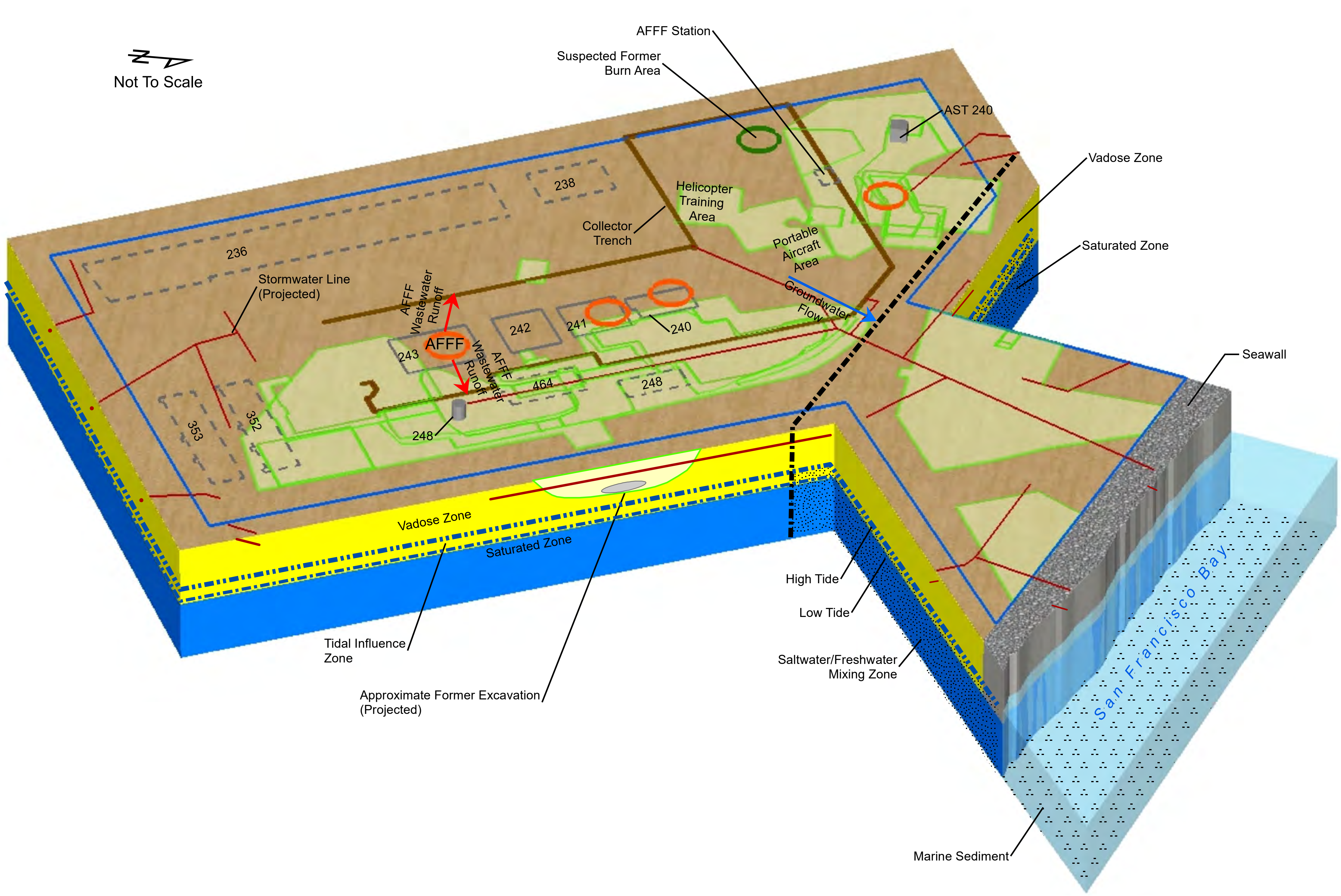

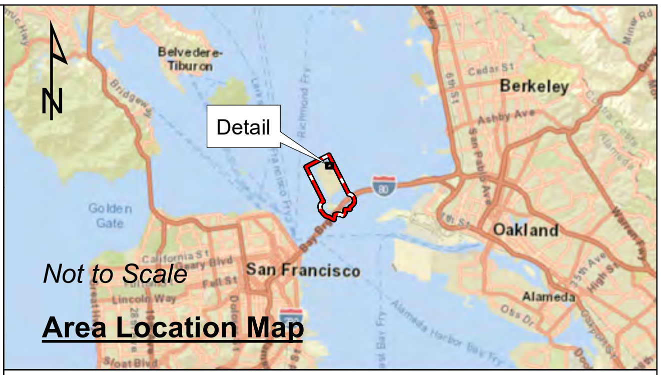

Area Location Map

Legend

- Stormwater Line (Projected)
- Collector Trench
- Groundwater Flow
- Tidal Influence Area
- AFFF Wastewater Runoff
- Water Table
- Former Burn
- Suspected Former Burn Pit
- Building (Former)
- Fire Training Mockup Building
- Former Excavation Area
- IRP Site 6 Location
- Former Naval Station Treasure Island Boundary

Notes:
AFFF = Aqueous Film-Forming Foam
AST = Aboveground Storage Tank
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances

Basemap Source: ESRI Online Streaming Service 2021

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Conceptual Site Model

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

NAVFAC

FIGURE
10

Path: D:\FilesFromWork\5026-204451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig10_TI_Site6_SiteMap_CSM.mxd

Date: 2/3/2022

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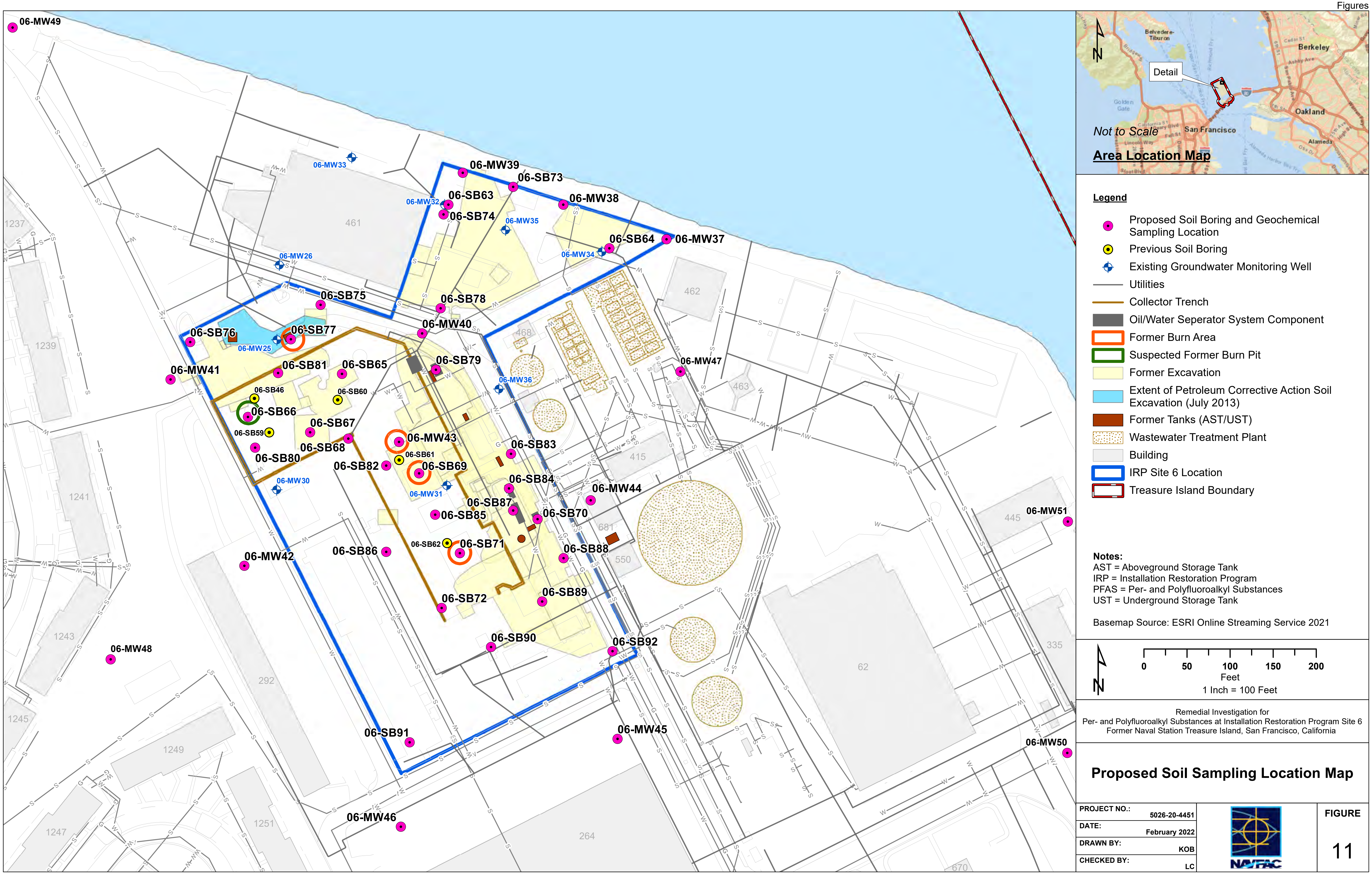

Legend

- ● Proposed Soil Boring and Geochemical Sampling Location
- ⊙ Previous Soil Boring
- ⊕ Existing Groundwater Monitoring Well
- — Utilities
- — Collector Trench
- ■ Oil/Water Seperator System Component
- ▢ Former Burn Area
- ▢ Suspected Former Burn Pit
- ▢ Former Excavation
- ▢ Extent of Petroleum Corrective Action Soil Excavation (July 2013)
- ■ Former Tanks (AST/UST)
- ▨ Wastewater Treatment Plant
- ▢ Building
- ▢ IRP Site 6 Location
- ▢ Treasure Island Boundary

Notes:
AST = Aboveground Storage Tank
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances
UST = Underground Storage Tank

Basemap Source: ESRI Online Streaming Service 2021

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Proposed Soil Sampling Location Map

PROJECT NO.:	5026-20-4451	FIGURE
DATE:	February 2022	11
DRAWN BY:	KOB	
CHECKED BY:	LC	

NAVFAC

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Date: 3/10/2022

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Legend

- 🟢 Proposed Groundwater Monitoring Well
- ⊙ Previous Soil Boring
- ⊗ Temporary Well Sampling
- ✦ Existing Groundwater Monitoring Well
- — Utilities
- — Collector Trench
- ■ Oil/Water Seperator System Component
- ▭ Former Burn Area
- ▭ Suspected Former Burn Pit
- ▭ Former Excavation
- ▭ Extent of Petroleum Corrective Action Soil Excavation (July 2013)
- ■ Former Tanks (AST/UST)
- ▨ Wastewater Treatment Plant
- ▭ Building
- ▭ IRP Site 6 Location
- ▭ Treasure Island Boundary

Notes:
Yellow Highlighted Wells Indicate Tidal Influence Study Well

AST = Aboveground Storage Tank
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances
UST = Underground Storage Tank

Basemap Source: ESRI Online Streaming Service 2021

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Proposed Groundwater Sampling Location Map

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

NAVFAC

FIGURE
12

Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\Fig12_TI_Site6_GW_Proposed.mxd

Date: 3/10/2022

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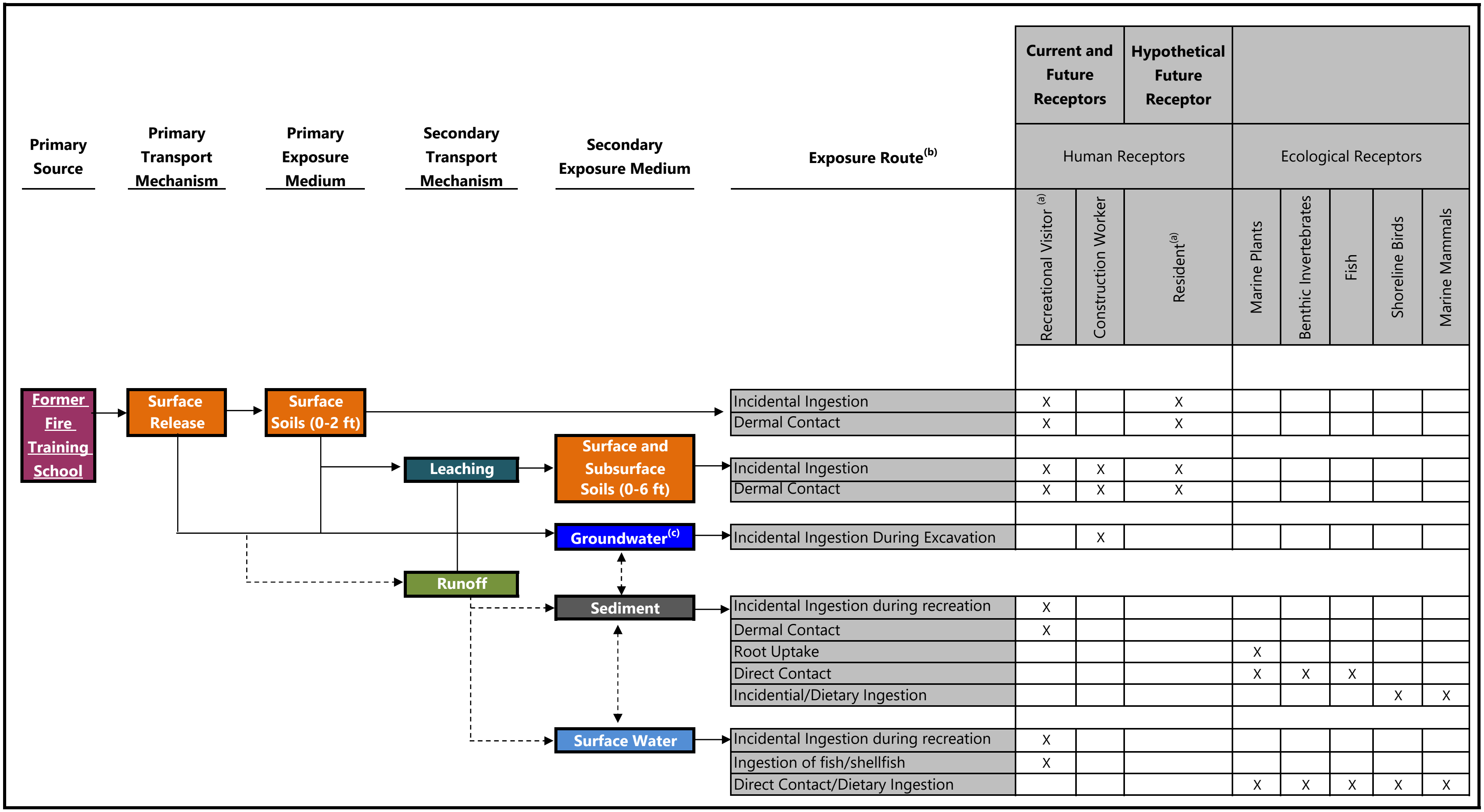
Figure 13
Risk Assessment Conceptual Site Model



Secondary Exposure Medium	Exposure Route(b)	Current and Future Receptors		Hypothetical Future Receptor					
		Human Receptors			Ecological Receptors				
		Recreational Visitor (a)	Construction Worker	Resident(a)	Marine Plants	Benthic Invertebrates	Fish	Shoreline Birds	Marine Mammals
Surface Soils (0-2 ft)	Incidental Ingestion	X		X					
	Dermal Contact	X		X					
Surface and Subsurface Soils (0-6 ft)	Incidental Ingestion	X	X	X					
	Dermal Contact	X	X	X					
Groundwater(c)	Incidental Ingestion During Excavation		X						
Sediment	Incidental Ingestion during recreation	X							
	Dermal Contact	X							
	Root Uptake				X				
	Direct Contact				X	X	X		
	Incidential/Dietary Ingestion							X	X
Surface Water	Incidental Ingestion during recreation	X							
	Ingestion of fish/shellfish	X							
	Direct Contact/Dietary Ingestion				X	X	X	X	X

Notes:
X: Indicates a potentially complete exposure pathway. Blank cells indicate an incomplete or negligible exposure pathway.
Dashed line indicates that the PFAS migration pathway is assumed but data has not yet been collected to confirm and is expected to be collected in a future phase of the RI.
(a) The recreational visitor and resident will be evaluated using the higher 95% UCLs between surface soil and subsurface soil (0–6 feet bgs) to account for potential future excavation and reworking/regrading of the site. The residential receptor may also be exposed through the recreational exposure pathways.
(b) The inhalation exposure pathway will not be quantitatively assessed for PFAS due to the absence of currently recommended toxicity values by USEPA, and dermal contact with PFAS in groundwater will not be quantitatively evaluated due to the limited dermal absorption of PFAS in water through human skin.
(c) Treasure Island has no potable use of groundwater on the island and none is expected in the future.

Prepared by: ARQ 11/4/2020
Checked by: LC 11/29/2020
Rev by: ARQ 1/25/21 and 11/30/21
Rev by: LC 3/4/2022

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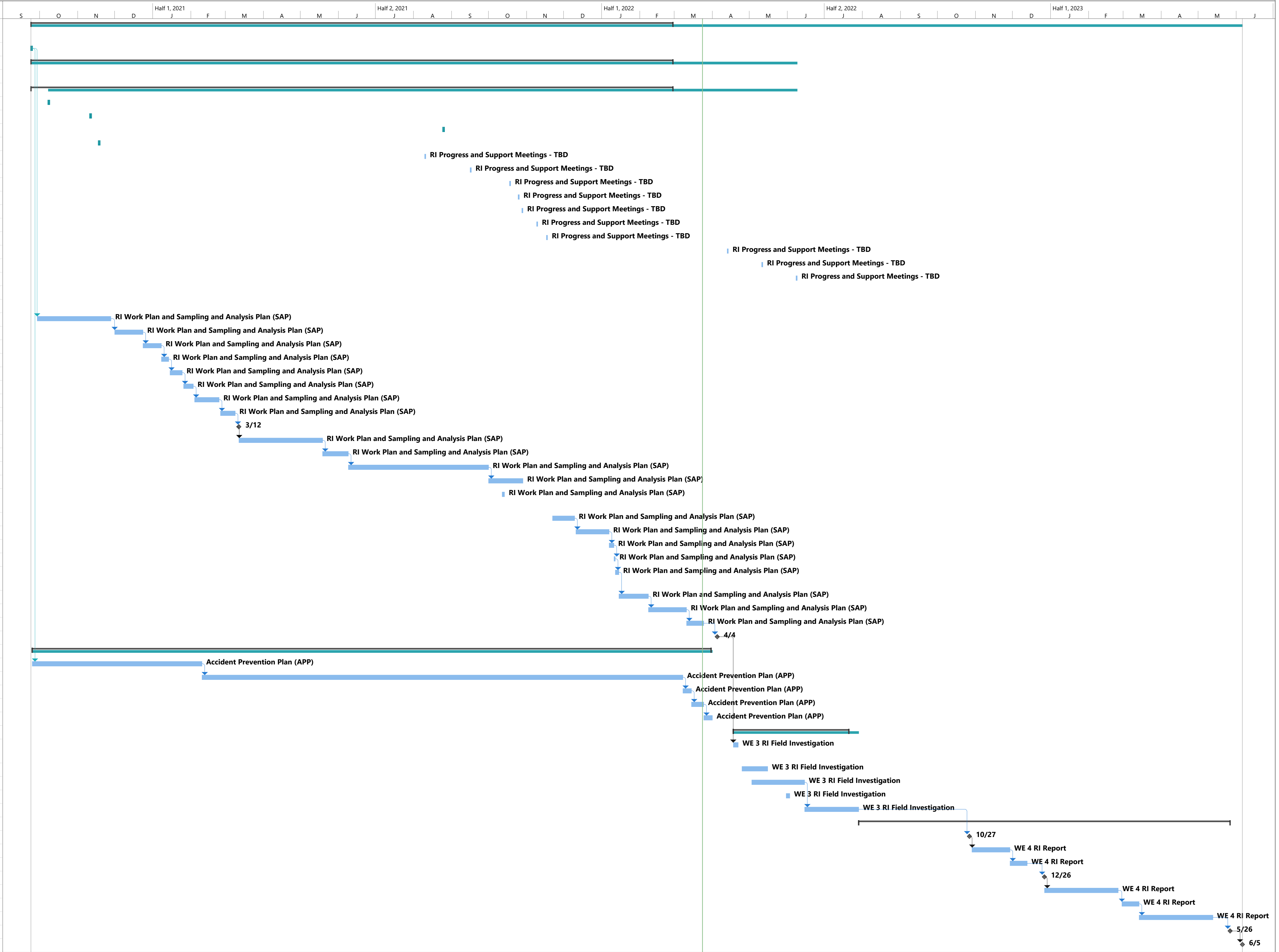
Figure 14 Project Schedule
Remedial Investigation for PFAS at Installation Restoration Site 6
Naval Station Treasure Island, San Francisco, California

ID	Task Name	Duration	Start	Finish
1	**N62470-19-D-4010 PTO X0842 IR Site 6 Remedial Investigation for PFAS (24-Month POP)**	**522 edays?**	**Thu 9/24/20**	**Mon 2/28/22**
2	Contract Award	1 eday	Thu 9/24/20	Fri 9/25/20
3	**Work Element (WE) 1 Project Management**	**522 edays?**	**Thu 9/24/20**	**Mon 2/28/22**
4	Monthly Status Reports	521 edays	Fri 9/25/20	Mon 2/28/22
5	**RI Progress and Support Meetings - TBD**	***522 edays?***	***Thu 9/24/20***	***Mon 2/28/22***
6	RI Kickoff Meeeting	1 eday	Thu 10/8/20	Fri 10/9/20
7	RI Planning Meeting with BRAC PMO	1 eday	Wed 11/11/20	Thu 11/12/20
8	RI WP RTCs meeting (Navy+Multi-MAC)	*1 eday*	*Wed 8/25/21*	*Thu 8/26/21*
9	*BCT Meetin 1 (Technical Approach)*	*1 eday*	*Wed 11/18/20*	*Thu 11/19/20*
10	RAB Meeting 1	*1 eday*	*Tue 8/10/21*	*Wed 8/11/21*
11	*BCT Meeting 2 (RTCs resolution)*	*1 eday*	*Thu 9/16/21*	*Fri 9/17/21*
12	BCT Meeting 3 (RTCs resolution)	*1 eday*	*Mon 10/18/21*	*Tue 10/19/21*
13	*BCT Meeting 4 (RTCs resolution)*	*1 eday*	*Mon 10/25/21*	*Tue 10/26/21*
14	*BCT Meeting 5 (RTCs resolution)*	*1 eday*	*Thu 10/28/21*	*Fri 10/29/21*
15	BCT Meeting 6 (RTCs resolution)	1 eday	Tue 11/9/21	Wed 11/10/21
16	BCT Meeting 7 (RTCs resolution)	1 eday	Wed 11/17/21	Thu 11/18/21
17	Technical Workgroup Meeting 1	1 eday	Wed 4/13/22	Thu 4/14/22
18	Technical Workgroup Meeting 2	1 eday	Wed 5/11/22	Thu 5/12/22
19	Technical Workgroup Meeting 3	1 eday	Wed 6/8/22	Thu 6/9/22
20	**WE 2 Planning Documents**	**535 edays?**	**Fri 9/25/20**	**Mon 3/14/22**
21	**RI Work Plan and Sampling and Analysis Plan (SAP)**	**535 edays?**	**Fri 9/25/20**	**Mon 3/14/22**
22	Internal Draft RI Work Plan	60 edays	Mon 9/28/20	Fri 11/27/20
23	Navy Review of Pre-Draft Work Plan	23 edays	Mon 11/30/20	Wed 12/23/20
24	Response to Navy Comments on Work Plan	15 edays	Wed 12/23/20	Thu 1/7/21
25	Additional Navy Comments#1	6 edays	Fri 1/8/21	Thu 1/14/21
26	Response to Additional Comments#1	10 edays	Fri 1/15/21	Mon 1/25/21
27	Additional Navy Comments#2	8 edays	Tue 1/26/21	Wed 2/3/21
28	Response to Additional Comments#2	20 edays	Thu 2/4/21	Wed 2/24/21
29	Navy Review/Concurrence on RTCs/QAO Review	12 edays	Thu 2/25/21	Tue 3/9/21
30	Draft Work Plan	3 edays	Tue 3/9/21	Fri 3/12/21
31	Agency Review of Draft Work Plan	68 edays	Fri 3/12/21	Wed 5/19/21
32	Responses to Agency Comments	21 edays	Wed 5/19/21	Wed 6/9/21
33	Navy Review/Concurrence on RTCs	114 edays	Wed 6/9/21	Fri 10/1/21
34	Agency Review of RTCs	28 edays	Fri 10/1/21	Fri 10/29/21
35	Submit Draft Final Work Plan as Redline/Strikeout Work Plan	2 edays	Tue 10/12/21	Thu 10/14/21
36	*Revised-Draft Work Plan (Phase I) for Onshore*	*18 edays*	*Mon 11/22/21*	*Fri 12/10/21*
37	Navy Review of Revised-Draft Final Work Plan	27 edays	Fri 12/10/21	Thu 1/6/22
38	Response to Navy Comments on Work Plan	4 edays	Thu 1/6/22	Mon 1/10/22
39	Navy concurrence	1 eday	Mon 1/10/22	Tue 1/11/22
40	Revised-Draft Work Plan submission for Agency Review	3 edays	Tue 1/11/22	Fri 1/14/22
41	Agency Review of Revised-Draft Work Plan	24 edays	Fri 1/14/22	Mon 2/7/22
42	Resolution of RTCs on Draft Final	31 edays	Mon 2/7/22	Thu 3/10/22
43	Navy QAO Review and Signature of Final SAP	14 edays	Thu 3/10/22	Thu 3/24/22
44	Final RI Work Plan	11 edays	Thu 3/24/22	Mon 4/4/22
45	**Accident Prevention Plan (APP)**	**394 days**	**Fri 9/25/20**	**Wed 3/30/22**
46	Draft APP	138 edays	Fri 9/25/20	Wed 2/10/21
47	Navy Review and Comment of Draft APP	279 days	Wed 2/10/21	Mon 3/7/22
48	RTCs to Navy Comments	7 edays	Mon 3/7/22	Mon 3/14/22
49	Resolution of Comments	10 edays	Mon 3/14/22	Thu 3/24/22
50	Final APP	7 edays	Thu 3/24/22	Thu 3/31/22
51	**WE 3 RI Field Investigation**	**68 days**	**Mon 4/18/22**	**Wed 7/20/22**
52	Mark Well/Soil Locations and Underground Utility Survey	4 edays	Mon 4/18/22	Fri 4/22/22
53	Soil Sampling	21 edays	Mon 4/25/22	Mon 5/16/22
54	Well Installation, Sampling, Land Surveying, Tidal Study	43 edays	Tue 5/3/22	Wed 6/15/22
55	IDW Management	3 edays	Tue 5/31/22	Fri 6/3/22
56	Laboratory Data and Validation	44 edays	Wed 6/15/22	Fri 7/29/22
57	**WE 4 RI Report**	**216 days**	**Fri 7/29/22**	**Fri 5/26/23**
58	Internal Draft RI Report	90 edays	Fri 7/29/22	Thu 10/27/22
59	Navy Review of Internal Draft RI Report	31 edays	Fri 10/28/22	Mon 11/28/22
60	RTCs delivered to Navy	14 edays	Mon 11/28/22	Mon 12/12/22
61	Draft RI Report	14 edays	Mon 12/12/22	Mon 12/26/22
62	Agency Review of Draft RI Report	60 edays	Mon 12/26/22	Fri 2/24/23
63	Respond to Agency Comments	14 edays	Mon 2/27/23	Mon 3/13/23
64	Redline/Strikeout RI Report and Comment Resolution	60 edays	Mon 3/13/23	Fri 5/12/23
65	Final RI Report	14 edays	Fri 5/12/23	Fri 5/26/23
66	**Data Entry and NIRIS Support**	**10 edays**	**Fri 5/26/23**	**Mon 6/5/23**



Project:
Date: Thu 3/24/22

Task	Milestone ◆	Project Summary	Inactive Milestone ◇	Manual Task	Manual Summary Rollup	Start-only [	External Tasks	Deadline ⬇	Manual Progress
Split	Summary	Inactive Task	Inactive Summary	Duration-only	Manual Summary	Finish-only]	External Milestone ◇	Progress	

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Tables

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Table 2-1 Summary of Previous Investigations

Investigation	Date Performed	Objective	Contaminants of Concern
Initial UST Investigation (ERM-West, 1987b)	May 5 to 13, 1987	Evaluate possible contamination from leaking UST	TPH in soil. TPH and VOCs in groundwater.
Initial Hazardous Material Investigation (HLA, 1987)	June to July 1987	Evaluate the nature and extent of hazardous substances	TPH, VOCs, PCBs, and Metals in soil. TPH in groundwater.
Floating Product Removal Study (PRC, 1992a)	September 23 to 30, 1991	Evaluate the viability of wells for floating product removal. Evaluate permeability of soils on site.	TPH and BTEX in groundwater.
Hazardous Waste Testing of Building Materials (PRC, 1992b)	February 1992	Evaluate potential presence of hazardous metals prior to building demolition	TPH, SVOCs, PCBs, Pesticides, and Metals on building surfaces.
UST 240A and 240B Removal (PRC, 1994)	April 1992	Remove USTs and collect additional data through soil and groundwater sampling	TPH and BTEX in soil. TPH and BTEX in groundwater.
Phase I RI (PRC, 1997c)	August 1992	Further define the extent of chemicals in soil near wells 06-MW05 and 06-MW08	TPH, VOCs, SVOCs, and Metals in soil.
Phase IIA RI (PRC, 1997c)	November 1994 to September 1996	Conduct quarterly sampling to monitor impacts from floating product on site	TPH, VOCs, SVOCs, and Metals in groundwater.
UST 248A and 248B Removal (Navy, 1997)	January 13, 1995	Evaluate impacts from leaking UST	TPH and BTEX in soil.

Table 2-1 Summary of Previous Investigations (continued)

Investigation	Date Performed	Objective	Contaminants of Concern
Treasure Island Tidal Influence Study (PRC, 1995)	1995	Evaluate the impact on groundwater from San Francisco Bay tidal forces on Treasure Island, including IR Site 6.	NA
Phase IIB RI (PRC, 1997c)	July 1995 to September 1996	Collect samples to define the limits of chemical releases. Identify type of fuel contamination present. Assess the presence of VOCs in the vadose zone. Install upgradient, cross-gradient, and downgradient wells to characterize groundwater contamination	TPH, VOCs, SVOCs, and Metals in soil. VOCs in soil gas. TPH, VOCs, SVOCs, and Metals in groundwater.
Environmental Baseline Survey Sampling (TtEMI, 1999a)	January, February, and August 1997	Evaluate potential contaminant pathways present on site.	TPH, BTEX, MTBE, SVOCs, and Metals in soil. TPH, BTEX, MTBE, SVOCs, and Metals in surface sediment. TPH, BTEX, and MTBE in groundwater.
Groundwater Monitoring (TtEMI, 1999b)	May and November 1998	Perform further groundwater monitoring and sampling in support of ongoing remedial activities	TPH, VOCs, SVOCs, Metals, and MNA Parameters in groundwater
Bioventing and Biosparging Pilot Test (TtEMI, 2000)	September 1999 to January 2000	Evaluate biosparging/ bioventing as potential remedial alternatives	TPH, BTEX, Iron, Organic Carbon, Nitrogen, Nitrite, Nitrate, Phosphorus, Percent Moisture, and Heterotrophic Plate Count in soil. TPH, Benzene, Carbon Dioxide, and Oxygen in soil gas. TPH, BTEX, and Iron in groundwater
Basewide-Tidal Mixing Zone Study (TtEMI, 2002a)	December 2000 to March 2001	Evaluate the distance inland from the shoreline over which tidal mixing occurs and estimate the degree of tidal mixing of surface water and groundwater.	NA

Table 2-1 Summary of Previous Investigations (continued)

Investigation	Date Performed	Objective	Contaminants of Concern
Focused Site Characterization Sampling and PAH Sampling (TtEMI, 2002b)	2000 to 2001	Further characterize the extent of petroleum contamination in soil and groundwater and evaluate the association (if any) between TPH and PAH at the site	PAH, TPH, BTEX, and MTBE in soil. TPH, BTEX, and MTBE in groundwater.
Petroleum Remedial Excavation Program (Shaw, 2004b)	May 2002 to January 2003	Remove TPH-contaminated soil in the UST 240 Area, Former Helicopter Training Area, and UST 248 Area	TPH, Dioxins and Furans, VOCs, and Lead in soil.
Environmental Baseline Survey Data Gaps Investigation (Shaw, 2005b)	April and August 2003	Further define the extent of dioxin- and furan-contaminated soil within Parcels T108, T111, and T112	Dioxins and Furans in soil.
Soil Gas Sampling (Shaw, 2005c)	July, August, and October 2004	Evaluate the presence and distribution of BTEX in the vadose zone within the UST 240 Area	BTEX and MTBE in soil gas.
Phase II PCB Investigation (SulTech, 2008a)	2006	Determine if PCB-contaminated soil and building materials were present at current or former locations of transformers and electrical devices	PCBs in soil, and on concrete and other building materials.
Data Gaps Investigation (ERRG, 2010)	August and September 2010	Further define the nature and extent of contaminants of concern on site	Dioxins and Furans, TPH, VOCs, PAHs, PCBs, Herbicides, and Arsenic in soil. TPH, VOCs, and Arsenic in groundwater. VOCs in soil gas.

Table 2-1 Summary of Previous Investigations (continued)

Investigation	Date Performed	Objective	Contaminants of Concern
Remedial Investigation/ Feasibility Study (ERRG, 2012)	2010-2012	Define the nature and extent of contaminants of concern on site using all available data, perform human health and ecological risk assessment, and evaluated potential remedial alternatives.	The following COCs were identified: volatile organic compounds (VOCs) (including 1,1,2-trichloroethane, benzene, ethylbenzene, naphthalene, and xylenes), total petroleum hydrocarbons (TPH), herbicides (methylchlorophenoxypropionic acid), and metals (arsenic and manganese) and dioxins. The RI/FS identified areas where the COCs exceeded established remedial goals.
Pre-Design Characterization (CE2K, 2015)	July 2015	Refinement of areas targeted for remediation.	Dioxins and furans, PFAS in soil.
Removal Action (CE2K, 2018)	May through October 2016	Removal action to excavate impacted soil for offsite disposal	VOCs (including 1,1,2-trichloroethane, benzene, ethylbenzene, naphthalene, and xylenes), TPH, the herbicide methylchlorophenoxypropionic acid, arsenic, and manganese, and dioxins in soil.
Groundwater Monitoring	1998 to present.	Monitor groundwater conditions over time. PFAS added to COC list beginning in 2017. Sampling events that included PFAS analysis occurred in 2017 and 2020.	TPH, VOCs, SVOCs, BTEX, MTBE, PAHs, Metals, Anions, MNA Parameters, PFAS in groundwater. PFOA, PFOS, and PFBS were detected in groundwater in May 2017, December 2017, April 2020, and September 2020.
Groundwater sampling (DON, 2020)	September 2020	Hydropunch sampling conducted to screen groundwater at IR Site 6 for PFAS.	PFOA, PFOS, and PFBS were detected in groundwater.

Table 2-1 Summary of Previous Investigations (continued)

Notes:
bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, and xylenes
ERM-West = Environmental Resources Management West, Inc.
ERRG = Engineering/Remediation Resources Group, Inc.
HLA = Harding Lawson Associates
IR = Installation Restoration
MNA = monitored natural attenuation
MTBE = methyl tert- butyl ether
PAHs = polycyclic aromatic hydrocarbons

Cited References:

ERRG, 2010. “Work Plan for Data Gaps Investigation, Installation Restoration Site 6, Former Fire Training School, Naval Station Treasure Island, San Francisco, California.” August. ERM-West, 1987a. “Tank Testing Study, Naval Station Treasure Island, U.S. Department of the Navy, Naval Facilities Engineering Command, Western Division.” July.

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RC Environmental Management, Inc. (PRC). 1992a. “Suitability of Floating Product Removal, Final Summary Report, Naval Station Treasure Island, San Francisco, California.” February 10.

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TtEMI, 1999b. “Groundwater Status Report: Summary of Groundwater Monitoring from January to November 1998, Naval Station Treasure Island, San Francisco, California.” May 7.

TtEMI, 2000. “Final Technical Memorandum, Biosparging/Bioventing Pilot-Scale Test, Naval Station Treasure Island, San Francisco, California.” August 31.

TtEMI, 2002a. Final Tidal Mixing Zone Study Technical Memorandum, Naval Station Treasure Island, San Francisco, California. April 11.

TtEMI, 2002b. “Final Corrective Action Plan for Sites 06, 14/22, 15, and 25, Naval Station Treasure Island, San Francisco, California.” June 28.

Shaw, 2004b. “Final Post-Construction Summary Report, Site 6 Fire Training School Remedial Excavation, Naval Station Treasure Island, Petroleum Remedial Excavation Program, Treasure Island, San Francisco, California.” March 30.

Table 2-1 Summary of Previous Investigations (continued)

Shaw, 2005b. "Final Field Activity Report, Environmental Baseline Survey Data Gaps Investigation, Naval Station Treasure Island, San Francisco, California." May 9. Shaw, 2005c. "Final Closure Report, Site 6, Request for No Further Action, Naval Station Treasure Island, San Francisco, California." December 16.

SulTech, 2008a. "Final PCB Summary Report, Naval Station Treasure Island, San Francisco, California." January.

United States Department of the Navy (DON), 2020. Personal e-mail transmitting April 2020 IR Site 6 groundwater sampling data, sent by Mr. David Clark. May 21.

Table 2-2: Summary of PFAS Analytical Results in Soil

Location	Sample Depth (feet bgs)	Sample Date	PFOS[1] (mg/kg)	PFOA[1] (mg/kg)
Screening Level[2]			**0.13**	**0.13**
06-SB46	0.5	07/08/2015	0.0375	0.0313
	4	07/08/2015	**0.226**	< 0.024 U
	5.5	07/08/2015	0.0777	< 0.024 U
06-SB59	2	07/08/2015	0.130	0.0574
	4	07/08/2015	**0.165**	0.0318
06-SB60	2	07/08/2015	< 0.012 U	< 0.024 U
	4	07/08/2015	0.0511	0.0113 J
06-SB61	2	07/08/2015	**1.240**	< 0.026 U
	4	07/08/2015	**1.080**	0.0123 J
06-SB62	2	07/08/2015	< 0.011 U	< 0.023 U
	4	07/08/2015	< 0.008 U	< 0.018 U

Notes:

Bold = exceeds screening criteria

1. Only PFOS and PFOA were analyzed as these were the only PFAS with screening levels established at the time of sampling.
2. DoD. 2021. Memorandum on Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program, Residential Scenario Screening Levels. September 15

Abbreviations:

mg/kg = milligrams per kilogram; bgs = below grouind surface; J = Value is estimated between the Detection Limit (Method Detection Limit) and the Limit of Detection (Reporting Limit); PFAS = per- and polyfluorinated substances; PFBS = perfluorobutanesulfonic acid; PFOA = perfluorooctanoic acid; PFOS = perfluorooctane sulfonate; U = Chemical not detected at or above indicated limit of detection value.

Source:

DON. 2020d. Personal email transmitting June 2015 IR Site 6 soil sampling data, sent by Mr. David Clark. May 21.

CE2-Kleinfelder Joint Venture (CE2-Kleinfelder JV). 2016. Final Remedial Design Remedial Action Work Plan, Installation Restoration Site 6, Former Naval Station Treasure Island, San Francisco, California. April.

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Table 2-3: Summary of PFAS Analytical Results in Groundwater

Monitoring Well Sampling Location	Sampling Date	PFBS (µg/L)	PFOA (µg/L)	PFOS (µg/L)
Screening Level[1]		**0.6**	**0.04**	**0.04**
06-MW25	5/9/2017	0.12	**7.32**	**7.12**
	12/12/2017	0.084 J	**4.1**	**18.0**
	4/8/2020	0.074	**1.1**	**9.9**
	9/21/2020	0.100	**1.1**	**10**
06-MW26	5/9/2017	0.038	**0.750**	**10.02**
	12/13/2017	0.028	**0.960**	**3.8**
	4/9/2020	0.020 J	**0.310**	**2.2**
	9/21/2020	0.028	**0.65**	**2.1**
06-MW30	5/9/2017	0.0060 J	0.032	**0.130**
06-MW30 (dup)	5/9/2017	0.0065 J	0.033	**0.170**
	12/12/2017	0.015 U	0.027	**0.097**
	4/9/2020	0.015 U	0.026	**0.150**
	9/21/2020	0.0063 J	0.035	**0.067**
06-MW31	12/14/2017	0.061	**0.270**	**1.2**
	4/8/2020	0.020	**0.160**	**0.4**
	9/21/2020	0.160	**0.45**	**1.7**
	9/21/2020	0.160	**0.44**	**1.8**
06-MW32	12/13/2017	0.13	**1.2**	**19.0**
06-MW32 (dup)	12/13/2017	0.15	**1.1**	**18.0**
06-MW32	4/9/2020	0.150	**2.0**	**30.0**
06-MW32 (dup)	4/9/2020	0.170	**2.1**	**27.0**
	9/21/2020	0.13	**1.2**	**23**
06-MW33	12/13/2017	0.064	**1.3**	**6.1**
	4/9/2020	0.120	**2.0**	**11.0**
	9/21/2020	0.069	**1.2**	**7**
06-MW34	12/13/2017	0.065	**0.380**	**3.1**
	4/9/2020	0.014 J	**0.100**	**1.8**
	9/21/2020	0.039	**0.20**	**2.4**
06-MW35	12/13/2017	0.048	**0.250**	**3.8**
	4/9/2020	0.026	**0.210**	**4.1**
	9/21/2020	0.033	**0.19**	**3.4**
06-MW36	12/13/2017	0.076	**0.350**	**1.4**
	4/9/2020	0.015 J	**0.081**	**0.770**
	9/21/2020	0.020 J	**0.062**	**0.75**
HP01	9/22/2020	0.012 J	**0.044**	**0.21**
HP02	9/22/2020	0.024	0.015 J	**0.14**
HP03	9/22/2020	0.0062 J	0.0066 J	**0.063**
HP03 (dup)	9/22/2020	0.0058 J	0.0059 J	**0.061**
HP04	9/22/2020	0.014 U	0.013 J	**0.053**
HP05	9/22/2020	0.0070 J	0.0057 J	**0.042**
HP06	9/22/2020	0.0094 J	0.026	**0.093**

Table 2-3: Summary of PFAS Analytical Results in Groundwater (continued)

Monitoring Well Sampling Location	Sampling Date	PFBS (µg/L)	PFOA (µg/L)	PFOS (µg/L)
Screening Level[1]		**0.6**	**0.04**	**0.04**
HP07	9/22/2020	0.019 J	**0.37**	**0.81**
HP08	9/22/2020	0.028	**0.75**	**1.2**
HP08 (dup)	9/22/2020	0.028	**0.790**	**1.1**
HP09	9/22/2020	0.016 J	**0.11**	**0.59**
HP10	9/22/2020	0.014 U	0.014 U	0.014 U
HP11	9/22/2020	0.034	**0.095**	**0.27**
HP12	9/23/2020	0.014 J	**0.072**	**0.44**
HP13	9/23/2020	0.0058 J	**0.028**	**0.19**

Notes:

Bold = exceeded screening criteria

1. Screening criteria for groundwater sample results follows “Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program” dated September 15, 2021.

Abbreviations and Acronyms:

-- = not analyzed; µg/L = microgram(s) per liter; dup = field duplicate sample; J = Value is estimated between the Detection Limit (Method Detection Limit) and the Limit of Detection (Reporting Limit); PFAS = per- and polyfluorinated substances; PFBS = perfluorobutanesulfonic acid; PFOA = perfluorooctanoic acid; PFOS = perfluorooctane sulfonate; U = analyte not reported at or above the method detection limit.

Sources:

1. NOREAS, Inc., 2019. Final 2017 Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California. February 2019.
2. NOREAS, Inc., 2020. Field Change Request to Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California. September.
3. DON. 2020c. Personal email transmitting April 2020 IR Site 6 groundwater sampling data, sent by Mr. David Clark. May 21.

Table 3-1: Conceptual Site Model

Information Category	Information Descriptor	Preliminary Findings
Physical Profile Land Use and Exposure Profile	Climate	See Section 2.4 of the Work Plan
	Topography	IR Site 6 encompasses 4.54 acres of asphalt, concrete, and unpaved open space. The site is relatively flat, with ground surface elevations ranging from approximately 9 to 11 feet above mean sea level. Surface runoff flows into onsite storm catch basins and drains directly into San Francisco Bay.
	Geology	See Section 2.5 of the Work Plan. IR Site 6 is underlain by dredged fill and shoal deposits consisting of fine- to coarse-grained sand, with varying proportions of shell fragments, silt, and clay. Groundwater occurs under unconfined conditions at an average depth of approximately 4.5 to 6 feet bgs.
	Soil	See Section 2.5 of the Work Plan. Soils at IR Site 6 are derived from dredged sediment and consist fine- to coarse-grained sand, with varying proportions of shell fragments, silt, and clay. Thin beds of clay occasionally developed as finer materials in the dredged sand fill settled out during fill operations. These soils extend to depth ranging from 40 to 50 feet bgs.
	Hydrogeology	Based on existing monitoring well data, groundwater occurs at IR Site 6 under unconfined conditions at an average depth of approximately 4.5 to 6 feet bgs. Groundwater levels vary seasonally; water levels are highest from November to April and lowest from May to October. Recharge occurs primarily through direct rainfall infiltration. Groundwater flow is generally from the center of the island toward San Francisco Bay, with an estimated gradient of 0.0007 to 0.02. Tidal forces in San Francisco Bay affect the groundwater near the shoreline (PRC, 1995; TtEMI, 2002). Groundwater at former NSTI is not suitable as a potential source of drinking water pursuant to State Water Resources Control Board Resolution 88-63 and RWQCB Resolution No. 89-39 (RWQCB, 2001). See Section 2.7 of the Work Plan.
	Hydrology	See Section 2.6 of the Work Plan.
	Vegetation	The ecological surveys identified vegetation at former NSTI consisting of landscaped lawns, trees, ornamental plants, and overgrowth of ruderal species (weeds) in vacant areas. Former NSTI has never supported a natural ecosystem or provided habitat for ecologically relevant wildlife.

Table 3-1: Conceptual Site Model (continued)

Information Category	Information Descriptor	Preliminary Findings
Physical Profile Land Use and Exposure Profile (continued)	Current Land Use	IR Site 6 encompasses 4.54 acres of asphalt, concrete, and unpaved open space. All buildings have been removed, and the site is currently vacant, closed to the public, and secured.
	Current Human Receptors	There are no current permanent receptors at IR Site 6. Currently, access to the site is restricted to authorized environmental workers. The presence of pavement, concrete, and gravel prevents direct contact with chemicals remaining in soil and acts as a barrier to prevent the exposure of environmental workers.
	Potential Future Land Use	The primary planned future use of IR Site 6 is publicly accessible open space and recreational facilities. The development plan also indicates that an approximately 0.9-acre area in the southeastern portion of IR Site 6 will be used for public services and institutional purposes to support expansion of the existing wastewater treatment plant (TIDA, 2011).
	Potential Future Human Receptors	A construction worker exposure scenario was also evaluated to account for potential workers that may infrequently encounter subsurface soil and groundwater during future redevelopment or site maintenance. Future recreational visitors, including recreational use (e.g., shellfish harvesting) nearshore of IR Site 6, will be evaluated as potential receptors. Hypothetical future residents will also be considered, although ICs currently prevent residential development (documented in Section 2.1.3) and no residential occupation is anticipated.
	Relationship of Contaminant Sources to Potential Receptors	There are no current operations at IR Site 6 that would lead to additional releases of PFAS. Human receptors may come into contact with PFAS in surface and subsurface soil or groundwater while onsite.
	Potential Future Land Use-Related Activities	Construction site work and maintenance of developed facilities.
	Zoning/Land Use Restrictions	The area is expected to be zoned for open space/industrial occupancy.
	Demographics/Zoning	The United States Census Bureau estimated the population of TI at 2,300 in 2011, with a population density of 2,600 persons per square mile.
	Beneficial Resources	There are no known beneficial resources onshore TI; however, the adjacent San Francisco Bay is considered a beneficial resource.

Table 3-1: Conceptual Site Model (continued)

Information Category	Information Descriptor	Preliminary Findings
Ecological Profile	Habitat Type	TI is artificial and no natural habitat is present onsite (terrestrial). Aquatic habitat is present nearshore, including potential benthic community and other potential higher trophic-level organisms. Marine receptors will be evaluated during the RI.
	Degree of Disturbance	Anticipated future activities at the site, such as construction, will not disturb the habitat or any ecological receptors known or potentially present within site areas.
	Federal Endangered or Threatened Species	No endangered or threatened terrestrial species have been identified on TI.
	Relationship of Contaminant Sources to Habitat and Potential Receptors	Terrestrial ecological receptors will not be exposed to PFAS, if present, in soil because they are not present onsite. Marine ecological receptors may ingest PFAS nearshore and PFAS that have been incorporated into the food chain (bioaccumulated in plants and prey).

Notes:
bgs = below ground surface; COPEC = contaminant of potential ecological concern; IR = Installation Restoration; NSTI = Naval Station Treasure Island; PFAS = per- and polyfluoroalkyl substances; RI = Remedial Investigation; TI = Treasure Island; TIDA = Treasure Island Development Authority

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Table 4-1 Rationale for Remedial Investigation Sampling Locations at IR Site 6

Sample Location[1]	Soil Sample Depth [2,3,4] (ft bgs)	Groundwater Sample Depth [5] (ft bgs)	Sample Location Rationale [6]
06-SB63	0–2 4–6	None	• Evaluate the nature and extent of previously reported soil impacts in an area adjacent to stormwater line. • Location of PFAS detection greater than screening level in groundwater monitoring well 06-MW32. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB64	0–2 4–6	None	• Evaluate the nature and extent of previously reported soil impacts in an area adjacent to stormwater line. • Location adjacent to groundwater monitoring well 06-MW34 with PFAS detection greater than screening level in groundwater. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB65	0–2 4–6	None	• Characterize potential PFAS release area in soil within a former portable aircraft area and evaluate residual PFAS potentially remaining onsite. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB66	0–2 4–6	None	• Characterize potential PFAS release area in soil at the suspected former burn pit and evaluate residual PFAS potential remaining onsite. • Collect 2 subsurface samples for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB67	0–2 4–6	None	• Characterize potential PFAS release area in soil at the former helicopter training area and evaluate residual PFAS potentially remaining onsite. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB68	0–2 4–6	None	• Characterize potential PFAS release area in soil along the former "L"-shaped collector trench used to collect and convey wastewater runoff from training exercises to sumps and surge pits along the eastern side of the site. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB69	0–2 4–6	None	• Characterize potential PFAS release area in soil at a former burn area and former firefighting structure/building and evaluate residual PFAS potentially remaining onsite. • Location adjacent to groundwater monitoring well 06-MW31 with PFAS detection greater than screening level in groundwater. • This area was previously excavated to a depth of 0.5 foot bgs; thus, the samples will be collected below the backfill material. This interval will be verified to be at a depth below the excavation/fill prior to sampling.
06-SB70	0–2 4–6	None	• Characterize a potential secondary potential PFAS release area in soil in a former oil-water separator downstream of the Collector Trench.
06-SB71	0–2 4–6	None	• Characterize a potential PFAS release area in soil in a former burn area. • Evaluate the extent of previously reported PFAS in soil at 06-SB62. • Collect 2 subsurface samples for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB72	0–2 4–6	None	• Characterize a potential source of PFAS in soil in the southern portion of the former "L"-shaped collector trench used to collect and convey wastewater runoff from training exercises to sumps and surge pits along the eastern side of the site.

Table 4-1 Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Sample Location[1]	Soil Sample Depth [2,3,4] (ft bgs)	Groundwater Sample Depth [5] (ft bgs)	Sample Location Rationale [6]
06-SB73	0–2 4–6	None	• Evaluate the nature and extent of PFAS impacts in soil in area that is tidally influenced. • Evaluate potential source of soil impacts along a stormwater line preferential pathway. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB74	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil adjacent to previous soil excavation at the northwestern boundary of IR Site 6 adjacent to a previous soil excavation area. • Evaluate potential source of soil impacts along a water line preferential pathway.
06-SB75	0–2 4–6	None	• Evaluate the nature and extent of PFAS impacts in soil downgradient of a former Burn Area and petroleum excavation area in the northern downgradient boundary of IR Site 6. • Evaluate the potential source of soil impacts along a stormwater line preferential pathway.
06-SB76	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the northeastern boundary of IR Site 6. • Characterize a previous petroleum excavation area that may be associated with fuel storage in above storage tank and/or firefighting activities at a former burn area.
06-SB77	0–2 4–6	None	• Characterize a potential source of PFAS in soil impacts in a former Burn Area and evaluate residual PFAS potentially remaining onsite. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB78	0–2 4–6	None	• Evaluate potential source of soil impacts along a stormwater line preferential pathway.
06-SB79	0–2 4–6	None	• Characterize a secondary potential PFAS release area in soil in the forward oil-water separator downstream of the “L”-shaped collector trench used to collect wastewater runoff from training exercises.
06-SB80	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil south of a suspected former burn pit. • Delineate previous soil detections of PFAS that were above the soil screening values in boring 06-SB59.
06-SB81	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the former AFFF Station in the northern boundary of the central training areas adjacent to the V-ditch collector trench.
06-SB82	0–2 4–6	None	• Delineate previous soil detections of PFAS that were above the soil screening values in boring 06-SB61. • Characterize potential PFAS release areas at former burn areas.
06-SB83	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the eastern boundary of former central firefighting training areas and former excavations. • Evaluate potential source of soil impacts along a stormwater line preferential pathway.
06-SB84	0–2 4–6	None	• Characterize a secondary potential PFAS release area in soil in the smothering pit downstream of the “L”-shaped collector trench used to collect wastewater runoff from training exercises.
06-SB85	0–2 4–6	None	• Characterize potential PFAS release area in soil at a former firefighting structure/building and evaluate residual PFAS potentially remaining onsite.

Table 4-1 Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Sample Location[1]	Soil Sample Depth [2,3,4] (ft bgs)	Groundwater Sample Depth [5] (ft bgs)	Sample Location Rationale [6]
06-SB86	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the western boundary of former central firefighting training areas.
06-SB87	0–2 4–6	None	• Characterize a secondary potential PFAS release area in soil in the alternative oil-water separator downstream of the "L"-shaped collector trench used to collect wastewater runoff from training exercises.
06-SB88	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southeastern boundary of IR Site 6. • Characterize previous excavation areas associated with central firefighting area and adjacent to a water utility line.
06-SB89	0–2 4–6	None	• Characterize previous petroleum excavation area that may be associated with fuel storage in aboveground storage tank and/or firefighting activities at a former burn area.
06-SB90	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southern boundary of IR Site 6. • Characterize soil adjacent previous excavation areas and a stormwater line preferential pathway.
06-SB91	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southern downgradient boundary of IR Site 6. • Characterize soil adjacent to preferential pathways including a stormwater line and water line.
06-SB92	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southern downgradient boundary of IR Site 6.
06-MW25	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater.
06-MW26*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW30	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater.
06-MW31*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW32*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW33*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW34*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.

Table 4-1 Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Sample Location[1]	Soil Sample Depth [2,3,4] (ft bgs)	Groundwater Sample Depth [5] (ft bgs)	Sample Location Rationale [6]
06-MW35*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW36	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater.
06-MW37*	0–2 4–6	5–15	• Delineate cross-gradient and downgradient extent of potential PFAS impacts in soil and groundwater. • Monitoring well location is cross-gradient of PFAS detection greater than screening level in groundwater monitoring well 06-MW34 and Hydropunch HP09. • Monitoring well location is within the assumed tidal mixing zone of 60 feet and will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW38*	0–2 4–6	5–15	• Delineate cross-gradient and downgradient extent of potential PFAS impacts in soil and groundwater. • Location is adjacent to a sewer line and is cross-gradient of PFAS detection greater than screening level in groundwater monitoring wells 06-MW34 and 06-MW35. • Monitoring well location is within the assumed tidal mixing zone of 60 feet and will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW39*	0–2 4–6	5–15	• Delineate downgradient extent of previously reported PFAS impacts in soil and groundwater in area where tidal influences may impact groundwater flow. • Monitoring well location is within the assumed tidal mixing zone of 60 feet and will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing. • Location is downgradient of potential PFAS release in the Collector Trench and Surge Pit, and is downgradient of monitoring well 06-MW32, where the highest concentrations of PFAS were reported in groundwater.
06-MW40*	0–2 4–6	5–15	• Delineate downgradient extent of potential PFAS release in the central training area. • Location is adjacent to a sewer line and is cross-gradient of PFAS detection greater than screening level in groundwater monitoring wells 06-MW34 and 06-MW35. • Monitoring well location will be used in the tidal study to evaluate groundwater-surface interaction. • Collect 2 subsurface samples for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-MW41	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the northwestern boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Monitoring well location is just upgradient to previous excavation to remove contaminants associated operation of the former training school.
06-MW42	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the western boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Monitoring well location is adjacent to PFAS detection greater than screening level in Hydropunch HP05.

Table 4-1 Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Sample Location[1]	Soil Sample Depth [2,3,4] (ft bgs)	Groundwater Sample Depth [5] (ft bgs)	Sample Location Rationale [6]
06-MW43	0–2 4–6	5–15	• Delineate the nature and extent of potential PFAS release to soil and its potential release to groundwater in a former Burn Area. • Location is adjacent to the highest detected PFAS concentration in soil at soil boring 06-SB61. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-MW44*	0–2 4–6	5–15	• Delineate cross-gradient extent of PFAS impacts in soil and groundwater. • Location is adjacent to a water and a sewer line and is adjacent to PFAS detection greater than screening level in Hydropunch HP07. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW45	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in area where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient.
06-MW46*	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in area where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient. • Monitoring well location will be used in the tidal study to evaluate groundwater-surface interaction.
06-MW47	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the western boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Location is adjacent to PFAS detection greater than screening level in Hydropunch HP5 within the wastewater treatment plant.
06-MW48	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in southwestern boundary where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient.
06-MW49	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the northwestern boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Location is cross gradient to PFAS detection greater than screening level in Hydropunch HP01 and Hydropunch HP2.
06-MW50	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in area where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient. • Location is cross gradient to reported PFAS impacts in soil and groundwater at IR Site 6, and PFAS detection greater than screening levels in Hydropunch HP12 and Hydropunch HP 13 within the wastewater treatment plant.
06-MW51	0–2 4–6	5–15	• Evaluate cross gradient characterization of potential PFAS impacts in soil and groundwater at the northeastern boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Location will confirm delineation of PFAS impacts in groundwater adjacent to Hydropunch HP10 where PFAS was not detected.
Total Number of Samples	**90**	**24**	

Table 4-1 Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Notes:

* Monitoring well will be used in the tidal study.

1. If multiple boreholes are needed to obtain samples of the different matrices (soil and groundwater) at a location, then a sequential letter designation will follow the number for each borehole, e.g.: 06-SB63-SO-02A etc.
2. Groundwater is at approximately 4–6 feet bgs; unless otherwise noted in the rationale, soil samples are targeted to be within the 0–6 feet bgs, typically used for exposure for risk assessments.
3. Depth indicated is the top depth of the sample. The proposed sample depth is estimated and may be adjusted slightly as appropriate based on actual field conditions (e.g., encountering fill material used during previous remedial actions) during the drilling and sampling.
4. Soil sampling from borings and trenches is described in Sections 4.2.1 and 4.2.2 of the Work Plan and in SAP Section
5. Groundwater monitoring well construction is described Section 4.3 of the Work Plan and in SAP Section 14.5.
6. Analytical groups for each sampling location are listed Sections 4.2.3, 4.3.2, and 4.5.4 of the Work Plan and in SAP Worksheet #18 Table 18-1.

Acronyms:

ft = feet; bgs = below ground surface; bss = below sediment surface; IR = Installation Restoration; PFAS = per-and polyfluoroalkyl substances

Table 5-1: Exposure Assumption Values Used For Daily Intake Calculations (RAGS D: Table 4): Reasonable Maximum Exposure - Soil (0-2.0 feet and 0-6 feet)

Scenario Timeframe: Current/Future
Medium: Soil (0-2 feet and 0-6 feet)
Exposure Medium: Soil (0-2 feet and 0-6 feet)

Exposure Route	Receptor	Receptor Age	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Location	Reference	Intake Equation / Model Name
Ingestion	Hypothetical Future Resident	Child (0-6 years)	IR Site 6 (0-2.0 feet and 0-6 feet)	CS	Chemical Concentration in Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Chronic Daily Intake
				IR	Ingestion Rate of Soil	200	mg/day	Residential child value	USEPA, 2014a	(mg/kg-day) from ingestion is shown below
				FI	Fraction Ingested	1	unitless	-	Assumption	
				RBA[a]	Relative Bioavailability in Soil	chemical-specific	unitless	-	USEPA, 2012	
				EF	Exposure Frequency	350	days/year	Default days spent at home	USEPA, 2014a	$Intake = \frac{C_{soil} \times IR \times FI \times RBA \times EF \times ED \times CF1}{BW \times AT}$
				ED	Exposure Duration	6	year	Default based on age range	USEPA, 2014a	
				BW	Body Weight	15	kg	Default child body weight	USEPA, 2014a	
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	2,190	day	365 days for 6 years	USEPA, 2014a	Source: RAGS Part A, Exhibit 6-14 (USEPA, 1989)
				CF1	Conversion Factor	1.0E-06	kg/mg	-		
		Adult	IR Site 6 (0-2.0 feet and 0-6 feet)	CS	Chemical Concentration in Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Chronic Daily Intake
				IR	Ingestion Rate of Soil	100	mg/day	Residential adult value	USEPA, 2014a	(mg/kg-day) from ingestion is shown below
				FI	Fraction Ingested	1	unitless	-	Assumption	
				RBA[a]	Relative Bioavailability in Soil	chemical-specific	unitless	-	USEPA, 2012	
				EF	Exposure Frequency	350	days/year	Default days spent at home	USEPA, 2014a	$Intake = \frac{C_{soil} \times IR \times FI \times RBA \times EF \times ED \times CF1}{BW \times AT}$
				ED	Exposure Duration	20	years	Default based on 26 year residence in one location.	USEPA, 2014a	
				BW	Body Weight	80	kg	Default adult body weight	USEPA, 2014a	
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	7,300	day	365 days for 20 years	USEPA, 2014a	Source: RAGS Part A, Exhibit 6-14 (USEPA, 1989)
				CF1	Conversion Factor	1.0E-06	kg/mg	-		
	Recreational Visitor	Child (0-6 years)	IR Site 6 (0-2.0 feet and 0-6 feet)	CS	Chemical Concentration in Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Chronic Daily Intake
				IR	Ingestion Rate of Soil	200	mg/day	Residential child value	USEPA, 2014a	(mg/kg-day) from ingestion is shown below
				FI	Fraction Ingested	1	unitless	-	Assumption	
				RBA[a]	Relative Bioavailability in Soil	chemical-specific	unitless	-	USEPA, 2012	
				EF	Exposure Frequency	75	days/year	Assumed receptor is exposed 5 days per week for 15 weeks	Assumption	$Intake = \frac{C_{soil} \times IR \times FI \times RBA \times EF \times ED \times CF1}{BW \times AT}$
				ED	Exposure Duration	6	year	Default based on age range	Assumption	
				BW	Body Weight	15	kg	Default child body weight	USEPA, 2014a	
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years x 365 days)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	2,190	day	Exposure duration (6 years x 365 days)	USEPA, 2014a	Source: RAGS Part A, Exhibit 6-14 (USEPA, 1989)
				CF1	Conversion Factor	1.0E-06	kg/mg	-		
		Adolescent/ Adult (6-26 years)	IR Site 6 (0-2.0 feet and 0-6 feet)	CS	Chemical Concentration in Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Chronic Daily Intake
				IR	Ingestion Rate of Soil	100	mg/day	Residential adult value	USEPA, 2014a	(mg/kg-day) from ingestion is shown below
				FI	Fraction Ingested	1	unitless	-	Assumption	
				RBA[a]	Relative Bioavailability in Soil	chemical-specific	unitless	-	USEPA, 2012	
				EF	Exposure Frequency	75	days/year	Assumed receptor is exposed 5 days per week for 15 weeks	Assumption	$Intake = \frac{C_{soil} \times IR \times FI \times RBA \times EF \times ED \times CF1}{BW \times AT}$
				ED	Exposure Duration	20	year	Default based on age range	Assumption	
				BW	Body Weight	80	kg	Default adult body weight	USEPA, 2014a	
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years x 365 days)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	7,300	day	Exposure duration (20 years x 365 days)	USEPA, 2014a	Source: RAGS Part A, Exhibit 6-14 (USEPA, 1989)
				CF1	Conversion Factor	1.0E-06	kg/mg	-		

Table 5-1: Exposure Assumption Values Used For Daily Intake Calculations (RAGS D: Table 4): Reasonable Maximum Exposure - Soil (0-2.0 feet and 0-6 feet)

Scenario Timeframe: Current/Future
Medium: Soil (0-2 feet and 0-6 feet)
Exposure Medium: Soil (0-2 feet and 0-6 feet)

Exposure Route	Receptor	Receptor Age	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Location	Reference	Intake Equation / Model Name
Ingestion	Construction	Adult	IR Site 6	CS	Chemical Concentration in Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Chronic Daily Intake
Cont'd	Worker		(0-6 feet)	IR	Ingestion Rate of Soil	330	mg/day	Construction Worker Value	USEPA, 2002a	(mg/kg-day) from ingestion is shown below
				FI	Fraction Ingested	1	unitless	-	Assumption	
				RBA[a]	Relative Bioavailability in Soil	chemical-specific	unitless	-	USEPA, 2012	
				EF	Exposure Frequency	250	days/year	Default worker exposure frequency	USEPA, 2014a	$Intake = \frac{C_{soil} \times IR \times FI \times RBA \times EF \times ED \times CF1}{BW \times AT}$
				ED	Exposure Duration	1	year	Excavation assumed to take place within one year	Assumption	
				BW	Body Weight	80	kg	Default adult body weight	USEPA, 2014a	
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years x 365 days)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	365	day	Excavation assumed to take place within one year	Assumption	Source: RAGS Part A, Exhibit 6-14 (USEPA, 1989)
				CF1	Conversion Factor	1.0E-06	kg/mg	-		
Dermal	Hypothetical	Child	IR Site 6	CS	Chemical Concentration In Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Dermally Absorbed Dose (DAD)
Contact	Future	(0-6 years)	(0-2.0 feet and	AF	Adherence Factor	0.2	mg/cm^2-event	Default residential child value	USEPA, 2014a	(mg/kg-day) from dermal is shown below
	Resident		0-6 feet)	AbF	Absorption Factor	chemical-specific	unitless	Chemical-Specific inputs in BHHRA	USEPA, 2004	
				SA	Available Skin Surface Area	2,373	cm^2	Default residential child value	USEPA, 2014a	$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$
				EV	Event Frequency per Day	1	event/day	-	Assumption	
				EF	Exposure Frequency	350	days/year	Default days spent at home	USEPA, 2014a	Where DA_{event} =
				ED	Exposure Duration	6	year	Default based on age range	USEPA, 2014a	
				BW	Body Weight	15	kg	Default child body weight	USEPA, 2014a	$DA_{event} = C_{soil} \times CF \times AF \times ABS_d$
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	2,190	day	365 days for 6 years	USEPA, 2014a	Source: RAGS Part E, Equation 3.11 and
				CF	Conversion Factor	1.0E-06	kg/mg	-		Equation 3.12 (USEPA, 2004)
		Adult	IR Site 6	CS	Chemical Concentration In Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Dermally Absorbed Dose (DAD)
			(0-2.0 feet and	AF	Adherence Factor	0.07	mg/cm^2-event	Default residential adult value	USEPA, 2014a	(mg/kg-day) from dermal is shown below
			0-6 feet)	AbF	Absorption Factor	chemical-specific	unitless	Chemical-Specific inputs in BHHRA	USEPA, 2004	
				SA	Available Skin Surface Area	6,032	cm^2	Default residential adult value	USEPA, 2014a	$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$
				EV	Event Frequency per Day	1	event/day	-	Assumption	
				EF	Exposure Frequency	350	days/year	Default days spent at home	USEPA, 2014a	Where DA_{event} =
				ED	Exposure Duration	20	years	Default based on 26 year residence in one location.	USEPA, 2014a	$DA_{event} = C_{soil} \times CF \times AF \times ABS_d$
				BW	Body Weight	80	kg	Default adult body weight	USEPA, 2014a	
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	7,300	day	365 days for 20 years	USEPA, 2014a	Source: RAGS Part E, Equation 3.11 and
				CF	Conversion Factor	1.0E-06	kg/mg	-		Equation 3.12 (USEPA, 2004)
	Recreational	Child	IR Site 6	CS	Chemical Concentration In Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Dermally Absorbed Dose (DAD)
	Visitor	(0-6 years)	(0-2.0 feet and	AF	Adherence Factor	0.2	mg/cm^2-event	Default residential child value	USEPA, 2014a	(mg/kg-day) from dermal is shown below
			0-6 feet)	ABS_d	Absorption Factor	chemical-specific	unitless	Chemical-Specific inputs in BHHRA	USEPA, 2004	
				SA	Available Skin Surface Area	2,373	cm^2	Default residential child value	USEPA, 2014a	$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$
				EV	Event Frequency per Day	1	event/day	-	Assumption	
				EF	Exposure Frequency	75	days/year	Default for recreator assumed by RAIS	RAIS, 2013	Where DA_{event} =
				ED	Exposure Duration	6	year	Default based on age range	Assumption	
				BW	Body Weight	15	kg	Default child body weight	USEPA, 2014a	$DA_{event} = C_{soil} \times CF \times AF \times ABS_d$
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years x 365 days)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	2,190	day	Exposure duration (6 years x 365 days)	USEPA, 2014a	Source: RAGS Part E, Equation 3.11 and
				CF	Conversion Factor	1.0E-06	kg/mg	-		Equation 3.12 (USEPA, 2004)

Table 5-1: Exposure Assumption Values Used For Daily Intake Calculations (RAGS D: Table 4): Reasonable Maximum Exposure - Soil (0-2.0 feet and 0-6 feet)

Scenario Timeframe: Current/Future
Medium: Soil (0-2 feet and 0-6 feet)
Exposure Medium: Soil (0-2 feet and 0-6 feet)

Exposure Route	Receptor	Receptor Age	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Location	Reference	Intake Equation / Model Name
Dermal Contact Cont.	Recreational Visitor	Adolescent/ Adult (6-26 years)	IR Site 6 (0-2.0 feet and 0-6 feet)	CS	Chemical Concentration In Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Dermally Absorbed Dose (DAD)
				AF	Adherence Factor	0.07	mg/cm²-event	Default residential adult value	USEPA, 2014a	(mg/kg-day) from dermal is shown below
				ABS_d	Absorption Factor	chemical-specific	unitless	Chemical-Specific inputs in BHHRA	USEPA, 2004	
				SA	Available Skin Surface Area	6,032	cm^2	Default residential adult value	USEPA, 2014a	$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$
				EV	Event Frequency per Day	1	event/day	-	Assumption	
				EF	Exposure Frequency	75	days/year	Default for recreator assumed by RAIS	RAIS, 2013	Where DA_{event} =
				ED	Exposure Duration	20	year	Default based on age range	Assumption	
				BW	Body Weight	80	kg	Default adult body weight	USEPA, 2014a	$DA_{event} = C_{soil} \times CF \times AF \times ABS_d$
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years x 365 days)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	7,300	day	Exposure duration (20 years x 365 days)	USEPA, 2014a	Source: RAGS Part E, Equation 3.11 and
				CF	Conversion Factor	1.0E-06	kg/mg	-		Equation 3.12 (USEPA, 2004)
	Construction Worker	Adult	IR Site 6 (0-6 feet)	CS	Chemical Concentration In Soil	95% UCL	mg/kg	EPC Calculations in BHHRA	USEPA, 2002b	The equation for Dermally Absorbed Dose (DAD)
				AF	Adherence Factor	0.8	mg/cm²-event	Construction Worker Value	CalEPA, 2019	(mg/kg-day) from dermal is shown below
				ABS_d	Absorption Factor	chemical-specific	unitless	Chemical-Specific inputs in BHHRA	USEPA, 2004	
				SA	Available Skin Surface Area	6,032	cm^2	Default worker value	CalEPA, 2019	$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$
				EV	Event Frequency per Day	1	event/day	-	Assumption	
				EF	Exposure Frequency	250	days/year	Default worker exposure frequency	USEPA, 2014a	Where DA_{event} =
				ED	Exposure Duration	1	year	Excavation assumed to take place within one year	Assumption	
				BW	Body Weight	80	kg	Default adult body weight	USEPA, 2014a	$DA_{event} = C_{soil} \times CF \times AF \times ABS_d$
				AT-C	Averaging Time (Cancer)	25,550	day	Lifetime (70 years x 365 days)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	365	day	Exposure duration (1 year x 365 days)	Assumption	Source: RAGS Part E, Equation 3.11 and
				CF	Conversion Factor	1.0E-06	kg/mg	-		Equation 3.12 (USEPA, 2004)

Prepared by: ARQ 11/4/20
Checked by: ST 11/18/20
Revised by: ARQ 1/25/21 & 11/30/21

Definitions and Notes:

95% UCL - The 95 percent Upper Confidence Limit of the mean concentration, which equals or exceeds the true mean with 95 percent confidence.
BHHRA - Baseline Human Health Risk Assessment.
cm^2 - square centimeters
kg - kilograms
mg/cm^2-event - milligram/centimeter squared per event.
mg/kg - milligram/kilogram
[a] - Relative Bioavailability in soil is 100% for all compounds anticipated to be evaluated in the BHHRA.

References:

California Environmental Protection Agency (CalEPA), 2019. Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities. DTSC Office of Human and Ecological Risk (HERO), HERO HHRA Note Number: 1. April 9.
RAIS, 2013. The Risk Assessment Information System (RAIS), 2013, RAIS Preliminary Remediation Goals (PRGs) for Chemicals User’s Guide. Oak Ridge National Laboratory.
USEPA, 1989. Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health Evaluation Manual (Part A): EPA/540/1-89/002.
USEPA, 2002a. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." OSWER 9355.4-24. December.
USEPA, 2002b. "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10.
USEPA, 2004. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.
USEPA, 2012. Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil and recommendations for Default Value for Relative Bioavailability of Arsenic in Soil Documents. OSWER 9200.1-113. Washington, D.C. December 31, 2012.
USEPA, 2014a. OSWER Directive 9200.1-120. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. Attachment 1. Recommended Default Exposure Factors.

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Table 5-2: Exposure Assumption Values Used For Daily Intake Calculations (RAGS D: Table 4): Reasonable Maximum Exposure - Groundwater

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Water pooling in an excavation

Exposure Route	Receptor	Receptor Age	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Table	Reference	Intake Equation / Model Name
Ingestion	Construction Worker	Adult	IR Site 6	CW	Chemical Concentration in Groundwater	Maximum	mg/L	Professional judgment	-	The calculation for Intake is shown below:
				IR	Ingestion Rate	0.011125	L/day	1/10th the amount ingested while swimming for an adult, upper bound estimate of 0.11125 L/hr as average ingestion rate for age 6-26 (Table 3-7; USEPA, 2019).	Assumption	$Intake=\frac{CW\times IR\times EF\times ED}{BW\times AT}$
				EF	Exposure Frequency	250	days/year	Default worker exposure frequency	USEPA, 2014a	
				ED	Exposure Duration	1	year	Excavation assumed to take place within one year	Assumption	
				BW	Body Weight	80	kg	Default adult body weight	USEPA, 2014a	
				AT-C	Averaging Time (Cancer)	25,550	days	Lifetime (70 years x 365 days)	USEPA, 2014a	
				AT-N	Averaging Time (Non-Cancer)	365	days	Excavation assumed to take place within one year	USEPA, 2014a	Source: RAGS Part A, Exhibit 6-11 (USEPA, 1989)

Definitions:

Prepared by: ARQ 11/4/20
Checked by: ST 11/18/20

95% UCL - The 95 percent Upper Confidence Limit of the mean concentration, which equals or exceeds the true mean with 95 percent confidence.

BHHRA - Baseline Human Health Risk Assessment.

mg/cm^2-event - milligram/centimeter squared per event.

References:

USEPA, 1989. Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health Evaluation Manual (Part A): EPA/540/1-89/002.

USEPA, 2014a. OSWER Directive 9200.1-120. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. Attachment 1. Recommended Default Exposure Factors.

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Appendix A:
Sampling and Analysis Plan

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Naval Facilities Engineering Systems Command

Naval Facilities Engineering Systems Command
Southwest
Base Realignment and Closure
Program Management Office West
San Diego, CA

Appendix A:

Final

Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan)

Phase I Remedial Investigation for Per- and Polyfluoroalkyl Substances at Installation Restoration Site 6

Former Naval Station Treasure Island
San Francisco, California

March 2022

Naval Facilities Engineering Systems Command Southwest
Base Realignment and Closure
Program Management Office West
San Diego, California

Appendix A

Final

Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan)

Phase I Remedial Investigation for Per- and Polyfluoroalkyl Substances at Installation Restoration Site 6

Former Naval Station Treasure Island, San Francisco, California

March 2022

DCN: Multi-MAC-4010-5451-0006

Prepared for:
United States Department of the Navy
Naval Facilities Engineering Systems Command Southwest
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Contract Number: N62470-19-D-4010; Task Order No. N6247320F5451

SAP Worksheet# 1 Title and Approval Page

FINAL

SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)

Phase I Remedial Investigation for Per- and Polyfluoroalkyl Substances at Installation Restoration Site 6

Former Naval Station Treasure Island, San Francisco, California

March 2022

Prepared for:

UNITED STATES DEPARTMENT OF THE NAVY
Naval Facilities Engineering Systems Command Southwest
Base Realignment and Closure Program Management Office West
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Executive Summary

This Sampling and Analysis Plan (SAP) for a Phase I Remedial Investigation (RI) for Per- and Polyfluoroalkyl Substances (PFAS) at Installation Restoration (IR) Site 6 at former Naval Station Treasure Island (NSTI) has been prepared by Multi-MAC Joint Venture (Multi-MAC JV), a joint venture of Wood Environment & Infrastructure Solutions, Inc. and Nicklaus Engineering, Inc. The RI will be conducted in two phases: onshore (Phase I) and offshore (Phase II). The soil and groundwater sampling activities described in this Work Plan constitute Phase I. A Phase II RI will be conducted after completion of the Phase I RI as needed.

The objectives of this project are to determine whether the presence of PFAS in soil and groundwater present an unacceptable risk to site users and ecological receptors. The Phase I RI consists of collecting sufficient soil and groundwater analytical data to define the nature and extent of potential impacts by PFAS at the site, performing a baseline Human Health Risk Assessment (HHRA), and evaluating groundwater analytical data against appropriate ecological screening criteria. This work is being performed under Naval Facilities Engineering Systems Command Southwest (NAVFAC SW) Base Realignment and Closure (BRAC) Program Management Office (PMO) West Contract Number N62470-19-D-4010, Task Order N6247320F5451.

This SAP details the approach for characterizing the nature and extent of PFAS in soil and groundwater at IR Site 6, the Former Fire Training School. Soil and groundwater samples will be collected and analyzed for perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorobutanesulfonic acid (PFBS) by liquid chromatography/tandem mass spectrometry (LC/MS-MS) compliant with the United States Department of Defense (DoD) *Quality Systems Manual (QSM), Version 5.3*, Table B-15. In addition to PFOA, PFOS, and PFBS, for the analyses will include 15 additional PFAS, which are currently included in the full compound list under United States Environmental Protection Agency (U.S. EPA) Method 537.1:

- N-ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
- N-methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
- Hexafluoropropylene oxide dimer acid (HFPO-DA)
- 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
- 9-chlorohexadecafluoro-3-oxanone -1-sulfonic acid (9Cl-PF3ONS)
- 4,8-dioxa-3H-perfluorononanoic acid (ADONA)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluorohexanoic acid (PFHxA)
- Perfluorononanoic acid (PFNA)
- Perfluorotetradecanoic acid (PFTeDA)
- Perfluorotridecanoic acid (PFTrDA)

- Perfluoroundecanoic acid (PFUnA)
- Perfluorodecanoic acid (PFDA)
- Perfluorododecanoic acid (PFDoA)

The Phase I RI for PFAS will include collection of environmental media samples (including quality control samples) for laboratory analysis as follows:

- Advance 30 soil borings and 15 new monitoring wells and collect soil samples to define the nature of extent of PFAS in soil.
- Develop 15 groundwater monitoring wells and collect groundwater samples from the 15 new wells and 9 existing monitoring wells to define the nature and extent of PFAS in groundwater.
- Evaluate detected PFAS concentrations against the current DoD screening and other applicable criteria.

The PFAS sampling objectives are addressed in the data quality objectives (DQOs) in Worksheet #11 of this SAP.

The site-specific sampling locations were chosen based on the preliminary conceptual site models (CSMs) presented in Worksheet #10 of this SAP. The preliminary CSMs were developed by reviewing available existing data, published documents, and historical photographs, and interviewing site personnel, as documented in the *2017 Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21 and 24* (NOREAS, Inc., 2019), *the Second Five-Year Review* (Adanta, Inc., 2020), and the *Preliminary Assessment (PA) Report for Basewide Investigation of Per- and Polyfluoroalkyl Substances, Former Naval Station Treasure Island, San Francisco, Californi*a (Multi-MAC Joint Venture, 2020). The detailed rationale for the sampling locations is presented in Worksheet #17 of this SAP.

Only the sampling results for PFBS, PFOA, and PFOS will be evaluated for site management decisions with respect to human health because there are currently no promulgated State of California comparison criteria or general criteria for the other PFAS in the analytical group. However, all sampling results will be documented in the Phase I RI Report.

A memorandum issued by the DoD in 2021 addressing PFAS in soil and groundwater within the Defense Environmental Restoration Program (DERP) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (DoD, 2021) is the source of the screening values for PFOS, PFOA and PFBS. Screening levels for PFOA and PFOS were calculated using the U.S. EPA online calculator on April 6, 2018, and screening values for PFBS were taken from the U.S. EPA regional screening level (RSL) table (DoD, 2021; U.S. EPA, 2021).

In addition, on December 19, 2019, U.S. EPA published a guidance document for interim recommendations for addressing groundwater impacted with PFOA and/or

PFOS. The guidance document recommends that sites should be screened on the basis of a target hazard quotient of 0.1 for PFOA or PFOS individually, which is currently 0.04 microgram per liter (µg/L) (i.e., site groundwater concentrations should be compared with one-tenth of the calculated tapwater RSL of 0.4 µg/L for PFOS or PFOA, which works out to 0.04 µg/L). The reason for selecting a target hazard quotient of 0.1 (i.e., one-tenth of the acceptable concentration for noncancer effects) is to protect against the possible co-occurrence in groundwater of multiple PFAS and other chemicals with similar or additive health effects. In addition, it recommends that the U.S. EPA lifetime health advisory (LHA) of 0.07 µg/L be used as the preliminary remediation goal for groundwater that is a current or potential source of drinking water where no state or tribal maximum contaminant level or other applicable or relevant and appropriate requirements are available or sufficiently protective (U.S. EPA, 2019). Groundwater at IR Site 6 is not currently a source of drinking water. For soil, a screening level of 0.13 milligram per kilogram (mg/kg) will be used for PFOA and PFOS, and a screening level of 1.9 mg/kg will be used for PFBS. Analytical results will be provided, in full, as part of the Phase I RI Report that will be prepared at the conclusion of this investigation.

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SAP Worksheets

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Abbreviations and Acronyms

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
µg/L	microgram(s) per liter
µS	microSiemen(s)
%R	percent recovery

A	analysis or average ratio
ADONA	4,8-dioxa-3H-perfluorononanoic acid
AFFF	aqueous film-forming foam
AHA	Activity Hazard Analysis
amu	atomic mass unit
APP	Accident Prevention Plan
AST	aboveground storage tank
ASTM	ASTM International

BCT	Base Closure Team
BEC	Base Realignment and Closure Environmental Coordinator
bgs	below ground surface
BRAC	Base Realignment and Closure
bss	below sediment surface

CA	corrective action
Caltrans	California Department of Transportation
CAM	California Administrative Manual
CAS	Chemical Abstracts Service
CCV	continuing calibration verification
CD3	Contaminant Data Display & Download
CDWR	California Department of Water Resources
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIH	Certified Industrial Hygienist
11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid
9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid
COC	chain of custody
COR	Contracting Officer Representative
CPR	cardiopulmonary resuscitation
CQCP	Contractor Quality Control Plan
CSM	conceptual site model
CSO	Contractor Support Office

Abbreviations and Acronyms (continued)

DCN	document control number
DEP	depth
DERP	Defense Environmental Restoration Program
DL	detection limit
DO	dissolved oxygen
DoD	United States Department of Defense
DOL	United States Department of Labor
DON	United States Department of the Navy
DOT	United States Department of Transportation
DQI	data quality indicator
DQO	data quality objective
DTSC	California Environmental Protection Agency, Department of Toxic Substances Control
DUP	duplicate
EB	equipment blank
EDD	electronic data deliverable
EIS	extracted internal standard
ELAP	Environmental Laboratory Accreditation Program
ERA	Ecological Risk Assessment
ERRG	Engineer/Remediation Resources Group, Inc.
ESV	environmental screening value
EtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
EWI	Environmental Work Instruction
FB	field blank
FEAD	Facilities Engineering and Acquisition Division
FTS	fluorotelomer sulfonic acid
GIS	geographic information system
GW	groundwater
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HERO	Human and Ecological Risk Office
HFPO-DA	hexafluoropropylene oxide dimer acid
HHRA	Human Health Risk Assessment

Abbreviations and Acronyms (continued)

HPLC/MS/MS	high-performance liquid chromatography and tandem mass spectrometry
H&S	health and safety
ICAL	initial calibration
ICV	initial calibration verification
ID	identification
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
IR	Installation Restoration
ISC	instrument sensitivity check
J	value estimated between the detection limit (method detection limit) and the limit of detection (reporting limit)
LC	liquid chromatography
LCL	lower control limit
LC/MS-MS	liquid chromatography/tandem mass spectroscopy
LCS	laboratory control sample
LCSD	laboratory control duplicate
LDC	Laboratory Data Consultants, Inc.
LHA	lifetime health advisory
LOD	limit of detection
LOQ	limit of quantitation
LRA	Local Redevelopment Authority
MB	method blank
MD	matrix duplicate
MeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
mg/kg	milligram(s) per kilogram
mL	milliliter(s)
MLLW	mean lower low water
mmHg	millimeter(s) of mercury
MS	matrix spike
MSD	matrix spike duplicate
MTRS	Meridian Township Range Section
Multi-MAC JV	Multi-MAC Joint Venture

Abbreviations and Acronyms (continued)

NA	not applicable or not available
NAVFAC	Naval Facilities Engineering Systems Command
NAVFAC SW	Naval Facilities Engineering Systems Command Southwest
NEDD	Navy Electronic Data Deliverable
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
NIRIS	Naval Installation Restoration Information Solution
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
NOAA	National Oceanic and Atmospheric Administration
NSTI	Naval Station Treasure Island
NTU	nephelometric turbidity unit(s)

OEA	Office of Economic Adjustment (DoD)
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration

PA	Preliminary Assessment
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnA	perfluoroundecanoic acid
PG	Professional Geologist
pH	potential of hydrogen
PID	photoionization detector
PLSS	Public Land Survey System
PM	Project Manager

Abbreviations and Acronyms (continued)

PMO	Program Management Office
POC	point of contact
PPE	personnel protective equipment
PQL	project quantitation limit
PRC	PRC Environmental Management, Inc.
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QCM	Quality Control Manager
QSM	Quality Systems Manual
RAB	Restoration Advisory Board
RF	response frequency
RI	Remedial Investigation
ROICC	Resident Officer In Charge of Construction
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	regional screening level
RT	retention time
RTC	response to comments
RWQCB	California Regional Water Quality Control Board, San Francisco Region
S	sampling
S&A	sampling and analysis
SAP	Sampling and Analysis Plan
SD	standard deviation
SERDP	Strategic Environmental Research and Development Program
SF	San Francisco
SFPUC	City of San Francisco Public Utilities Commission
Shaw	Shaw Environmental, Inc.
SI	Site Inspection
S/N	signal-to-noise ratio
SO	soil
SOP	standard operating procedure
SPE	solid-phase extraction

Abbreviations and Acronyms (continued)

SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
TBD	to be determined
TI	Treasure Island
TIDA	Treasure Island Development Authority
TO	Task Order
TOC	total organic carbon
TPH	total petroleum hydrocarbons
U	chemical not detected at or above indicated limit of detection value
UCL	upper control limit
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USCS	Unified Soil Classification System
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound
WE	work element
WMP	Waste Management Plan
Wood	Wood Environment & Infrastructure Solutions, Inc.
YBI	Yerba Buena Island
YYYYMMDD	year-month-day

SAP Worksheet# 2 SAP Identifying Information

Site Name/Number:	Former Naval Station Treasure Island (NSTI), San Francisco, California Installation Restoration (IR) Site 6
Operable Unit:	Not applicable (NA)
Contractor Name:	Multi-MAC Joint Venture (Multi-MAC JV) (a joint venture of Wood Environment & Infrastructure Solutions, Inc. [Wood] and Nicklaus Engineering, Inc.)
Contract Number:	N62470-19-D-4010, Task Order (TO) Number N6247320F5451
Contract Title:	Multi-MAC Engineering Support Services Contract
Work Assignment Number (optional):	NA
DCN:	MMAC-4010-5451-0006

This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP; Intergovernmental Data Quality Task Force [IDQTF], United States Environmental Protection Agency [U.S. EPA], 2005) and *EPA Guidance for Quality Assurance Project Plans*, (U.S. EPA, 2002).

This SAP was also prepared based on the requirements provided in the following documents:

- United States Department of Defense (DoD). 2019a. *Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.3.* May.
- DoD. 2019b. *General Data Validation Guidelines, Revision 1.* November.
- DoD. 2020. *General Data Validation Guidelines, Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by Quality Systems Manual Table B-15*. Environmental Data Quality Workgroup. May.
- DoD. 2021. *Memorandum: Investigating Per- and Polyfluoroalkyl Substances Within the Department of Defense Cleanup Program.* September 15.
- United States Department of the Navy (DON). 2009. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. October.
- DON. 2018. *Department of the Navy Environmental Restoration Program Manual.*

- DON. 2020b. *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for Naval Facilities Engineering Systems Command (NAVFAC) Remedial Project Managers (RPMs), November 2020 Update*. November 24.
- Naval Facilities Engineering Systems Command Southwest (NAVFAC SW). 2001. *Environmental Work Instruction (EWI) #1, Data Validation Guidelines for Chemical Analysis of Environmental Samples.* November.
- NAVFAC SW. 2010. *EWI #3, Selecting an Environmental Laboratory that Meets Environmental Restoration Program Requirements.* August.
- NAVFAC SW. 2011. *EWI #2, Review, Approval, Revision, and Amendment of SAPs.* January.
- NAVFAC SW. 2018. *EWI #4, Implementing and Maintaining the Environmental Records Management Program at NAVFAC SW.* September.
- NAVFAC SW. 2021. *EWI #6, Environmental Data Management and Required Electronic Delivery Standards*. November.
- U.S. EPA. 1988. *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Compliance with Other Laws Manual*, *Draft Guidance.* EPA/540/G-89/006. August.
- U.S. EPA. 2000. *Guidance for the Data Quality Objective (DQO) Process.* August.
- U.S. EPA. 2006. *Guidance on Systematic Planning Using the DQO Process.* EPA QA/G-4. EPA/240/B-06/001. February.
- U.S. EPA. 2019. *Interim Recommendation for Addressing Groundwater Contaminated with Perfluorooctanoic Acid (PFOA) and Perfluorooctane sulfonate (PFOS)*. December 19.

Identify regulatory program: CERCLA Installation Restoration Program

This SAP is specific to PFAS sampling and analysis at IR Site 6.

List dates of scoping sessions that were held:

- Scoping Session for PFAS Remedial Investigation (RI) on October 8, 2020

List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation:

- NOREAS, Inc. 2017. *Final Work Plan Basewide Groundwater and Soil Gas Monitoring at Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California*. May.

- NOREAS, Inc. 2020. *Field Change Request Form for Final Sampling and Analysis Plan, Basewide Groundwater and Soil Gas Monitoring at Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, CA*. (Document Control Number [DCN]: NRS-2018-0000-0001). FCRF-3180-03. September 2020.

List organizational partners (stakeholders) and connection with lead organization:

- California Regional Water Quality Control Board, San Francisco Region (RWQCB).
- California Environmental Protection Agency Department of Toxic and Substances Control (DTSC)

These agencies are state regulatory agency and are not connected to the DON or to NAVFAC SW. Documents are provided to the State in accordance with the requirements of CERCLA.

Lead organization (see Worksheet #7 for a detailed list of data users):

- Base Realignment and Closure (BRAC) Program Management Office (PMO) West

Any required SAP elements or required information that are not applicable to the project or are provided elsewhere are explained and noted in the crosswalk column of the table below.

- All worksheets are applicable, and none have been omitted.

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	
2	Table of Contents SAP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
Project Organization		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	
Project Planning/Problem Definition		
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background Site Maps (historical and present)	
11	Site-Specific Project Quality Objectives	
12	Measurement Performance Criteria Table	

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	
14	Summary of Project Tasks	
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	
18	Sampling Locations and Methods/SOP Requirements Table Sample Location Map(s)	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving, and Disposal Sample Handling Flow Diagram	
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain of Custody Form and Seal	
Quality Control Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	
Data Management Tasks		
29	Project Documents and Records Table	
30	Analytical Services Table Analytical and Data Management SOPs	
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	
32	Assessment Findings and Corrective Action Responses Table	
33	QA Management Reports Table	
D. Data Review		
34	Verification (Step I) Process Table	
35	Validation (Steps IIa and IIb) Process Table	
36	Validation (Steps IIa and IIb) Summary Table	
37	Usability Assessment	

Notes:
QA = quality assurance; QC = quality control; SAP = sampling and analysis plan; SOP = standard operating procedure;
UFP-QAPP = Uniform Federal Policy for Quality Assurance Project Plans

SAP Worksheet# 3 Distribution List

Name of SAP Recipient	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Dennis Parker	RPM	NAVFAC SW	(619) 524-5257	dennis.r.parker.ctr@us.navy.mil
David J. Clark	Lead RPM	NAVFAC SW	(619) 524-6870	david.j.clark9.civ@us.navy.mil
Adrianne Saboya	QAO	NAVFAC SW	(619) 705-5485	adrianne.v.saboya.civ@us.navy.mil
Izzat Amadea	ROICC	ROICC SF Bay	(510) 333-2621	izzat.s.amadea.ctr@us.navy.mil
Diane Silva	Administrative Record Manager	NAVFAC SW	(619) 556-1280	diane.c.silva.civ@us.navy.mil
Celina Hernandez	Project Manager	RWQCB	(510) 622-2447	Celina.Hernandez@Waterboards.ca.gov
Peyton Ward	Project Manager	DTSC	(510) 540-3798	Peyton.Ward@dtsc.ca.gov
Lansana Coulibaly	Project Manager	Multi-MAC JV	(858) 633-2795	lansana.coulibaly@woodplc.com
Matthew Brookshire	Program QCM	Multi-MAC JV	(858) 633-2793	matthew.brookshire@woodplc.com
Nick Breshears	Field Team Lead	Multi-MAC JV	(928) 304-2660	nbreshears@neiaw.com
Brad Closson	SSHO and Site Supervisor	Multi-MAC JV	(928) 919-1776	bclosson@neiaw.com
Kim Shiroodi	Project Chemist	Multi-MAC JV	(630) 506-1247	kimberly.shiroodi@woodplc.com
Elvin Kumar	Project Manager	SGS	(408) 612-9410	Elvin.Kumar@sgs.com
Pei Geng	Project Manager	LDC	(760) 827-1100	pgeng@lab-data.com

Notes:
DTSC = California Environmental Protection Agency Department of Toxic Substances Control; LDC = Laboratory Data Consultants, Inc.; Multi-MACJV = Multi-MAC Joint Venture; NAVFAC SW = Naval Facilities Engineering Systems Command Southwest; QAO = Quality Assurance Officer; QCM = Quality Control Manager; ROICC = Resident Officer in Charge of Construction; RPM = Remedial Project Manager; RWQCB = California Regional Water Quality Control Board, San Francisco Bay Region; SAP = Sampling and Analysis Plan; SF = San Francisco; SSHO = Site Safety and Health Officer

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SAP Worksheet# 4 Project Personnel Sign-Off Sheet

Name[1]	Organization/ Title/Role	Telephone Number (Optional)	Signature/E-mail Receipt[2]	SAP Section Reviewed	Date SAP Read
Lansana Coulibaly	Multi-MAC JV PM	(858) 633-2795		All Worksheets	
Nick Breshears	Field Team Lead	(928) 304-2660		All Worksheets	
Brad Closson	SSHO, Site Supervisor	(928) 919-1776		All Worksheets	
Elvin Kumar	SGS Project Manager	(408) 612-9410		Worksheets #15, 19, 23, 24, 25, 26, 28, 30, 34, 35, 36	
Pei Geng	LDC Project Manager	(760) 827-1100		Worksheets #1, 3, 12, 15, 19, 20, 22, 23, 24, 25, 28, 30, 34, 35, 36	

Notes:

1. Matthew Brookshire, Multi-MAC JV Quality Control Manager, and Joe Arlauskas, NAVFAC SW Quality Assurance Officer, have reviewed and approved this SAP; therefore, their names are not listed above in the project personnel sign-off worksheet.
2. A copy of the complete sign-off sheet will be maintained in the project file.

LDC = Laboratory Data Consultants, Inc.; Multi-MAC JV = Multi-MAC Joint Venture; PM = Project Manager; SAP = Sampling and Analysis Plan; SSHO = Site Safety and Health Officer

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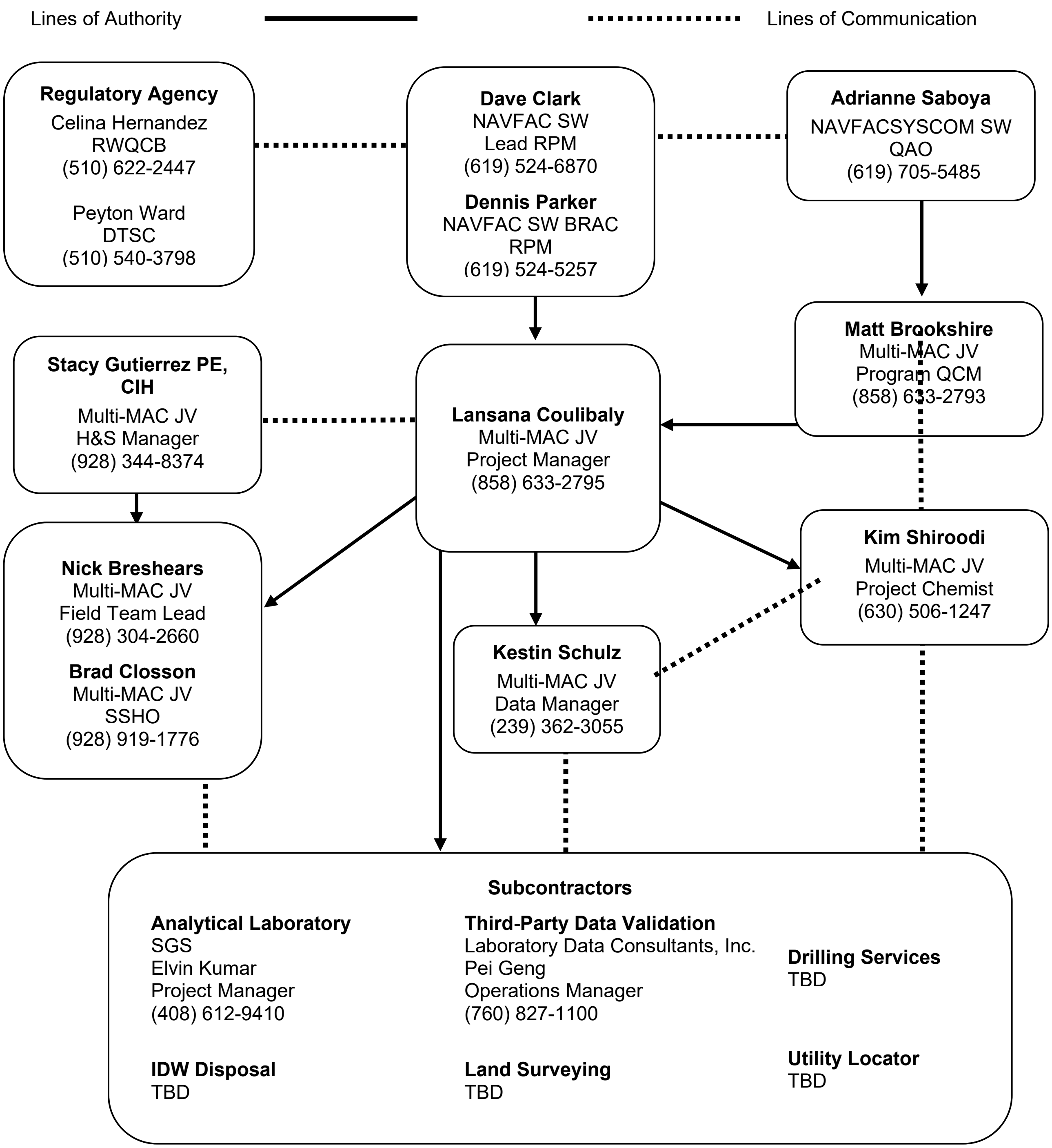
SAP Worksheet# 5 Project Organizational Chart



Acronyms:

CIH = Certified Industrial Hygienist DTSC = California Environmental Protection Agency Department of Toxic Substances Control; H&S = Health and Safety; IDW = investigation derived waste; LDC = Laboratory Data Consultants, Inc.; Multi-MAC JV = Multi-MAC Joint Venture; NAVFAC SW = Naval Facilities Engineering Systems Command Southwest; PE = Professional Engineer; QAO = Quality Assurance Officer; QCM = Quality Control Manager; RPM = Remedial Project Manager; RWQCB = California Regional Water Quality Control Board, San Francisco Region; SSHO = Site Safety and Health Officer; TBD = to be determined

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SAP Worksheet# 6 Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure (Timing, Pathway to and from, etc.)
SAP Amendments	Multi-MAC JV	Program QCM: Matt Brookshire	(858) 633-2793 matthew.brookshire@woodplc.com	The Multi-MAC JV QCM will submit all SAP amendments electronically to the NAVFAC SW QAO for review and approval prior to regulatory review and/or field implementation (see NAVFAC SW EWI #2). Major or significant changes will be documented in SAP amendments.
Field Change Request	Multi-MAC JV	PM: Lansana Coulibaly	(858) 633-2795 lansana.coulibaly@woodplc.com	The Multi-MAC JV PM will document any deviation from the SAP, including minor changes, by notifying the Multi-MAC JV QCM by telephone and e-mail within 24 hours (see NAVFAC SW EWI #2). The NAVFAC SW PM and QAO will be notified of field changes and of changes relating to site characterization that may entail a change in sampling location or analyses. The QAO must approve FCR before changes are implemented. All completed field changes will be documented in the final report.
Field Audit	Multi-MAC JV	Program QCM: Matt Brookshire	(858) 633-2793 matthew.brookshire@woodplc.com	The Multi-MAC JV QCM may conduct a field audit during project fieldwork. The audit report will be maintained in project and QA files. Any issues requiring corrective action will be documented and assigned an appropriate response period. Problems with data quality will be reported to the Multi-MAC JV PM by telephone and e-mail within 24 hours.

SAP Worksheet #6 Continued

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure (Timing, Pathway to and from, etc.)
Stop Work	Multi-MAC JV	PM: Lansana Coulibaly Program QCM: Matt Brookshire SSHO: Brad Closson	(858) 633-2795 lansana.coulibaly@woodplc.com (858) 633-2793 matthew.brookshire@woodplc.com (928) 919-1776 bclosson@neiaw.com	The Multi-MAC JV PM, QCM, SSHO, and/or the NAVFAC RPM, Acting QAO, or FEAD may stop work in response to any serious quality- or safety-related issue, if warranted. The PM will communicate work stoppages to the project organization and NAVFAC SW RPM by telephone and e-mail within 24 hours. If DON staff or an official site visitor note an unsafe condition, they can request that work be stopped temporarily to address the immediate condition. If the unsafe condition requires attention beyond a temporary work stoppage, an official Stop Work Order can be initiated through notification to the DON BRAC RPM, Lead RPM, and/or BEC, who will in turn notify the DON ROICC and Multi-MAC JV PM.
	BRAC PMO West/NAVFAC SW	RPM: Dennis Parker QAO: Adrianne Saboya ROICC: Izzat Amadea	(619) 524-5257 dennis.r.parker.ctr@us.navy.mil (619) 705-5485 adrianne.v.saboya.civ@us.navy.mil (510) 333-2621 izzat.amadea.ctr@navy.mil	
Reporting of H&S Issues	Multi-MAC JV	PM: Lansana Coulibaly	(858) 633-2795 lansana.coulibaly@woodplc.com	All H&S issues involving an injury, a “near miss,” or a condition that may result in an incident must be reported to the Multi-MAC JV H&S Manager and the Multi-MAC JV PM immediately. The PM will notify the NAVFAC SW PM of serious H&S incidents/issues within 24 hours of occurrence. Non-serious incidents/issues may be forwarded to the NAVFAC PM through the PM on a monthly basis via the monthly progress reports.
Sample Receipt Variances	SGS	Elvin Kumar	(408) 612-9410 Elvin.Kumar@sgs.com	The laboratory will notify the Multi-MAC JV project chemist via telephone and/or e-mail within 24 hours of sample receipt. The Multi-MAC JV project chemist will then notify Multi-MAC JV QCM and PM via telephone and/or e-mail.

SAP Worksheet #6 Continued

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure (Timing, Pathway to and from, etc.)
Laboratory Quality Control Variances	SGS	Elvin Kumar	(408) 612-9410 Elvin.Kumar@sgs.com	The laboratory will notify the Multi-MAC JV project chemist and QCM via telephone and/or e-mail within 24 hours of identified variance(s). If quality control variances contradict the minimum requirements of the DoD Quality Systems Manual, then the Multi-MAC JV QCM and PM will contact NAVFAC SW PM via telephone and/or e-mail to discuss and receive approval for the variances within 7 days of the notice of variance.
Analytical Corrective Actions	Multi-MAC JV	Program QCM: Matt Brookshire	(858) 633-2793 matthew.brookshire@woodplc.com	The Multi-MAC JV QCM will respond to laboratory issues with corrective action(s) via telephone and/or e-mail (within 1 week of notification from the laboratory).
Regulatory Agency Interface	NAVFAC SW	RPM: Dennis Parker	(619) 524-5257 Dennis.r.parker.ctr@us.navy.mil	The RPM will inform the regulatory agencies of changes in project tasking, procedures, schedule, and budget. The RPM will inform the regulatory agencies of the need for any field change requests and work stoppages and will send them copies of the completed field change requests and work stoppage documentation for informational purposes.
Notification of Non-Usable Analytical Data	Multi-MAC JV	Program QCM: Matt Brookshire	(858) 633-2793 matthew.brookshire@woodplc.com	If significant problems are identified by the laboratory or the project team that impact the usability of the data (i.e., the data are rejected or the DQOs are not met), the Multi-MAC JV QCM and the PM will notify the DON Lead RPM by telephone and e-mail within 24 hours or the next business day.
Reporting Data Validation Issues	Multi-MAC JV	Program QCM: Matt Brookshire	(858) 633-2793 matthew.brookshire@woodplc.com	The Multi-MAC JV QCM will resolve data verification issues with the contract laboratory within one week of the issue being identified.

SAP Worksheet #6 Continued

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure (Timing, Pathway to and from, etc.)
Data Validation Corrective Actions	Multi-MAC JV	Program QCM: Matt Brookshire	(858) 633-2793 matthew.brookshire@woodplc.com	The Multi-MAC JV QCM will resolve data validation issues with the contract laboratory within one week of the issue being identified.
Data Review Corrective Actions	Multi-MAC JV	Program QCM: Matt Brookshire	(858) 633-2793 matthew.brookshire@woodplc.com	The Multi-MAC JV QCM will communicate necessary data review corrective actions with the contract laboratory via telephone and/or e-mail within one week of corrective actions.

Notes:

BEC = BRAC Environmental Coordinator; BRAC = Base Realignment and Closure; DoD = United States Department of Defense; DON = United States Department of the Navy; DQO = data quality objective; EWI = Environmental Work Instruction; FEAD = Facilities Engineering and Acquisition Division; H&S = Health and Safety; Multi-MAC JV = Multi-MAC Joint Venture;
NAVFAC SW = Naval Facilities Engineering Systems Command Southwest; PG = Professional Geologist (California); PM = Project Manager; PMO = Program Management Office;
QA = Quality Assurance; QAO = Quality Assurance Officer; QCM = Quality Control Manager; ROICC = Resident Officer In Charge of Construction; RPM = Remedial Project Manager;
SAP = Sampling and Analysis Plan; SSHO = Site Safety and Health Officer

SAP Worksheet# 7 Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Dave Clark	Lead RPM	NAVFAC SW	• Serves as the project management representative for NAVFAC SW. • Verifies that work is accomplished as required by project scope of work. • Oversees project cost and schedule. • Serves as the lead interface between agencies involved.
Dennis Parker	RPM	BRAC	• Verifies that work is accomplished as required by project scope of work. • Oversees project cost and schedule. • Interfaces with Multi-MAC JV staff. • Serves as the interface between agencies involved.
Adrianne Saboya	QAO	NAVFAC SW	• Reviews and approves SAP for compliance with NAVFAC SW and UFP-QAPP requirements. • Provides DON oversight of Multi-MAC JV's QA Program. • Provides technical and administrative oversight of Multi-MAC JV's surveillance audit activities. • Serves as point of contact for QA and the DON's Laboratory QA Program issues. • Coordinates training for improving the generation and maintenance of quality data. • Holds the authority to suspend project activities if QA requirements are not met.
Lansana Coulibaly	PM	Multi-MAC JV	• Coordinates work activities for the Multi-MAC JV and subcontractor personnel and ensures that field activities are being performed in accordance with the Work Plan, SAP, and AHA. • Promotes a safe work environment for all project personnel by applying work guidelines as specified in the AHA and all applicable OSHA regulations. • Oversees project, financial, schedule, and technical day-to-day management of the project. • Assists appropriate NAVFAC SW technical personnel in decision making when necessary. • Serves as representative of internal PFAS Work Group on PFAS assigned to this project. • Serves as a technical resource to project team and stakeholders. • Reviews technical elements specific to PFAS.

SAP Worksheet #7 Continued

Name	Title/Role	Organizational Affiliation	Responsibilities
Matt Brookshire	Program QCM	Multi-MAC JV	• Ensures that project-specific SAP conforms to current NAVFAC SW and UFP-QAPP requirements. • Reviews and approves SAPs and work plans. • Communicates with PM and notifies PM of deviations from the SAP and nonconformance issues. • Coordinates field and laboratory QA and oversees field QA and project QA compliance. • Holds the authority to suspend project activities if QA requirements are not met.
Kim Shiroodi	Project Chemist	Multi-MAC JV	• Coordinates with the selected contracted laboratory. • Verifies appropriateness of sampling procedures, analytical methods, and laboratory quality systems. • Coordinates with the laboratory for field supplies, schedule, sample shipping, and deliverables. • Oversees data quality review and QA data validation deliverables.
Brad Closson	SSHO, Site Supervisor	Multi-MAC JV	• Ensures that all field activities are conducted in accordance with the SAP and AHA. • Provides direction to field staff and subcontractors.
Elvin Kumar	Project Manager	SGS	• Responsible for communication between the laboratory and Multi-MAC JV. • Ensures that the analysis is performed in accordance with specifications and meets the requirements of this SAP. • Reviews the laboratory data package before it is delivered to the Multi-MAC JV.
Pei Geng	Project Manager	LDC	• Conducts independent, third-party validation of analytical data received from the laboratory per this project-specific SAP. • Assures data end-users of known and documented data quality.

Notes:

AHA = Activity Hazard Analysis; DON = United States Department of Navy; LDC = Laboratory Data Consultants, Inc.; Multi-MAC JV = Multi-MAC Joint Venture; NAVFAC SW = Naval Facilities Engineering Systems Command Southwest; OSHA = Occupational Safety and Health Administration; PG = Professional Geologist (California); PFAS = per- and polyfluoroalkyl substances; PM = Project Manager; QA = quality assurance; QAO = Quality Assurance Officer; QCM = Quality Control Manager; RPM = Remedial Project Manager; SAP = Sampling and Analysis Plan; SSHO = Site Safety and Health Officer; UFP-QAPP = Uniform Federal Policy for Quality Assurance Project Plans

SAP Worksheet# 8 Special Personnel Training Requirements Table

All field personnel will be required to have completed the Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Emergency Response Operations (HAZWOPER) Standard Protection training described in Title 29 Code of Federal Regulations Section 1910.120, have completed the continued 8-hour HAZWOPER refresher training, and submit to annual medical surveillance, as required by OSHA. Field personnel who directly supervise employees engaged in hazardous waste operations will also receive at least 8 hours of specialized supervisor training. The supervisor training covers health and safety (H&S) program requirements, training requirements, personal protective equipment (PPE) requirements, the spill containment program, and health-hazard monitoring procedures and techniques. At least one of the onsite field personnel will maintain cardiopulmonary resuscitation (CPR) and standard first aid training certificates.

Safety requirements are addressed in detail in the Activity Hazard Analysis (AHA), prepared separately. Copies of certifications and training records for team members and supervisors will be kept in the Multi-MAC JV project file at the Multi-MAC JV Office, 9177 Sky Park Court, San Diego, California 92123.

The subcontractor laboratory selected for this project has successfully completed the laboratory evaluation process as described in the DoD *QSM Version 5.3* (DoD, 2019a). Copies of the current laboratory certifications are included in Attachment 1.

All field personnel will complete an internal training for staff conducting PFAS-related work. This training focuses on the unique aspects and best practices for sample collection, testing, and analysis for PFAS, consistent with the Multi-MAC JV SOPs (Attachment 2).

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SAP Worksheet# 9 Project Scoping Session Participants

9.1 Meeting Summary, October 8, 2020

Name	Role	Email
Base Realignment and Closure (BRAC) Program Management Office/Naval Facilities Engineering Systems Command Southwest (NAVFAC SW)		
Dennis Parker	Remedial Project Manager (RPM)	dennis.r.parker.ctr@us.navy.mil
Dave Clark	Lead RPM	david.j.clark9.civ@us.navy.mil
Tahirih Linz	BRAC Environmental Coordinator (BEC)	tahirih.p.linz.civ@us.navy.mil
Louie Cardinal	Contracting Officer Representative (COR)	rene.l.cardinale.civ@us.navy.mil
Izzat Amadea	Resident Officer in Charge of Construction (ROICC)	izzat.s.amadea.ctr@us.navy.mil
Doug Delong	Contractor Support Office (CSO)	douglas.delong.ctr@us.navy.mil
Multi-MAC JV		
Lansana Coulibaly	Project Manager	lansana.coulibaly@woodplc.com
Matt Brookshire	Program Quality Control Manager	matthew.brookshire@woodplc.com
Don McHugh	Senior Geologist	dmchugh@gce-pc.com
Rolf Schottle	Senior Aquatic Scientist	rolf.schottle@woodplc.com
Usha Vedagiri	Senior Risk Assessor	usha.vedagiri@woodplc.com
Tony Rodolakis	Ecological Risk Assessor	tony.rodolakis@woodplc.com
Amy Quintin	Human Health Risk Assessor	amy.quintin@woodplc.com
James Field	Senior Hydrogeologist	james.feild@woodplc.com
Stephen Campbell	Aquatic Scientist	stephen.campbell@woodplc.com

The kickoff meeting for the IR Site 6 PFAS RI was attended by the individuals listed above. The following meeting summary provides the information discussed by the BRAC PMO and Multi-MAC JV, as outlined in the meeting agenda.

I. Introductions

The kickoff meeting began with the introduction of all attendees.

a. BRAC PMO attendees: Dennis Parker (RPM), Dave Clark (Lead RPM), Tahirih Linz (BRAC Environmental Coordinator [BEC]), Louie Cardinale (Contracting Officer Representative [COR]), Izzat Amadea (Remedial Officer in Charge of Construction [ROICC]), and Doug Delong (Contractor Support Office [CSO])

b. Multi-MAC JV meeting attendees: Lansana Coulibaly (Project Manager [PM]), Rolf Schottle (Senior Aquatic Scientist), Matt Brookshire (Quality Control Manager [QCM]), Don McHugh (Senior Geologist), and Eric Gardner (Project Engineer)

c. Regulatory Agency Oversight: Mr. Parker identified the overseeing agencies, as follows:
   i. DTSC; lead agency: with input from California Department of Fish and Wildlife
   ii. RWQCB
   iii. The Treasure Island Development Authority (TIDA) may also provide input in the planning and reporting phase of the project

II. Scope of Work Overview

Mr. Coulibaly stated that the period of performance is 24 months from the TO award date of September 24, 2020, and the objective of the project is to perform an RI, including installation of new monitoring wells and subsurface trenches. Multimedia sampling will be performed in soil, groundwater, sediment, and pore water to delineate the vertical and lateral extent of PFAS at IR Site 6. Previous investigation results for PFAS at IR Site 6 will be incorporated with the results from the current investigation to conduct a baseline human health and ecological risk assessment to support site decisions.

III. Summary of Remedial Investigation Elements

Mr. Coulibaly described the planning documents to be prepared for this project: a Work Plan, SAP, Waste Management Plan (WMP), Contractor Quality Control Plan (CQCP), and Accident Prevention Plan (APP).

Mr. Coulibaly described the following field tasks scheduled to occur in 2021 following acceptance of the Final Work Plan by BRAC and the regulatory agencies:

a. Install up to 10 groundwater monitoring wells to supplement the existing monitoring wells onsite and the recently completed 13 Hydropunch™ locations sampled in June and September 2020 (data will be provided to Multi-MAC JV by the RPM as soon as they are available). All new wells will be installed with a screen across the water table (approximately 6 to 8 feet below ground surface [bgs]), developed, and surveyed. The groundwater sampling at each well will occur no sooner than 72 hours following well redevelopment to allow the aquifer to stabilize.

   Following sampling of the monitoring wells, a tidal study will be performed to estimate the tidal efficiency and lag time in selected locations to determine the overall groundwater flow direction and flow reversal and fluxes and to infer the hydraulic properties of the site. Although the practice was previously allowed, the RWQCB has publicly stated that they will no longer accept the use of generic dilution attenuation factors when evaluating the potential discharge of impacted groundwater to adjacent bay water. Direct measurement in the receiving water is proposed to reduce the significant uncertainties associated with model groundwater-surface water interaction.

b. Drill 20 shallow soil borings to a maximum depth of 6 to 8 feet bgs with two samples per boring: one at the surface (0 to 1 foot bgs) and one at depth (6 to 8 feet bgs). As many as 40 soil samples will be collected. Representative soil samples will be collected for geotechnical analysis to support the fate and transport evaluation of PFAS at IR Site 6. These geotechnical analyses include soil potential of hydrogen (pH), organic content, particle size distribution, density, and cation and anion exchange capacity.

c. Advance trenches of up to 100 linear feet to a maximum depth of 8 feet bgs and collect 10 soil samples inside the trenches to characterize PFAS in subsurface soil.

d. Because of the proximity of IR Site 6 to San Francisco Bay, collect and analyze sediment and pore water from 11 nearshore locations in the immediate vicinity of the site.

Mr. Coulibaly stated that all PFAS samples will be analyzed using liquid chromatography/tandem mass spectroscopy (LC/MS-MS) for 18 PFAS, and the results will be presented in the RI Report, along with the data validation report. The analytical data will be uploaded to the Naval Installation Restoration Information Solution (NIRIS).

IV. Summary of Project Work Elements

Work Element (WE) 1 – Project Management and Meetings. Mr. Coulibaly stated that this WE includes technical support, budget and schedule reviews and tracking, and attendance and presentations at three technical meetings with the RPM and up to two Base Closure Team (BCT) and two Restoration Advisory Board (RAB) meetings through the end of the period of performance. Weekly conference calls will occur with the RPM.

WE 2 – Work Plan

- **RI Work Plan, SAP, WMP, and CQCP.** Mr. Coulibaly stated that the internal draft Work Plan/SAP will be submitted for BRAC review, including by the DON Quality Assurance Officer (QAO) and regulatory agencies following the project schedule (see attached). Mr. Parker confirmed that a redline edit version of the draft document will be required in lieu of a separate draft final document.

- **Safety Document.** Mr. Coulibaly stated that draft and final versions of the APP, Site Safety and Health Plan (SSHP), and corresponding appendices will be reviewed by the DON only.

WE 3 – Field Investigation. Mr. Coulibaly reiterated that the fieldwork for this TO will include installation of 10 groundwater monitoring wells and 20 soil borings, installation of 100 feet of trenches on shore, and sediment and pore water sampling offshore. A tidal study will be performed. Ms. Linz inquired about the timing of the tidal study. Mr. Coulibaly indicated that the tidal study will be performed during the same field mobilization, at the completion of groundwater sampling. Investigation-derived waste (IDW) will be disposed of properly. All soil borings will be abandoned in accordance with well code and appropriate bentonite slurry. The trenches will be backfilled with clean fill meeting DTSC clean fill guidance.

WE 4 – RI Report. Mr. Coulibaly stated that the RI Report will be prepared in internal draft, draft, draft-final (electronic red-line), and final RI versions. The tidal survey will be included as an appendix in the RI Report.

The RPM inquired how ecological risk will be assessed given the emerging status of PFAS and the general lack of toxicity values. The Multi-MAC JV ecological risk assessor indicated that the DoD Strategic Environmental Research and Development Program (SERDP) has recently released a framework for ecological risk assessments for PFAS. Furthermore, toxicity data available from the Canadian and Australian regulatory agencies have been used recently to evaluate the ecological risk of PFAS.

WE 5 – Data Entry and NIRIS Support. Mr. Coulibaly stated that NIRIS data will be submitted at the conclusion of the project prior to closeout, unless otherwise requested. The contractual due date for submittal of NIRIS data is not specified in the contract.

V. SCHEDULE

Mr. Coulibaly stated that the attached project schedule is a draft and requested input from the team. Mr. Parker requested that the duration be revised to calendar date format. Ms. Linz requested that the delivery timeframe for the internal draft work plan be moved forward to the extent feasible to align with previous DON commitments to the regulatory agencies. A delivery date of November 18, 2020, was suggested by the DON, and Multi-MAC JV will look to optimize the proposed schedule. The revised project schedule will be attached to the meeting summary and will be updated frequently for RPM review.

VI. LOGISTICS

The RPM, Mr. Parker, is the primary point of contact (POC) for the BRAC PMO for this project. The DON ROICC, Mr. Amadea, is the POC for safety- and quality-related issues. The DON CSO, Mr. Delong, is the primary POC for fieldwork, and Multi-MAC JV will coordinate with him to obtain access to the site and select a suitable staging area.

Mr. Coulibaly is the primary POC for Multi-MAC JV. He will first speak with the RPM prior to contacting other members of the BRAC team. Mr. Cardinale is the COR and will be copied on contract and budget related communications.

VII. RESOURCES

Mr. Coulibaly indicated that several references have been received from the BRAC PMO, and other references were downloaded from NIRIS. He stated that references to the recent 2020 PFAS investigation planning document or report are not yet available to Multi-MAC JV.

Additionally, Multi-MAC JV is requesting access to source files, including geographic information system (GIS) files, as soon as possible to allow for the development of the planning document and formulating a sampling approach. These files include source files from the RI and remedial action completion report, as well as the recent 2020 PFAS sampling completed at IR Site 6. The RPM indicated that these resources will be provided as available.

VIII. OPEN DISCUSSION

Mr. Parker reiterated that the RWQCB is very interested in the PFAS investigation at the installation and has requested that investigation data be collected and presented in an expedient manner. Ms. Linz indicated that a BCT meeting is scheduled for November 18, 2020, and he anticipates that a discussion of the PFAS effort and proposed work plan will be presented.

Ms. Linz indicated that BRAC PMO indicated the delivery of the Final RI Work Plan in May 2021 to the regulatory agencies in accordance with the schedule of the most recent 5-year review report.

The discussion turned to the availability of PFAS in ambient bay water, sediment, and biota. Multi-MAC JV indicated that the San Francisco Estuary Institute and Aquatic Science Center recently published a bay-wide characterization of PFAS with detected concentrations of PFAS reported in the water, sediment, and biota tissue (San Francisco Estuary Institute, 2020).

IX. ACTION ITEMS

Mr. Coulibaly will provide the revised project schedule to the RPM for review.

Mr. Coulibaly will provide the draft meeting summary to the team for review and comment.

Mr. Parker will provide source files of the references discussed in Section VIII to the Multi-MAC JV team in a timely manner to allow the preparation of the planning documents.

The RPM will inform Multi-MAC JV of new DON Guidance and Policy on the use of PFAS screening values at DON facilities.

Meeting adjourned at 1210.

9.2 DON and Regulatory Agencies Technical Meetings

During the preparation of the internal draft work plan and prior to submittal of the document for review by the regulatory agencies, the DON organized a “storyboard” meeting to provide advanced information of the proposed scope of work on November 12, 2020. The DON presented the sampling plan, planned media to be sampled, and approach to the human health and ecological risk assessments. Regulatory agency participants included the technical team from DTSC, including its sister agencies, the RWQCB and TIDA.

Following the review of the draft work plan by the regulatory agencies, the DON prepared responses to comments (RTCs) received from the agencies and organized a series of technical meetings to discuss the comments. The dates and participants for these meetings are as follows:

- September 16, 2021 – DON, DTSC, and RWQCB
- October 18, 2021 – DON, DTSC, and RWQCB
- October 25, 2021 – DON, DTSC, and RWQCB
- October 28, 2021 – DON and DTSC with Human and Ecological Risk Office (HERO) Division
- November 9, 2021 – DON, DTSC, and RWQCB
- November 17, 2021 – DON, DTSC, and RWQCB

The details of these technical meetings are summarized in the RTCs (Appendix D of the work plan) as follow-up comments provided by the regulatory agencies and responses provided by the DON.

SAP Worksheet# 10 Conceptual Site Model and Problem Definition

The location of former NSTI and the area that will be investigated as part of the Phase I RI are shown on Figure A-1.

This worksheet presents the conceptual site model (CSM) for PFAS released by activities at IR Site 6 and the methods for their potential impacts on media. This worksheet also summarizes the environmental problem to be addressed by the project DQOs presented in Worksheet #11.

10.1 Installation Description

Former NSTI is located in San Francisco Bay, midway between San Francisco and Oakland within the City and County of San Francisco. It consists of two adjacent islands: Yerba Buena Island (YBI) and the man-made Treasure Island (TI), connected by a causeway (Figure A-1). The land mass of the northern island, TI, encompasses approximately 403 acres, and the land mass of the southern island, YBI, encompasses approximately 147 acres (NOREAS, Inc., 2019). Additionally, more than 527 acres of submerged lands within San Francisco Bay surrounding the two islands are also part of the former NSTI (DON, 2020a).

10.1.1 Installation History and Use

TI was constructed on the Yerba Buena Shoals north and northwest of YBI from 1936 to 1937 under the direction of the United States Army Corps of Engineers (USACE). TI consists primarily of sediments dredged from San Francisco Bay that were placed within a retaining wall of rock and sand dikes. TI was originally constructed for the 1939 Golden Gate International Exposition World’s Fair (NOREAS, Inc., 2019). The DON acquired it by condemnation in 1942 (Trevet, 2016).

Military activities in the area date back to 1866 when the United States Government took possession of YBI for defensive fortifications. The DON operated the first West Coast Naval Training Station on YBI until 1923, when the center was transferred to the City of San Francisco. YBI continued to function as a Naval Receiving Station until World War II, when naval operations were transferred to TI. In response to a DON request in 1941, the City of San Francisco leased TI to the DON for the duration of World War II. The island became a major naval facility, processing approximately 12,000 military personnel per day for service overseas and upon their return to the United States (Trevet, 2016). It was used primarily to provide training, administration, housing, and other support services to the United States Pacific Fleet. In 1993, the Defense BRAC Commission recommended the closure of NSTI. The facility was subsequently closed on September 30, 1997 (NOREAS, Inc., 2019).

The DoD Office of Economic Adjustment (OEA) designated San Francisco as the Local Redevelopment Authority (LRA) for former NSTI in May 1994. In 1997, the California State Legislature created a special reuse authority for former NSTI, transferring the LRA status from San Francisco to the TIDA. TIDA is a state agency staffed by the San Francisco mayor's office and is the entity responsible for planning the reuse and redevelopment of the former installation (Trevet, 2016). TIDA is a nonprofit, public benefit agency dedicated to the economic development of former NSTI. The authority is vested with the right to administer Tidelands Trust property. TIDA is also responsible for administering vital municipal services to TI and YBI (TIDA, 2020). Former NSTI is now part of District 6 of the City and County of San Francisco (Villages at Treasure Island, 2020), and public utilities such as water, wastewater, and power are provided by the City of San Francisco Public Utilities Commission (SFPUC) (TIDA, 2020). The DON has transferred over 80 percent of the property at former NSTI to TIDA (DON, 2020a).

In addition to TIDA, there have been property transfers to federal entities. The United States Department of Labor (DOL) operates a Job Corps Center in the central portion of TI (Adanta, Inc., 2019). The United States Coast Guard (USCG), Sector San Francisco, operates on USCG-owned property on the southeastern portion of YBI, of which slightly more than half is submerged (DON, 2020a). The DON owned the property comprising the area beneath the San Francisco Bay Bridge on YBI until 2000, when the Federal Highway Administration obtained the bridge right-of-way and subsequently transferred it to the California Department of Transportation (Caltrans). All areas on YBI have been transferred (Adanta, Inc., 2019). Of the total 1,077.6 acres at former NSTI, 948.6 acres (88 percent) have been transferred, and 129 acres remain under DON custody and control and have yet to be transferred to TIDA.

IR Site 6 was used from 1944 to 1992 for various firefighting training activities. The Former Fire Training School at IR Site 6 included a central training yard where training fires were ignited within various buildings and facilities. Most of IR Site 6 is presently unpaved because recent remedial actions have removed most of the paving at the site (DON, 2020c). The site features present during the operational period of the training school are presented on Figures A-2 and A-3. The use of aqueous film-forming foam (AFFF) at IR Site 6 has been documented. An AFFF Station was located in the northern boundary of the central training areas adjacent to the V-ditch collector trench (Harding Lawson Associates, 1987). The Preliminary Assessment (PA) at former NSTI (Multi-MAC JV, 2020) evaluated IR Site 6, the Former Fire Training School, to determine its potential to have released PFAS to the environment from the use of AFFF during training activities and recommended further PFAS investigation.

10.2 Topography and Climate

Treasure Island is topographically flat, ranging from 12 to 15 feet above the mean lower low water (MLLW) level (NOREAS, Inc., 2019). The soil at former NSTI consists primarily of sand dredged from San Francisco Bay and the Sacramento-San Joaquin Delta and retained by a perimeter of rock and sand dikes. All land above sea level and extending to a depth of approximately 10 to 50 feet below sea level is composed of fill.

The climate of former NSTI can be defined as "Mediterranean with cool summers." Both the winter temperatures and the rainfall pattern are typical of the Mediterranean climate, but summers are unusually cool because the cold current that flows along the coast of California causes fog in San Francisco Bay and functions as a natural air conditioner for the city and the surrounding areas (Climates to Travel, 2020).

Records indicate that the temperatures in the former NSTI area range from an average low of 46 degrees Fahrenheit (°F) in December and January to a high of 70°F in September. Annual rainfall averages 24 inches, with monthly totals ranging from 0 inches in the summer (July) to 4.56 inches in the winter (December). The prevailing winds of San Francisco Bay Area are from a westerly direction. Winds are approximately 4 miles per hour; June is the windiest month each year with an average of 6 miles per hour. Heavy fogs occur on an average of 21 days per year (The Weather Company, 2020).

10.3 Geology

TI was constructed from sandy sediments dredged from San Francisco Bay and placed within a retaining wall of rock and sand dikes. Dredging and construction of the island, as directed by the USACE, began in 1936 and was completed in 1937. The island was constructed on the Yerba Buena Shoals, a spit of sand that extended north and northwest of naturally occurring YBI (NOREAS, Inc., 2019).

Subsurface materials at TI can be divided into the following four geologic units, listed from youngest (shallowest) to oldest (deepest) (NOREAS, Inc., 2019):

- Fill and Shoal Sands (dredged sand fill and Yerba Buena Shoal sands)
- Younger Bay Mud
- Older Bay Mud
- Franciscan Assemblage

10.3.1 Fill and Shoal Sands

Dredged sediments used to construct TI consisted primarily of fine- to coarse-grained sand with lesser amounts of silt, clay, and gravel (Figure A-4). The dredged sand included some shell fragments and clay nodules. The clay nodules were derived from clay beds within the sediment, excavated by dredging, and rounded as they passed through the delivery pipeline. Thin beds of clay occasionally developed as finer materials in the dredged sand fill settled out during fill operations (NOREAS, Inc., 2019).

10.3.2 Younger Bay Mud

Underlying the Yerba Buena Shoal and fill sands are Younger Bay Mud sediments of marine origin that consist of soft to stiff, olive-gray silty clay and clay with interbedded sand and silt layers in some areas. Younger Bay Mud sediments range from approximately 10 to 120 feet thick (Figure A-5 and A-6). These sediments are thinnest on the eastern portion of the island and thicken toward the northwestern portion of the island (NOREAS, Inc., 2019).

10.3.3 Older Bay Mud

Underlying the Younger Bay Mud sediments are the Older Bay Mud sediments, which consist of stiff to very stiff, sandy and silty clays that extend to the Franciscan Assemblage bedrock. The Older Bay Mud sediments, ranging from approximately 20 to 170 feet thick (Figure A-5 and A-6), are thinnest on the southern portion of the island and thicken toward the northern portion of the island (NOREAS, Inc., 2019).

10.3.4 Franciscan Assemblage

Underlying the Older Bay Mud sediments is bedrock of the Franciscan Assemblage, which consists of interbedded shales and sandstone. Observations from borings that penetrated bedrock on the northwestern portion of TI indicate that the estimated depth to the Franciscan Assemblage ranges from 150 to 320 feet bgs. Depths are shallowest on the southern portion of the island and deepest toward the northern portion of the island (Geomatrix Consultants, Inc., 1990).

10.4 Hydrogeology

The dredged material and shoal sands used to construct TI act as an unconfined aquifer with an average depth to the water table of 5.6 feet bgs. Perched groundwater may exist locally above the shallow water table because of the presence of silt and clay lenses. Groundwater recharge occurs primarily from infiltration of precipitation, with some contribution from landscape irrigation. Shallow groundwater flow is generally radial from the center of the island toward the shoreline with low gradients. Tidal fluctuations influence the groundwater gradient at locations within 200 to 250 feet of the shoreline (Figure A-7). Salinity across IR Site 6 ranges from 0.01 percent at boring 06-MW03, 500 feet from the shoreline, to 0.06 percent at boring 06-MW09, 235 feet from the shoreline, (PRC Environmental Management, Inc. [PRC], 1995).

Former NSTI lies within several hydrogeological stratigraphic units. The portion of the island north of the Bay Bridge lies in the Bay Water hydrogeological unit, and the portion of the island south of the Bay Bridge lies within the Bay Channel hydrogeological unit). Additionally, a search for United States Geological Survey (USGS) or Public Land

Survey System (PLSS) Meridian Township Range Section (MTRS) well locations indicated that no wells are located within a 1-mile buffer zone surrounding the island.

10.5 Problem Definition

PFAS are documented to have been released in environmental media from past DON activities and non-DON anthropogenic sources in and around San Francisco Bay. During the 1970s, the DoD began using firefighting foams that contained PFAS during training activities and have potentially released PFAS in the environment. Based on a review of previous reports, IR Site 6, the Former Fire Training School, was used for firefighting training activities from 1944 through 1992, and the release of PFAS has been reported onsite. IR Site 6 was identified as an area of interest requirement further investigation in the PA Report (Multi-MAC JV, 2020). Additionally, previous soil and groundwater monitoring results indicated that PFAS concentrations exceeded screening criteria at IR Site 6.

The objective of this SAP is to provide guidance to complete the Phase I RI to determine the nature and extent of PFAS in soil and groundwater, evaluate risk, and guide site management decisions. This section summarizes the review of applicable regulatory requirements, available PFAS data collected at IR Site 6, and goals of the Phase I RI.

10.5.1 Regulatory Requirements

PFAS have been identified by U.S. EPA as emerging chemicals of concern (U.S. EPA, 2017) and are of environmental concern because of their persistence in the environment and in organisms, migration potential in aqueous systems (e.g., groundwater), historically ubiquitous use in commercial products, and possible adverse health effects at low levels of exposure. At this time, only three PFAS have U.S. EPA-derived toxicity values available to help understand potential health effects from exposure: perfluorobutanesulfonic acid (PFBS), PFOA, and PFOS. In 2016, U.S. EPA issued a drinking water lifetime health advisory (LHA) of 0.07 microgram per liter (µg/L) for PFOA and PFOS. When both PFOA and PFOS are found in drinking water, the combined concentrations of PFOA and PFOS (PFOA+PFOS) should also be compared with the 0.07-µg/L LHA level because of the similarity in the noncancer health effects of PFOS and PFOA (U.S. EPA, 2016a, 2016b, 2016c). Although not legally enforceable, the LHA has been a driving force for investigation and remediation efforts. On September 15, 2021, the DoD issued a memorandum for addressing PFAS in soil and groundwater within the Defense Environmental Restoration Program (DERP) under CERCLA (DoD, 2021). As indicated in the memorandum, screening levels for PFOA and PFOS were calculated using the U.S. EPA online calculator, and screening values for PFBS were derived from the U.S. EPA regional screening level (RSL) table. For groundwater, screening levels of 0.04 µg/L for PFOA, 0.04 µg/L for PFOS, and 0.6 µg/L for PFBS are used to evaluate impacts on groundwater. Screening levels of

0.13 milligram per kilogram (mg/kg) for PFOA, 0.13 mg/kg for PFOS, and 1.9 mg/kg for PFBS are used to evaluate impacts on soil (DoD, 2021).

Currently, PFBS is the only PFAS listed in the November 2021 U.S. EPA RSL table. The generic RSL table provides noncancer reference doses, screening levels for residential soil (19 mg/kg), industrial soil (250 mg/kg), and tapwater (6.0 µg/L), and soil screening levels for protection of groundwater (0.0019 mg/kg) for PFBS only (U.S. EPA, 2021). Although no health advisories have been established for PFAS (except for PFOA and PFOS), an RSL of 0.6 µg/L for PFBS has been established (U.S. EPA, 2021; DoD, 2021).

In addition, on December 19, 2019, U.S. EPA published a guidance document for interim recommendations for addressing groundwater impacted by PFOA and/or PFOS. The guidance document also recommends that screening of sites be based on a target hazard quotient of 0.1 for PFOA or PFOS individually, which is currently 0.04 µg/L (i.e., site groundwater concentrations should be compared with one-tenth of the calculated tapwater RSL of 0.4 µg/L for PFOS or PFOA, which works out to 0.04 µg/L). The reason for selecting a target hazard quotient of 0.1 (i.e., one-tenth of the acceptable concentration for noncancer effects) is to protect against the possible co-occurrence in groundwater of multiple PFAS and other chemicals with similar or additive health effects. In addition, it recommends that the U.S. EPA LHA of 0.07 µg/L be used as the preliminary remediation goal for groundwater that is a current or potential source of drinking water where no state or tribal maximum contaminant level or other applicable or relevant and appropriate requirements are available or sufficiently protective (U.S. EPA, 2019). Groundwater at IR Site 6 is not currently a source of drinking water.

10.5.2 Site History

IR Site 6 is in the northeastern portion of former NSTI. IR Site 6 was used from 1944 to 1992 for various firefighting training activities. The Former Fire Training School at IR Site 6 included 10 buildings, 6 underground storage tanks (USTs), 1 known aboveground storage tank (AST), and a central training yard. Training fires were ignited within various buildings and facilities in the central training yard. The use of AFFF at IR Site 6 has been documented. An AFFF Station was located in the northern boundary of the central training areas adjacent to the V-ditch collector trench (Harding Lawson Associates, 1987). Most of IR Site 6 is presently unpaved because recent remedial actions have removed most of the paving at this site (DON, 2020c). The site features present during the operation period of the training school are presented on Figure A-3.

IR Site 6 also included a vehicle parking area, forklift parking area, hazardous materials storage area, hazardous waste storage area, and storage area for former training structures. All buildings were demolished and removed from the site in 1993. However, Building 461 is directly adjacent to IR Site 6 and overlies the PFAS plume in groundwater.

10.5.3 Prior PFAS Investigations

*S*oil sampling for PFAS was conducted at IR Site 6 in July 2015 (Figure A-8). Only PFOA and PFOS were analyzed because these were the only PFAS with screening levels established at the time of sampling (Figure A-8 and Table 10-1). PFOA was detected in 8 of the 11 soil samples at concentrations ranging from not detected to 0.0574 mg/kg, which were all below the screening criteria of 0.13 mg/kg. PFOS was detected in 5 of the 11 soil samples. PFOS concentrations ranged from not detected to 1.240 mg/kg. Five of the soil samples contained detected PFOS at concentrations above the screening criteria of 0.13 mg/kg (DON, 2020d).

Groundwater was sampled for PFAS at IR Site 6 in May and December 2017 and in April and September 2020 (Figure A-9 and Table 10-2). The results of these sampling events indicate that PFAS are present in the site groundwater, summarized as follows (NOREAS, Inc., 2019; DON, 2020d):

- PFOA was detected in 48 of 49 samples at concentrations ranging from 0.0057 µg/L to 7.32 µg/L. A total of 37 of 49 reported PFOA results exceeded the DoD screening level of 0.04 µg/L.
- PFOS was detected in 48 of 49 samples at concentrations ranging from 0.042 µg/L to 30 µg/L. All 48 reported PFOS results exceeded the DoD screening level of 0.04 µg/L.
- Similarly, PFBS was detected in 45 of 49 samples at concentrations ranging from 0.0058 µg/L to 0.17 µg/L. However, none of the PFBS results exceeded the screening criteria of 0.6 µg/L.

10.5.4 Problem Summary

Previous investigations at IR Site 6 have reported PFAS in soil and groundwater samples at concentrations that exceed their screening levels. An RI is necessary to evaluate the nature and extent of PFAS in different media, including soil and groundwater. The soil and groundwater sampling activities described in this SAP comprise Phase I RI. The Phase II RI will be described in a future Work Plan Addendum based on the results of the Phase I RI.

During the Phase I RI, a multimedia characterization of PFAS will be conducted to address the following:

(1) Delineate the nature and extent of PFAS at IR Site 6 in soil and groundwater using DoD screening criteria (Figures A-10 and A-11).

(2) Evaluate whether PFAS in soil are a source of PFAS in groundwater.

(3) Evaluate the potential transport of PFAS in groundwater to San Francisco Bay.

A baseline Human Health Risk Assessment (HHRA) will be performed to evaluate whether PFAS in soil and groundwater pose a potentially unacceptable risk to human health. For ecological exposure, groundwater samples collected during the Phase I RI will be compared with appropriate screening criteria as a conservative first step in assessing potential risk to marine receptors. Additionally, site-specific geotechnical and hydraulic properties of subsurface soil and sediment and results of a tidal study will be used to evaluate potential tidal mixing and assess preferential migration pathways of PFAS onsite.

Table 10-1: Summary of PFOS and PFOA Analytical Results in Soil

Location	Sampling Depth (feet bgs)	Sampling Date	PFOS[1] (mg/kg)	PFOA[1] (mg/kg)
		Screening Level[2]	0.13	0.13
06-SB46	0.5	07/08/2015	0.0375	0.0313
	4	07/08/2015	**0.226**	< 0.024 U
	5.5	07/08/2015	0.0777	< 0.024 U
06-SB59	2	07/08/2015	0.130	0.0574
	4	07/08/2015	**0.165**	0.0318
06-SB60	2	07/08/2015	< 0.012 U	< 0.024 U
	4	07/08/2015	0.0511	0.0113 J
06-SB61	2	07/08/2015	**1.240**	< 0.026 U
	4	07/08/2015	**1.080**	0.0123 J
06-SB62	2	07/08/2015	< 0.011 U	< 0.023 U
	4	07/08/2015	< 0.008 U	< 0.018 U

Notes:

Bold = exceeds screening criteria

1. Only PFOS and PFOA were analyzed because these were the only PFAS with screening levels established at the time of sampling.
2. DoD. 2021. *Memorandum on Investigating Per- and Polyfluoroalkyl Substances with the Department of Defense Cleanup Program, Residential Scenario Screening Levels*. September 15.

bgs = below ground surface; J = value estimated between the detection limit (method detection limit) and the limit of detection (reporting limit); mg/kg = milligram(s) per kilogram; PFAS = per- and polyfluorinated substances; PFBS = perfluorobutanesulfonic acid; PFOA = perfluorooctanoic acid; PFOS = perfluorooctane sulfonate; U = chemical not detected at or above indicated limit of detection value

Source:

DON. 2020d. Personal e-mail transmitting June 2015 IR Site 6 soil sampling data, sent by Mr. David Clark. May 21.

Table 10-2: Summary of PFAS Analytical Results in Groundwater

Monitoring Well Sampling Location	Sampling Date	PFBS (µg/L)	PFOA (µg/L)	PFOS (µg/L)
	Screening Level[1]	0.60	0.04	0.04
06-MW25	5/9/2017	0.12	**7.32**	**7.12**
	12/12/2017	0.084 J	**4.1**	**18.0**
	4/8/2020	0.074	**1.1**	**9.9**
	9/21/2020	0.100	**1.1**	**10**
06-MW26	5/9/2017	0.038	**0.750**	**10.02**
	12/13/2017	0.028	**0.960**	**3.8**
	4/9/2020	0.020 J	**0.310**	**2.2**
	9/21/2020	0.028	**0.65**	**2.1**
06-MW30 06-MW30 (dup)	5/9/2017	0.0060 J	0.032	**0.130**
	5/9/2017	0.0065 J	0.033	**0.170**
	12/12/2017	0.015 U	0.027	**0.097**
	4/9/2020	0.015 U	0.026	**0.150**
	9/21/2020	0.0063 J	0.035	**0.067**
06-MW31	12/14/2017	0.061	**0.270**	**1.2**
	4/8/2020	0.020	**0.160**	**0.4**
	9/21/2020	0.160	**0.45**	**1.7**
	9/21/2020	0.160	**0.44**	**1.8**
06-MW32 06-MW32 (dup) 06-MW32 06-MW32 (dup)	12/13/2017	0.13	**1.2**	**19.0**
	12/13/2017	0.15	**1.1**	**18.0**
	4/9/2020	0.150	**2.0**	**30.0**
	4/9/2020	0.170	**2.1**	**27.0**
	9/21/2020	0.13	**1.2**	**23**
06-MW33	12/13/2017	0.064	**1.3**	**6.1**
	4/9/2020	0.120	**2.0**	**11.0**
	9/21/2020	0.069	**1.2**	**7**
06-MW34	12/13/2017	0.065	**0.380**	**3.1**
	4/9/2020	0.014 J	**0.100**	**1.8**
	9/21/2020	0.039	**0.20**	**2.4**
06-MW35	12/13/2017	0.048	**0.250**	**3.8**
	4/9/2020	0.026	**0.210**	**4.1**
	9/21/2020	0.033	**0.19**	**3.4**
06-MW36	12/13/2017	0.076	**0.350**	**1.4**
	4/9/2020	0.015 J	**0.081**	**0.770**
	9/21/2020	0.020 J	**0.062**	**0.75**
HP01	9/22/2020	0.012 J	**0.044**	**0.21**
HP02	9/22/2020	0.024	0.015 J	**0.14**
HP03 HP03 (dup)	9/22/2020	0.0062 J	0.0066 J	**0.063**
	9/22/2020	0.0058 J	0.0059 J	**0.061**
HP04	9/22/2020	0.014 U	0.013 J	**0.053**
HP05	9/22/2020	0.0070 J	0.0057 J	**0.042**
HP06	9/22/2020	0.0094 J	0.026	**0.093**

Table 10-2: Summary of PFAS Analytical Results in Groundwater (continued)

Monitoring Well Sampling Location	Sampling Date	PFBS (µg/L)	PFOA (µg/L)	PFOS (µg/L)
HP07	9/22/2020	0.019 J	**0.37**	**0.81**
HP08	9/22/2020	0.028	**0.75**	**1.2**
HP08 (DUP)	9/22/2020	0.028	**0.790**	**1.1**
HP09	9/22/2020	0.016 J	**0.11**	**0.59**
HP10	9/22/2020	0.014 U	0.014 U	0.014 U
HP11	9/22/2020	0.034	**0.095**	**0.27**
HP12	9/23/2020	0.014 J	**0.072**	**0.44**
HP13	9/23/2020	0.0058 J	**0.028**	**0.19**

Notes:

Bold = exceeded screening criteria

1. Screening criteria for groundwater sample results follow *Investigating Per- and Polyfluoroalkyl Substances within the DoD Cleanup Program* dated September 15, 2021 (DoD, 2021).

µg/L = microgram(s) per liter; DUP = field duplicate sample; J = value estimated between the detection limit (method detection limit) and the limit of detection (reporting limit); PFAS = per- and polyfluorinated substances; PFBS = perfluorobutanesulfonic acid; PFOA = perfluorooctanoic acid; PFOS = perfluorooctane sulfonate; U = analyte not reported at or above the method detection limit

Sources:

1. NOREAS, Inc., 2019. *Final 2017 Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California*. February 2019.
2. DON. 2020d. Personal e-mail transmitting April 2020 IR Site 6 groundwater sampling data, sent by Mr. David Clark. May 21.

SAP Worksheet# 11 Project Quality Objectives/Systematic Planning Process Statements

This worksheet provides Steps 1 through 7 of the DQO process as detailed in the *Guidance on Systematic Planning Using the DQO Process* (U.S. EPA, 2006). This process is used to determine the type, quantity, and quality of data necessary to support decision making regarding current site conditions and future site management decisions.

This worksheet provides the objectives of the Phase I RI, the information inputs and analytical approach that will be used to achieve the objectives, and the performance criteria that will be used to ensure that the data used to make project decisions are of sufficient quality.

IR Site 6, Former Fire Training School	
STEP 1	**State the Problem**
	Several of the more common PFAS are documented to have been released in environmental media from past DON activities as well as non-DON anthropogenic sources in and around San Francisco Bay. PFAS are a class of emerging chemicals of concern whose toxicity and fate and transport characteristics are uncertain. During the 1970s, the DoD began using firefighting foams that contained PFAS. Previous firefighting training activities have been documented to release PFAS in the environment at the IR Site 6, the Former Fire Training School, at former NTSI. Based on a review of previous reports, the Former Fire Training School was used for firefighting training activities from 1944 through 1992, and the release of PFAS has been reported onsite. The Former Fire Training School at IR Site 6 included 10 buildings, 6 USTs, 1 known AST, and a central training yard. Training fires were ignited within various buildings and facilities in the central training yard. Historical features and uses of IR Site 6 also included a vehicle parking area, forklift parking area, hazardous materials storage area, hazardous waste storage area, and storage area for former training structures. The buildings were demolished and removed from the site in 1993. Previous investigations have reported PFAS in soil and groundwater samples at concentrations that exceed project screening levels. An RI is necessary to evaluate the nature and extent of PFAS at IR Site 6. This SAP addresses the Phase I RI, which includes soil and groundwater sampling only. During the Phase I RI, a multimedia characterization of PFAS will be conducted to delineate the nature and extent of PFAS in soil and groundwater at IR Site 6 using DoD screening criteria, evaluate exposure risk for current and potential future human and ecological receptors, and recommend further investigation, if warranted. Additionally, site-specific geochemical and hydraulic properties of subsurface soil and results of a tidal study will be used to evaluate potential tidal mixing and assess preferential migration pathway of PFAS onsite.
STEP 2	**Identify the Goals of the Phase I RI**
	The following are the project goals related to chemical data collection for the Phase I RI: 1. Delineate the nature and extent of PFAS in soil and evaluate whether PFAS in soil present a potential source to groundwater. 2. Delineate the nature and extent of PFAS in groundwater and evaluate their potential transport to San Francisco Bay. 3. Evaluate whether PFAS in soil and groundwater pose a potentially unacceptable risk to human health through direct contact pathways. 4. Evaluate whether PFAS in groundwater pose a potential risk to ecological receptors through comparison of groundwater concentrations with ecological screening benchmarks.

IR Site 6, Former Fire Training School	
STEP 3	**Identify Information Inputs**
	The DON has collected site-specific IR Site 6 information during previous investigations, including hydrogeologic data collected through years of investigation and remediation associated with the petroleum and related chemicals released onsite and more recent investigations associated with the release of PFAS, specifically PFOA, PFOS, and PFBS, in soil and groundwater, as follows: 1. Environmental data and information on site features contained in previous former NSTI-wide studies, petroleum investigations, a PA/site inspection (SI), and several phases of RI under the DON IR Program from 1986 through 2010. These previous investigations are summarized in the most recent RI Report (Engineer/Remediation Resources Group, Inc. [ERRG], 2012) and are not repeated in this SAP. 2. Information on previous investigations, including the RI for Offshore Sediment, from 1999 through 2004 (Tetra Tech EM Inc., 2000, 2001, 2002), and removal actions in 2002–2003 (Shaw Environmental, Inc. [Shaw], 2004) under the DON petroleum program, predesign characterization (CE2-Kleinfelder Joint Venture, 2015), and a 2016 remedial action (CE2-Kleinfelder Joint Venture, 2018). 3. *Final 2020 Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California* (NOREAS, Inc., 2021). 4. Recently completed groundwater and Hydropunch sampling for PFAS at IR Site 6. 5. Validated soil and groundwater data collected during the Phase I RI. 6. Assessment of geotechnical and hydraulic properties of subsurface soil including moisture content, dry density, total organic carbon (TOC), pH, cation exchange capacity, anion exchange capacity, particle size analysis, specific gravity, effective porosity, and hydraulic conductivity to support the fate and transport evaluation of PFAS at IR Site 6. 7. Applicable DoD screening criteria for PFAS in environmental media (see Table 11-1).
STEP 4	**Define the Boundaries of the Study**
	1. *Horizontal*: The boundary of the RI includes the entire 4.54 acres of IR Site 6 and its immediate vicinity, as shown on Figure A-11. 2. *Vertical*: Groundwater was encountered at a depth of approximately 4.5 to 6.0 feet bgs during the most recent investigations (CE2-Kleinfelder Joint Venture, 2018). Vadose zone soil will be sampled at a depth of 4 to 6 feet bgs. Groundwater monitoring wells will be installed to a depth of approximately 15 feet bgs and will have a 10-foot screen across the water table. *Temporal*: The time duration from the previous investigation results from 2015 through the completion of the current task order (September 2022). Fieldwork for the Phase I RI is scheduled to occur in March and April 2022 and is expected to last approximately 8 weeks. The project schedule is presented in Worksheet #16.

IR Site 6, Former Fire Training School	
STEP 5	**Develop the Analytical Approach**
	The following decision criteria will determine whether the project goals in DQO Step 2 have been met: 1. **If** concentrations of PFAS in soil samples exceed the screening criteria specified in Table 11-1, **then** the soil results will be used to evaluate the residual PFAS present in soil. **Otherwise**, additional characterization is not warranted at this time. If new technical information on PFAS arises, additional actions may be required in the future. 2. **If** concentrations of PFAS in groundwater samples exceed the screening criteria specified in Table 11-1, **then** additional evaluation (e.g., PFAS concentrations in wells nearest the shoreline, tidal study, etc.) will be used to assess the potential transport of PFAS to San Francisco Bay. **Otherwise**, additional characterization of PFAS in groundwater is not warranted at this time. If new technical information on PFAS arises, additional actions may be required in the future. 3. A baseline HHRA will be conducted to determine whether further action is warranted to address the PFAS releases as follows (it is noted that DoD-vetted and approved noncancer toxicity values are available only for PFOS, PFOA, and PFBS, and a carcinogenic slope factor is currently available for only PFOA): a. **If** the baseline HHRA concludes that PFAS concentrations in soil and/or groundwater pose potentially acceptable cumulative risk, considering legacy chemicals, (cancer risk within the CERCLA risk management range of 10^{-6} to 10^{-4} and noncancer hazard index per target organ below 1), **then** the DON and regulatory agencies will review the results to determine whether no further action is appropriate." b. **If** the baseline HHRA concludes that PFAS concentrations in soil and/or groundwater pose a potentially unacceptable cumulative risk, considering legacy chemicals, (cancer risk exceeds 10^{-4} or noncancer hazard index per target organ exceeds 1), **then** further action will be recommended for soil or groundwater, as applicable. Further action may also be recommended for cancer risks of 10^{-6} to 10^{-4}, based on site-specific information.
STEP 6	**Specify Performance or Acceptance Criteria**
	Sampling locations and associated depths are based on results from previous investigations at IR Site 6, data necessary to support a baseline HHRA and Ecological Risk Assessment (ERA), and data to evaluate the nature and extent of contaminants onsite. The results from the Phase I RI will be used to refine the site-specific CSM as appropriate. Statistically derived limits on sampling design error are not quantifiable, because a judgmental sampling design will be followed to select sampling locations for this RI. Sampling locations will be chosen to obtain representative coverage of areas of concern and account for previously collected site data. Thus, tolerable limits on decision errors cannot be precisely defined. Precise limits on data are provided in Worksheets #12, #24, and #28. Analytical method requirements and project-specific DQOs were established to limit decision errors. To maximize data comparability and to minimize sampling error, sampling will be conducted using the methods described in Worksheets #14 and #21. For reproducibility and comparability of analytical data, standard DoD-approved analytical methods will be used, and laboratories that have current accreditations from the California State Water Resources Control Board Division of Drinking Water Environmental Laboratory Accreditation Program (ELAP) and DoD ELAP will be used (Attachment 1). Data validation will be conducted as described in Worksheets #14 and #35. To limit uncertainty in the obtained environmental data, criteria have been developed for the precision, accuracy, representativeness, completeness, and comparability parameters and limits of detection (LODs) for the chemicals of concern presented in Worksheet #37. Measurement errors will be controlled by using appropriate sampling and analytical methods; laboratory errors will be controlled by adhering to established SOPs and having third-party data validation to verify laboratory processes per Attachment 3. Each field crew member will review this SAP before beginning sampling activities to ensure the application of consistent sampling methods and limit sample collection errors. The subcontracted analytical laboratory will have a copy of the Final SAP and will follow DoD QSM guidance to limit measurement errors.

IR Site 6, Former Fire Training School	
STEP 7	**Develop the Plan for Obtaining Data**
	This section describes the quantities of samples by medium to achieve the Phase I RI objectives. Soil and groundwater samples will be collected in accordance with Worksheet #14 at the locations shown in Figures A-10 and A-11 and described in Worksheet #17. For each investigation medium, the following samples will be collected: **Soil**: A total of 45 soil borings will be advanced in the vadose soil to delineate previous soil concentrations that exceeded the DoD screening values for PFAS and assess the vertical and lateral delineation in soil. Soil samples will be collected from two depth intervals (0–2 feet bgs and approximately 4–6 feet bgs), as shown on Figure A-10. The interval from 0–2 feet bgs will be used to evaluate risk to the current recreational visitor and hypothetical resident, and the interval from 0–6 feet bgs will be used to evaluate risk to the future recreational, hypothetical resident and construction worker. **Groundwater:** A total of 15 new groundwater monitoring wells will be installed. The 15 new wells and 9 existing monitoring wells will be sampled for PFAS to delineate the extent of PFAS in groundwater (Figure A-11). The wells will be constructed using a 10-foot screen interval across the water table (approximately 6 feet bgs), and one groundwater sample will be collected at each location for PFAS analysis. The locations of the new monitoring wells are based on previous monitoring results from 9 existing monitoring wells as well as results from the September 2020 Hydropunch sampling at 13 locations at IR Site 6 (NOREAS Inc., 2021) with the objective of determining the lateral extent of PFAS in groundwater. Each media sample is described in detail in Worksheet #18. The rationale for the sampling locations is presented in Worksheet #17. Multi-MAC JV will present the results of the field investigation in the Phase I RI Report to be prepared after completion of field activities. Analytical results for PFOS, PFOA, and PFBS will be compared with the screening criteria in Table 11-1 as an initial evaluation of the extent of PFAS in soil and groundwater. Additional screening benchmarks for human health protectiveness may also be used to further evaluate data quality and to conduct the baseline HHRA and ecological screening evaluation. An additional 15 PFAS included in U.S. EPA Method 537.1 will also be reported. In addition, field measurements and observations will be documented in the Phase I RI Report and will be used as lines of evidence to support conclusions. Data collection and analysis methods are described in Worksheet #14 and will satisfy the DQOs specified in the preceding six steps. Analytical data will be validated by a third-party data validator.

Table 11-1: PFAS Screening and Criteria for Media of Concern

Analyte Name[1]	Acronym	CAS Number	DoD Groundwater Screening Criteria[2] (µg/L)	DoD Soil Screening Criteria[2] (mg/kg)	Salt Water Ecological Target Value[3,4] (µg/L)
Perfluorooctanoic acid	PFOA	335-67-1	**0.04**	**0.13**	**4.4**
Perfluorooctane sulfonate	PFOS	1763-23-1	**0.04**	**0.13**	**0.075**
Perfluorobutanesulfonic acid	PFBS	375-73-5	**0.6**	**1.9**	**640**
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	–	-	–
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	–	–	–
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	–	-	-
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	–	–	–
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	–	-	–
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	–	–	–
Perfluoroheptanoic acid	PFHpA	375-85-9	–	–	**870**
Perfluorohexanesulfonic acid	PFHxS	355-46-4	–	–	–
Perfluorohexanoic acid	PFHxA	307-24-4	–	-	**210**
Perfluorononanoic acid	PFNA	375-95-1	–	-	**2.2**
Perfluorotetradecanoic acid	PFTeDA	376-06-7	–	-	–
Perfluorotridecanoic acid	PFTrDA	72629-94-8	–	–	–
Perfluoroundecanoic acid	PFUnA	2058-94-8	–	–	**49**
Perfluorodecanoic acid	PFDA	335-76-2	–	–	**140**
Perfluorododecanoic acid	PFDoA	307-55-1	–	–	**72**

Notes:

1. These established criteria provide guidance only, and no federal or state of California promulgated criteria currently exist. Screening criteria are derived as described in note 2.
2. All criteria are from the DoD memorandum: *Investigating Per- and Polyfluoroalkyl Substances with the Department of Defense Cleanup Program* (DoD, 2021). The criteria were calculated using slope factors or reference doses for PFOS and PFOA published by the U.S. EPA Office of Water in support of the Lifetime Health Advisory, and default exposure assumptions for each potential receptor scenario, contained in U.S. EPA's RSL Calculator on April 6, 2018 (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search). PFBS screening criteria are in U.S. EPA's RSL table or RSL calculator.

Table 11-1: DoD Other Applicable PFAS Screening and Criteria for Media of Concern (continued)

3. There are no current U.S. EPA-published, peer-reviewed or consensus ESVs for surface water. The ecological target screening levels were selected to set project-specific quantitation limits that enable data quality to be sufficient to perform an ERA as part of the Phase I RI. Prior to preparation of the RI screening-level ERA, the ESVs to be used for comparison with site media will be reviewed on the basis of current science and relevancy to site-specific receptors (e.g., relevant ecological receptors). ESVs selected for use will be presented in an ESV screening memorandum for regulatory review prior to preparation of the draft Phase I RI Report.
4. Saltwater ecological target values are the lower of concentrations protective of wildlife food chain ingestion or direct contact for plants, invertebrates, and fish (Divine et al., 2020; Conder et al., 2020).

– = not available; µg/L = microgram(s) per liter; CAS = Chemical Abstract Service; DoD = United States Department of Defense; ERA = ecological risk assessment; ESV = environmental screening value; GW = groundwater; mg/kg = milligram(s) per kilogram; PFAS = per- and polyfluoroalkyl substance; PFOA = perfluorooctanoic acid; PFOS = perfluorooctane sulfonate; RI = remedial investigation; RSL = regional screening level; U.S. EPA = United States Environmental Protection Agency

SAP Worksheet# 12 Measurement Performance Criteria Table

Table 12-1 presents the measurement performance criteria for PFAS analysis.

Table 12-1: Measurement Performance Criteria

QC Sample	Analytical Group	Frequency	DQI	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analysis (A), or Both (S&A)
Field Duplicate[1] (aqueous samples only)	PFAS	10%	Precision	RPD ≤ 30% for water samples if the results are ≥LOQ; or the difference between analyte concentrations should be ≤ LOQ if results are < LOQ	S&A
Equipment Blanks[2]	PFAS	One per day, per method of sample collection	Accuracy/Bias, Contamination	If the blank result is > LOD and associated sample result is ≤ LOD; or > LOD but ≤ LOQ U qualify the sample result as non-detect at the LOD. If the blank result is > LOD and associated sample result is > LOQ but ≤ 5x the concentration in the associated blank J quality the sample result as estimated.	S
Field Blanks[3]	PFAS	One per day of groundwater sampling or 1 for every 20 samples, whichever is more frequent	Accuracy/Bias, Contamination		S
Temperature Blank	PFAS	One per cooler	Accuracy/ Bias	≤10ºC within 48 hours of sample collection, then must be stored at ≤ 6ºC	S
Extracted Internal Standards	PFAS	All samples and standards	Accuracy/Bias	More conservative of laboratory-specified limits or areas within 50-150% of the average areas measured during initial calibration	A
Matrix Spike/Matrix Spike Duplicate	PFAS	1 per 20 field samples of the same matrix collected from the same installation	Accuracy/Bias/Precision	Laboratory-specified limits or 70–130% recovery for analytes without laboratory-specified limits, RPD <30%	A

Notes:

1. Field duplicates will not be collected for soil. Refer to Worksheet #14, Section 14.11 for additional details.
2. Equipment blanks will be collected only when nondedicated sampling equipment is used. Groundwater samples will be collected using a bladder or submersible pump and disposable tubing.
3. Field blanks are used to evaluate the potential for cross-contamination between the ambient environment and the matrix collected for

ºC = degree(s) Celsius; A = analysis; DQI = data quality indicator; LOQ = limit of quantitation; PFAS = per- and polyfluoroalkyl substances; QC = quality control; RPD = relative percent difference; S = sampling; S&A = sampling and analysis

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SAP Worksheet# 13 Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title, and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
Previous soil data for IR Site 6	Personal email transmitting: June 2015 IR Site 6 soil sampling data, sent by Mr. David Clark. May 21, 2020.	CE2-Kleinfelder JV, soil data, 2016	Multi-MAC JV will use the information to evaluate assumptions regarding site conditions (i.e., the CSM) and the nature and extent of impacts.	The data will be evaluated for applicability of use in the baseline HHRA.
Previous groundwater data for IR Site 6	NOREAS, Inc. *Final 2017 Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California.* February 2019. Personal email transmitting, *April 2020 IR Site 6 groundwater sampling data, sent by Mr. David Clark*. May 21, 2020. NOREAS, Inc. *Field Change Request to Annual Basewide Groundwater and Soil Gas Monitoring Report, Installation Restoration Sites 6, 12, 21, and 24, Former Naval Station Treasure Island, San Francisco, California*. September 2020.	NOREAS, Inc, groundwater data, 2017 NOREAS, Inc, groundwater data, 2020	Multi-MAC JV will use the information to evaluate assumptions regarding site conditions (i.e., the CSM) and the nature and extent of impacts.	The data will be evaluated for applicability of use in the baseline HHRA.

Notes:

CSM = conceptual site model; HHRA = Human Health Risk Assessment; IR = Installation Restoration; Multi-MAC JV = Multi-MAC Joint Venture

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SAP Worksheet# 14 Summary of Project Tasks

Sampling for PFAS requires that sampling equipment be free of parts that may contain PFAS and have the potential to cross-contaminate the soil and groundwater samples being collected. Prior to the start of fieldwork, all field and sampling equipment to be used by Multi-MAC JV and any associated subcontractors will be carefully inspected to ensure materials that are known to, or could potentially, contain PFAS are removed. A list of prohibited and acceptable field items is included in *Field Sampling Protocols to Avoid Cross-Contamination of Per- and Polyfluoroalkyl Substances* SOP Wood-01 (Attachment 2). These procedures will be implemented for all tasks discussed in this section.

Multi-MAC JV will perform the following tasks associated with the Phase I RI at IR Site 6 at former NSTI.

14.1 Permitting and Notification

Under CERCLA-regulated cleanups, no federal, state, or local permits are required for onsite investigations. To comply with the substantive requirements, notification will be submitted to the San Francisco Department of Public Health, Environmental Health Section, prior to drilling soil borings and installing groundwater monitoring wells.

Site activities will be coordinated with the base ROICC, the RPM, and the CSO representative.

14.2 Mobilization, Site Preparation, and Demobilization

Mobilization for the fieldwork will include field personnel, subcontractors, and other support staff as needed. Mobilization efforts will include, but are not limited to, obtaining supplies and equipment, conducting a field kickoff meeting covering sampling activities, locating a source of potable water for the drilling subcontractor, and designating laydown and decontamination areas. The field kickoff meeting may be held prior to mobilization to discuss project scope, health and safety requirements, drilling procedures, excavation procedures, sampling procedures, status of submittals and procurements, and quality control (QC) protocols.

A perimeter will be designated around the investigation areas, as needed. This area will include exclusion, contamination reduction, and support zones. A portable toilet will be brought to the site and stored within the project area in the support zone if there is no restroom access nearby. A project staging area and an IDW storage area will be designated through coordination with the RPM and/or ROICC.

Prior to drilling, the site will be prepared for work activities. Some soil boring locations may require concrete coring; this coring will be performed by the drilling subcontractor prior to laying down plastic. After coring is complete, plastic or suitable material will be laid down underneath the portions of the drill rig that are likely to come in contact with subsurface soil.

14.3 Utility Clearance

Underground utility clearance will be performed by a third-party utility locator subcontractor. Underground Service Alert will be notified at least 72 hours prior to the initiation of any subsurface activities. Multi-MAC JV will notify DON personnel at least 2 weeks prior to the initiation of any drilling activities and will secure the appropriate authorization from the required base personnel. Prior to drilling activities, each drilling location will be cleared to a depth of 5 feet bgs (i.e., hand auger) to ensure clearance of subsurface utilities. The hand auger will be decontaminated prior to use and after each use and will be compatible with PFAS sampling requirements.

Surface geophysical methods that may be used include, but are not limited to, electromagnetic induction and geomagnetics. Anticipated utilities to be cleared include, but are not limited to, pipelines for natural gas, water, and fuel; electrical lines; telephone and other transmission lines; drainage lines; sewers; and tanks.

14.4 Soil Sampling

A total of 30 shallow soil borings will be drilled to a maximum depth of 6–8 feet bgs, with two soil samples collected per boring. In addition, two soil samples will be collected per boring during drilling of the 15 monitoring wells (see Section 4.3 for information on monitoring well drilling and installation). Therefore, soil samples will be collected from 45 locations. The soil samples from the soil borings and during drilling of the monitoring wells will be collected: one at the surface (approximately 0–2 feet bgs) and one at depth (approximately 4–6 feet bgs) of the soil/groundwater interface. The soil/groundwater interface sample will be targeted to be representative of the capillary fringe (i.e., just above the soil/groundwater interface). To collect a sample that is representative of the capillary fringe, field personnel under the direction of a Professional Geologist (PE) will use field observations of the soil moisture content of the sample core in accordance with the ASTM International (ASTM) D2488-17 Visual-Manual Method (based on the Unified Soil Classification System [USCS]). In addition, the depth to groundwater measured in nearby monitoring wells (if available), and if possible measured in the soil boring itself, may be used to help assess the depth of the capillary fringe. Groundwater is estimated to occur at a depth of approximately 4–6 feet bgs at IR Site 6. The soil sampling depth rationale for each boring and monitoring wells locations is listed in Worksheet #17 Table 17-1.

Soil sampling will be conducted in accordance with the procedures described in this SAP and *Soil Sampling* SOP Wood-02 (PFAS) (Attachment 2). Soil samples will be logged in accordance with ASTM Method D2487 *Standard Practice for Clarification of Soils for Engineering Purposes*.

Shallow soil sampling will follow these general procedures:

(1) If collecting or handling soil samples, wear disposable nitrile gloves to prevent cross-contamination and provide personal protection. New gloves will be donned for sample collection at each sampling location (i.e., at each new vertical or horizontal position), or whenever gloves are torn or otherwise compromised. The shallow soil sample within the interval from 0–2 feet bgs will be collected in an acetate-lined stainless-steel hand auger. A discrete sample will be collected below the first occurrence of undisturbed native soil (e.g., below surface features such as road base material) for PFAS analysis. The sampler, wearing clean disposable nitrile gloves, will remove pebbles, roots, etc. from the sample.

(2) Record the location/depth of scooped soil within the interval from 0–2 feet bgs on the soil/boring log.

(3) Place soil directly into the sample containers from the auger. Soil samples will not be homogenized because of the tendency of PFAS to adhere to sampling equipment.

(4) For subsurface soil sampling, collect soil samples (depth of less than 5 feet bgs) by hand auger while the boring is being cleared for utilities. If groundwater occurs deeper than 5 feet bgs, those locations may require soil sample collection by direct-push technology. On a direct-push drill rig, hydraulic rams are used to push the sampler to desired depth, and then the tip of the sampler is retracted to the top of the sampler to expose the hollow sample core to the undisturbed soils below the sampler barrel. The sampler is then pushed to the bottom of the interval to be sampled, allowing relatively undisturbed soil to enter the sampler. The soil sample is collected in a series of clean sample tubes that line the solid sampler barrel. The full sample barrel is then withdrawn to the surface and the sample tubes removed from the sampler; the selected sample interval will be cut from the sample tube and sealed with plastic end caps only (no Teflon sheeting is to be used).

(5) Between each sampling location and prior to each sampling run, decontaminate the drill tooling, sample barrel, and other nondisposable sampling equipment as described in *Equipment Decontamination SOP* Wood-10 (Attachment 2).

(6) Advance the borehole to the desired depth or target horizon where the sampling run is to begin.

(7) Push the sampler to the bottom of the interval to be sampled, allowing relatively undisturbed soil to enter the sample. Collect the soil sample in a series of clean sample tubes that line the solid sampler barrel.

(8) Withdraw the full sample barrel to the surface and remove the sample tubes from the sampler.

(9) Cut the selected sample interval from the sample tube and seal the tube with plastic end caps only (no Teflon sheeting is to be used).

(10) Label the sample with a unique identification number, sample date and time, and other relevant sample data described in the SAP.

(11) Document any observed field problems associated with the sampling attempt (e.g., refusal) or lack of recovery on the boring log.

(12) Base sample selection on four factors: judgment that the sample represents relatively undisturbed intact material, not slough; proximity to the drive shoe; minimal exposure to air; lithology; and obvious evidence of contamination. The soil core should also be visually recorded on a boring log.

(13) Place the samples on ice in an insulated cooler under chain-of-custody protocols for transportation to the laboratory.

14.5 Groundwater Sampling

A total of 15 new groundwater monitoring wells will be installed to augment the existing groundwater monitoring well network of 9 wells at the site. During drilling of the monitoring wells, two soil samples will be collected per boring from depths of 0–2 feet bgs and approximately 4–6 feet bgs (at the capillary fringe) as discussed in Section 14.4. Groundwater samples and water elevations will be collected at the 15 new wells and 9 existing wells. Only one groundwater sample at each monitoring well is planned as part of the Phase I RI. The locations of the existing and proposed new groundwater monitoring wells are shown on Figure A-11. The depth to groundwater is anticipated to occur from 4–6 feet bgs.

14.5.1 Groundwater Monitoring Well Design

A conceptual construction design of the proposed groundwater monitoring wells is provided in Figure A-12. The general design of each well is as follows:

- A 2-inch-diameter Schedule 40 polyvinyl chloride (PVC) casing with flush-threaded joints
- A 10-foot long PVC well screen with a screen slot size of 0.010 inch
- A 0.5-foot-long PVC sump below the bottom of the screen interval

- Filter pack – #2/12 sand (or equivalent) from the bottom of the borehole to 2 feet above the top of the screen
- Bentonite seal (e.g., grains, pellets, chips, or slurry) – Approximately 1 foot of bentonite chips to be placed as a seal above the sand and hydrated
- Annular seal (e.g., neat cement, sand cement, and bentonite) from the top of the bentonite seal
- Surface/sanitary seal (e.g., expanding cement or concrete), including a well apron of at least 3 feet laterally in all directions, at least 4 inches thick, and sloping away from the casing
- A 3-foot by 3-foot traffic rated flush-mounted well box to be used for the surface completion at all monitoring well

The wells will be installed in approximately 8-inch-diameter borings, with a total depth that extends approximately 8 feet below the measured depth to groundwater (i.e., approximately 8 feet of screen below groundwater plus the 0.5-foot-long sump, with approximately 2 feet of screen above groundwater). The final well depth and screen interval may be adjusted in the field based on measured static depth to groundwater and the depth and thickness of the water-bearing strata encountered during drilling. The monitoring well design is consistent with State of California Standards and guidance (California Department of Water Resources [CDWR], 1991; DTSC, 2014). Well design specifics for each site are presented in Worksheet #17.

14.5.2 Well Installation and Development

A drill rig capable of turning hollow-stem augers will be mobilized to the site for well installation. Groundwater monitoring well installation will be completed by a licensed, insured, and bonded groundwater monitoring well contractor with a C-57 Water Well Contractor’s License and will be performed under the guidance of a California-licensed PG or California-licensed Professional Engineer (PE). Drilling cuttings will be logged by the field geologist in accordance with the Visual-Manual Method based on the USCS. Logging will be overseen by a California-licensed PG. Groundwater monitoring well installation will be performed in accordance with the *Monitoring Well Installation* SOP (Wood-04 [Attachment 2]). The following procedures will be used:

(1) Following utility clearance, the drilling subcontractor will core concrete or asphalt, if required. A coring bit will be slowly advanced, and the surface continuously wetted to minimize dust generation. Coring operators will stage equipment so that they are upwind of any generated dust.

(2) After removing the asphalt or concrete core, the soil will be hand-augered to 5 feet bgs for utility clearance purposes.

(3) Plastic sheeting deemed appropriate for PFAS-related work will be laid out over the borehole and footprint of the drill rig to capture any fugitive cuttings or fluids from the rig. The drill rig will then be positioned over the drilling location.

(4) The borehole to contain the monitoring well will first be drilled to the desired subsurface soil sampling depth. Subsurface soil samples will be collected according to the procedure in Section 14.4. Once subsurface soil sampling is completed, the borehole will be advanced to the targeted depth specified in Worksheet #17.

(5) All downhole equipment and tools used will be deemed appropriate for PFAS-related work prior to use. Drill cuttings (including hand-auger cuttings) will be placed in 55-gallon United States Department of Transportation (DOT)-approved drums or rolloff bins pending waste characterization, and will be appropriately labeled with the date, borehole number, project number, and contact information for the Multi-MAC JV, the RPM, and the Environmental Affairs POC.

Once the desired drilling depth is reached, the total depth inside the borehole casing will be evaluated using a weighted measuring tape. If heaving sands are encountered, resulting in the loss of borehole depth, the borehole will be redrilled to the target depth. If the borehole will not stay open to the target depth because of flowing sands, potable water may be added to the drill casing to increase the hydrostatic head and reduce the potential for heave. The approximate volume of water added will be recorded on the boring log. The drill rig will advance casing for an 8-inch-diameter boring to the estimated depth to water; if water is encountered, then the borehole will be allowed to equilibrate and the well design will be finalized with the PM. The well will have a 10-foot screen and is intended to have 2 feet of the screen above the top of the groundwater table.

After reaching the water-bearing zone, the depth to groundwater will be recorded and drilling logging will continue farther for approximately 10 feet. A groundwater monitoring well will be installed in accordance with *Monitoring Well Installation* SOP Wood-04 (PFAS) (Attachment 2), CDWR Bulletins 4-81 and 74-90 (CDWR, 1991) and Section 14.5.1. The field geologist will record the details of well construction in the logbook. Each well will have a lockable well cap.

The annular seal will be allowed to set for at least 24 hours before well development begins. Well development will be conducted in accordance with *Monitoring Well Development* SOP Wood-05 (PFAS) (Attachment 2). During development, the bailer and pump will be moved up and down the screen interval to ensure that the full screen length is worked.

The following general procedure will be followed when developing groundwater monitoring wells:

(1) Gentle bailing will be used to remove sand and fine material that may have accumulated in the well and will continue until sand content has been removed. The bailer should be made of PFAS-free material.

(2) After most of the sand has been removed, the well will be surged. A surge block, attached to a rod of sufficient length to reach the well bottom, will be used to move sediments from the filter pack into the well casing. The surge block will be moved up and down the well screen interval to generate a strong back-and-forth flow of groundwater between the well and the formation to dislodge particles smeared along the borehole wall and any particles clogging the screen. Surging should be followed by additional bailing to remove sand and fine materials that may have entered the well during this effort. This cycle will be repeated until only very small quantities of fine material are recovered by surging and bailing.

(3) After surging is complete and the sand and fine materials have been bailed out, a PFAS-free submersible pump will be used to continue well development. The pump should be moved up and down the well screen interval until the purge water is relatively clear.

(4) During well development, water quality parameters will be monitored (i.e., temperature, pH, specific conductivity, turbidity, dissolved oxygen [DO], and oxidation-reduction potential [ORP]). Well development will be considered complete once a minimum of three well volumes have been removed and turbidity nephelometric turbidity unit (NTU) readings have stabilized within 10 percent between readings over one well volume, or a maximum of 12 saturated well volumes have been removed (these volumes are in addition to removing the equivalent volume of any added potable water during well installation).

All reusable sampling equipment will be thoroughly decontaminated prior to use according to the decontamination procedure specified in Section 14.9 to minimize the potential for cross-contamination.

14.5.2 Monitoring Well Sampling

The groundwater monitoring wells will be sampled in accordance with U.S. EPA low-stress (low-flow) procedure (U.S. EPA, 2017). Groundwater sampling will be performed in accordance with the *Groundwater Sampling* SOP (Wood-03 [Attachment 2]).

The following low-flow sampling procedures will be followed for collecting groundwater samples from the newly installed monitoring wells:

(1) Confirm the well identification at each well.

(2) Put on a new, clean, and chemical-resistant pair of disposable nitrile gloves. Calibrate field instruments in accordance with the manufacturer’s directions. Record all calibration documentation in the field logbook or on the groundwater monitoring form.

(3) Measure the depth to water using an electronic water level indicator probe. Record the water level measurement to the nearest 0.01 foot on the groundwater sampling form.

(4) Connect the PFAS-free sampling tubing to the peristaltic pump and slowly lower the tube into the well to avoid any disturbance to the groundwater as possible. If the water level is above the top of the screen, place the pump intake at the middle or slightly above the middle of the screened interval to minimize the potential for pumping of stagnant casing water and avoid resuspension of settled solids from the bottom of the well. If the water level is below the top of the screen, place the pump intake in the middle of the water column.

(5) Begin purging groundwater from the monitoring well and recording water quality parameters and depth to water on the groundwater sampling form. Measurements should be collected every 3 to 5 minutes and pumping rates adjusted so that drawdown does not exceed 0.10 foot, if possible. Pumping rates should target from 100 to 500 millimeters per minute.

(6) After groundwater parameters have stabilized and the minimum amount of groundwater has been purged (as described in *Groundwater Sampling* SOP Wood-03 [PFAS] [Attachment 2]), disconnect the water quality meter. Collect a groundwater sample in the container(s) listed in Worksheet #19. Place groundwater sample in the cooler with ice.

14.6 Tidal Study

During the Phase I RI, hydraulic communication between site groundwater and San Francisco Bay will be evaluated using existing and new wells by conducting a long-duration, 2-week groundwater elevation study to capture several tidal cycles. Nine wells and one surface water (bay) location will have pressure transducers installed and the groundwater elevation recorded at approximately 10-minute intervals for a minimum of 2 weeks. All new wells will be screened at the top of the first water-bearing zone, from a depth of approximately 5 to 15 feet bgs. The study will be conducted during the dry season (non-raining) to represent 9 of the 12 months of the year and preferably during the period of maximum tidal amplitude, when tidal effects on the groundwater are expected to be greatest (i.e., the period when the tidal cycle has the greatest difference between low and high tides, thus representing seasonal low and high tide levels within the study period. In San Francisco Bay, such extreme tidal fluctuations are predicted to occur at least once each month according to National Oceanic and Atmospheric Administration [NOAA] Tide Predictions).

Pressure transducers (In-Situ™ Aqua Troll 600 Multiparameter Sonde or equivalent) will be deployed in approximately four to six wells along the flow path of groundwater from the source area(s) to San Francisco Bay. One transducer will be placed in San Francisco Bay. Each pressure transducer will be capable of measuring pressure (groundwater elevation), pH/ORP, specific conductivity, salinity, density, DO, and temperature. The pressure transducers will be placed in the specified wells for approximately 2 weeks. The transducer data will be downloaded 2 to 3 days following deployment as a check that the transducers are collecting data and are operational.

Additionally, variation in geochemical parameters (specific conductivity, temperature, pH/ORP, and DO) will be monitored over several tidal cycles to determine areas of tidal mixing zone and areas of fresh (non-tidally mixed) groundwater.

14.7 Borehole Abandonment

After drilling, logging, and sampling, borings (except for those borings with monitoring wells installed) will be abandoned in accordance with *Borehole Abandonment* SOP Wood-06 (Attachment 2). Boring abandonment consists generally of backfilling to the surface with bentonite chips, pellets, or bentonite-cement grout. If bentonite chips or pellets are used, they should be added to the boring in 2-foot lifts and hydrated with water from a potable water supply. This process should be repeated until the entire boring is plugged. Care must be taken to ensure that the bentonite chips, pellets, or grout do not bridge, forming gaps or voids in the grout column. The surface will be completed to match the predrilling condition (asphalt, concrete, or similar surface).

14.8 Analytical Tasks

Soil and groundwater samples will be analyzed for PFOA, PFOS, and PFBS by LC/MS-MS compliant with *QSM Version 5.3* Table B-15. In addition to PFOS, PFOA, and PFBS, all samples will be analyzed for the following 15 additional PFAS listed in U.S. EPA Method 537.1 (U.S. EPA, 2018):

- N-ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
- N-methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
- Hexafluoropropylene oxide dimer acid (HFPO-DA)
- 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)

- 9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
- 4,8-dioxa-3H-perfluorononanoic acid (ADONA)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluorohexanoic acid (PFHxA)
- Perfluorononanoic acid (PFNA)
- Perfluorotetradecanoic acid (PFTeDA)
- Perfluorotridecanoic acid (PFTrDA)
- Perfluoroundecanoic acid (PFUnA)
- Perfluorodecanoic acid (PFDA)
- Perfluorododecanoic acid (PFDoA)

Only the analytical results for PFAS with screening criteria listed in Worksheet #11 Table 11-1 will be evaluated for site management decisions because these are currently the only PFAS that have U.S. EPA-derived toxicity values.

In 2021, the DoD issued a memorandum for addressing PFAS within the DERP under the CERCLA (DoD, 2021). As indicated in the memorandum, federal screening levels for PFOA and PFOS were calculated using the U.S. EPA online calculator on April 6, 2018, and screening values for PFBS were taken from the U.S. EPA RSL table (DoD, 2021; U.S. EPA, 2021). Soil and groundwater sampling results will be compared with the screening criteria discussed previously. The results for the additional 15 PFAS will be included in the laboratory reports in the report that will be prepared to summarize the Phase I RI.

In addition, 14 soil samples will be evaluated for geotechnical properties. The locations of geochemical samples are selected to provide coverage across the IR Site 6. The samples selected for geochemical analysis are listed in Table 17-1. The samples will be submitted to the laboratory to be analyzed for the following:

- Moisture content (ASTM D2216 or equivalent)
- Dry density (ASTM D2937 or equivalent)
- Total organic carbon (Walkley-Black)
- pH (ASTM D4972 or equivalent)
- Cation exchange capacity (ASTM D7503 or equivalent)

- Anion exchange capacity (ASTM D7503 or equivalent)
- Particle size analysis (ASTM D422 or equivalent)
- Specific gravity (ASTM D854 or equivalent)

A total of 11 of the 14 geochemical soil samples will also be submitted to the laboratory to be analyzed for the following:

- Effective porosity (California State Water Resources Control Board)
- Saturated hydraulic conductivity (ASTM D5084)

14.9 Equipment Decontamination

All sampling equipment and larger equipment (e.g., drill rig, excavator, and downhole equipment) will be thoroughly decontaminated prior to initiating any site work in accordance with *Equipment Decontamination* SOP Wood-10 (PFAS) (Attachment 2). Sampling equipment will be decontaminated using PFAS-free water provided by an analytical laboratory. Larger equipment will be decontaminated using potable water followed by a PFAS-free water rinse. All reusable sampling equipment and large equipment will be decontaminated prior to use at each sampling location to minimize the potential for contaminant migration or cross-contamination. Equipment decontamination areas will be located within or adjacent to the fieldwork area, as designated by supervising field personnel. Sampling equipment decontamination will be conducted as follows:

(1) Potable water and nonphosphate detergent (i.e., Liquinox) wash (using brushes or a steam cleaner, as appropriate)

(2) Potable water rinse

(3) Distilled or deionized, PFAS-free water rinse

(4) Equipment air-dried and stored until used

The effectiveness of the decontamination procedures and traceability of potential impacts from ambient conditions will be tested by collecting one equipment blank per day of use of sampling equipment (i.e., some days of well installation will not include collecting samples for offsite analyses) following the end-of-the-day equipment decontamination and one field blank per day of groundwater sampling or one per 20 groundwater samples, whichever is more frequent, in accordance with *Protocol to Provide Water Free of Per- and Polyfluoroalkyl Substances for Collection of Field Blanks and Equipment Blanks* SOP Wood-12 (PFAS) (Attachment 2). The laboratory-supplied, analyte-free water will be poured over and around the decontaminated sampler and collected at the site for analysis at the laboratory. Decontamination liquids will be managed along with other IDW as described below. Refer to Section 14.11 for details on the collection of field blanks.

14.10 Field Documentation

Field measurements will be made by qualified field team leads, field geologists, engineers, environmental scientists, and/or technicians. All field data will be recorded in ink on the forms listed below. Field data and records will be reviewed by the field team lead or designee. Instrument selections and use, including calibration and standardization, field deviations, and sampling limitations, will be recorded on the daily field log (see Worksheet #27). Field records will be initialed by the reviewer prior to their incorporation into reports or use in making program decisions. Changes or corrections to field form entries will be completed by striking out the incorrect entry with a single line and initialing (by the person making the correction) and dating the correction. The original item, although erroneous, must remain legible beneath the crossed-out line. The new information should be written clearly above the crossed-out item.

Examples of the field forms listed below are provided in Attachment 4:

- Daily report/field log
- Chain-of-custody (COC) form
- Groundwater sampling form
- Well development form
- Boring log

14.11 Sampling Quality Control

QC samples will be collected at a frequency designated in Worksheets #12, #20, and #28. QC samples will include field duplicates (aqueous samples only), matrix spikes (MSs) and matrix spike duplicates (MSDs), equipment blanks, and field blanks. Field duplicates will not be collected for soil samples because, based on the DQOs for the Phase I RI, sample variability from a specific sampling location is expected to have minimal impact on the identification of areas requiring additional site characterization. If reusable sampling equipment is used, an equipment blank will be collected from decontaminated sampling equipment. Analytical methods will include initial calibrations, continuing calibration, tuning, laboratory blanks, replicates, laboratory control spikes, and other applicable QC as defined by the methods.

Samples will be collected, handled, and shipped to the selected laboratory in accordance with the guidelines presented in SAP Worksheets #26 and #27 and SOP *Sample Handling and Custody* SOP Wood-11 (PFAS) (Attachment 2). Field QC samples and MS/MSD samples will be submitted and analyzed as directed in SAP

Worksheets #12 and #20. Details of QC sample requirements are further presented in SAP Worksheet #28.

Field blanks will be collected by pouring laboratory provided PFAS-free water into an empty-shipped sample bottle while in the field. The field blank will be shipped back to the laboratory with the rest of the samples and analyzed for PFAS by LC/MS/MS compliant with DoD *QSM Version 5.3*.

14.12 Surveying

Soil borings and newly installed groundwater monitoring wells will be surveyed by a California state-licensed land surveyor. The geographical coordinates with the corresponding projection system and elevations will be collected with a minimum accuracy of ± 0.01 foot. Elevations will be surveyed relative to mean sea level.

14.13 Investigation-Derived Waste Management

IDW generated during the field activities will include purged groundwater, soil from drilling activities, decontamination fluids, PPE, and other disposable sampling materials. Pending characterization, soil IDW will be stored onsite in a secure and controlled area. IDW will be containerized in DOT-approved lined rolloff bins or drums and appropriately labeled until waste characterization is complete. The rolloff bins or drums will include a lockable cover to secure IDW when work is not occurring. Aqueous IDW will be stored in 55-gallon drums. Each container of IDW generated will have a self-adhesive label affixed to the outside of the container. At a minimum, the label will document the following:

- Waste type (e.g., purge water, decontamination fluids, soil)
- Site name
- The area/boring that the IDW was generated from
- Start date of accumulation
- Estimated quantity in container (e.g., 50 gallons)
- A contact name and telephone number as an emergency contact

Multi-MAC JV will verify and document that the rolloff bins and drums are sealed and that the material is transported to a safe staging area upon completion of the IDW containment. The IDW will be stored at the staging area until analytical results are received prior to disposal.

All IDW will be characterized in accordance with applicable U.S. EPA and state regulations as discussed in Section 4.5 of the Phase I RI Work Plan. Multi-MAC JV will sample and profile containerized IDW for transportation and disposal offsite in accordance with the requirements of the disposal facility, and as summarized below.

IDW aqueous and soil samples will be analyzed for some or all of the following parameters to characterize the waste for disposal:

- Volatile organic compounds (VOCs) using U.S. EPA Test Method 8260B
- Total petroleum hydrocarbons (TPH) as gasoline and diesel by U.S. EPA Method 8015D
- PFAS by LC/MS-MS Compliant with DoD *QSM Version 5.3* Table B-15
- California Administrative Manual (CAM) 17 metals (soil only) by U.S. EPA Methods 6010B//7471A

If aqueous IDW contains PFAS concentrations of PFOA and PFOS that are above 0.07 µg/L, treatment may be required prior to disposal. Once waste characterization results are received, Multi-MAC JV will discuss disposal options with NAVFAC SW and will coordinate disposal with the waste transporter and receiving facility. In addition, all aqueous and soil waste profiles and manifest will state that the IDW generated as part of the Phase I RI activities may contain PFAS.

Additional analysis may be required by the receiving facility based on the initial sampling results. Analytical results will be provided to the DON in addition to the completed waste manifests.

A small amount of nonhazardous PPE and sampling equipment IDW will be generated during the fieldwork. Used PPE may consist of protective coveralls, nitrile gloves, and other disposable gear associated with field activities. Sampling equipment may include such items as sampling tools, cleaning/decontamination equipment, and used paper towels. Used PPE will be stored onsite, double-bagged, and disposed of along with other nonhazardous solid waste pending the analytical results of the field samples. Disposal of IDW will be performed within 90 days of waste generation. The removal of IDW to an offsite disposal facility will be coordinated with the NAVFAC SW RPM.

14.14 Data Management Review

Data from this sampling effort will be generated from three primary pathways: field activities, laboratory analytical data, and validated data. Data from all three pathways will be submitted to the Navy Electronic Data Deliverable (NEDD)/NIRIS website in accordance with the data format described in EWI #6, *Environmental Data Management and Required Electronic Delivery Standards* (NAVFAC SW, 2021).

Data generated during field activities will be recorded using a field logbook and field forms. The field manager will review these forms for compliance with QC criteria established in the SAP for completeness and accuracy.

Upon sample arrival, the analytical laboratory will verify each sample's physical condition and ensure that all pertinent documentation associated with each sample is complete. Data generated from the laboratory analysis will be recorded in hardcopy and in electronic data deliverables for submission to the DON NEDD/NIRIS database. Analytical laboratory staff will verify the data according to the process described in Worksheet #34. The laboratory quality assurance (QA) director will review the data before they are submitted for third-party data validation. Details on data validation are provided in Section 14.15 and in SAP Worksheets #35 through 37.

Pertinent data (i.e., geological, spatial, and temporal descriptions) from the field records and third-party-validated electronic data deliverables will then be entered into the DON's NEDD/NIRIS web-based database. Through the web-based system, the data can be compiled rapidly, plotted in GIS and reviewed for changes in target analyte concentrations at each sampling point. Hardcopy field records will be stored in a secure project file.

14.15 Third-Party Data Validation

Data generated for this project will be reviewed and verified by the Multi-MAC JV chemist and validated by Laboratory Data Consultants, Inc. (LDC), an independent, third-party data validation laboratory located in Carlsbad, California. The data validation process and criteria are described in Worksheets #35 through 37. These requirements are established in accordance with EWI #1, *Data Validation Guidelines for Chemical Analysis of Environmental Samples* (NAVFAC SW, 2001), Laboratory SOPs, the DoD *QSM Version 5.3* (DoD, 2019a), *General Data Validation Guidelines, Revision 1* (DoD, 2019b), and the DoD *Data Validation Guidelines Module 3* (DoD, 2020) (Attachment 3).

The data set will be independently validated using the measurement performance criteria (Worksheet #12) and criteria in Worksheets #24 and #28, and using the guidelines in Worksheet# 36. To provide a thorough review of the analytical results, 100 percent of the data are subjected to a Stage 4 validation (DoD, 2020). The validator will perform calculation checks for these data and the data for the associated laboratory QC samples. The data validator will also facilitate uploading the validated data into the NEDD/NIRIS database in accordance with EWI #6 (NAVFAC SW, 2021).

Stage 4 data validation follows the guidelines in the *General Data Validation Guidelines, Revision 1* (DoD, 2019b) and *Data Validation Guidelines, Module 3* (DoD, 2020). Stages in the DoD *Data Validation Guidelines, Module 3*, are described below (Stage 1 through Stage 4). These guidelines apply to analytical data packages that include the raw data (e.g., spectra and chromatograms) and backup documentation for calibration standards, analysis run logs, laboratory control samples (LCSs), dilution factors, and other types of information.

This additional information is used in the Stage 4 data validation process:

Stage 1: Includes review for representativeness (compliance with required analytical protocols outlined in the SAP), completeness, and project sensitivity needs. The following is an inclusive list in accordance with the DoD *Data Validation Guidelines, Module 3* (DoD, 2020):

- Cover sheet
- Table of contents
- Case narrative
- Sampling results forms, or equivalent laboratory report
- Transition ion summary
- COC forms, laboratory receipt checklists, and other supporting records
- Field QC forms and supporting records

Stage 1 includes the validation of investigation and field QC samples.

Stage 2A: Includes all of Stage 1 and requires the review and qualification of the summary documentation. The following is an inclusive list in accordance with the DoD *Data Validation Guidelines, Module 3* (DoD, 2020):

- Ion ratio summary
- Extracted internal standard recovery summary
- LCS/LCS duplicate recovery and relative percent difference (RPD) summary
- MS/MSD recovery and RPD summary
- Post-spike sample recovery summary
- Method blank summary form
- Dilution/reanalysis summary

Both LCS/LCSD and MS/MSD RPD acceptance criteria will be evaluated against the MS/MSD RPD stated in the *QSM Version 5.3* (≤ 30 percent). Stage 2A is the validation of preparation batch-specific QC data in addition to any sample-specific parameters included in Stage 1.

Stage 2B: Includes all of Stages 1 and 2A and requires the review and qualification of the summary documents for each instrument. The following is an inclusive list in accordance with the DoD *Data Validation Guidelines, Module 3* (DoD, 2020):

- Sequence and preparation logs (or equivalent to include instrument blanks)
- Instrument performance check summary (mass calibration verification)

- Initial calibration summary (any equivalent to include the initial calibration analyte responses, isometric profiles, average response factors, and regression)
- Instrument blank summary
- Initial/continuing calibration verification (CCV) and instrument sensitivity check summaries (any equivalent to include initial and CCV and instrument sensitivity checks)

Stage 2B adds for review, the validation of instrument-specific QC data.

Stage 3: Includes all of Stages 1, 2A, and 2B. The following is an inclusive list in accordance with the DoD *Data Validation Guidelines, Module 3* (DoD, 2020):

- Raw data (including any laboratory forms, instrument outputs, spreadsheets, or handwritten calculations necessary for recalculation and requantification).
- Standards traceability forms and worksheets
- Detection limit studies

Stage 3 validation includes the recalculation and requantification of selected samples, and method and instrument QC. The types of results that should be recalculated and requantified include target analytes, analytes with detections above the limit of quantitation (LOQ), and field QC samples (blanks and duplicates). For method QC results, spiked recoveries and method blanks should be considered. For instrument QC, calibrations (including response factors and regressions), calibration verifications, and extracted internal standard (EIS) recoveries should be recalculated and requantified. Some calculations may include the need to review standards preparation and serial dilutions.

Stage 4: Includes Stages 1, 2A, 2B, and 3. The following requirement is in accordance with the DoD *Data Validation Guidelines, Module 3* (DoD, 2020):

- Raw data (including any instrument outputs, mass spectra, or chromatograms).

Stage 4 validation is a qualitative review of nondetected and detected results from instrument outputs. Chromatograms are checked for peak integration (10 percent of automated integration and 100 percent of manual integrations), baseline, and interferences; mass spectra are checked for minimum quantitative ion and qualitative ion signal-to-noise ratio, transition ion ratios, and retention times or relative retention times within method requirements for analyte identification. Raw data quantitation reports and ion transition chromatograms are required to review of the instrument outputs.

Analytical data may be qualified on the basis of data validation reviews. Qualifiers will be consistent with the DoD *Data Validation Guidelines, Module 3* (DoD, 2020) and will be used to provide data users with an estimate of the level of uncertainty associated with the qualified results.

The project team will determine the data usability, in part, based on data validation results with respect to the following qualifiers:

> U – The analyte was not detected and was reported as less than the limit of detection (LOD). The LOD has been adjusted for any dilution or concentration of the sample.
>
> J – The reported result was an estimated value with an unknown bias.
>
> X – The sample results (including nondetects) were affected by serious deficiencies in the ability to analyze the sample and to meet published method and project QC criteria. The presence or absence of the analyte cannot be substantiated by the data provided. The project team will determine the final qualifier for all X-qualified results based on project DQOs and Worksheet #37.
>
> UJ – The analyte was not detected and was reported at a concentration less than the LOD. However, the associated numerical value is approximate.

For any instances in which the validation qualifiers impact the overall data interpretation and project recommendations, the data usability assessment will discuss the issue and the necessary corrective action. Acceptance or rejection of X-qualified data will be decided by the project team, but exclusion of X-qualified data is recommended. Criteria used to evaluate the usability of the data are documented in Worksheet #37.

SAP Worksheet# 15 Reference Limits and Evaluation Table

Matrix: Liquid – Groundwater (PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15)

Analyte	Acronym	CAS Number	Human Health Screening Criteria (µg/L)	Ecological Screening Criteria (µg/L	Selected Screening Criteria Reference	Project Quantitation Limit Goal (µg/L)	Achievable Laboratory Limits		
							LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Required Analyte List[1]									
Perfluorooctanoic acid	PFOA	335-67-1	0.04[2]	4.4[2]	DoD	0.02	0.008	0.004	0.002
Perfluorooctane sulfonate	PFOS	1763-23-1	0.04[2]	0.075[2]	DoD	0.02	0.008	0.004	0.002
Perfluorobutanesulfonic acid	PFBS	375-73-5	0.6[2]	640[2]	DoD	0.3	0.008	0.004	0.002
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	NA	0.016[3]	0.016	0.008	0.004
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	NA	0.016[3]	0.016	0.008	0.004
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	NA	NA	NA	0.04[3]	0.04	0.016	0.008
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	NA	NA	0.016[3]	0.016	0.008	0.004
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	NA	NA	0.016[3]	0.016	0.008	0.004
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	NA	NA	0.016[3]	0.016	0.008	0.004
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	870[2]	Conder (2020)	0.008[3]	0.008	0.004	0.002
Perfluorohexanesulfonic acid	PFHxS	355-46-4	NA	NA	NA	0.008[3]	0.008	0.004	0.002
Perfluorohexanoic acid	PFHxA	307-24-4	NA	210[2]	Conder (2020)	0.008[3]	0.008	0.004	0.002
Perfluorononanoic acid	PFNA	375-95-1	NA	2.2[b]	Conder (2020)	0.008[3]	0.008	0.004	0.002
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	NA	0.008[3]	0.008	0.004	0.002
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	NA	0.008[3]	0.008	0.004	0.002
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	49[2]	Conder (2020)	0.008[3]	0.008	0.004	0.002
Perfluorodecanoic acid	PFDA	335-76-2	NA	140[2]	Conder (2020)	0.008[3]	0.008	0.004	0.002
Perfluorododecanoic acid	PFDoA	307-55-1	NA	72[2]	Conder (2020)	0.008[3]	0.008	0.004	0.002

SAP Worksheet #15 Continued

Notes:

1. All samples collected will be analyzed for PFOA, PFOS, PFBS, EtFOSAA, MeFOSAA, HFPO-DA, 11Cl-PF3OudS, 9Cl-PF3ONS, ADONA, PFHpA, PFHxS, PFHxA, PFNA, PFTeDA, PFTrDA, PFUnA, PFDA, and PFDoA by PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15, based on comparison criteria from the DoD memorandum for PFAS investigation screening criteria (DoD, 2021). The most conservative of the criteria from SAP Worksheet #11 Table 11-1 is depicted (which assumes multiple PFAS will be detected).
2. Based on comparison criteria from the DoD memorandum for PFAS investigation screening criteria (DoD, 2021) for human receptors; and the lower of freshwater chronic ecological screening benchmark protective of exposure to aquatic receptors and values estimated by Conder (2020) to be protective wildlife food chain ingestion for ecological receptors. No benchmarks are currently available for marine environments. However, the current understanding of PFAS toxicity indicates that PFAS are less toxic in saltwater environments; thus, freshwater benchmarks over-predict risks to marine receptors (i.e., freshwater benchmarks are conservative). The most conservative of the criteria from SAP Worksheet #11 Table 11-1 are depicted (which assumes multiple PFAS will be detected).
3. Project quantitation limit (PQL) goal has been set at the LOQ.

µg/L = microgram(s) per liter; CAS = Chemical Abstracts Service; DL = detection limit; LC/MS-MS = liquid chromatography and tandem mass spectrometry; LOD = limit of detection; LOQ = limit of quantitation; NA = not available; U.S. EPA = United States Environmental Protection Agency

SAP Worksheet #15 Continued

Matrix: Solid – Soil (PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15)

Analyte	Acronym	CAS Number	Federal Screening Criteria (mg/kg)	Selected Screening Criteria Reference	Project Quantitation Limit Goal (mg/kg)	Achievable Laboratory Limits		
						LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Required Analyte List [1]								
Perfluorooctanoic acid	PFOA	335-67-1	0.13 [2]	DoD	0.06	0.001	0.0005	0.00025
Perfluorooctane sulfonate	PFOS	1763-23-1	0.13 [2]	DoD	0.06	0.001	0.0005	0.00025
Perfluorobutanesulfonic acid	PFBS	375-73-5	1.9 [2]	DoD	1	0.001	0.0005	0.00025
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	0.001 [3]	0.001	0.0005	0.00025
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	NA	NA	0.0025 [3]	0.0025	0.001	0.0005
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	NA	0.001 [3]	0.001	0.0005	0.00026
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	NA	0.001 [3]	0.001	0.0005	0.00029
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluorohexanesulfonic acid	PFHxS	355-46-4	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	0.001 [3]	0.001	0.0005	0.00027
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	0.001 [3]	0.001	0.0005	0.00025
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	0.001 [3]	0.001	0.0005	0.00025

Notes:

1. All samples collected will be analyzed for PFOA, PFOS, PFBS, EtFOSAA, MeFOSAA, HFPO-DA, 11Cl-PF3OUdS, 9Cl-PF3ONS, ADONA, PFHpA, PFHxS, PFHxA, PFNA, PFTeDA, PFTrDA, PFUnA, PFDA, and PFDoA by PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15. The screening criteria and laboratory limits are in dry-weight basis.
2. Based on comparison criteria from the DoD memorandum for PFAS investigation screening criteria (DoD, 2021). The most conservative of the criteria from SAP Worksheet #11 Table 11-1 are depicted (which assumes multiple PFAS will be detected).
3. Project quantitation limit (PQL) goal has been set at the LOQ.

CAS = Chemical Abstracts Service; DL = detection limit; LC/MS-MS = liquid chromatography and tandem mass spectrometry; LOD = limit of detection; LOQ = limit of quantitation; mg/kg = milligram(s) per kilogram; NA = not available

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SAP Worksheet# 16 Project Schedule/Timeline Table (Optional Format)

The project schedule is presented in a Gantt chart in Figure A-13. The final schedule is contingent on the approval of this SAP by NAVFAC SW and the RWQCB.

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SAP Worksheet# 17 Sampling Design and Rationale

This SAP has been prepared to collect data for the Phase I RI at IR Site 6 to support evaluation of the nature and extent of PFAS in soil and groundwater to support baseline HHRA and ecological screening evaluations. These data will augment previous data collected to evaluate the nature and extent of the release and potential threats to human health and the environment, and support decisions regarding the need for further investigation or remediation activities. Worksheet #17 describes the sampling design and rationale for soil and groundwater sample collection planned to accomplish the project objectives and address the DQOs (Worksheet #11), based on the preliminary CSM (Worksheet #10) for IR Site 6.

Step 7 of the DQOs describes the general sampling plan for obtaining data to address the DQOs, specifically the goals in Step 2 and the associated decision rules in Step 5. This plan consists of collecting discrete soil samples from 45 soil borings and groundwater samples from 24 monitoring wells at IR Site 6. The proposed sampling locations are shown on Figures A-10 and A-11. Note that 15 of the soil sampling locations will be converted to new groundwater monitoring wells. The proposed samples, the sampling depths at each location, and the rationale for the location selected for each sample are provided in Table 17-1.

The general rationale for the sampling locations and depths is to further evaluate the horizontal and vertical nature and extent of PFAS. The sampling locations are designed to provide coverage where previous investigations provided limited or no data (Worksheet #10 Section 10.5) and evaluate suspected contaminant source locations. Soil and groundwater samples will be collected onsite to provide comprehensive coverage, ascertain whether sources of PFAS remain, and provide data necessary to evaluate PFAS migration.

Soil Sampling

The preliminary CSM for IR Site 6 was used to select sampling locations. A total of 45 shallow soil samples will be collected. A total of 45 soil borings will be advanced to collect a subsurface soil sample at a depth of approximately 4–6 feet bgs at each boring location. A total of 15 of the 45 soil boring locations will be converted to groundwater monitoring wells. Boring locations may be adjusted in the field because of site features such as markings on the ground or building walls, repairs to the pavement or building walls, decommissioned utilities (visible and results from the underground utility clearance), and existing utilities. A description of soil sampling methods is presented in Worksheet #14.

Groundwater Sampling

The preliminary CSM for IR Site 6 was used to select sampling locations to define the nature and extent of PFAS in groundwater. A total of 15 groundwater samples from newly installed groundwater monitoring wells and 9 groundwater samples from 9 existing monitoring wells will be collected. Groundwater is anticipated to be first encountered at depths from approximately 4–6 feet bgs.

Groundwater elevations and samples will be collected using the procedures in Worksheet # 14. Worksheet #18 presents the sampling locations, matrices, and analytical methods for soil and groundwater samples.

SAP Worksheet #17 Continued

Table 17-1: Rationale for Remedial Investigation Sampling Locations at IR Site 6

Sampling Location[1]	Soil Sampling Depth [2,3,4] (feet bgs)	Groundwater Sampling Depth [5] (feet bgs)	Sampling Location Rationale [6]
06-SB63	0–2 4–6	None	• Evaluate the nature and extent of previously reported soil impacts in an area adjacent to stormwater line. • Location of PFAS detection greater than screening level in groundwater monitoring well 06-MW32. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB64	0–2 4–6	None	• Evaluate the nature and extent of previously reported soil impacts in an area adjacent to stormwater line. • Location adjacent to groundwater monitoring well 06-MW34 with PFAS detection greater than screening level in groundwater. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB65	0–2 4–6	None	• Characterize potential PFAS release area in soil within a former portable aircraft area and evaluate residual PFAS potentially remaining onsite. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB66	0–2 4–6	None	• Characterize potential PFAS release area in soil at the suspected former burn pit and evaluate residual PFAS potential remaining onsite. • Collect 2 subsurface samples for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB67	0–2 4–6	None	• Characterize potential PFAS release area in soil at the former helicopter training area and evaluate residual PFAS potentially remaining onsite. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB68	0–2 4–6	None	• Characterize potential PFAS release area in soil along the former "L"-shaped collector trench used to collect and convey wastewater runoff from training exercises to sumps and surge pits along the eastern side of the site. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB69	0–2 4–6	None	• Characterize potential PFAS release area in soil at a former burn area and former firefighting structure/building and evaluate residual PFAS potentially remaining onsite. • Location adjacent to groundwater monitoring well 06-MW31 with PFAS detection greater than screening level in groundwater. • This area was previously excavated to a depth of 0.5 foot bgs; thus, the samples will be collected below the backfill material. This interval will be verified to be at a depth below the excavation/fill prior to sampling.
06-SB70	0–2 4–6	None	• Characterize a potential secondary potential PFAS release area in soil in a former oil-water separator downstream of the Collector Trench.
06-SB71	0–2 4–6	None	• Characterize a potential PFAS release area in soil in a former burn area. • Evaluate the extent of previously reported PFAS in soil at 06-SB62. • Collect 2 subsurface samples for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB72	0–2 4–6	None	• Characterize a potential source of PFAS in soil in the southern portion of the former "L"-shaped collector trench used to collect and convey wastewater runoff from training exercises to sumps and surge pits along the eastern side of the site.
06-SB73	0–2 4–6	None	• Evaluate the nature and extent of PFAS impacts in soil in area that is tidally influenced. • Evaluate potential source of soil impacts along a stormwater line preferential pathway. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB74	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil adjacent to previous soil excavation at the northwestern boundary of IR Site 6 adjacent to a previous soil excavation area. • Evaluate potential source of soil impacts along a water line preferential pathway.
06-SB75	0–2 4–6	None	• Evaluate the nature and extent of PFAS impacts in soil downgradient of a former Burn Area and petroleum excavation area in the northern downgradient boundary of IR Site 6. • Evaluate the potential source of soil impacts along a stormwater line preferential pathway.
06-SB76	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the northeastern boundary of IR Site 6. • Characterize a previous petroleum excavation area that may be associated with fuel storage in above storage tank and/or firefighting activities at a former burn area.
06-SB77	0–2 4–6	None	• Characterize a potential source of PFAS in soil impacts in a former Burn Area and evaluate residual PFAS potentially remaining onsite. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-SB78	0–2 4–6	None	• Evaluate potential source of soil impacts along a stormwater line preferential pathway.
06-SB79	0–2 4–6	None	• Characterize a secondary potential PFAS release area in soil in the forward oil-water separator downstream of the "L"-shaped collector trench used to collect wastewater runoff from training exercises.
06-SB80	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil south of a suspected former burn pit. • Delineate previous soil detections of PFAS that were above the soil screening values in boring 06-SB59.
06-SB81	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the former AFFF Station in the northern boundary of the central training areas adjacent to the V-ditch collector trench.

SAP Worksheet #17 Continued

Table 17-1: Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Sampling Location[1]	Soil Sampling Depth[2,3,4] (feet bgs)	Groundwater Sampling Depth[5] (feet bgs)	Sampling Location Rationale[6]
06-SB82	0–2 4–6	None	• Delineate previous soil detections of PFAS that were above the soil screening values in boring 06-SB61. • Characterize potential PFAS release areas at former burn areas.
06-SB83	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the eastern boundary of former central firefighting training areas and former excavations. • Evaluate potential source of soil impacts along a stormwater line preferential pathway.
06-SB84	0–2 4–6	None	• Characterize a secondary potential PFAS release area in soil in the smothering pit downstream of the “L”-shaped collector trench used to collect wastewater runoff from training exercises.
06-SB85	0–2 4–6	None	• Characterize potential PFAS release area in soil at a former firefighting structure/building and evaluate residual PFAS potentially remaining onsite.
06-SB86	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the western boundary of former central firefighting training areas.
06-SB87	0–2 4–6	None	• Characterize a secondary potential PFAS release area in soil in the alternative oil-water separator downstream of the “L”-shaped collector trench used to collect wastewater runoff from training exercises.
06-SB88	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southeastern boundary of IR Site 6. • Characterize previous excavation areas associated with central firefighting area and adjacent to a water utility line.
06-SB89	0–2 4–6	None	• Characterize previous petroleum excavation area that may be associated with fuel storage in aboveground storage tank and/or firefighting activities at a former burn area.
06-SB90	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southern boundary of IR Site 6. • Characterize soil adjacent previous excavation areas and a stormwater line preferential pathway.
06-SB91	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southern downgradient boundary of IR Site 6. • Characterize soil adjacent to preferential pathways including a stormwater line and water line.
06-SB92	0–2 4–6	None	• Evaluate the nature and extent of PFAS in soil at the southern downgradient boundary of IR Site 6.
06-MW25	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater.
06-MW26*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW30	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater.
06-MW31*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW32*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW33*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW34*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW35*	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW36	None	5–15	• Support groundwater monitoring of a location with PFAS previously detected at a concentration greater than screening level in groundwater.
06-MW37*	0–2 4–6	5–15	• Delineate cross-gradient and downgradient extent of potential PFAS impacts in soil and groundwater. • Monitoring well location is cross-gradient of PFAS detection greater than screening level in groundwater monitoring well 06-MW34 and Hydropunch HP09. • Monitoring well location is within the assumed tidal mixing zone of 60 feet and will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW38*	0–2 4–6	5–15	• Delineate cross-gradient and downgradient extent of potential PFAS impacts in soil and groundwater. • Location is adjacent to a sewer line and is cross-gradient of PFAS detection greater than screening level in groundwater monitoring wells 06-MW34 and 06-MW35. • Monitoring well location is within the assumed tidal mixing zone of 60 feet and will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.

SAP Worksheet #17 Continued

Table 17-1: Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Sampling Location[1]	Soil Sampling Depth[2,3,4] (feet bgs)	Groundwater Sampling Depth[5] (feet bgs)	Sampling Location Rationale[6]
06-MW39*	0–2 4–6	5–15	• Delineate downgradient extent of previously reported PFAS impacts in soil and groundwater in area where tidal influences may impact groundwater flow. • Monitoring well location is within the assumed tidal mixing zone of 60 feet and will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing. • Location is downgradient of potential PFAS release in the Collector Trench and Surge Pit, and is downgradient of monitoring well 06-MW32, where the highest concentrations of PFAS were reported in groundwater.
06-MW40*	0–2 4–6	5–15	• Delineate downgradient extent of potential PFAS release in the central training area. • Location is adjacent to a sewer line and is cross-gradient of PFAS detection greater than screening level in groundwater monitoring wells 06-MW34 and 06-MW35. • Monitoring well location will be used in the tidal study to evaluate groundwater-surface interaction. • Collect 2 subsurface samples for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-MW41	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the northwestern boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Monitoring well location is just upgradient to previous excavation to remove contaminants associated operation of the former training school.
06-MW42	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the western boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Monitoring well location is adjacent to PFAS detection greater than screening level in Hydropunch HP05.
06-MW43	0–2 4–6	5–15	• Delineate the nature and extent of potential PFAS release to soil and its potential release to groundwater in a former Burn Area. • Location is adjacent to the highest detected PFAS concentration in soil at soil boring 06-SB61. • Collect 1 subsurface sample for geochemical characterization to support the fate and transport evaluation of PFAS within IR Site 6.
06-MW44*	0–2 4–6	5–15	• Delineate cross-gradient extent of PFAS impacts in soil and groundwater. • Location is adjacent to a water and a sewer line and is adjacent to PFAS detection greater than screening level in Hydropunch HP07. • Monitoring well will be used in the tidal study to evaluate groundwater-surface interaction and potential tidal mixing.
06-MW45	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in area where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient.
06-MW46*	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in area where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient. • Monitoring well location will be used in the tidal study to evaluate groundwater-surface interaction.
06-MW47	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the western boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Location is adjacent to PFAS detection greater than screening level in Hydropunch HP5 within the wastewater treatment plant.
06-MW48	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in southwestern boundary where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient.
06-MW49	0–2 4–6	5–15	• Evaluate upgradient characterization of potential PFAS impacts in soil and groundwater at the northwestern boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Location is cross gradient to PFAS detection greater than screening level in Hydropunch HP01 and Hydropunch HP2.
06-MW50	0–2 4–6	5–15	• Provide upgradient groundwater quality information for PFAS impacts in soil and groundwater in area where tidal influences are not likely to have an impact on groundwater flow. • Monitoring well will be used to establish local groundwater gradient. • Location is cross gradient to reported PFAS impacts in soil and groundwater at IR Site 6, and PFAS detection greater than screening levels in Hydropunch HP12 and Hydropunch HP 13 within the wastewater treatment plant.
06-MW51	0–2 4–6	5–15	• Evaluate cross gradient characterization of potential PFAS impacts in soil and groundwater at the northeastern boundary of IR Site 6. • Monitoring well will be used to establish local groundwater gradient. • Location will confirm delineation of PFAS impacts in groundwater adjacent to Hydropunch HP10 where PFAS was not detected.
Total Number of Samples	**90**	**24**	

SAP Worksheet #17 Continued

Table 17-1: Rationale for Remedial Investigation Sampling Locations at IR Site 6 (continued)

Notes:

* Monitoring well will be used in the tidal study.

1. If multiple boreholes are needed to obtain samples of the different matrices (soil and groundwater) at a location, then a sequential letter designation will follow the number for each borehole, e.g.: 06-SB63-SO-02A etc.
2. Groundwater is at approximately 6 feet bgs; unless otherwise noted in the rationale, soil samples are targeted to be within the interval from 0–6 feet bgs, typically used for exposure for risk assessments.
3. Depth indicated is the top depth of the sample. The proposed sampling depth is estimated and may be adjusted slightly as appropriate based on actual field conditions (e.g., encountering fill material used during previous remedial actions) during the drilling and sampling.
4. Soil sampling from borings is described in Sections 4.2.1 and 4.2.2 of the Work Plan and in SAP Worksheet #14 Section 14.4.
5. Groundwater monitoring well construction is described Section 4.3 of the Work Plan and in SAP Worksheet #14 Section 14.5.
6. Analytical groups for each sampling location are listed Sections 4.2.4 and 4.3.2 of the Work Plan and in SAP Worksheet #18 Table 18-1.

bgs = below ground surface; bss = below sediment surface; IR = Installation Restoration; PFAS = per-and polyfluoroalkyl substances; SAP = Sampling and Analysis Plan

SAP Worksheet# 18 Sampling Locations and Methods/SOP Requirements Table

All sampling locations are identified in Table 18-1. Sampling activities, described in Worksheet #18, will be conducted in compliance with the sampling procedures and guidelines in Worksheet #14. SAP Worksheet #17 Table 17-1 and Worksheet #17 provide the proposed sampling plan, and Table 18-1 describes the sampling details for field implementation. The screen intervals for new groundwater monitoring wells planned for installation are estimated and are subject to change based on the final monitoring well design.

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SAP Worksheet #18 Continued

Table 18-1: Sample Identification

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
Soil Borings						
06-SB63-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB64-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB65-SO-DEP-YYYYMMDD	Soil	NA	0-2, 5–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB66-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB67-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB68-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB69-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB70-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB71-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB72-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB73-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB74-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB75-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-SB76-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB77-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB78-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB79-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB80-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB81-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB82-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB83-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB84-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB85-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB86-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB87-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB88-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB89-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-SB90-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB91-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-SB92-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
Monitoring Wells						
06-MW25-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW26-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW30-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW31-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW32-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW33-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW34-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW35-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW36-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW37-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-MW37-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW38-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW38-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW39-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW39-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW40-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW40-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW41-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW41-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW42-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW42-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW43-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW43-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW44-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-MW44-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW45-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW45-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW46-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW46-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW47-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW47-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW48-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW48-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW49-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW49-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW50-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21
06-MW50-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
06-MW51-SO-DEP-YYYYMMDD	Soil	NA	0–2, 4–6	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	2	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-MW51-GW-YYYYMMDD	Groundwater	5–15	NA	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	1	Worksheets #14 and #21
Soil Geochemical Analyses						
06-SB63-SO-DEP-YYYYMMDD	Soil	NA	4–6 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	1	Worksheets #14 and #21
06- SB64-SO-DEP-YYYYMMDD	Soil	NA	4–6 [2]	M Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	1	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-SB65-SO-DEP-YYYYMMDD	Soil	NA	4–6 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	1	Worksheets #14 and #21
06-SB66-SO-DEP-YYYYMMDD	Soil	NA	0–2; 4–6 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	2	Worksheets #14 and #21
06-SB67-SO-DEP-YYYYMMDD	Soil	NA	4–6 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	1	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-SB68-SO-DEP-YYYYMMDD	Soil	NA	0–2 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854)	1	Worksheets #14 and #21
06-SB71-SO-DEP-YYYYMMDD	Soil	NA	0–2; 4–6 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	2	Worksheets #14 and #21
06-SB73-SO-DEP-YYYYMMDD	Soil	NA	4–6 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	1	Worksheets #14 and #21

SAP Worksheet #18 Continued

Table 18-1: Sample Identification (continued)

Sample ID	Matrix	Estimated Groundwater Monitoring Well Screen Interval (feet bgs)	Estimated Soil Sampling Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
06-SB77-SO-DEP-YYYYMMDD	Soil	NA	0–2 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854)	1	Worksheets #14 and #21
06-MW40-SO-DEP-YYYYMMDD	Soil	NA	0–2; 4–6 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854), effective porosity (California State Water Resources Control Board), saturated hydraulic conductivity (ASTM D5084)	2	Worksheets #14 and #21
06-MW43-SO-DEP-YYYYMMDD	Soil	NA	0–2 [2]	Moisture content (ASTM D2216), dry density (ASTM D2937), total organic carbon (Walkley-Black), pH (ASTM D4972), cation exchange/anion exchange (ASTM D7503), particle size analysis (ASTM D422), specific gravity (ASTM D854)	1	Worksheets #14 and #21

Notes:

1. SOPs are on file at the laboratory.
2. Geochemical analysis will be performed on one sample within the sampling interval based on field observation.

ASTM = ASTM International; bgs = below ground surface; DEP = depth; GW = groundwater; ID = identification; IR = Installation Restoration; LC/MS-MS = liquid chromatography/tandem mass spectroscopy; NA = not applicable; PFAS = per- and polyfluoroalkyl substances; QSM = Quality Systems Manual; SO = soil; SOP = standard operating procedure; YYYYMMDD = year month day

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SAP Worksheet# 19 Analytical SOP Requirements Table

Table 19-1 presents laboratory-specific analytical SOP requirements.

Table 19-1: Analytical SOP Requirements

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Containers (number, size, and type)	Sample volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (extraction/ analysis)
Aqueous	PFAS	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15 / OP 069.4/MS019.4	2 x 250 mL HDPE bottle unpreserved (one as back-up)	250 mL	≤10°C for up to 48 hours after sampling, then ≤ 6°C	14/28 days
Solid	PFAS	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15 / QA034.09/OP070.4/MS019.4	4-ounce HDPE jar	10 grams	≤10°C for up to 48 hours after sampling, then ≤ 6°C	14/60 days

Notes:
ºC = degree(s) Celsius; HDPE =high-density polyethylene; LC/MS-MS = liquid chromatography tandem mass spectrometry; mL = milliliter(s); PFAS = per- and polyfluoroalkyl substances; QSM = Quality Systems Manual; SOP = standard operating procedure

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SAP Worksheet# 20 Field Quality Control Sample Summary Table

Matrix	Analytical Group	Number of Samples[1]	Number of Field Duplicates (10%)[2]	Number of MS/MSDs (5%)[3]	Number of Field Blanks[4]	Number of Equip. Blanks[5]	Number of Temperature Blanks[6]	Total Number of Samples to Lab
Groundwater	PFAS	24	3	2	3	3	One per cooler	35
Soil	PFAS	90	0	5	0	10	One per cooler	104

Notes:

1. Samples will be collected in accordance with Worksheet #18.
2. Field duplicates will not be collected for soil samples (see Worksheet #14, Section 14.11). Field duplicates for groundwater samples will be collected at a frequency of 1 per 10 samples, or 10%.
3. MS/MSD samples will be collected at a rate of 1 per 20 samples, or 5%.
4. Field blanks will not be collected for soil samples. Field blank is a sample of PFAS-free water supplied by the laboratory that is transferred from one sample container directly into another sample container in the field and will be collected at a frequency of one per day of groundwater sampling or 1 per 20 samples, whichever is more frequent.
5. Equipment Blank: An equipment blank (rinsate blank) is used to assess the effectiveness of decontamination procedures for reusable sampling equipment. Collected at a frequency of one per day per method of sample collection.
6. One temperature blank per cooler is provided by the laboratory.

MS = matrix spike; MSD = matrix spike duplicate; PFAS = per- and polyfluoroalkyl substances

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SAP Worksheet# 21 Project Sampling SOP References Table

All project-specific tasks and procedures are detailed within SAP Worksheets #14 and #17. Attachment 2 presents the field SOPs for collection of groundwater and soil samples for PFAS analysis. These field SOPs are summarized below.

SOP # or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Yes/No	Comments
Wood-01	Field Sampling Protocols to Avoid Cross-Contamination of PFAS, Rev. 4, 12/21/2020	Wood	NA	No	NA
Wood-02	Soil Sampling, Rev. 2, 12/21/2020	Wood	Surface (shovel or spoon); subsurface (split-spoon)	No	NA
Wood-03	Groundwater Sampling, Rev. 2, 12/21/2020	Wood	Peristaltic pump, electric submersible pump, bailer	No	NA
Wood-04	Monitoring Well Installation, Rev. 2, 12/21/2020	Wood	NA	No	NA
Wood-05	Monitoring Well Development, Rev. 2, 12/21/2020	Wood	NA	No	NA
Wood-06	Borehole Abandonment, Rev. 2, 12/21/2020	Wood	NA	No	NA
Wood-10	Equipment Decontamination, Rev. 1, 12/21/2020	Wood	NA	No	NA
Wood-11	Sample Handling and Custody, Rev. 1, 12/21/2020	Wood	NA	No	NA
Wood-12	Protocol to Provide Water Free of Perfluorinated Compounds for Collection of Field Blanks and Equipment Blanks, Rev. 2, 12/21/2020	Wood	NA	No	Incorporates PFAS protocols

Notes:

NA = not applicable; PFAS = per- and polyfluoroalkyl substances; SOP = standard operating procedure

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SAP Worksheet# 22 Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment[1]	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person[1]	SOP Reference[2]	Comments
YSI ProDSS 4 (Water Quality Meter)	Visual Inspection	Daily, prior to sampling activity	Parts and materials should not be damaged.	If there is any damage, contact YSI customer service center	Field Team Lead	YSI ProDSS User Manual	–
	Maintenance and Charging	Daily, prior to sampling activity. Maintenance check at end of day	Clean keypad, connectors, ports and sensors. Battery should be charged at least 50% prior to the start of field work.	Wipe with dampened cloth. It is recommended to recharge the instrument upon returning from fieldwork	Field Team Lead	YSI ProDSS User Manual	–
	Calibration	Daily, prior to sampling activity and as needed	Conductivity (freshwater 1,000 to 10,000 µS; salt water 50,000µS) True (uncorrected) barometer reading = 760 mmHg DO, pH, ORP and depth- white line on graph shows no significant change for 40 seconds Turbidity- 1 point (0-1 NTU); 2-point (5-200 NTU); 3-point (400-4200 NTU) Instrument readings within 10 percent of all manufacturer-provided calibration solutions (DO, conductivity, pH, ORP, and turbidity).	Recalibrate until acceptable range or return to manufacturer for repair	Field Team Lead	YSI ProDSS User Manual	–

SAP Worksheet #22 Continued

Field Equipment[1]	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person[1]	SOP Reference[2]	Comments
RAE MiniRAE 3000 PID	Visual Inspection	Daily, prior to sampling activity	Within manufacturer's recommended values	Operator correction or return to manufacturer for repair.	Field Team Lead	MiniRAE 3000, ppbRAE 3000, Basic Operation Pocket Reference. PN: 059-4030-000-D, Rev. B August 2010 (Attachment 2)	–
	Maintenance and Charging	Daily, prior to sampling activity. Maintenance check at end of day	Within manufacturer's recommended values. Battery should be charged at least 50% prior to the start of field work.	Operator correction or return to manufacturer for repair. It is recommended to recharge the instrument upon returning from fieldwork.	Field Team Lead	MiniRAE 3000, ppbRAE 3000, Basic Operation Pocket Reference. PN: 059-4030-000-D, Rev. B August 2010 (Attachment 2)	–
	Calibration	Daily, prior to sampling activity and as needed	Within manufacturer's recommended values	Recalibrate until acceptable range or return to manufacturer for repair.	Field Team Lead	MiniRAE 3000, ppbRAE 3000, Basic Operation Pocket Reference. PN: 059-4030-000-D, Rev. B August 2010 (Attachment 2)	–
	Testing	Daily, during sampling activity	Within manufacturer's recommended values Instrument readings within 10 percent of manufacturer-provided calibration gas (isobutylene).	Operator correction or return to manufacturer for repair.	Field Team Lead	MiniRAE 3000, ppbRAE 3000, Basic Operation Pocket Reference. PN: 059-4030-000-D, Rev. B August 2010 (Attachment 2)	–

Notes:

1. Rental equipment and instruments are frequently used in the field by Multi-MAC JV. The rental firms will be responsible for the proper care, maintenance, and repair of these items, and for tracking and documenting equipment and instrument maintenance and repairs. Multi-MAC JV will be responsible for validating the usability of rental equipment when rented.
2. Manufacturer calibration and operating instructions are provided in Attachment 2.

µS = microSiemen(s); DO = dissolved oxygen; mmHg = millimeters of mercury; Multi-MAC JV =Multi-MAC Joint Venture; NTU = nephelometric turbidity unit(s);
ORP = oxidation reduction potential; PID = photoionization detector; SOP = standard operating procedure

SAP Worksheet# 23 Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?[1] (Yes/No)
MS019.4	Analysis of Per- and Polyfluorinated Alkyl Substances by LC/MS/MS and Isotope Dilution, References LC/MS/MS and QSM 5.3 Table B-15, Rev. Date 10/2019	Definitive	PFAS in aqueous and solids	LC/MS-MS	SGS Orlando	No
QA034.09	Procedure for Obtaining Representative Solid Sample Aliquots (Homogenization), Rev. Date 06/2020	Definitive	PFAS in solids	NA- preparation method	SGS Orlando	No
OP 069.4	Standard Operating Procedure for the Extraction of Per- and Polyfluorinated Alkyl Substances from Water Samples for LC/MS/MS Analysis, Rev. Date 02/2020	Definitive	PFAS in aqueous	NA- preparation method	SGS Orlando	No
OP 070.4	Standard Operating Procedure for the Extraction of Per- and Polyfluorinated Alkyl Substances from Soil Samples for LC/MS/MS Analysis, Rev. Date 02/2020	Definitive	PFAS in solids	NA- preparation method	SGS Orlando	No

Notes:

1. Analytical laboratory SOPs are on file at the laboratory.

LC/MS-MS = liquid chromatograph/tandem mass spectrometry; NA = not applicable; PFAS = per- and polyfluoroalkyl substances; QSM = Quality Systems Manual; SOP = standard operating procedure

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SAP Worksheet# 24 Analytical Instrument Calibration Table

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	Aqueous Sample Preparation	Each sample and associated batch QC samples.	SPE must be used unless samples are known to contain high PFAS concentrations (e.g., AFFF formulations). Inline SPE is acceptable. Entire sample plus bottle rinsate must be extracted using SPE. Known high PFAS concentration samples require serial dilution be performed in duplicate. Documented project approval is needed for samples prepared by serial dilution as opposed to SPE	NA	NA	Analyst	Samples with > 1% solids may require centrifugation prior to SPE extraction. Pre-screening of separate aliquots of aqueous samples is recommended.	OP069,4
LC/MS-MS	Solid Sample Preparation	Each sample and associated batch QC samples.	Entire sample received by the laboratory must be homogenized prior to subsampling.	Flagging is not appropriate.	NA	Analyst	NA	OP070.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	Sample Cleanup Procedure	Each sample and associated batch QC samples. Not applicable to AFFF and AFFF Mixture Samples.	ENVI-Carb™ or equivalent must be used on each sample and batch QC sample.	Flagging is not appropriate.	NA	Analyst	Cleanup should reduce bias from matrix interferences.	OP069.4 and OP070.4
LC/MS-MS	Mass Calibration	Instrument must have a valid mass calibration prior to any sample analysis. Mass calibration is verified after each mass calibration, prior to ICAL.	Calibrate the mass scale of the mass spectrometer with standard calibration compounds and procedures described by the manufacturer. Mass calibration range must bracket the ion masses of interest. The most recent mass calibration must be used for every acquisition in an analytical run. Mass calibration must be verified to be ±0.5 amu of the true value, by acquiring a full scan continuum mass spectrum of a PFAS stock.	Flagging is not appropriate.	If the mass calibration fails, then recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance.	Analyst	Problem must be corrected. No samples may be analyzed under a failing mass calibration. The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses fall outside of the ±0.5 amu of the true value, major instrument maintenance is performed, or the instrument is moved).	MS019.4
LC/MS-MS	Mass Spectral Acquisition Rate	Each analyte, EIS analyte.	A minimum of 10 spectra scans are acquired across each chromatographic peak.	NA	NA	Analyst	NA	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	Calibration, Calibration Verification, and Spiking Standards	All analytes	Standards containing both branched and linear isomers must be used when commercially available. PFAS method analytes may consist of both branched and linear isomers, but quantitative standards that contain the linear and branched isomers do not exist for all method analytes. For PFAS that do not have a quantitative branched and linear standard, identify the branched isomers by analyzing a qualitative standard that includes both linear and branched isomers and determine retention times, transitions and transition ion ratios. Quantitate samples by integrating the total response (i.e., accounting for peaks that are identified as linear and branched isomers) and relying on the ICAL that uses the linear isomer quantitative standard.	NA	NA	Analyst	Standards containing both branched and linear isomers are to be used during method validation and when reestablishing retention times, to ensure the total response is quantitated for that analyte. Technical grade standards cannot be used for quantitative analysis.	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	Sample PFAS ID	All analytes detected in a sample.	The chemical derivation of the ion transitions must be documented. A minimum of two ion transitions (Precursor → quantitation ion and precursor → confirmation ion) and the ion transitions ratio per analyte are required for confirmation. Exception is made for analytes where two transitions do not exist (PFBA and PFPeA). Documentation of the primary and confirmation transitions and the ion ratio is required. In-house acceptance criteria for evaluation of ion ratios must be used and must not exceed 50-150%. S/N must be ≥ 10 for all ions used for quantification and must be ≥ 3 for all ions used for confirmation. Quant ion and confirmation ion must be present and must maximize simultaneously (±2 seconds).	PFAS identified with Ion ratios that fail acceptance criteria must be flagged. Any quantitation ion peak that does not meet the maximization criteria shall be included in the summed integration and the resulting data flagged as “estimated, biased high.”	NA	Analyst	For example: Ion Ratio = (quant ion abundance/ confirm ion abundance) Calculate the average ratio (A) and SD using the ICAL standards. An acceptance range of ratio could be within A ±3 SD for confirmation of detection.	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	Ion Transitions (Precursor-> Product)	Every field sample, standard, blank, and QC sample.	In order to avoid biasing results high due to known interferences for some transitions, the following transitions must be used for the quantification of the following analytes: PFOA: 413 → 369 PFOS: 499 → 80 PFHxS: 399 → 80 PFBS: 299 → 80 4:2 FTS: 327 → 307 6:2 FTS: 427 → 407 8:2 FTS: 527 → 507 NEtFOSAA: 584 → 419 NMeFOSAA: 570 → 419 If these transitions are not used, the reason must be technically justified and Documented (e.g., alternate transition was used due to observed interferences).	Flagging is not appropriate.	NA	Analyst	NA	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	ICAL[2]	At instrument set-up and after ICV or CCV failure, prior to sample analysis.	The isotopically labeled analog of an analyte (EIS analyte) must be used for quantitation if commercially available (isotope dilution quantitation). Commercial PFAS standards available as salts are acceptable providing the measured mass is corrected to the neutral acid concentration. Results shall be reported as the neutral acid with appropriate CAS number. If a labeled analog is not commercially available, the EIS Analyte with the closest retention time or chemical similarity to the analyte must be used for quantitation. (Internal Standard Quantitation) Analytes must be within 70-130% of their true value for each calibration standard. ICAL must meet one of the two options below: Option 1: The RSD of the RFs for all analytes must be ≤ 20%.	Flagging is not appropriate.	Correct problem, then repeat ICAL.	Analyst	No samples shall be analyzed until ICAL has passed. External Calibration is not allowed for any analyte. Calibration can be linear (minimum of 5 standards) or quadratic (minimum of 6 standards); weighting is allowed.	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
			Option 2: Linear or non-linear calibrations must have $r^2 \geq 0.99$ for each analyte.					
LC/MS-MS	RT window position establishment	Once per ICAL and at the beginning of the analytical sequence.	Position must be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA	NA	Analyst	Calculated for each analyte and EIS.	MS019.4
LC/MS-MS	RT window width	Every field sample, standard, blank, and QC sample.	RT of each analyte and EIS analyte must fall within 0.4 minute of the retention time of the midpoint standard in the ICAL or, on days when ICAL is not performed the initial CCV may be used. Analytes must elute within 0.1 minute of the associated EIS. This criterion applies only to analyte and labeled analog pairs.	NA	Correct problem and reanalyze samples.	Analyst	Calculated for each analyte and EIS.	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	ISC	Prior to analysis and at least once every 12 hours.	Analyte concentrations must be at LOQ; concentrations must be within ±30% of their true values.	Flagging is not appropriate.	Correct problem, rerun ISC. If problem persists, repeat ICAL.	Analyst	No samples shall be analyzed until ISC has met acceptance criteria. ISC can serve as the initial daily CCV.	MS019.4
LC/MS-MS	ICV	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Analyte concentrations must be within ±30% of their true value.	Flagging is not appropriate.	Correct problem, rerun ICV. If problem persists, repeat ICAL.	Analyst	No samples shall be analyzed until calibration has been verified.	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	CCV	Prior to sample analysis, after every 10 field samples, and at the end of the analytical sequence.	Concentration of analytes must range from the LOQ to the mid-level calibration concentration. Analyte concentrations must be within ±30% of their true value	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternately, recalibrate if necessary; = reanalyze all associated samples since the last acceptable CCV.	Analyst	Results may not be reported without valid CCVs. ISC can serve as a bracketing CCV.	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte must be ≤ ½ the LOQ. Instrument Blank must contain EIS to enable quantitation of contamination.	Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample left.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If sample concentrations exceed the highest allowed standard and the sample(s) following exceed this acceptance criteria (>1/2 LOQ), they must be reanalyzed.	Analyst	No samples to be analyzed until instrument blank has met acceptance criteria. Note: Successful analysis following the highest standard analyzed determines the highest concentration that carryover does not occur. When the highest standard analyzed is not part of the calibration curve, it cannot be used to extend out the calibration range, it is used only to document a higher concentration at which carryover still does not occur.	MS019.4

SAP Worksheet #24 Continued

Instrument	Quality Control Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	CA	Title/Position Responsible for CA	Comments	SOP Reference[1]
LC/MS-MS	EIS Analytes[3]	Every field sample, standard, blank, and QC sample.	Added to solid sample prior to extraction. Added to aqueous samples, into the original container, prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to final dilution of samples prior to analysis. EIS analyte recoveries must be within 50% to 150% of ICAL midpoint standard area or area measured in the initial CCV on days when an ICAL is not performed.	Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner.	Correct problem. If required, re-extract and reanalyze associated field and QC samples. If recoveries acceptable for QC samples, but not field samples, the field samples must be re-extracted and analyzed (greater dilution may be needed). Samples may be re-extracted and analyzed outside of hold times, as necessary for corrective action associated with QC failure.	Analyst	Failing analytes shall be thoroughly documented in the Case Narrative. EIS should be 96% (or greater) purity. When the impurity consists of the unlabeled analyte, the EIS can result in a background artifact in every sample, standard and blank, if the EIS is fortified at excessive concentrations.	MS019.4, OP069.4, and OP070.4

SAP Worksheet #24 Continued

Notes:

1. All laboratory SOPs are on file at the laboratory. The DoD's *General Validation Guidelines, Revision 1* (2019c) and *Data Validation Guidelines, Module 3* (DoD, 2020) are included in Attachment 3.
2. The instrument is calibrated using both branched and linear compounds.
3. Isotope dilution method is used as an internal standard for quantitation. Internal standards for PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15 are as follows: 13C2-PFOA, 13C8-PFOS, 13C3-PFBS, 13C3-PFBA, 13C3-PFPeA, 13C2-PFHxA, 13C4-PFHpA, 13C3-PFHxS, 13C5-PFNA, 13C8-PFOSA, 13C2-PFDA, d3-MeFOSAA, 13C2-PFUnA, d5-EtFOSAA, 13C2-PFDoA, 13C3-HFPO-DA, and 13C2-PFTeDA.

A = average ratio; AFFF = aqueous film-forming foam; amu = atomic mass unit; CA = corrective action; CCV = continuing calibration verification; EIS = extracted internal standard; FTS = fluorotelomer sulfonic acid; ICAL = initial calibration; ICV = initial calibration verification; ID = identification; ISC = instrument sensitivity check; LC/MS-MS = liquid chromatography and tandem mass spectrometry; LOQ = limit of quantitation; NA = not applicable; NEtFOSAA = N-ethyl perfluorooctanesulfonamidoacetic acid; NMeFOSAA = N-methyl perfluorooctanesulfonamidoacetic acid; PFAS = per- and polyfluoroalkyl substances; PFBA = perfluorobutanoic acid; PFBS = perfluorobutanesulfonic acid; PFDA = perfluorodecanoic acid; PFDoDA = perfluorododecanoic acid; PFHpA = perfluoroheptanoic acid; PFHxA = perfluorohexanoic acid; PFHxS = perfluorohexanesulfonic acid; PFNA = perfluorononanoic acid; PFOA = perfluorooctanoic acid; PFOS = perfluorooctanesulfonic acid; PFPeA = perfluoropentanoic acid; PFTeDA = perfluorotetradecanoic acid; PFTrDA = perfluorotridecanoic acid; PFUnA = perfluoroundecanoic acid; QC = quality control; RF = response frequency; RSD = relative standard deviation; RT = retention time; SD = standard deviation; S/N = signal-to-noise ratio; SOP = standard operating procedure; SPE = solid phase extraction

All analytical instruments will be calibrated, and the calibration acceptance criteria must be met before samples are analyzed. The analytical laboratories will follow calibration procedures that comply with the DoD *QSM Version 5.3*. Calibration standards will be prepared with National Institute for Standards and Testing traceable standards and analyzed per methods requirements.

Worksheet #25 will be used to identify all project-specific analytical instrumentation that requires maintenance, testing, or inspection and to provide the SOP reference number for each.

SAP Worksheet# 25 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Agilent HPLC/MS/MS	Spray chamber, clean capillary	DoD QSM 5-series Table B-15 Perfluorinated compounds	Check tune Leak check Pressure check Mobile phase filters Needle inspection	Need for maintenance determined by passing calibration–see MS019	Passing calibration	Check LC column Run Autotune Check calculations Rerun affected samples	Laboratory Analyst	MS109.4

Notes:

1. All laboratory SOPs are on file at the laboratory.

DoD = United States Department of Defense; HPLC/MS/MS = high-performance liquid chromatography and tandem mass spectrometry; LC = liquid chromatography; QSM = Quality Systems Manual; SOP = standard operating procedure

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SAP Worksheet# 26 Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Sampling Personnel, Multi-MAC JV
Sample Packaging (Personnel/Organization): Field Sampling Personnel, Multi-MAC JV
Coordination of Shipment (Personnel/Organization): Quality Assurance Manager/Project Manager, Multi-MAC JV
Type of Shipment/Carrier: Commercial Express Carrier
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receiving Dept., SGS Orlando (soil/sediment and water samples for PFAS), and EGLab, Inc. (soil samples for geotechnical)
Sample Custody and Storage (Personnel/Organization): Sample Receiving Dept., SGS Orlando (soil/sediment and water samples for PFAS), and EGLab, Inc. (soil samples for geotechnical)
Sample Preparation (Personnel/Organization): Sample Preparation Group, SGS Orlando (soil/sediment and water samples for PFAS), and EGLab, Inc. (soil samples for geotechnical)
Sample Determinative Analysis (Personnel/Organization): Various chemists and technicians, SGS Orlando (soil/sediment and water samples for PFAS), and EGLab, Inc. (soil samples for geotechnical)
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 60 days, or as required on a project-specific basis
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 60 days or as required on a project-specific basis
Biological Sample Storage (No. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodian, SGS Orlando (soil/sediment and water samples for PFAS), and EGLab, Inc. (soil samples for geotechnical)
Number of Days from Reporting: 60 days, or as required on a project-specific basis

Notes:
Multi-MAC JV = Multi-MAC Joint Venture; NA = not applicable; PFAS = per- and polyfluoroalkyl substances

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SAP Worksheet# 27 Sample Custody Requirements Table

27.1 Sample Identification Number

Each sample collected will be assigned a unique sample identification (ID) used to record and report the results. The coded sample ID assignments will use these criteria:

The ID will begin with the IR site number indicating that the sample was collected at that specific IR Site (i.e. 06 for IR Site 6), followed by a hyphen

Then, the sampling location ID from which the sample was collected, followed by a hyphen. For soil borings and monitoring wells, the numbering will start from the latest installed soil boring or monitoring well at IR Site 6 (currently 06-SB62 and 06-MW36). XX indicates the sampling location numbering.

- SBXX – Soil borings
- MWXX – Monitoring well

After the sampling location ID, a two-character designation of the specific type of media that is being sampled will be included in each sample ID code, followed by a hyphen. This two-character designation will correspond to the following criteria:

- Soil – SO
- Groundwater – GW

Following the media identifier, each sample collected will be assigned a unique sample ID used to record and report the results. The coded sample ID assignments will use these criteria:

- The depth the sample was collected (soil samples only).
- The DATE is eight digits identifying the date on which the sample was collected (YYYYMMDD).

For example, if a soil sample were collected from a depth of 2 feet bgs at soil boring location 1 on June 1, 2021, the sample ID would be as follows: 06-SB63-SO-2-20210601. The ID indicates that the soil sample was collected from soil boring location 63 on June 1, 2021, from a depth of 2 feet bgs.

QC samples collected during groundwater sampling will use the same coding system as the environmental samples. Field QC designations will conform to the following formats:

- **Duplicate Samples**: Duplicate sample identifiers will consist of a “DUP,” a sequential number, and the DATE (YYYYMMDD). For example: GWXXDUP01-20210601.

- **Field Blanks:** Field blank (FB) sample identifiers will consist of an “FB” label, the sequential number, and the DATE (YYYYMMDD). Example: FB01-20210601.
- **Equipment Blanks:** Equipment blank (EB) sample identifiers will consist of an “EB” label, a sequential number, and the DATE (YYYYMMDD). Example: EB01-20210601.
- **Temperature Blanks:** will be labeled as temperature blanks. Temperature blanks are not subject to chemical analysis and the results will not be entered into the database.

27.2 Field Documentation

Complete and accurate documentation is essential to ensure proper sample identification and to demonstrate that sampling procedures are carried out as described in the SAP. Field activities and original data generated in the field will be recorded using permanently bound, hardcover, uniquely labeled field logbooks with sequentially numbered pages.

The following general guidelines for maintaining field documentation will be followed by project personnel:

- Documentation will be completed in permanent blue or black ink.
- All entries will be legible.
- Errors will be corrected by drawing a single line through the error and writing the correct information; the correction will be initialed and dated.
- Unused pages will be crossed out, and each page will be signed and dated.

In addition, a field logbook will be maintained by the field sampler to summarize chronologically all field activities performed during a given workday. Details on the logbook procedures are discussed in this Worksheet under Field Logbook.

All information pertinent to field sampling will be recorded in a field logbook to maintain the integrity and traceability of samples. All samples will be properly labeled, and custody sealed before they are transported to the laboratory and will be accompanied by completed COC documentation. All documentation will be recorded in a field logbook in indelible ink.

No information will be obliterated from a sample label, logbook, instrument calibration form, or COC record. Corrections made to any field forms or logbooks will be made by drawing a line through the error, entering the correct information, and entering initials by the individual making the correction and the date on which the correction was made. If the error is noted after the sample label has been taped for protection or after a custody seal has been affixed to the sample container before being shipped, the field sampler will discard the erroneous label or seal and make a new one. Error corrections made to a sample label or COC form will be noted in the logbook.

27.3 Sample Labels

Sample labels serve to prevent misidentification of samples by openly displaying unique identification. Sample containers can be prepared before field work or onsite. Sample labels will be made of weatherproof paper or plastic with a gummed back and will be completed with indelible ink. When necessary, the labels will be lined over with clear tape to minimize damage to the label. This information will be entered into the laboratory database during sample check-in. A description of the sample (including the sample identification number and sample date and time) will be recorded in the field logbook. Any other pertinent information regarding sample identification will be recorded on the sample log sheets or in the field logbooks.

The following information will be on each sample label:

- Sample ID code
- Identification of the project site of sample collection
- Name or initials of field sampler
- Analysis required and sample preservation (if applicable)
- Date of sampling (MM/DD/YYYY)
- Local standard time of sample collection, using 24-hour clock notation

27.4 Chain of Custody

The field sampler is responsible for creating a COC record where information for each sample collected in the field will be entered. The COC record is necessary to physically trace sample possession from the time of collection to ultimate disposition. Each COC record will be signed as relinquished or received with each change of possession.

The following information must be contained in the COC record:

- Project name and number
- Names of field samplers
- Sample identification number
- Date of sampling
- Local standard time of sample collection, using 24-hour clock notation
- Sample matrix
- Number and type of containers for each sample aliquot

- Type of analysis requested
- Preservation of sample containers (if applicable)
- Means of transmittal to the analytical laboratory or unusual circumstances
- Special handling instructions
- Destination of samples
- Name, date, time, and signature of each individual releasing the shipping container
- Name, address, and individual to receive results

The “COMMENTS/INSTRUCTIONS” line in the COC record will be used to communicate any specific instructions to the analytical laboratory. Additional information relating to a sample may also be noted in the “REMARKS” line. In the event that more than one analytical laboratory will be used, different COC forms will be made for each lab. The number of containers (i.e., coolers) intended to go to a specific analytical laboratory will be made clear on the COC form under the block, “NO. OF COOLERS SHIPPED.” Attachment 4 provides a sample of the COC form.

27.5 Field Logbook

A logbook will be maintained by the field sampler to summarize chronologically all field activities performed during a given workday. The logbook is intended to provide interested parties, not present in the field at the time of data entry, with all the necessary information about field conditions in order to recreate the event that occurred during field work. Logbooks are to be prebound with numbered pages and all entries must be made in indelible ink. To avoid tampering, the user will draw a line across any unused space and initial to signify that no entries were made in those blank pages or spaces by the authorized user.

Logbooks will contain, at a minimum, the following information:

- Date of entry and recorder’s name
- Site location
- Sampling location, including distances to the nearest fixed point(s) of reference
- Sample depth (bgs, if applicable)
- Sample matrix
- Sample appearance
- Volume of sample collected

- Field measurements (if applicable)
- Type of sampling equipment used
- Names of all individuals present during sampling
- Sample collection date and times, using 24-hour clock notation
- Sample identification numbers
- Type and number of sample containers used per sampling site
- Designation of QC samples (e.g., blanks, splits, or duplicates)

A logbook is considered a legal document and is admissible as evidence in legal proceedings; therefore, entries made should be factual, detailed, and objective.

27.6 Sample Packing and Shipment

Because degradation of samples can occur rapidly following collection as a result of physical, chemical, and biological factors, it is important to exercise precaution when handling, transporting, or storing samples prior to laboratory analyses. Immediately following collection, the samples will be appropriately labeled, packaged, and placed in a cooler with ice (double-bagged in re-sealable bags), to maintain a temperature less than or equal to 6 degrees Celsius (°C). The samples will be delivered to the laboratory at the earliest possible time (but no later than 2 days following collection) and accompanied by a proper COC record and shipping documentation to track any change in sample possession. Details of the sample packing and shipment procedures are as follows.

Sample packaging and shipment procedures for this project will conform to DOT/International Air Transport Association procedures as applicable for packaging. All sample containers will be placed in double, resealable plastic bags to protect the sample from moisture and to minimize the potential for breakage or cross-contamination during transportation to the laboratory. If transported by a commercial carrier, all glass sample containers will be protected with bubble wrap before they are placed in coolers.

Each cooler will be shipped with a temperature blank. The temperature of the cooler will be recorded by the laboratory on the COC record immediately upon receipt of the samples. Sample-cooler drain spouts will be taped from the inside and outside of the cooler to prevent leakage.

The samples will be packed in a sample cooler with ice (double-bagged in resealable bags) below and above sample containers. Two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. The COC record will be completed and signed by the courier. The cooler and the top two copies (white and pink) of the COC record will then be released to the courier for transportation to the laboratory.

Saturday deliveries will be coordinated with the laboratory in advance, and field sampling personnel or their designee must confirm that Saturday delivery stickers are placed on each cooler.

27.7 Laboratory Custody Procedures

Laboratory sample receipt, handling, and custody procedures are provided in more detail in the lab quality systems manual. The lab SOP includes laboratory sample management and COC procedures. At a minimum, the following procedures will be included. The laboratory sample custodian will inspect the integrity of the cooler custody seals and measure the temperature of the samples received using the “Temperature Blank” container included in each cooler. The samples will be checked according to the laboratory “Sample Receiving Checklist” against the COC form for holding times, sample identification, and integrity. The samples will be logged into the laboratory management system. Immediately after receipt, the samples will be stored in an appropriate, secure storage area. Custody of the samples will be maintained and recorded in the laboratory from receipt to analysis and this record will be included with the data package deliverables. If the laboratory sample custodian judges sample custody to be invalid (e.g., samples arrive damaged or custody seals have been broken), the Multi-MAC JV PM will be advised immediately, and the samples will not be analyzed unless the Multi-MAC JV PM so authorizes. The Multi-MAC JV PM, the laboratory PMs, and QCM will be notified. The Multi-MAC JV PM will decide as to the fate of the sample(s) in question on a case-by-case basis.

The sample(s) will be either processed "as is" with custody failure noted along with the analytical data or rejected with sampling rescheduled if necessary. Any problem with a sample will be noted in the appropriate data report.

In addition, SGS will follow the laboratory SOPs for proper disposal of the environmental samples in accordance with federal, state, and local ordinances.

SAP Worksheet# 28 Laboratory QC Samples Table

Matrix	Aqueous/Soil
Analytical Group	PFAS
Analytical Method/ SOP Reference	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15/SOP MS019.4, OP069.4, and OP070.4

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Flagging Criteria	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria	Comments
Method Blank	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. Samples may be re-extracted and analyzed outside of hold times as necessary for corrective action associated with QC failure. Examine the project specific requirements. Contact the client as to additional measures to be taken.	Analyst/ Laboratory Quality Assurance Officer	Accuracy	All analytes in the laboratory blank must be < 1/2 the LOQ, < 1/10 the lowest concentration detected in the associated samples or < 1/10 applicable regulatory limits, whichever is greater.	Results may not be reported without a valid MB. Flagging is appropriate only in cases where the samples cannot be reanalyzed.

SAP Worksheet #28 Continued

Matrix	Aqueous/Soil
Analytical Group	PFAS
Analytical Method/ SOP Reference	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15/SOP MS019.4, OP069.4, and OP070.4

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Flagging Criteria	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria	Comments
LCS	One per preparation batch of 20 or fewer field samples of the same matrix extracted during the same analytical shift.	Blank spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration. For LCSD: Sample spiked with all analytes at a concentration ⩾ LOQ and ⩽ the mid-level calibration concentration. A laboratory must use the DoD/DOE QSM Appendix C MS/MSD Limits for LCS/LCSD batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. RPD ⩽ 30% (between LCS and LCSD).	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Correct problem, and reprepare and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call the PM. Samples may be reextracted and analyzed outside of hold times, as necessary for corrective action associated with QC failure. Examine the project specific requirements. Contact the client as to additional measures to be taken	Analyst/ Laboratory Quality Assurance Officer	Accuracy	If an LCSD is analyzed, the RPD must be ⩽ 30% (between LCS and LCSD).	Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

SAP Worksheet #28 Continued

Matrix	Aqueous/Soil
Analytical Group	PFAS
Analytical Method/ SOP Reference	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15/SOP MS019.4, OP069.4, and OP070.4

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Flagging Criteria	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria	Comments
MS/MSD	One MS/MSD per 20 or fewer field samples of the same matrix collected from the same installation	Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration. A laboratory must use the DoD QSM Appendix C Limits (listed below) for batch control. Laboratory-specified limits (current as of February) are used for compounds not listed in QSM 5.3 Appendix C. RPD ≤ 30% (between MS and MSD or sample and MD)	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative.	Examine the project specific requirements. Contact the client as to additional measures to be taken	Analyst/Laboratory Quality Assurance Officer	Accuracy and Precision	RPD ≤ 30% (between MS and MSD or sample and MD)	For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error). The data shall be evaluated to determine the source of difference. For Sample/MD: RPD criteria only apply to analytes whose concentration in the sample is ≥ LOQ.

SAP Worksheet #28 Continued

Matrix	Aqueous/Soil
Analytical Group	PFAS
Analytical Method/ SOP Reference	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15/SOP MS019.4, OP069.4, and OP070.4

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Flagging Criteria	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria	Comments
								The MD is a second aliquot of the field sample that has been prepared by serial dilution.

Notes:

DoD = United States Department of Defense; DQI = data quality indicator; LCS = laboratory control sample; LCSD = laboratory control sample duplicate; LC/MS-MS = liquid chromatography/tandem mass spectrometry; LOQ = limit of quantitation; MB = method blank; MD = matrix duplicate; MS = matrix spike; MSD = matrix spike duplicate; PFAS = per- and polyfluoroalkyl substances; PM = Project Manager; QC = quality control; QSM = Quality Systems Manual; RPD = relative percent difference; SOP = standard operating procedure; SPE = solid phase extraction

SAP Worksheet #28 Continued

QC Limit Table (PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15)[2]

CAS	Analyte	Aqueous		Solid	
		LCL	UCL	LCL	UCL
375-73-5	Perfluorobutane sulfonic acid	72	130	72	128
1763-23-1	Perfluorooctane sulfonic acid	65	140	68	136
335-67-1	Perfluorooctanoic acid	71	133	69	133
13252-13-6[1]	Hexafluoropropylene oxide dimer acid	60	140	60	140
763051-92-9[1]	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	60	140	60	140
756426-58-1[1]	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	60	140	60	140
919005-14-4[1]	4,8-dioxa-3H-perfluorononanoic acid	60	140	60	140
375-85-9	Perfluoroheptanoic acid	72	130	71	131
355-46-4	Perfluorohexane sulfonic acid	68	131	67	130
375-95-1	Perfluorononanoic acid	69	130	72	129
307-24-4	Perfluorohexanoic acid	72	129	70	132
335-76-2	Perfluorodecanoic acid	71	129	69	133
2058-94-8	Perfluoroundecanoic acid	69	133	64	136
307-55-1	Perfluorododecanoic acid	72	134	69	135
72629-94-8	Perfluorotridecanoic acid	65	144	66	139
376-06-7	Perfluorotetradecanoic acid	71	132	69	133
2991-50-6	N-Ethyl perfluorooctanesulfonamidoacetic acid	61	135	61	139
2355-31-9	N-Methyl perfluorooctanesulfonamidoacetic acid	65	136	63	144

Notes:

1. LCLs and UCLs are not listed in QSM 5.3 Tables C-44 and C-45. Laboratory limits will be used instead.
2. LCL and UCL bounds represent LCS/LCSD limits from the QSM 5.3 and will be used for both LCS/LCSD and MS/MSD evaluation.

LCL = lower control limit; UCL = upper control limit

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SAP Worksheet# 29 Project Documents and Records Table

Document	Where Maintained
Work Plan	Multi-MAC JV Project File and NAVFAC SW Administrative Record
SAP	Multi-MAC JV Project File and NAVFAC SW Administrative Record
Accident Prevention Plan and Site Safety and Health Plan	Multi-MAC JV Project File and NAVFAC SW Administrative Record
Fieldnotes/logbook	Multi-MAC JV Project File
Chain-of-custody forms	Multi-MAC JV Project File and NAVFAC SW Administrative Record
Audit checklists/reports	Multi-MAC JV Project File
Field photographs	Multi-MAC JV Project File
Laboratory analytical reports including the data packages (Stage 4) as follows: • Table of contents • Signed cover letter • Chain of custody • Sample receipt form 1 • Communication logs (e-mails, phone logs, etc.) • Data qualifier table • Case narrative • Results summary forms • QC summary forms • Calibration summary forms • Extraction analysis logs • Nonconformance report (if applicable) • Raw data for samples, associated laboratory QC samples, and calibrations	Multi-MAC JV, Laboratory Project File, and NAVFAC SW Administrative Record
Third-party Stage 4 data validation reports	Multi-MAC JV Project File and NAVFAC SW Administrative Record
Validated Laboratory Electronic Data Package	Multi-MAC JV Project File and NAVFAC NEDD NIRIS Website

Notes:
Multi-MAC JV = Multi-MAC Joint Venture; NAVFAC SW = Naval Facilities Engineering Systems Command Southwest;
NEDD = Navy Electronic Data Deliverable; NIRIS = Naval Installation Restoration Information Solution; QC = quality control;
SAP = Sampling and Analysis Plan

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SAP Worksheet# 30 Analytical Services Table

Matrix	Analytical Group	Sampling Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization
Aqueous	PFAS	Worksheet #18 contains all sampling locations. Worksheet #27 defines sample IDs.	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	7 calendar days preliminary/ 14 calendar day Final	SGS Orlando 4405 Vineland Road, Suite C-15 Orlando, FL 32811 (408) 612-9410 PM: Elvin Kumar Elvin.Kumar@sgs.com	Torrent Laboratory, Inc. 483 Sinclair Frontage Road Milpitas, CA 95035 (408) 263-5258 ext. 204 PM: Traci Reilly pm@torrentlaboratory.com
Soil	PFAS	Worksheet #18 contains all sampling locations. Worksheet #27 defines sample IDs.	PFAS by LC/MS-MS Compliant with QSM 5.3 Table B-15	7 calendar days/ 14 calendar day Final	SGS Orlando 4405 Vineland Road, Suite C-15 Orlando, FL 32811 (408) 612-9410 PM: Elvin Kumar Elvin.Kumar@sgs.com	Torrent Laboratory, Inc. 483 Sinclair Frontage Road Milpitas, CA 95035 (408) 263-5258 ext. 204 PM: Traci Reilly pm@torrentlaboratory.com
Soil/Sediment	Geotechnical Analysis	Worksheet #18 contains all sampling locations. Worksheet #27 defines sample IDs.	Moisture content (ASTM D2216) Dry density (ASTM D2937) Total organic carbon (Walkley-Black) pH (ASTM D4972) Cation exchange capacity (ASTM D7503) Anion/ exchange capacity (ASTM D7503 or equivalent) Particle size analysis (ASTM D422) Specific Gravity (ASTM D854) Effective porosity (California State Water Resources Control Board) Saturated hydraulic conductivity (ASTM D5084)	45 calendar days	EGLab, Inc. 11819 Goldring Road, Unit D Arcadia, CA 91006 (626) 263-3588 Jun Tadique (ryan@eglab.com)	AGVISE Laboratories 604 Hwy 15 West PO Box 510 Northwood, ND (701) 587-6010 PM: Amber Storey (ambers@agvise.com)

SAP Worksheet #30 Continued

Notes:

SGS Orlando, Elvin Kumar, PM, (408) 612-9410, elvin.kumar@sgs.com, 4405 Vineland Road, Suite C-15, Orlando, FL 32811

Torrent Laboratory Inc; pm@torrentlaboratory.com, Traci Reilly, (408) 263-5258 ext. 204, 483 Sinclair Frontage Road, Milpitas, CA 95035

SGS and Torrent Laboratory are currently certified by the California Department of Health Services Environmental Laboratory Accreditation Program (ELAP) and have received accreditation from a United States Department of Defense ELAP-accrediting body for analysis of hazardous materials for the methods specified in this SAP.

ID = identification; LC/MS-MS= liquid chromatography tandem mass spectrometry; PFAS = per- and polyfluoroalkyl substances; PM = Project Manager; QSM = Quality Systems Manual

SAP Worksheet# 31 Planned Project Assessments Table

Assessment Type[1]	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Operational Readiness Review	Prior to sampling activity	Internal	Multi-MAC JV	PM, Multi-MAC JV	PM, Multi-MAC JV	PM, Multi-MAC JV	PM, Multi-MAC JV
Field Sampling Surveillance	At the start of, and during sampling activity	Internal	Multi-MAC JV	QCM or other QC personnel, Multi-MAC JV	PM, Multi-MAC JV	QCM, Multi-MAC JV	QCM, Multi-MAC JV PM, Multi-MAC JV
Field Documentation Review	Daily	Internal	Multi-MAC JV	QCM, Multi-MAC JV PM, Multi-MAC JV	PM, Multi-MAC JV	QCM, Multi-MAC JV	QCM, Multi-MAC JV PM, Multi-MAC JV
Data Review Surveillance	Once	Internal	Multi-MAC JV	QCM, Multi-MAC JV	PM, Multi-MAC JV	QCM, Multi-MAC JV	QCM, Multi-MAC JV PM, Multi-MAC JV

Notes:

1. Attachment 4 includes a copy of the sample daily field report form.

Multi-MAC JV = Multi-MAC Joint Venture; PM = Project Manager; QC = quality control; QCM = Quality Control Manager

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SAP Worksheet# 32 Assessment Findings and Corrective Action Responses

Assessment Type[1]	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Operational Readiness Review	Audit Report	Matthew Brookshire Multi-MAC JV	1 day after completion of the inspection	Corrective Action Report	Matthew Brookshire, QCM, Multi-MAC JV	5 days
Field Sampling Surveillance	Audit Report	Matthew Brookshire Multi-MAC JV	1 day after completion of the inspection	Corrective Action Report	Matthew Brookshire, QCM, Multi-MAC JV	5 days
Field Documentation Review	Audit Report	Matthew Brookshire Multi-MAC JV	1 day after completion of the inspection	Corrective Action Report	Matthew Brookshire, QCM, Multi-MAC JV	5 days
Data Review Surveillance	Audit Report	Matthew Brookshire Multi-MAC JV	2 days after completion of the inspection	Corrective Action Report	Matthew Brookshire, QCM, Multi-MAC JV	5 days

Notes:

1. Attachment 4 includes a copy of the sample field report form.

Multi-MAC JV = Multi-MAC Joint Venture; QCM = Quality Control Manager

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SAP Worksheet# 33 QA Management Reports Table

Type of Report[1]	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Operational Readiness Review	Prior to initiating field work and periodically throughout the duration of the project.	5 days after completion	Matthew Brookshire, QCM, Multi-MAC JV	Multi-MAC JV PM
Field Sampling Surveillance	After all field work has been completed.	5 days after completion	Matthew Brookshire, QCM, Multi-MAC JV	Multi-MAC JV PM
Field Documentation Review	After all field work has been completed.	5 days after completion	Matthew Brookshire, QCM, Multi-MAC JV	Multi-MAC JV PM
Data Review Surveillance	After all data have been generated and reviewed.	5 days after completion	Matthew Brookshire, QCM, Multi-MAC JV	Multi-MAC JV PM
Corrective Action Plan	After all data have been generated and reviewed.	Preliminary Draft of report approximately 60 days after validated data received. Final report delivery TBD after internal and regulatory review cycles have been established.	Lansana Coulibaly, PM, Multi-MAC JV	NAVFAC RPM

Notes:

1. Attachment 4 includes a copy of the sample field report form.

Multi-MAC JV = Multi-MAC Joint Venture; NAVFAC = Naval Facilities Engineering Systems Command; PM = Project Manager; QCM = Quality Control Manager; RPM = Remedial Project Manager

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SAP Worksheet# 34 Verification (Step I) Process Table

Verification Input	Description	Internal/External	Responsible for Verification
Chain-of-Custody Forms	Content of the COC form will be reviewed daily and verified for completeness against the samples within the associated cooler. A copy of the COC form, once reviewed, will be filed with other project documents in the assigned project file. The original COC form will be taped on the inside of the cooler for sample shipment.	Internal	Nick Breshears Field Lead Multi-MAC JV
Field Notes/ Logbook	Field sampling data, i.e., field logbooks and field forms, will be reviewed and verified for completeness. Field notes/logbook will be forwarded to the Project Manager, reviewed, and placed in the project file. A copy of the field notes will be included with the Final Technical Memorandum.	Internal	Nick Breshears Field Lead Multi-MAC JV
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file.	Internal	Nick Breshears Field Lead Multi-MAC JV Matthew Brookshire, QCM, Multi-MAC JV
Analytical Data Package	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be verified externally and internally according to the data validation process specified in Worksheet #36.	Internal/ External	Elvin Kumar, SGS Pei Geng, LDC
Electronic Data Deliverables	100% of electronic data deliverables will be verified internally by the laboratory performing the work for completeness and technical accuracy between the EDD and the pdf copy data package prior to submittal. 10% of received electronic data deliverables will be verified externally and internally against the laboratory data packages, with the percentage raised to 100% if discrepancies are found during the 10% verification.	Internal/ External	Elvin Kumar, SGS Pei Geng, LDC

Notes:

COC = chain of custody; EDD = electronic data deliverable; LDC = Laboratory Data Consultants, Inc.; Multi-MAC JV = Multi-MAC Joint Venture, QCM = Quality Control Manager

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SAP Worksheet# 35 Validation (Steps IIA and IIB) Process Table

Step IIa/IIb[1]	Validation Input	Description	Documentation Method	Responsible for Validation
IIa	Communication	Establish that the required communication procedures were followed by field or laboratory personnel.	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV
IIa	Methods (sampling and analysis)	Establish that required sampling and analytical methods were implemented and that any deviations were noted. Evaluate whether proper procedures met performance criteria.	Final SI Report	Matt Brookshire, Multi-MAC JV; Pei Geng, LDC
IIa	Location, maps, and sample ID numbers	Verify the accuracy and precision of the information under scrutiny.	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV
IIa	Holding times	Ensure that samples were analyzed within holding times specified in the method, procedure, or contract requirements. If holding times were not met, confirm that deviations were documented and appropriate notifications were made. Documentation of holding times or deviations will be documented in the lab analytical report and data validation report.	Lab Analytical Report Data Validation Report	Pei Geng, LDC
IIa	List of project-specific analytes	Establish that the project-specific analytes were reported as specified in governing documents (i.e., analytical method, contract, etc.). Documentation will be in the lab analytical report and data validation report.	Lab Analytical Report Data Validation Report	Pei Geng, LDC
IIa	Field logbook	On a weekly basis, the QCM or assignee will review and verify the completeness of the information in the field logbooks as described in Worksheet #27 of this SAP.	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV
IIa & IIb	Sampling instrument decontamination records	Establish that proper decontamination procedures were implemented by field sampling personnel.	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV
IIa	Sampling instrument calibration logs	Establish that field instrumentation requiring calibration was implemented in accordance with the method, manufacturer's manual, or procedure.	Multi-MAC JV Field Logbook	Matt Brookshire, Multi-MAC JV
IIa	Chain-of-custody forms	Review COC records for completeness and accuracy on a daily basis. The QCM or assignee will look primarily for project information, sample analyses requested, number of field QC samples collected, and Stage 2B and 4 validation to be performed by the data validator.	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV

SAP Worksheet #35 Continued

Step IIa/IIb[1]	Validation Input	Description	Documentation Method	Responsible for Validation
IIa	Sample receipts	Check the sample cooler for compliance with temperature and packaging requirements in Worksheet #19 of this SAP.	Lab Analytical Report	Pei Geng, LDC
IIa	Sample logins	Review sample login for accuracy against the COC form.	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV; Pei Geng, LDC
IIb	Sampling plan and procedures	Evaluate whether the sampling plan was executed as specified (i.e., the number, location, and type of field samples that were collected and analyzed as specified in the SAP). Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support (i.e., techniques, equipment, decontamination, volume, preservation, temperature, etc.).	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV
IIb	Project quantitation limits	Determine that quantitation limits were achieved as outlined in the SAP and that the laboratory successfully analyzed a standard at the quantitation limit.	Data Validation Report	Pei Geng, LDC
IIb	Performance criteria	Evaluate QC data against project-specific performance criteria in the SAP (i.e., evaluate quality parameters beyond those outlined in the methods).	Data Validation Report	Matt Brookshire, Multi-MAC JV Pei Geng, LDC
IIa	Laboratory data packages	The third-party data validator will validate laboratory data packages for technical accuracy. Review data packages for accuracy against the laboratory data that was faxed/e-mailed.	Data Validation Report	Pei Geng, LDC
IIb	Data validation reports	Review data validation reports in conjunction with the project DQOs and DQIs per the SAP.	Multi-MAC JV Checklist	Matt Brookshire, Multi-MAC JV Pei Geng, LDC

Notes:

1. IIa=compliance with methods, procedures, and contracts (see Table 10, page 117, UFP-QAPP manual, V.1, March 2005)
   IIb=comparison with measurement performance criteria in the SAP (see Table 11, page 118, UFP-QAPP manual, V.1, March 2005)

COC = chain of custody; DQI = data quality indicator; DQO = data quality objective; ID = identification; LDC = Laboratory Data Consultants Inc.; Multi-MAC JV = Multi-MAC Joint Venture; QC = quality control; QCM = Quality Control Manager; SAP = Sampling and Analysis Plan

SAP Worksheet# 36 Analytical Data Validation (Stage 4) Summary Table

Stage	Matrix	Analytical Group	Concentration Level	Validation Criteria	Documentation Method	Data Validator
Stage 4	Ground water and Soil	PFAS	All	In accordance with: • Criteria cited in the SAP • DoD *Quality Systems Manual, Version 5.3* (DoD, 2019a) • DoD *Data Validation Guidelines, Module 3* (DoD, 2020) • General Data *Validation Guidelines, Revision 1* (DoD, 2019b) • NAVFAC SW *EWI #1 Data Validation Guidelines for Chemical Analysis of Environmental Samples* (2001)	Data Validation Report	LDC

Notes:
DoD = United States Department of Defense; EWI = Environmental Work Instruction; LDC = Laboratory Data Consultants Inc.; NAVFAC SW = Naval Facilities Engineering Systems Command Southwest; QSM = Quality Systems Manual

Data Validation

An independent third-party contractor (LDC) will validate all laboratory data referencing the criteria cited in the SAP, method and SOP criteria, the current QC requirements specified in the most current version of the DoD *QSM Version 5.3*, NAVFAC SW *EWI #1 Data Validation Guidelines for Chemical, Analysis of Environmental Samples* (NAVFAC SW, 2001), *General Validation Guidelines* (DoD, 2019b), and *General Data Validation Guidelines, Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15* (DoD, 2020). The data validation strategy will be consistent with the DON guidelines. To provide a thorough review of the analytical results, 100 percent of the data are subjected to a U.S. EPA Stage 4 validation.

Stage 4 Full Data Validation

Full validation will be completed on 100 percent of the data for the constituents of concern. The data reviewer is required to notify the laboratory and request any missing information needed from the laboratory to complete the review. Elimination of the data from the review process is not allowed. All data will be qualified, as necessary, in accordance with established criteria. Data packages will consist of sample results, QC summaries and all associated raw data required to recalculate all reported results.

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SAP Worksheet# 37 Usability Assessment

The data usability assessment process is used to evaluate and document the usability (i.e., Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity [PARCCS]) of the data by considering the project DQOs and whether the data are suitable during the decision-making process. The analytical laboratory will be responsible for reviewing all analytical data generated under this contract to ensure that they meet the requirements of the UFP-QAPP. Each analyst reviews the quality of his/her work based on established protocols specified in laboratory SOPs, analytical method protocol, project-specific requirements, and DQOs.

The intent of the data quality assessment process is to establish the levels of PARCCS and the usability of the final results with respect to the project DQOs. Each data point will be assessed as nonqualified, qualified, or rejected based upon the acceptance criteria, and finalized data validation flags will be added to the project database. The final qualification will be based on QC criteria specified in this SAP and the DoD *QSM Version 5.3*. Usability will be assessed with respect to project DQOs and the CSM.

The usability assessment process will consist of the project chemist reviewing the data validation reports for both usable analytical data (i.e., no validation qualifications or estimated “J”/”UJ” qualifications) and “X” qualified analytical data, as well as evaluating the data for discrepancies or deviations. This assessment will evaluate the impact of the discrepancies or deviations on the usability of the data and assess whether all the necessary information has been provided for use in the decision-making process. Based on the validator recommendations, professional judgment, DQOs and the CSM, the project team will assign a U, UJ or rejected (R) qualification to the “X” qualified during validation. Data qualified as R will not be used for evaluating DQOs. Summaries of final qualifiers applied to X qualified data during the usability assessment and rationale for the final qualifiers will be included in the usability assessment writeup. Documentation of deviations in sampling activities (e.g., incorrect sample location or analysis performed), COC documentation, or holding times; compromised samples (i.e., damaged samples) and the need to resample; or changes to SOPs or methods that could potentially impact data quality. An evaluation of QC sample results will be performed to assess whether unacceptable QC results (e.g., blank detections) impact data usability. For data that do not meet the DQOs or DQIs, data use limitations will be discussed in the data usability assessment. Other parameters to be evaluated during the usability assessment may include, but are not limited to, the following:

- Matrix Effects – matrix conditions (e.g., salt water) that may impact the performance of the extraction or analytical method
- Site conditions – unusual weather conditions or site conditions that may affect the sampling plan

- Identification of critical and noncritical samples or target analytes
- Background or historical data
- Data restrictions – data that do not meet the project DQOs or were “R” qualified might be restricted but usable as qualitative values for limited decision-making purposes

Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Analytical precision is the measurement of the variability associated with duplicate or replicate analyses. Laboratory duplicate, MSD, and LCS duplicate (if analyzed) samples will be used to assess field and analytical precision. The precision measurement will be determined using the RPD between the duplicate sample results as follows:

$$RPD = \frac{|A-B|}{(A+B)/2} \ x \ 100$$

where:

A = First duplicate concentration

B = Second duplicate concentration

The RPD limits for precision are presented in Worksheet #28. Associated samples that do not meet the criteria will be evaluated by the Multi-MAC JV Project Chemist as described in Worksheet #35.

Accuracy/Bias

Accuracy/Bias is defined as the nearness of a result, or the mean of a set of results, to the true or accepted value. Analytical accuracy is measured by comparing the percent recovery (%R) of analytes spiked into a sample against a control limit. Accuracy will be measured using spiked samples, such as MS, MSD, LCS, and surrogates, if applicable. Surrogates, MS, MSD, and LCS analyzed for contaminants will also be used to assess matrix interferences. Calculation of %R is as follows:

$$Percent\ Recovery = \frac{S-C}{T} \ x \ 100$$

where:

S = Measured spike sample concentration

C = Sample concentration

T = True or actual concentration of the spike

The laboratory will review the QC samples and surrogate recoveries for each analysis to ensure that the %R lies within the control limits listed in the SAP. Otherwise, data will be flagged by the laboratory.

Representativeness

Representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. It is a qualitative parameter that depends on the proper design of the sampling program.

The representativeness of data will be maintained by the use of established field and laboratory procedures and their consistent application.

Field personnel will be responsible for collecting and handling samples according to the procedures in this SAP so that samples are representative of field conditions. Errors in sample collection, packaging, preservation, or COC procedures may result in samples being judged as non-representative and may form a basis for rejecting the data.

Completeness

Completeness is the percentage of measurements made that are judged to be valid compared to the amount that was expected to be obtained under correct, normal conditions (planned). The completeness goal is to generate a sufficient amount of valid data to meet project needs. To be considered complete, the data set must contain all analytical results and data specified for the project. In addition, all data are compared to project requirements to determine whether specifications were met. Completeness is evaluated by comparing the project objectives to the quality and quantity of the data collected to determine if any deficiencies exist. Data validation and data quality assessment will determine which data are valid and which data are rejected or missing.

Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of planned individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with a rejected (R) flag. Completeness will be calculated for both field (number of samples collected versus the number of samples planned) and laboratory (number of valid measurements compared to the total number of measurements planned). Field completeness will be required to be 100 percent.

The requirement of laboratory completeness is 90 percent for samples and is determined using the following equation:

$$Completeness = \frac{Number\ of\ Valid\ Measurements}{Number\ of\ Planned\ Measurements} \times 100$$

Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another, whether it was generated by a single laboratory or during inter-laboratory studies. The use of standardized field and analytical procedures ensures the comparability of analytical data. Sample collection and handling procedures will adhere to U.S. EPA-approved protocols. Laboratory procedures will follow standard analytical protocols, use standard units and standardized report formats, follow the calculations as referenced in approved analytical methods, and use a standard statistical approach for QC measurements.

Sensitivity

Sensitivity is the ability of the analytical test method and/or instrumentation to differentiate between detector responses to varying concentrations of the target constituent. Methodology to establish sensitivity for a given analytical method or instrument includes an examination of standardized blanks, instrument detection limit studies, and calibration of the LOQ. The findings of the usability of the data relative to sensitivity will be included in the report, including any limitations on the data set and/or individual analytical results.

The PARCCS measured performance criteria are described in Worksheets #12, #15, and #28. The following steps will be performed:

- Evaluate whether the project-required quantitation limits listed in Worksheet #15 were achieved for non-detected site contaminants. If no detectable results were reported and data are acceptable for the verification and validation steps, then the data are usable.
- If detectable concentrations are reported and the verification and validation steps are acceptable, the data are usable.
- If verification and validation are not acceptable, the data are qualified. Qualifiers (J, UJ) will be added for minor QC deviations that do not affect the data usability, or X will be added for major QC deviations affecting data usability. The impact of X qualified data will be evaluated and resampling may be necessary. The use of estimated data will be discussed in the project report.

Personnel Responsible for Performing the Usability Assessment

Multi-MAC JV Project Chemist or designee.

Documentation to Be Generated During Usability Assessment (and how usability assessment results will be presented so that they identify trends, relationships [correlations], and anomalies)

The data will be presented in tabular format; data qualifiers such as estimation (J, UJ) or X will be applied. Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest resampling if necessary to fill out the data gaps.

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Figures

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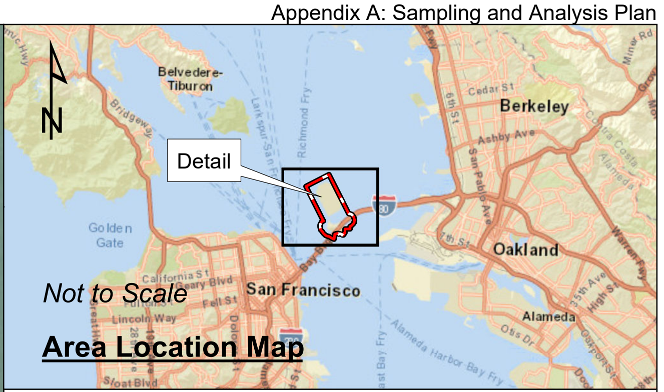
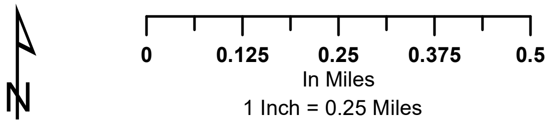


Legend

🟦	IRP Site 6 Location
🟥	Former Naval Station Treasure Island Boundary

Notes:
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances

Basemap Source: ESRI Online Streaming Service 2021



Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Location Map

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

FIGURE
A-1

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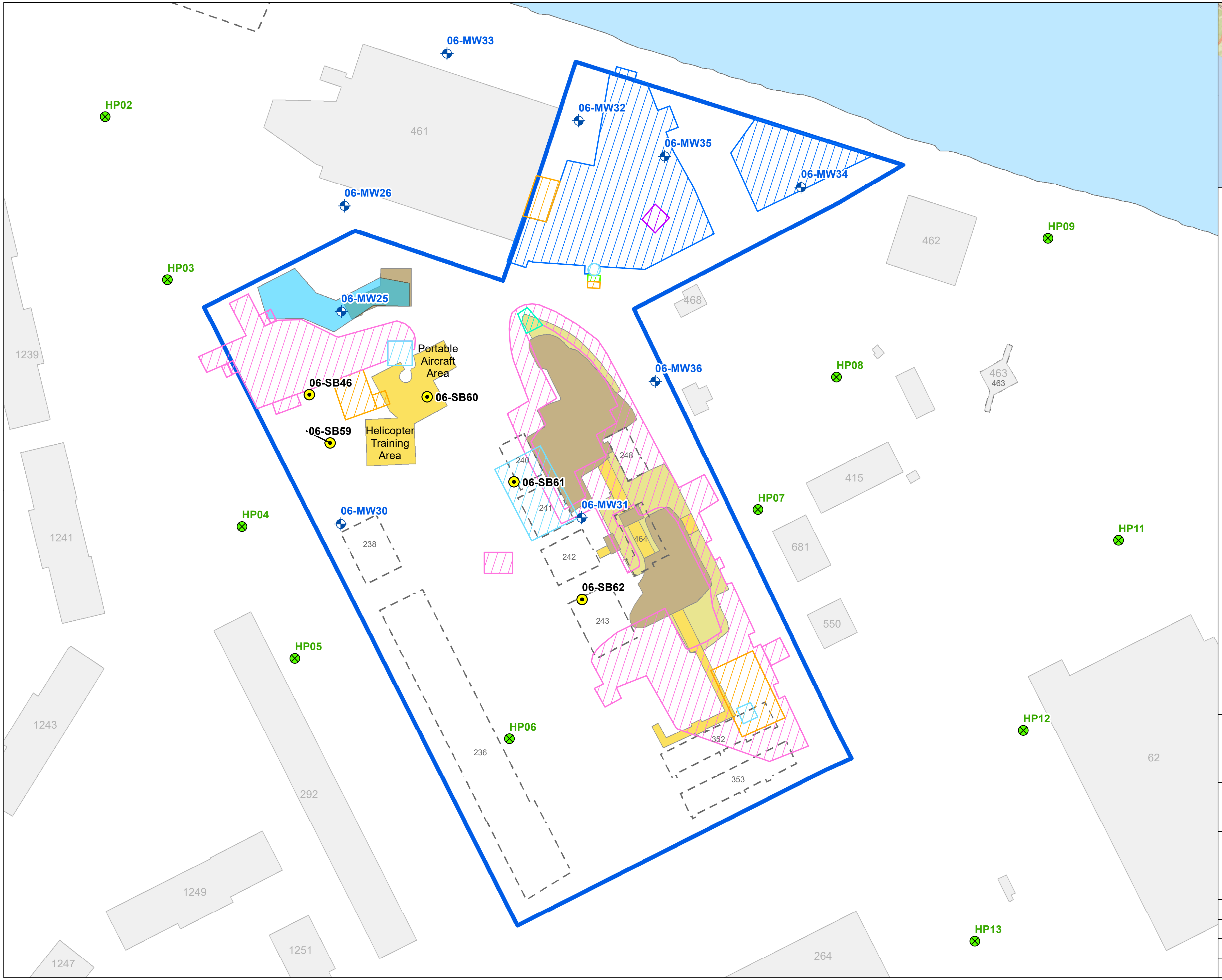

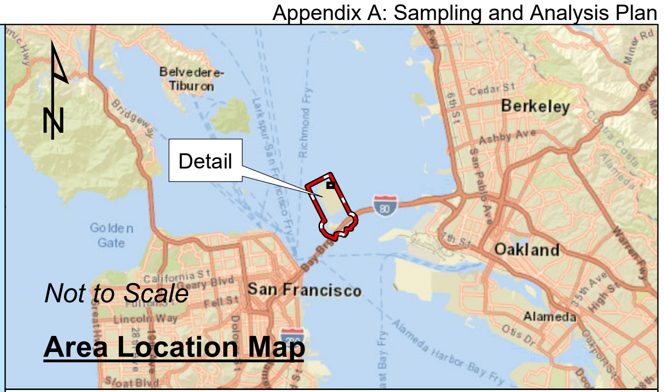

Area Location Map

Legend

- ● Previous Soil Boring
- ⊗ Temporary Well Sampling
- ⌖ Existing Groundwater Monitoring Well
- ■ Extent of Petroleum Corrective Action Soil Excavation (July 2013)

Remedial Action Excavation (2016)

- ▨ 0.5 - foot Deep Excavation
- ▨ 2.0 - foot Deep Excavation
- ▨ 2.5 - foot Deep Excavation
- ▨ 3.0 - foot Deep Excavation
- ▨ 3.5 - foot Deep Excavation
- ▨ 5.0 - foot Deep Excavation
- ▨ 5.5 - foot Deep Excavation

Former Excavation Area (2002-2003)

- ■ 1-2 - foot Deep Excavation
- ■ 2-5 - foot Deep Excavation
- ■ 5-9 - foot Deep Excavation
- ■ Building (Existing)
- ☐ Building (Former)
- ☐ IRP Site 6 Location
- ☐ Former Naval Station Treasure Island Boundary

Notes:
IRP = Installation Restoration Program

Basemap Source: ESRI Online Streaming Service 2021

N
0 40 80 120 160
Feet
1 Inch = 80 Feet

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Site Features
Former Excavation Areas

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

NAVFAC

FIGURE
A-2

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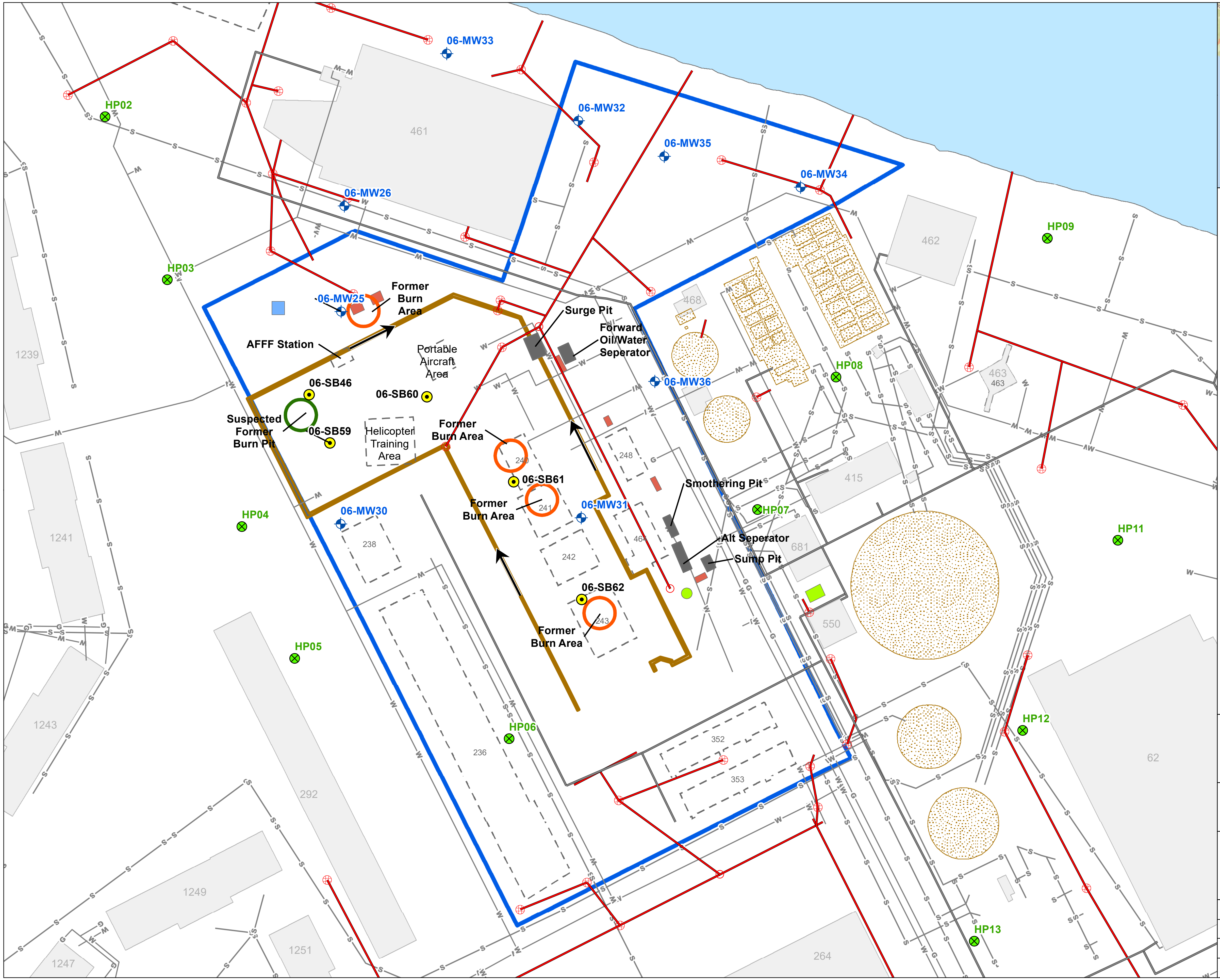

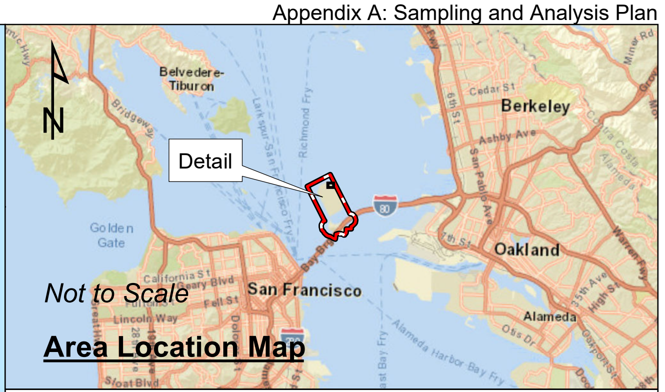

Area Location Map

Legend

- ● Previous Soil Boring
- ⊗ Temporary Well Sampling
- ⊕ Existing Groundwater Monitoring Well
- ⊕ Stormwater Catch Basin
- ○ Manhole
- Stormwater Line
- Steam Line
- W — Water Line
- S — Sewer Line
- G — Gas Line
- Collector Trench
- → Direction of AFFF Wastewater Flow
- ■ Oil/Water Seperator System Component
- 🟩 Removed AST
- 🟥 Removed UST
- 🟦 Suspected AST
- ○ Former Burn Area
- ○ Suspected Former Burn Pit
- ▨ Wastewater Treatment Plant
- ☐ Building (Existing)
- ☐ Building (Former)
- ☐ IRP Site 6 Location
- ☐ Former Naval Station Treasure Island Boundary

Notes:
AFFF = Aqueous Fire Fighting Foam
AST = Aboveground Storage Tank
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances
UST = Underground Storage Tank

Basemap Source: ESRI Online Streaming Service 2021

0 40 80 120 160
Feet
1 Inch = 80 Feet

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Site Features
Utilities

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

FIGURE

A-3

Date: 1/31/2022 Path: D:\FilesFromWork\5026-204451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\FigA03_TI_Site6_Utilities.mxd

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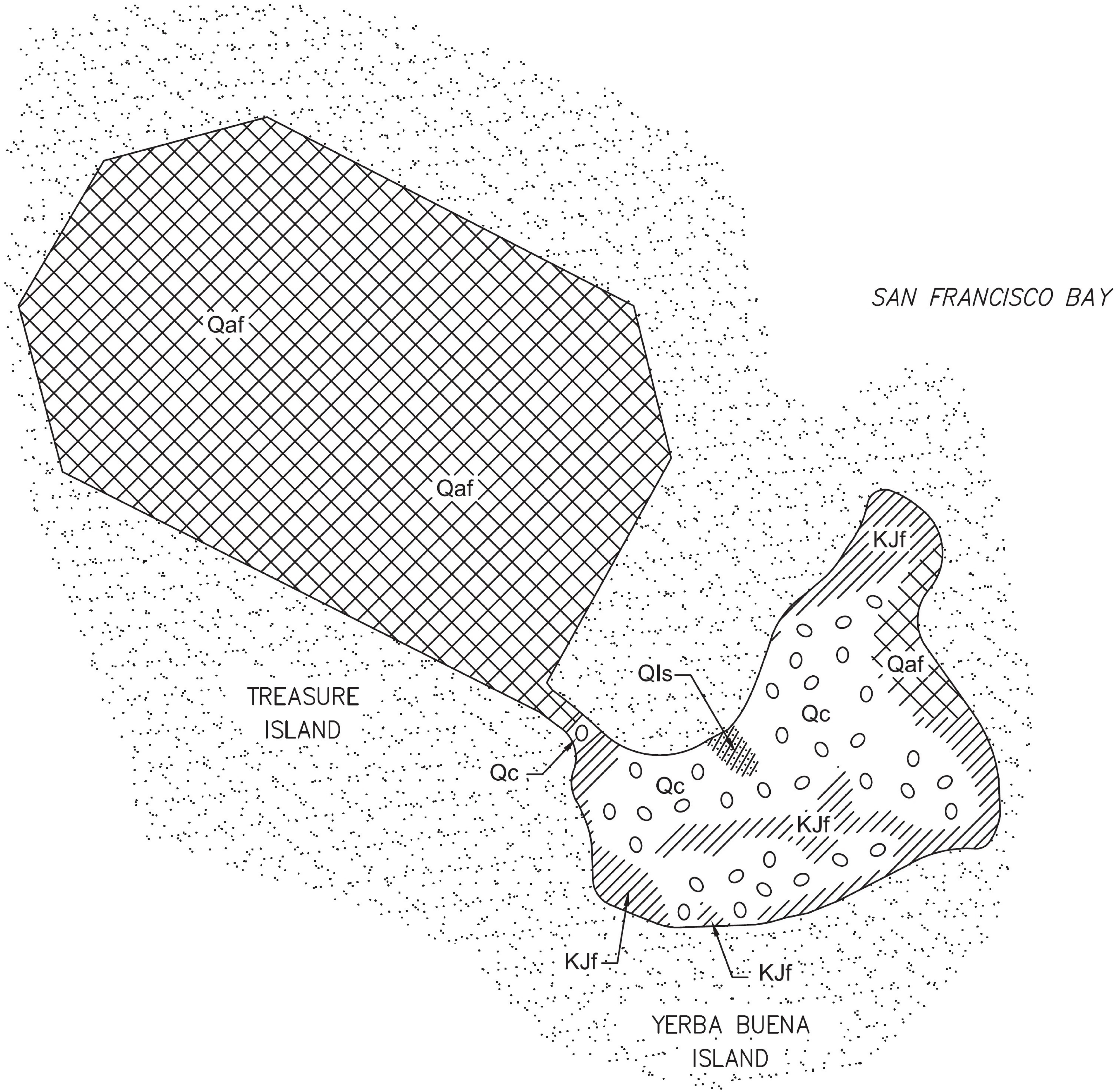

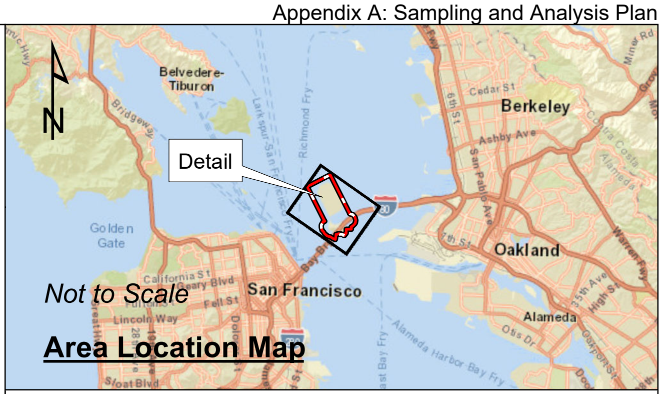

Not to Scale

Area Location Map

Legend

Qls	LANDSLIDE DEBRIS
Qaf	ARTIFICIAL FILL (SAND, CLAY OR MISCELLANEOUS REFUSE)
Qc	COLLUVIUM/EOLIAN SANDS (SAND WITH MINOR SANDY SILT, CLAY, AND GRAVEL INTERBEDS)
KJf	FRANCISCAN ASSEMBLAGE (SANDSTONE AND SHALE)
⁘	SAN FRANCISCO BAY

SOURCE:
FINAL GROUNDWATER STATUS REPORT, SUMMARY OF GROUNDWATER MONITORING, MARCH THROUGH OCTOBER 2000, NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA
TETRA TECH EM INC. (TtEMI, 2002c)
COMPILED FROM:
DAMES AND MOORE (1988)
BLAKE AND OTHERS (1974)
RADBRUCH (1957)

Notes:
IRP = Installation Restoration Program
PFAS = Per- and Polyfluoroalkyl Substances

Reference: ERRG 2011

Basemap Source: ESRI Online Streaming Service 2021

0 500 1,000 1,500 2,000
Feet
1 Inch = 1,000 Feet

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Generalized Regional Geologic Map

PROJECT NO.: 5026-20-4451
DATE: February 2022
DRAWN BY: KOB
CHECKED BY: LC

FIGURE
A-4

Date: 1/31/2022 Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\FigA04_TI_Site6_GeoRegional.mxd

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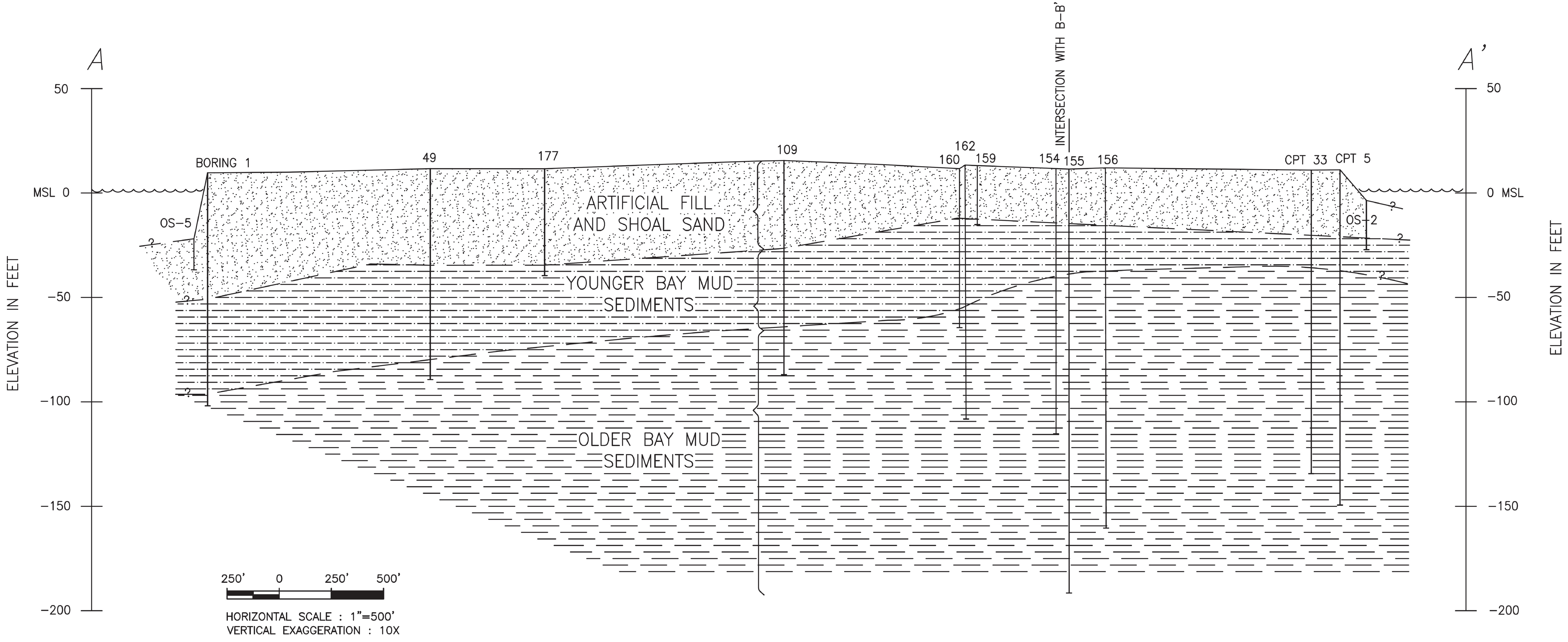


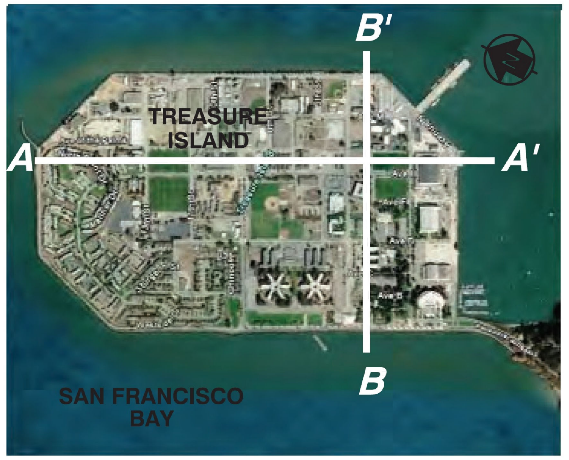
HORIZONTAL SCALE : 1"=500'
VERTICAL EXAGGERATION : 10X

LEGEND:

▨	ARTIFICIAL FILL AND SHOAL SANDS (Predominantly fine– to medium–grained sand and silty sands)
▤	YOUNGER BAY MUD SEDIMENTS (Predominantly soft to stiff clay, silty clay, or sandy clay with some silty sands and clayey sands)
▤	OLDER BAY MUD SEDIMENTS (Predominantly stiff to very stiff clay, silty clay, or sandy clay with some silty sands and clayey sands)
—?— –	LITHOLOGIC CONTACT (dashed where inferred, queried where uncertain)
49	SOIL BORING OR CONE PENETROMETER TEST (CPT)

NOTES:

1. CROSS SECTION SOURCE FROM CROSS SECTION A–A' (TtEMI, 2002c).
2. CROSS SECTION MODIFIED FROM CROSS SECTION M–M' (GEOMATRIX, 1990).
3. THE NUMBER OVER EACH SOIL BORING/CPT CORRESPONDS TO A SPECIFIC BORING INDEX NUMBER (GEOMATRIX, 1990).
4. THIS CROSS SECTION REPRESENTS ONE INTERPRETATION BASED ON AVAILABLE DATA; OTHER INTERPRETATIONS ARE POSSIBLE.



LOCATION MAP
NTS

Reference: ERRG 2011

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Geologic Cross Section A-A'

PROJECT NO.:	5026-20-4451
DATE:	February 2022
DRAWN BY:	KOB
CHECKED BY:	LC

NAVFAC

FIGURE
A-5

Date: 1/31/2022 Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\FigA05_TI_Site6_Geo_A-A.mxd

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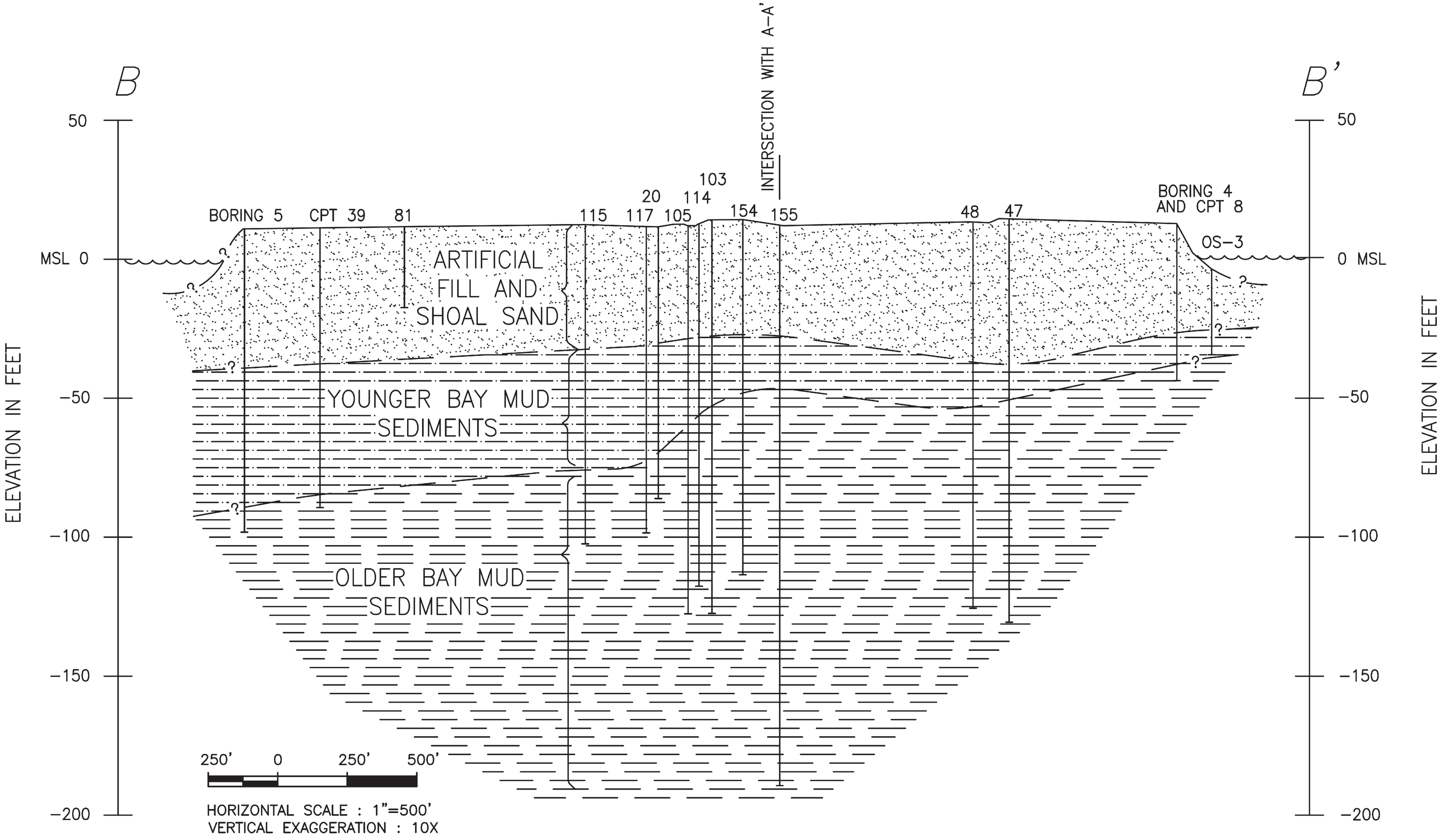
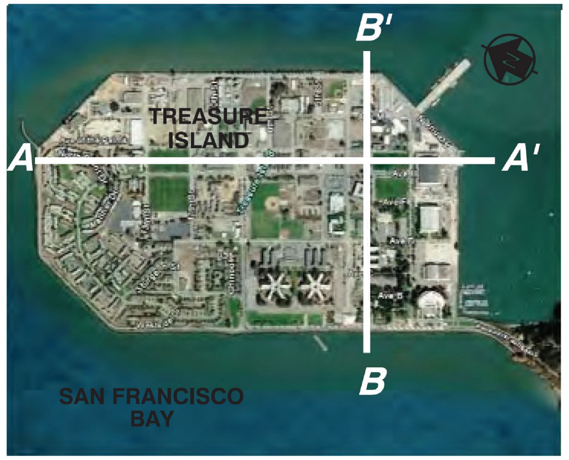


LEGEND:

▨	ARTIFICIAL FILL AND SHOAL SANDS (Predominantly fine– to medium–grained sand and silty sands)
☰	YOUNGER BAY MUD SEDIMENTS (Predominantly soft to stiff clay, or sandy clay with some silty sands and clayey sands)
☰	OLDER BAY MUD SEDIMENTS (Predominantly stiff to very stiff clay, silty clay, or sandy clay with some silty sands and clayey sands)
—?— –	LITHOLOGIC CONTACT (dashed where inferred, queried where uncertain)
81 │	SOIL BORING OR CONE PENETROMETER TEST (CPT)

NOTES:

1. CROSS SECTION SOURCE FROM CROSS SECTION A–A' (TtEMI, 2002c).
2. CROSS SECTION MODIFIED FROM CROSS SECTION P–P' (GEOMATRIX, 1990).
3. THE NUMBER OVER EACH SOIL BORING/CPT CORRESPONDS TO A SPECIFIC BORING INDEX NUMBER (GEOMATRIX, 1990).
4. THIS CROSS SECTION REPRESENTS ONE INTERPRETATION BASED ON AVAILABLE DATA; OTHER INTERPRETATIONS ARE POSSIBLE.



LOCATION MAP
NTS

Reference: ERRG 2011

Remedial Investigation for
Per- and Polyfluoroalkyl Substances at Installation Restoration Program Site 6
Former Naval Station Treasure Island, San Francisco, California

Geologic Cross Section B-B'

PROJECT NO.: 5026-20-4451
DATE: February 2022
DRAWN BY: KOB
CHECKED BY: LC

FIGURE
A-6

Date: 1/31/2022 Path: D:\FilesFromWork\5026-20\4451_TreasureIsland_PFAS_IRP6\GIS\Figs_TI_RI_WP_IRP6_Jan2021\FigA06_TI_Site6_Geo_B-B.mxd

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