SITE INSPECTION REPORT FOR PER- AND POLYFLUOROALKYL SUBSTANCES AT RIVERBANK ARMY AMMUNITION PLANT, RIVERBANK, CALIFORNIA

Prepared for:

U.S. ARMY

ODCS, G-9, ISE BRAC

Final
November 2023

SITE INSPECTION REPORT FOR PER- AND POLYFLUOROALKYL SUBSTANCES AT RIVERBANK ARMY AMMUNITION PLANT, RIVERBANK, CALIFORNIA

Prepared for:
ODCS, G-9, ISE BRAC
600 Army Pentagon
Washington, DC 20310

Prepared by:

Leidos
1750 Presidents Street
Reston, Virginia 20190

Contract Number W912DR-18-D-0003
Delivery Order Number W912DR21F0140

Timothy Runkle, GIT
Project Geologist

Vasu Peterson, P.E., PMP
Leidos BRAC PFAS Project Manager

Rita Schmon-Stasik
Leidos QA Manager

Lisa Jones-Bateman, REM, PMP
Leidos Principal

Final
November 2023

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

%R	Percent Recovery
amsl	Above Mean Sea Level
AOPI	Area of Potential Interest
Army	U.S. Army
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CoC	Chain-of-Custody
CSM	Conceptual Site Model
DERP	Defense Environmental Restoration Program
DoD	U.S. Department of Defense
DQO	Data Quality Objective
DUA	Data Usability Assessment
DWR	Department of Water Resources
E/P	Evaporation/Percolation
EDC	Economic Development Conveyance
EDR	Environmental Data Resources
EIS	Extracted Internal Standard
FCR	Field Change Request
GIT	Geologist in Training
GPS	Global Positioning System
HDPE	High-Density Polyethylene
HFPO-DA	Hexafluoropropylene Oxide Dimer Acid (GenX)
HQ	Hazard Quotient
ID	Identifier
IDW	Investigation-Derived Waste
IPaC	Information for Planning and Consultation
IWTP	Industrial Wastewater Treatment Plant
LC/MS/MS	Liquid Chromatography with Tandem Mass Spectrometry
LCS	Laboratory Control Sample
LOD	Limit of Detection
LUC	Land Use Control
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NWI	National Wetlands Inventory
OSD	Office of the Secretary of Defense
P.E.	Professional Engineer
PA	Preliminary Assessment
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutane Sulfonate
PFHxS	Perfluorohexane Sulfonate
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PMP	Project Management Professional
PPE	Personal Protective Equipment

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

QA	Quality Assurance
QC	Quality Control
QSM	Quality Systems Manual
REM	Registered Environmental Manager
RI	Remedial Investigation
RLRA	Riverbank Local Redevelopment Authority
ROD	Record of Decision
RPD	Relative Percent Difference
RSL	Regional Screening Level
SDG	Sample Delivery Group
SI	Site Inspection
SL	Screening Level
SOP	Standard Operating Procedure
T&E	Threatened and Endangered
TCLP	Toxicity Characteristic Leaching Procedure
U.S.C.	United States Code
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

The U.S. Army (Army) is conducting Preliminary Assessments (PAs) and Site Inspections (SIs) to determine the use, storage, disposal, or release of per- and polyfluoroalkyl substances (PFAS) at multiple Base Realignment and Closure (BRAC) installations, nationwide. This report documents SI activities conducted for six areas of potential interest (AOPIs) at the Riverbank Army Ammunition Plant (RBAAP) in Riverbank, California. AOPIs were identified during the PA phase for investigation through multimedia sampling in an SI phase to determine whether a PFAS release occurred. Activities were completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 United States Code [U.S.C.] §9601, et seq.); the Defense Environmental Restoration Program (DERP, 10 U.S.C. §2701, et seq.); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 Code of Federal Regulations [CFR] Part 300); Army and U.S. Department of Defense (DoD) policy and guidance; and U.S. Environmental Protection Agency (USEPA) guidance.

The PA identified areas where PFAS-containing materials were used, stored, and/or disposed of, or areas where known or suspected releases to the environment occurred. Based on recommendations from the PA, soil and groundwater samples were collected from the six AOPIs. The field investigation at RBAAP was conducted in accordance with the Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b). Samples collected during this SI were analyzed for PFAS using procedures compliant with the DoD Quality Systems Manual (QSM) Version 5.4, Table B-15 (DoD 2021) and the laboratory standard operating procedure (SOP).

To determine if future investigation was warranted at each AOPI, this SI followed established USEPA guidance and DoD policy and guidance for perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutane sulfonate (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) (also known as GenX) (DoD 2022a). Samples collected during this SI were compared to risk screening levels (SLs) established as the residential scenario SLs calculated using the USEPA regional screening level (RSL) calculator for soil and the tap water criteria for groundwater and published in the 2022 Office of the Secretary of Defense (OSD) Memorandum (DoD 2022a). Since PFAS are a large grouping consisting of thousands of individual chemicals, PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA altogether will be referred to in this report as “Target PFAS.”

Conceptual site models (CSMs) were developed during the PA and then updated for each AOPI where Target PFAS were detected at concentrations above the limit of detection (LOD). The updated CSMs detail site geological conditions; determine primary and secondary release mechanisms; identify potential human receptors; and detail complete, potentially complete, and incomplete exposure pathways for current and reasonably anticipated future exposure scenarios. PFAS were detected in at least one medium at two AOPIs. PFAS concentrations exceeded SLs in groundwater at two of the AOPIs. Only PFOS and PFOA were detected in groundwater at concentrations that exceeded SLs, and HFPO-DA was not detected at any AOPI. Figure ES-1 depicts the facility-wide map of AOPIs and PFAS groundwater results, including the distribution of SLs exceedances and proximity to facility boundaries.

Table ES-1 summarizes the AOPIs investigated during the SI and recommendations for further investigation.

Table ES-1. Summary of AOPIs and Recommendations for Further Investigation

AOPI Name	Exceedance of SLs		Recommendation
	Groundwater	Soil	
Metal Plating Line 6	No	No	Further investigation not recommended
Metal Plating Line 1	Yes	No	Further investigation recommended
IWTP	Yes	No	Further investigation recommended

Table ES-1. Summary of AOPIs and Recommendations for Further Investigation (Continued)

AOPI Name	Exceedance of SLs		Recommendation
	Groundwater	Soil	
IWTP Sewer Line Break Area (Effluent Force Main)	No	No	Further investigation not recommended
E/P Ponds	No	No	Further investigation not recommended
North Landfill	No	No	Further investigation not recommended

Highlighted values indicate AOPIs with a recommendation for further investigation.

1. INTRODUCTION

The U.S. Army (Army) is conducting Preliminary Assessments (PAs, 40 Code of Federal Regulations [CFR] §300.420(b)) and Site Inspections (SIs, 40 CFR §300.420(c)) to investigate the presence or release of per- and polyfluoroalkyl substances (PFAS), by investigating the use, storage, or disposal of PFAS at multiple Base Realignment and Closure (BRAC) installations, nationwide. This SI is focused on the former Riverbank Army Ammunition Plant (RBAAP), and was conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 United States Code [U.S.C.] §9601 et seq.); the Defense Environmental Restoration Program (DERP, 10 U.S.C. §2701 et seq.); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300); Army and U.S. Department of Defense (DoD) policy and guidance; and U.S. Environmental Protection Agency (USEPA) guidance. The former RBAAP was officially named to the National Priorities List (NPL) in February 1990, and the Army is responsible for compliance with CERCLA in accordance with Executive Order 12580, as amended.

Based on results of the RBAAP PFAS PA (Leidos 2023), multiple areas of potential interest (AOPIs) were identified for investigation through multimedia sampling in an SI to determine whether a PFAS release occurred. RBAAP is located in Riverbank, California, as shown in Figure 1-1. The entire former RBAAP is referred to as the "site," "facility," or "installation" throughout this document. Any references to "offsite" refer to areas that are outside the original boundary of RBAAP.

1.1 SCOPE AND OBJECTIVES

The overall objective of the SI is to determine the presence or absence of PFAS at each AOPI. This SI Report uses the findings from the PA in conjunction with soil and groundwater sampling data to determine whether PFAS have been released to the environment and whether a release has affected or may affect specific human health targets. Furthermore, the SI evaluates and summarizes the need for additional investigation (40 CFR §300.420(c)(1)).

The SI scope included preparation of project planning documents, field investigation, validation and management of analytical data, comparison of analytical data to the Office of the Secretary of Defense (OSD) screening levels (SLs), and documentation of the investigation results. This SI was conducted in accordance with the Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b). The field activities followed site-specific sampling and health and safety protocols, as identified in the Programmatic Accident Prevention Plan (Leidos 2022c) and RBAAP Site Safety and Health Plan (Appendix A of the RBAAP UFP-QAPP Addendum [Leidos 2022b]).

1.2 RBAAP DESCRIPTION

RBAAP is composed of two non-contiguous tracts of property. The first is the main installation, which is divided into six parcels (Parcels A, B, 1, 1a, 2, and 2a) and the Northwest Stormwater Reservoir site. The second tract of property is the evaporation/percolation (E/P) ponds (Parcel 4), which is approximately 1.5 miles north of the main installation. On October 17, 2017, Parcel B (24.42 acres) was transferred to the Riverbank Local Redevelopment Authority (RLRA) for use as an aspect of a new green industry park via a no-cost Economic Development Conveyance (EDC). The remaining acreage on the main installation is leased by RLRA, which then subleases the facilities for manufacturing, light industrial use, storage, and repair facilities (U.S. Army 2020). The Army plans to transfer Parcel A (77.8 acres) and the Northwest Stormwater Reservoir (3.3 acres) via a no-cost EDC to RLRA (U.S. Army 2020). The remaining parcels will be transferred via other conveyance methods: Negotiated Sale, Public Sale, or Public Benefit Conveyance.

During the development of the PA, historical records, interviews, aerial photographic analysis, site reconnaissance, available documentation, and physical evidence were reviewed to determine where PFAS-containing materials may have previously been stored, used, or disposed of (40 CFR §300.420(b)). For RBAAP, the sites evaluated include fire stations, fire training areas, landfills, metal plating operations, wastewater treatment plants, pesticide facilities, vehicle maintenance shops, paint shops, and photographic processing facilities. The RBAAP PFAS PA recommended six AOPIs for further investigation in an SI due to known or potential historical PFAS-containing material use, storage, or disposal. The AOPIs, as well as the dates of operation and size of each area, are presented in Table 1-1 and illustrated in Figure 1-2.

Table 1-1. List of AOPIs at RBAAP

AOPI Name	Dates of Operation	Size (acres)
Metal Plating Line 6	1952 to 1954, 2000 to 2009	0.86
Metal Plating Line 1	1952 to 1954, 1966 to 1976, 1990 to 1992	0.86
IWTP	1951 to present	1.15
IWTP Sewer Line Break Area (Effluent Force Main)	1951 to present	0.05
E/P Ponds	1952 to 1966	27.26
North Landfill	1972 to 1980	1.85

1.3 REPORT ORGANIZATION

The contents of the remaining sections of this SI Report are summarized below:

- ***Section 2. Environmental Setting***—This section discusses the environmental setting at RBAAP. Demographics, land use, geology, hydrogeology, hydrology, soil, and climate are described.
- ***Section 3. Field Investigation Activities***—This section provides field procedures followed during the implementation of the SI.
- ***Section 4. Data Analysis and Quality Assurance Summary***—This section describes the laboratory chemical analysis program for the investigation. Sample handling procedures, laboratory equipment calibration, laboratory analytical methods, data reporting and validation, and sample data quality assurance (QA)/quality control (QC) are discussed.
- ***Section 5. Site Inspection Screening Levels***—This section presents the Target PFAS with SLs outlined in the 2022 OSD Memorandum (DoD 2022a) and the SLs to which SI results are compared.
- ***Section 6. Site Inspection Results***—This section presents the data gathered during the SI activities and updated conceptual site models (CSMs).
- ***Section 7. Conclusions and Recommendations***—This section summarizes the SI conclusions and presents recommendations for the RBAAP AOPIs.
- ***Section 8. References—***This section lists the references that were used in the preparation of this report.
- ***Appendices***—Appendices A through I include data from field activities or related assessments:
  - Appendix A. Daily Field Summary Notes
  - Appendix B. Photograph Log
  - Appendix C. Field Activity Logs
  - Appendix D. Boring Logs
  - Appendix E. Sampling Forms and Calibration Logs
  - Appendix F. Field Change Request
  - Appendix G. Investigation-Derived Waste (IDW) Documents
  - Appendix H. Data Usability Assessment (DUA)
  - Appendix I. Data Presentation Tables.

2. ENVIRONMENTAL SETTING

This section provides general information about RBAAP, including the site location, operational history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 5-mile radius of the installation, and applicable ecological receptors.

2.1 SITE LOCATION

RBAAP is located at 5300 Claus Road, Riverbank, Stanislaus County, California. It is 1 mile south of the Stanislaus-San Joaquin County border and approximately 5 miles northeast of the city of Modesto (Figure 1-1). While in operation, RBAAP was approximately 168 total acres and is composed of two non-contiguous tracts of property: the main installation (139.2 acres) and the E/P Ponds (28.8 acres) (U.S. Army 2017). Townsend Avenue and railroad tracks bound the main installation to the north, Claribel Road bounds the site to the south, and Claus Road borders the main installation to the west. The four E/P Ponds are approximately 1.5 miles to the north of the main installation along the Stanislaus River. Figure 2-1 depicts the RBAAP site features.

2.2 SITE OPERATIONAL HISTORY

RBAAP was purchased by the Defense Plant Corporation in 1942. Under the authority of the Defense Plant Corporation, the plant was constructed by Aluminum Corporation of America as an aluminum reduction plant. The land and plant ownership were transferred to the United States in 1948. The E/P Ponds property was purchased by the United States in 1948 (CH2M Hill 2006).

In 1949, the title was transferred from the Defense Plant Corporation to the Federal Works Administration. The decision was made by the Ordnance Corps to convert to the manufacture of steel cartridge cases for joint Army and Navy use in 1951. RBAAP was assigned to the Army on June 1, 1951, and became a Government-Owned/Contractor-Operated industrial installation under the jurisdiction of the Army Joint Munitions Command. Industrial wastewaters, including phosphate, nitrate, sulfate, chloride, zinc, iron, lead, copper, manganese, chromium, nickel, mercury, cyanide, sulfuric acid, and chromic acid, have resulted from these processes (CH2M Hill 2006).

Norris Thermador Corporation (later changed to Norris Industries, Inc. and then to NI Industries) was awarded a contract for the conversion and operation of RBAAP on January 30, 1952. Seven production lines were constructed. Lines 1, 2, 3, and 4 produced 105mm cartridge cases. Lines 5 and 6 produced 3-inch/59, 5-inch/38, and 5-inch/54 naval cartridge cases. Line 7 supplied additional 105mm cases. Full production began on September 17, 1952, and continued until May 1954, when the plant was placed on a limited-production schedule. The manufacture of 105mm cartridge cases continued until 1958. Production ceased following the Korean War, and the plant was placed on layaway status until 1963. The General Services Administration attempted to sell the property. The property was removed from the sales market and placed on standby status until 1966 (CH2M Hill 2006).

The facility was reactivated to support requirements for the Vietnam War. Norris Thermador Corporation was issued a contract by the Army Ammunition Procurement and Supply Agency on June 30, 1966, to provide for reactivation of existing facilities to produce 105mm cartridge cases and the acquisition and installation of necessary facilities to concurrently produce 60mm and 81mm mortar projectiles. Final production of 81mm mortar projectiles was completed in September 1975. Activities at the facility from September 1975 through 1976 were limited to modernization and expansion of Line 1, layaway of idle facilities, limited manufacturing and technology updates, maintenance, and protection of the facility. From 1977 to 1990, only grenade casing and mortar casing production lines were operational. Grenade casing production ceased in June 1990. Production of 5-inch and 105mm artillery casing continued until base closure in 2010 (CH2M Hill 2006).

In 1990, RBAAP was proposed for inclusion on the NPL with a Hazard Ranking System score of 63.94 and was officially named to the NPL in February 1990. Subsequently, an Interagency Agreement (Federal Facility Agreement) was signed by the Army, USEPA Region 9, California Environmental Protection Agency Department of Toxic Substances Control, and California Regional Water Quality Control Board. The Interagency Agreement became effective in June 1990. A Record of Decision (ROD) for soils and groundwater was finalized in March 1994, and construction of the Groundwater Treatment System expansion was completed in September 1997 (CH2M Hill 2006).

RBAAP was recommended for closure by the 2005 (PUB L. 101-510) BRAC Commission and was formally closed on March 31, 2010. After closure, RLRA leased the facility for use.

2.3 DEMOGRAPHICS, PROPERTY TRANSFER, AND LAND USE

The RBAAP main installation area is bounded by residential areas and farmland. In 2022, the U.S. census reported a population of 24,826 for the city of Riverbank, California, and 218,069 for Modesto, California (U.S. Census Bureau 2022).

The main installation is divided into six parcels (Parcels A, B, 1, 1a, 2, and 2a) and the Northwest Stormwater Reservoir site, as shown in Figure 1-2. On October 17, 2017, Parcel B (24.42 acres) was transferred to RLRA for use as an aspect of a new green industry park via a no-cost EDC. The remaining acreage on the main installation is leased by RLRA, which then subleases the facilities for manufacturing, light industrial use, storage, and repair facilities (U.S. Army 2020). The Army plans to transfer Parcel A (77.8 acres) and the Northwest Stormwater Reservoir (3.3 acres) via a no-cost EDC to RLRA (U.S. Army 2020). The remaining parcels will be transferred via other conveyance methods: Negotiated Sale, Public Sale or Public Benefit Conveyance.

The deed for Parcel B includes restrictions on certain uses of the site; however, these restrictions are not currently part of CERCLA documents. None of the AOPIs identified in this SI are located on Parcel B. A second Explanation of Significant Differences recommending groundwater use restrictions for areas impacted by groundwater contamination, unrelated to PFAS, has been prepared by the Army and is currently in regulatory review.

2.4 TOPOGRAPHY

RBAAP is located between the Stanislaus River and Dry Creek on the northeastern side of the San Joaquin Valley within the Great Valley geomorphic province. The topography of RBAAP is flat, featureless valley land. The ground surface elevation of RBAAP is 135 feet above mean sea level (amsl) and slopes southwestwardly at a rate of 25 feet per mile (USACE 2013).

2.5 GEOLOGY

RBAAP is located within the San Joaquin Valley, part of the Great Valley Province, a deep, northwest-southeast trending structural trough. It is bounded on the east by the Sierra Nevada Mountains, which consist of tilted fault blocks of igneous and metamorphic crystalline rock, with a relatively gradual westward slope forming the eastern boundary of the valley. The valley is filled with Cretaceous, Tertiary, and Quaternary aged sediments (Weston 1991).

The sediments underlying the valley floor are part of the Great Valley sequence. The older valley fill deposits were formed under marine conditions, derived from the erosion of the ancestral Sierra Nevada range as it rose in the east. During the Tertiary age, the coastal ranges formed along the western margin of the Great Valley, eventually making it a closed basin. This resulted in increased deposition of sediments along both the eastern and western margins. Vast quantities of unconsolidated sediment were deposited under continental conditions as alluvial fans built out into the valley (Weston 1991).

The main installation at RBAAP is located in an area of low alluvial plains and fans less than 2 miles south of the Stanislaus River. The surficial geology at RBAAP consists of unconsolidated Pleistocene non-marine sedimentary deposits, locally referred to as the Riverbank Formation and Aromas Red Sands. These deposits consist of gray to brown and yellow to red cross-bedded sands, which also contain minor amounts of clay and silt with some pebbles (CH2M Hill 2008).

The fluvial depositional environment has resulted in the shallow subsurface geology being similar to the surficial geology; however, the fluvial deposits are hundreds of feet of interbedded sands, clays, and gravels, with some clay layers being substantially thick (CH2M Hill 2008).

Geological conditions at the E/P Ponds are similar to the main installation, and fluvial deposits are present below the E/P Ponds. The effluent from the industrial wastewater treatment plant (IWTP), formally located on the main parcel, discharged into the E/P Ponds. Sediment in the effluent deposits on the bottom of the E/P Ponds and is predominantly composed of silts and clays.

The top of bedrock at RBAAP has not been intercepted with any of the monitoring or production wells around the facility. The California Geological Survey Geologic Map of California published in 2010 (Jennings et al. 2010) identifies the bedrock as “basement crystalline rock units,” and the available bedrock geology maps of the area indicate the bedrock may be 1,000 feet below ground surface (bgs).

2.6 HYDROGEOLOGY

The hydrostratigraphy of RBAAP has been defined through several Remedial Investigation (RI) phases and subsequent remedial design phases. The presence of discontinuous fine-grained sediment layers creates a complex groundwater flow pattern in the vicinity of RBAAP. Five zones of relatively coarse-grained sediments, separated by interbeds of finer-grained material, have been identified at RBAAP (Weston 1991) and confirmed with in situ well installations (Ahtna 2015). These stratigraphic zones vary in continuity, thickness, and depth at RBAAP:

- Zone A – Sand and silty sand; approximately 10 feet thick, extends from approximately 30 to 40 feet bgs
- Interzone A/A’ – Clay and silt, approximately 25 feet thick, extends from approximately 40 to 65 feet bgs
- Zone A’ – Sand and silty sand with clay lenses, approximately 20 feet thick, extends from approximately 65 to 85 feet bgs
- Interzone A’/B – Clayey silt and clayey sand interbedded with Zone A’, approximately 10 feet thick, extends from approximately 80 to 90 feet bgs
- Zone B – Well-graded and poorly graded sand, approximately 20 feet thick, extends from approximately 90 to 110 feet bgs
- Interzone B/C – Clay/silty clay with isolated areas of sandy silt, approximately 10 feet thick, extends from approximately 110 to 120 feet bgs
- Zone C – Sand and silty sand with isolated areas of silt and clay, approximately 25 feet thick, extends from approximately 120 to 145 feet bgs
- Interzone C/D – Silt and clay, approximately 50 feet thick, extends from approximately 145 to 195 feet bgs
- Zone D – Gravel and clayey gravel, greater than 45 feet thick, top of unit approximately 195 feet bgs.

The shallow and deep aquifer zones were determined to be hydraulically interconnected (Weston 1991). The presence of discontinuous fine-grained sediment layers creates a complex flow pattern in the subsurface in which the flow between interfingered lithologic unites varies across the installation. Groundwater flows generally toward the southwest (Figure 2-2). Regionally, the groundwater table is lowering, and the Zone A aquifer is essentially dry. Only the lower portion of Zone A becomes saturated during the late fall and winter (CH2M Hill 2008).

2.7 SURFACE WATER HYDROLOGY

RBAAP is located within the San Joaquin River watershed, specifically within the North Stanislaus minor subarea of the East Valley Floor Subarea of the Lower San Joaquin River Watershed. RBAAP has minimal relief and slopes downward gently approximately 25 feet per mile toward the southwest. The surface water features at RBAAP are shown in Figure 2-1.

Stormwater runoff at the main installation is diverted to a drainage system that collects water into two large evaporatory storm reservoirs: the Southeast and Northwest Stormwater Reservoirs. The Southeast Stormwater Reservoir, with a capacity of approximately 400,000 gallons, receives runoff from the southeastern part of the main installation (southern portion of Parcel A), and the collected stormwater is then pumped to the Northwest Stormwater Reservoir. The Northwest Stormwater Reservoir has a capacity of 2.5 million gallons and receives stormwater runoff from most of the main installation as well as from the Southeast Stormwater Reservoir. The storm system could hold a 24-hour rainfall event of approximately 1.78 inches. If the main stormwater reservoir exceeds the maximum capacity, the excess rainwater would flow into the Oakland Irrigation District canal. While flooding events have occurred in the past after heavy rainfall, the probability of a 24-hour rainfall event at 2.00 inches is low (USACE 2009).

2.8 WATER USAGE

RBAAP operates a non-transient, non-community water system that provides potable water for the facilities at the main installation. Although the system was once composed of six wells (designated Production Wells 01 through 06), the Army has abandoned Production Wells 02, 03, and 04. The primary water is obtained from two wells (Production Wells 05 and 06) located on the plant property (Figure 2-1). Production Well 01 is held in reserve. The production wells can cumulatively produce 2,600 gallons per minute (USACE 2009).

Records indicate that Production Well 01 draws water from 158 to 170 feet bgs. Production Wells 05 and 06 were installed with several intervals of perforated casing and can draw from multiple depths from 104 to 677 feet bgs (Production Well 05) or 120 to 600 feet bgs (Production Well 06). The system operates under a State of California Domestic Water Supply Permit, and water is treated at the wellheads by gas chlorination by RLRA. Production Well 01 was placed on standby in 2005 and is available for emergency use only. Production Well 01 lies within the designated Category 5 area of the Environmental Condition of Property Phase I Report (CH2M Hill 2006), where release, disposal, and/or migration of hazardous substances has occurred, but remediation is incomplete. Production Wells 05 and 06 are in the southern portion of RBAAP in an area designated as Category 3 in the Environmental Condition of Property Phase I Report (CH2M Hill 2006); groundwater contamination was present but has been below the cleanup standards in this area. Contamination in Zone C or deeper has not been detected in this area previously.

The city of Riverbank provides water within the city limits of Riverbank and the immediately surrounding areas to the east, north, and west of RBAAP. The city's water is sourced entirely from nine active wells and one inactive production well (Kjeldsen, Sinnock & Neudeck, Inc. 2021). The city of Modesto provides water within the city limits of Modesto and the immediately surrounding area to the south of RBAAP. Modesto uses surface water from the Tuolumne River and 75 groundwater wells as sources for its water supply. The Tuolumne River is located more than 6 miles to the south of RBAAP. Water demands in the outlying service area of Modesto are met entirely by groundwater, while areas within the city limits are met with a combination of surface water and groundwater (West Yost 2021). In 1992, the Army completed a response action to protect residents from potential exposure to groundwater contaminated with chromium and cyanide migrating downgradient from RBAAP to the west (USAEC 1994). The response action included extending the city of Riverbank's public water supply system into the residential areas west of Riverbank. In addition, the Army drilled deeper wells for a small number of residents that still wanted to use wells for irrigation (U.S. Army 2006).

An Environmental Data Resources (EDR) report identified 109 well records for wells within 1 mile of the main installation of RBAAP, which includes monitoring, residential, and commercial wells (EDR 2021). Data in the EDR report were verified using the California Department of Water Resources (DWR) database of well completion reports (CA DWR 2001). The DWR database was also used to include a 1-mile radius around the E/P Ponds, bringing the total number of permitted wells retrieved between both resources to 200 wells. A review of DWR records between a 1- and 4-mile radius of RBAAP identified 792 additional wells. In ongoing efforts to meet concerns raised by the regulators during the 5-Year Review process, the Army conducted a Well Survey Public Outreach in 2021. A preliminary evaluation identified 54 well records within a ¼-mile downgradient buffer of the 50 µg/L dissolved chromium plume at RBAAP. Mailed questionnaires and door-to-door reconnaissance were used to obtain information about the identified wells. The survey confirmed that eight properties within the search area had a well for domestic use or were suspected of having a domestic use well. Ten properties contained inactive wells or wells used only for irrigation. Eleven additional properties contained a well; however, the use could not be determined. The remaining well records were either determined to be located outside the buffer area or no information could be obtained (Ahtna 2022).

2.9 ECOLOGICAL PROFILE

Most of the main installation area is developed, and the ground has either been paved or is covered by other hardscape and structures. Most of the E/P area is undeveloped and maintained for use and has open field or crushed gravel. The little vegetation that occurs in the developed areas of RBAAP is characterized by nonnative species that provide little habitat value to wildlife species. Areas that have not been developed are characterized by five vegetation types: ruderal grassland, irrigated pasture, emergent marsh, riparian woodland, and wetlands. The grassland is predominantly along the southern periphery of the main installation in the area that was a former parking lot and is dominated by nonnative plant species, including yellow starthistle (*Centaurea solstitialis*), wild oat (*Avena fatua*), soft chess (*Bromus hordeaceus*), and dove weed (*Eremocarpus setigerus*). Irrigated pastures occur in areas on the main installation that were formerly annual grassland but have been irrigated to provide year-round forage for livestock. Common plant species found in irrigated pastures include Dallis grass (*Paspalum dilatum*), bird's-foot trefoil (*Lotus corniculatus*), curly dock (*Rumex crispus*), and a few sedge species (*Carex* sp.). Emergent marshes on the main installation property occur within a stormwater ditch in the southeastern portion of the site and in water detention basins in the northwestern portion of the site. Emergent marshes are dominated by plant species that are adapted to inundation or saturation year-round, including cattails (*Typha latifolia*) and arrowhead (*Sagittaria cuneata*).

The E/P Ponds were constructed along the banks of the Stanislaus River. Mature riparian woodland forest remains along the bank and typically consists of tall, dense, deciduous broadleaf trees, including Fremont cottonwood (*Populus fremontii*), California box elder (*Acer negundo* ssp. *californicum*), black willow (*Salix gooddingi*i), western sycamore (*Planatus racemosa*), and valley oak (*Quercus lobata*). The National Wetlands Inventory (NWI) mapping indicates the wetlands along the bank of the Stanislaus River in the E/P Ponds area is an approximately 18-acre freshwater forested/scrub wetland complex (NWI 2023). Based on the 1970s imagery, wetlands within the main installation are limited to the ditches to the north, south, and east (NWI 2023). The NWI mapping describes these ditches as semipermanently flooded, manmade, riverine wetlands. Although the reservoirs are not depicted as wetlands on the NWI mapping, the Southeast and Northwest Stormwater Reservoirs contain water or are moist most of the rainy season (U.S. Army 2018a).

The developed areas at RBAAP provide little habitat value to most wildlife species; wildlife on the property is typically composed of common species that are adapted to residential or urban settings. Wildlife that may be present in the ruderal grassland, irrigated pastures, and emergent marsh in the main installation include species such as deer mouse (*Peromyscus maniculatus*), black-tailed jackrabbit (*Lepus californicus*), mourning dove (*Zenaida macroura*), killdeer (*Charadrius vociferus*), red-tailed hawk (*Buteo jamaicensis*), red-winged blackbird (*Agelaius phoeniceus*), great blue heron (*Ardea herodias*), bullfrog (*Rana catesbeiana*), western fence lizard (*Sceloporus occidentalis*), and gopher snake (*Pituophis catenifer*) (USACE 2009). Wildlife that may be present in the riparian forests of the E/P Ponds area include mammalian species such as Western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), Virginia opossum (Didelphis virginiana), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and mule deer (*Odocoileus hemionus*), as well as various species of raptors, songbirds, and waterfowl (USACE 2009).

The U.S. Fish and Wildlife Service Environmental Conservation Online System Information for Planning and Consultation (IPaC) tool identified four federally listed threatened and endangered (T&E) species as potentially occurring (i.e., known or expected to be on or near) at RBAAP (USFWS 2023). The federally listed T&E species included the threatened California tiger salamander (*Ambysoma californiense*), threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), threatened vernal pool fairy shrimp (*Branchinecta lynchi*), and endangered vernal pool tadpole shrimp (*Lepidurus packardi*). One candidate species, the monarch butterfly (*Danaus plexippus*), was identified by IPaC as potentially occurring at RBAAP (USFWS 2023). The potential for these T&E and candidate species to occur does not mean the species are present at RBAAP. For example, there is no suitable habitat (i.e., vernal pools, ephemeral stock ponds, small ponds, lakes, or vernal pools in grassland and oak woodlands for larvae) for the California tiger salamander, vernal pool fairy shrimp, or vernal pool tadpole shrimp, and these species are unlikely to occur at RBAAP. The Valley elderberry longhorn beetle requires riparian and oak savanna habitats with elderberry shrubs. The beetle may be present in the elderberry shrubs surrounding the E/P Ponds (USACE 2009).

Ten migratory birds of particular concern are identified by the IPaC tool as potentially occurring on RBAAP. These birds include species such as the bald eagle (*Haliaeetus leucocephalus*), Bullock's oriole (*Icterus bullockii*), Nuttall's woodpecker (*Picoides nuttallii*), and yellow-billed magpie (*Pica nuttalli*) (USFWS 2023).

2.10 CLIMATE

The average temperature at RBAAP is 61.7°F, which is slightly higher than the California average temperature of 61.2°F and the national average temperature of 54.5°F. The annual rainfall amount is 14.60 inches with 34.03 days of 0.1 inches or more of rain. The annual snowfall amount is 0.00 inches with 0.00 days of 1 inch or more of snow. Average wind speed for the area is 16.33 miles per hour (USA.com 2021).

3. FIELD INVESTIGATION ACTIVITIES

This section provides field procedures followed during the implementation of the SI (40 CFR §300.420(c)(4)(i)). The principal guidance documents for the field investigation activities and procedures used for the RBAAP SI were consistent with the requirements presented in the Army *Guidance for Addressing Releases of PFAS* (U.S. Army 2018b).

3.1 SITE INSPECTION DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) were developed to define the problem at the AOPIs, identify the necessary decisions, specify decision-making rules and the level of confidence necessary to resolve the problem, identify the number of samples necessary to support the decision, and obtain agreement from the decision makers before the sampling program was initiated. The RBAAP sample locations were determined based on current site conditions (i.e., groundwater flow direction), presence of site media (e.g., sediment and surface water were not present), historical data (e.g., suspected location of PFAS release), and historical activities (e.g., remedial activities, disposal of potentially contaminated materials). The project stakeholders concurred that selected sampling schemes would be representative of site conditions prior to initiation of field investigation activities. The field investigation at RBAAP was conducted in accordance with the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b). The field activities employed to execute the Programmatic UFP-QAPP and RBAAP UFP-QAPP Addendum are described below and include any variances or deviations.

3.2 SAMPLE DESIGN AND RATIONALE

Six AOPIs were investigated during the RBAAP SI to determine the presence or absence of PFAS in the environment. Information inputs from the preliminary CSMs presented on Worksheet #10 of the RBAAP UFP-QAPP Addendum (Leidos 2022b) are the basis for sample design at each AOPI. All samples were analyzed for the Target PFAS list of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) perfluorobutane sulfonate (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) (also known as GenX).

The general approach originally proposed in the RBAAP UFP-QAPP Addendum (Leidos 2022b) for the determination of the presence or absence of PFAS at an AOPI consists of installation of two monitoring wells, one within and one downgradient from the AOPI; collection of two groundwater samples; collection of three soil samples from three soil borings; and collection of one colocated surface water and sediment sample, if the media are present. The U.S. Army Corps of Engineers (USACE)-approved Field Change Request (FCR) 2022-02 (Appendix F) replaced the drilling and installation of deep soil borings and groundwater wells at the site with the sampling of additional existing wells to achieve project goals and objectives (see Section 3.4.7). Therefore, the general approach for determining the presence or absence of PFAS at RBAAP consisted of facility-wide groundwater sample collection from existing monitoring wells where proximal to AOPIs or the facility boundary. In addition, surface and shallow subsurface soil samples were collected from proposed soil boring locations.

Each location that was sampled, with a unique set of coordinates, was assigned a specific site location: RBAAP-XXX-##.

Where:

- XXX = abbreviation for the AOPI being sampled
- ## = the sequential number of each sample location within the AOPI.

For existing monitoring wells, the sequential number of each sample location was replaced with the existing monitoring well identifier (ID).

Each sample that was collected received a unique sample number, related to the site ID above, in the format of RBXXX##-ZZzz.

Where:

- XXX = abbreviation for the AOPI being sampled
- ## = the sequential number of each sample location within the AOPI
- ZZ = sample media (i.e., MW = groundwater, SS = surface soil, SB = subsurface soil, SW = surface water, SD = sediment)
- zz = the sequence number for the sample at the location.

For existing monitoring wells, the unique sample number used RBXXX where XXX is the abbreviation for the AOPI that was sampled followed by the monitoring well ID.

QA/QC samples were denoted according to the sample type. Rinsate blanks, field duplicates, and matrix spike (MS) and matrix spike duplicate (MSD) samples were denoted by appending "RB," "FD," "MS," and "MSD," respectively, to the parent sample ID. Field blanks and potable/source water blanks were named using the format of RBAAP-YY##.

Where:

- YY = FB (field blank) or SRC (source blank)
- ## = sequential number of each type of blank sample collected.

3.3 FIELD INVESTIGATION ACTIVITIES

SI field activities were conducted from August 29 to September 16, 2022. The locations and methods of sample collection during the SI are described in the following sections. Sampling procedures adhered to the Programmatic UFP-QAPP (Leidos 2022a), RBAAP UFP-QAPP Addendum (Leidos 2022b), and FCR 2022-02, with relevant information summarized below.

Sampling activities at RBAAP included collecting surface and subsurface soil samples and groundwater samples from existing monitoring wells. Samples were analyzed for 26 PFAS by liquid chromatography with tandem mass spectrometry (LC/MS/MS) compliant with Table B-15 of DoD Quality Systems Manual (QSM) Version 5.4 (DoD 2021) to determine the presence or absence of Target PFAS. Thirty samples were collected among the 6 AOPIs, including 20 existing monitoring well groundwater samples, 4 surface soil samples, and 6 subsurface soil samples. As surface water and sediment were not present at the AOPIs, no surface water or sediment samples were collected. A breakdown of samples and their associated AOPI is provided in Table 3-1. Prior to beginning sampling, site reconnaissance and utility clearance were performed. Sampling was completed at one AOPI before moving to the next AOPI when feasible. Any variances in sampling procedure, such as moving a location or sample point elimination, were discussed with the project team and communicated in daily field summary emails (Appendix A). Field procedures and any variances are discussed in the following sections. Photographs of SI field activities are provided in Appendix B.

Table 3-1. RBAAP AOPI SI Sample Collection

AOPI Name	Soil Samples	Groundwater Samples
Metal Plating Line 6	0 SS/3 SB	3
Metal Plating Line 1	0 SS/2 SB	8
IWTP	0 SS/1 SB	3
IWTP Sewer Line Break Area (Effluent Force Main)	0 SS/0 SB	1
E/P Ponds	4 SS/0 SB	2
North Landfill	0 SS/0 SB	3
Total	**4 SS/6 SB**	**20**

SS = Surface soil sample
SB = Subsurface soil sample

3.4 FIELD PROCEDURES

The following sections describe utilities clearance, bulk source water sampling, field procedures for sampling each medium, equipment calibration, and location survey. Specific details regarding each of these activities are documented on Task Team Activity Log Sheets that are provided in Appendix C.

Because many materials routinely used during environmental investigations can potentially contain PFAS, the field crew conducted SI activities in accordance with the PFAS sampling standard operating procedure (SOP) presented in Appendix A of the Programmatic UFP-QAPP (Leidos 2022a). Procedures include requirements for equipment, containers, handling, and sampling, including PFAS-specific requirements, to ensure that sample contamination does not occur during collection and transport.

3.4.1 Utility Clearance

Prior to initiating intrusive activities, the field manager coordinated underground utility clearances for the six AOPIs through USA North Underground Service Alert “USA North 811.” As part of the utility clearance process, individual utility companies were consulted as needed, and each area was visually inspected to verify that utilities had been marked. The field manager looked for signs of unidentified utilities, including overhead utilities, and completed a Subsurface Clearance Checklist prior to initiating intrusive operations. All soil borings were installed using a low-impact technique (hand auger).

3.4.2 Bulk Source Water Sampling

Prior to beginning work, three bulk source water samples (RBAAP-SRC-01, RBAAP-SRC-02, and RBAAP-SRC-03) were collected on June 24, 2022, for PFAS analysis to determine if the source water was PFAS-free and could be used for drilling and decontamination. Samples RBAAP-SRC-01 and RBAAP-SRC-02 were collected from the facility’s Production Wells 05 and 06, respectively. Sample RBAAP-SRC-03 was collected from a low-pressure water tap located adjacent to the former IWTP. Water sources were purged for a minimum of 1 minute prior to filling high-density polyethylene (HDPE) bottles. Water from the production wells was determined to be PFAS-free (i.e., PFAS not detected above the limit of detection [LOD]) and was used as a drilling and decontamination water source during field sampling. Water from the outdoor spigot contained a single detection of perfluoro-1-octanesulfonamide and was not used as a water source during the SI.

3.4.3 Soil Sampling

All soil samples were collected in accordance with the procedures outlined in the Programmatic UFP-QAPP (Leidos 2022a), RBAAP UFP-QAPP Addendum (Leidos 2022b), and FCR 2022-02 (Appendix F). QC samples, including, duplicates, rinsate blanks, and MS/MSDs, were also collected.

Soil samples were collected with a stainless steel hand auger. Each soil core was logged for lithology in accordance with USACE guidance (ASTM International D2488 [2017]) and recorded on a boring log (provided in Appendix D). Soil sample intervals were homogenized in disposable HDPE bags prior to placing the soil into HDPE sample bottles. Sample bottles were labeled and sealed in zip-lock bags and placed on wet ice for cooling to ≤6°C. Additional details on protocols for obtaining soil samples are outlined on Worksheet #18 and the Leidos SOP “Soil Sampling” provided in the Programmatic UFP-QAPP (Leidos 2022a).

Surface soil samples from 0 to 1 foot bgs were collected at the E/P Ponds AOPI. Surface soil samples were not collected from the remaining AOPIs due to the presence of gravel, asphalt, or concrete. Surface soil sample depths did not exceed 1 foot bgs. Information for one surface soil sample collected at the E/P Ponds AOPI (location RBAAP-EPP-04) was logged on a sediment/surface water sampling form (Appendix E), as the soil was scooped from atop a concrete erosion barrier instead of a soil boring.

One subsurface soil sample was collected from each soil boring advanced at the Metal Plating Line 6, Metal Plating Line 1, and IWTP AOPIs. During the advancement of the soil borings, soil cuttings were evaluated for recording lithology and documenting visual observations. Subsurface soil samples were collected as grab samples from 2-foot intervals, and the interval from which the sample was collected was recorded on the boring log. Samples for laboratory analysis were biased toward organic-rich zones, as PFAS may sorb to organics, but were generally from the bottom of the boring and no greater than 5 feet bgs.

Soil borings were abandoned following sample collection by backfilling the borehole with sand as boreholes did not exceed 5 feet bgs. Surface restoration matched the surrounding surface (e.g., concrete, asphalt, grass).

3.4.4 Groundwater Sampling

All groundwater samples were collected in accordance with the procedures outlined in the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b). QC samples, including equipment blanks, duplicates, and MS/MSDs, were also collected. Groundwater was sampled from existing monitoring wells using stainless steel bladder pumps and the low-flow purge method.

Prior to sampling, static water level measurements were collected to the nearest 0.01 foot. Following completion of monitoring well purging and stabilization of parameters (temperature, pH, and conductivity) as specified in the RBAAP UFP-QAPP Addendum (Leidos 2022b), samples were collected in laboratory-supplied HDPE plastic containers. All samples were collected and handled while wearing clean, non-powdered, disposable nitrile gloves. Sample bottles were labeled and sealed in zip-lock bags and placed on wet ice for cooling to ≤6°C. New, clean nitrile gloves were donned prior to each new sample collected. Sampling containers were labeled with the following information: site name, sample ID, date and time of sample collection, name of sampler, sample preservation, and type of analysis (i.e., PFAS).

All groundwater samples were collected from already established groundwater monitoring wells.

3.4.5 Equipment Calibration

A water quality instrument (i.e., Horiba U-52) used during groundwater sampling was calibrated daily per Worksheet #24 of the Programmatic UFP-QAPP (Leidos 2022a) against known standards in accordance with the manufacturer’s instructions and documented on the calibration logs provided in Appendix E.

3.4.6 Location Survey

Environmental sample locations and notable site features were located and mapped using a portable Trimble global positioning system (GPS) unit capable of achieving ± 3 feet accurate results. GPS data were transferred for use in ArcGIS mapping applications during data evaluation and reporting.

3.4.7 Deviations and Field Change Requests

No instances of field modification impacting project scope and/or data usability/quality were encountered during the SI fieldwork. FCR 2002-02 was approved prior to the beginning of fieldwork to document a change to remove the drilling/installation of deep soil borings and groundwater wells from the technical approval to assess the AOPIs. Shallow soil sampling and existing monitoring wells were used instead to collect data for the SI. A copy of FCR 2022-02 is provided in Appendix F. The FCR incorporated the following changes and alternative sampling approaches into the RBAAP UFP-QAPP Addendum (Leidos 2022b):

- Wells were not installed and soil samples were not collected deeper than the shallow soil interval (5 feet bgs) at the following locations: RBAAP-PL6-01, RBAAP-WPT-01, RBAAP-EPP-01, and RBAAP-EFL-01.

- Soil sampling deeper than the shallow soil interval (5 feet bgs) was not conducted at the following boring locations: RBAAP-PL6-02, RBAAP-PL6-03, RBAAP-PL1-01, RBAAP-PL1-02, RBAAP-EPP-02, and RBAAP-EPP-03.
- Zone A’ wells that did not contain sufficient water for sampling were substituted with an associated Zone B well at the same location. During implementation, all three Zone A’ wells at the IWTP AOPI and MW125A’ at the Metal Plating Line 1 AOPI did not have sufficient volume for sampling; therefore, the samples were collected from the corresponding Zone B wells.
- If a Zone A’ well did not have an associated Zone B interval, an alternative Zone B well within the general proximity was selected for sampling. This condition affected wells EW69A’, MW65A’, and MW73A’.

The sediment sample that was planned for collection at location RBAAP-EPP-04 was reclassified to a surface soil sample based on observed site conditions (i.e., the area was dry, and it is unknown if/when the area retains water).

3.5 DECONTAMINATION PROCEDURES

To ensure that chemical analysis results reflect the actual concentrations at sample locations, the non-dedicated, reusable equipment used in sampling activities was rigorously cleaned and decontaminated between sample locations in accordance with the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b). The non-disposable sampling equipment used to conduct sampling activities (e.g., hand augers, stainless steel pumps, water level meters) was decontaminated before sampling activities began, between locations, between sampling events, and after sampling activities were completed. Decontamination guidelines followed the direction provided in the March 2020 Interstate Technology & Regulatory Council fact sheet that discusses site characterization considerations (ITRC 2020) and PFAS decontamination procedures described by the Michigan Department of Environmental Quality (MDEQ 2018). Wastewater generated from decontamination activities was handled as IDW. Decontamination water was combined with well development and sampling purge water and managed as one medium.

The decontamination process included an initial scrub with a laboratory-grade, phosphate-free, biodegradable detergent (e.g., Liquinox®) and PFAS-free bulk source water to remove particulate matter and surface film. Equipment was scrubbed using polyethylene or polyvinyl chloride brushes. Following this scrub, the equipment was then rinsed twice in separate bins containing bulk source water and deionized water. Decontaminated sampling equipment was wrapped in thin sheets of HDPE to prevent subsequent contamination if being stored and not used immediately.

3.6 DISPOSITION OF FIELD INVESTIGATION-DERIVED WASTE

The IDW generated during the SI at RBAAP included solids (soil, personal protective equipment [PPE], and tubing) and liquids (well purge water and decontamination rinse water). These materials were managed in accordance with the IDW Management Plan provided in Appendix B of the RBAAP UFP-QAPP Addendum (Leidos 2022b).

All IDW generated at RBAAP was placed in United Nations-approved, 55-gallon drums for storage, transport, and disposal. Permanent labels for the drums included a unique container number, a description of the contents (i.e., soil or wastewater), the fill date, the source location, the generator’s name (i.e., RBAAP), and a telephone number for the generator’s point of contact (e.g., the Army BRAC Environmental Coordinator). Each bucket or carboy used to temporarily store liquid IDW before it was transferred to a 55-gallon drum was marked “Nonpotable Water” or “Decontamination Waste” to comply with requirements of the IDW Management Plan.

The contents of the IDW drums were sampled for characterization and profiling. A solid waste sample was composited by collecting aliquots from the solid waste drums using a decontaminated stainless steel hand auger. The solids were homogenized in an HDPE plastic bag and then placed into laboratory-supplied sample containers. For drums containing liquid IDW, a composite sample was collected using a peristaltic pump and new HDPE tubing and pumping directly into sample bottles. The waste hauler (US Ecology) was contacted prior to sampling to determine parameters required for disposal of waste potentially containing PFAS. The certified waste hauler provided guidance to analyze for suspected contaminants based on site history and previous investigations. The samples were analyzed for PFAS, toxicity characteristic leaching procedure (TCLP) volatile organic compounds, TCLP semivolatile organic compounds, TCLP metals, TCLP pesticides, TCLP herbicides, pH, and flashpoint. The sample results indicated the material was non-hazardous waste.

On February 7, 2023, US Ecology removed the solid and liquid IDW waste drums from RBAAP for disposal. Both solid and liquid waste was disposed of at US Ecology Nevada, Inc., Hwy 95, 11 Miles South of Beatty, Beatty, Nevada. Copies of the waste manifests and certificates of disposal are provided in Appendix G.

4. DATA ANALYSIS AND QUALITY ASSURANCE SUMMARY

This section summarizes the QA/QC program and laboratory chemical analysis program implemented as part of the RBAAP SI field activities (40 CFR §300.420(c)(4)). Additional information on these procedures is presented in the RBAAP UFP-QAPP Addendum (Leidos 2022b).

Pace Laboratory, Inc., located in West Columbia, South Carolina, was the analytical laboratory under contract for the analysis of PFAS during the RBAAP SI field activities. Sections 4.1 through 4.4 summarize sample handling procedures, laboratory analytical methods, data QA/QC, data reporting and validation, and sample QA/QC. A QA summary of the analytical data is presented in Section 4.5. Appendix H provides the DUA that details the quality and usability of the SI analytical data and the process performed to evaluate the data for compliance with established QC criteria.

4.1 SAMPLE HANDLING PROCEDURES

A critical aspect of sample collection and analysis protocols is the maintenance of strict chain-of-custody (CoC) procedures, which include tracking and documentation during sample collection, shipment, and laboratory processing. The Sample Manager was responsible for sample custody until the samples were properly packaged, documented, and released to the commercial carrier. The laboratory was responsible for sample custody thereafter in accordance with approved procedures.

4.1.1 Chain-of-Custody Record

CoC forms were used to document the traceability and integrity of all samples from the point of collection to the laboratory by maintaining a record of sample collection, shipment, and receipt by the laboratory. A CoC form was filled out and was signed and dated by each sample custodian.

Shipping containers were sealed with custody tape. Sealed coolers were transported to the commercial carrier for overnight delivery to the laboratory. The air bill number, written on the CoC form, acted as the custody documentation while the sealed coolers were in the possession of the commercial carrier. The CoC form was placed in a resealable plastic bag and taped to the inside lid of the cooler.

When the possession of samples was transferred, the individual relinquishing the samples and the individual receiving the samples signed, dated, and noted the time of transferal on the CoC. This record represents the official documentation for all transferal of sample custody until the samples arrived at the laboratory.

4.1.2 Laboratory Sample Receipt

All samples received by the Laboratory Sample Custodian or designee were checked for proper preservation (e.g., pH, temperature of coolant blank above 2°C or below 6°C); integrity (e.g., leaking, broken bottles); and proper, complete, and accurate documentation and ID of the samples. The temperature of the coolant blank was noted. No insufficiencies and/or discrepancies were noted.

Samples received at the laboratory were logged into the laboratory computer database. Initial entries included field sample number, date of receipt, and analyses required. As samples were received, they were assigned a laboratory sample ID. The sample custodian labeled each container with its sample ID, and the samples then were transferred to their designated storage areas.

Samples received by the laboratory were considered to be physical evidence and were handled according to USEPA procedural safeguards. In addition, all data generated from the sample analyses, including all associated calibrations, method blanks, and other supporting QC analyses, were identified with the project name, project number, and sample delivery group (SDG) designation. All data were maintained under the proper custody. The laboratory provided complete security for samples, analyses, and data.

4.2 LABORATORY ANALYTICAL METHODS

The chemical analysis program for the RBAAP SI conforms to the analytical requirements presented in the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b) for the chemical analysis of field investigation samples. All samples were analyzed for PFAS using LC/MS/MS procedures compliant with DoD QSM Version 5.4, Table B-15 (DoD 2021) and the laboratory SOP.

4.3 DATA QUALITY ASSURANCE/QUALITY CONTROL

This section presents the QA/QC procedures applied during sampling and laboratory analysis. This discussion includes laboratory QA/QC (Section 4.3.1) and field QA/QC (Section 4.3.2) procedures. Details on the results of the QC samples (field and laboratory) are presented in the DUA included in Appendix H.

4.3.1 Laboratory Quality Assurance/Quality Control

Samples were analyzed for PFAS using LC/MS/MS in compliance with DoD QSM Version 5.4, Table B-15 (DoD 2021). QC checks included holding times, method blanks, calibration standards, extracted internal standards (EISs), laboratory control samples (LCSs), MS/MSDs, and detection limits. The acceptance criteria and laboratory SOP are provided in the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b).

Method Blanks—Method blanks were used to monitor the possibility of laboratory-induced contamination by running a volume of approved reagent water through the entire analytical scheme (i.e., extraction, concentration, analysis). Blank requirements are specified in the DoD QSM Version 5.4, Table B-15 (DoD 2021) and the laboratory SOP.

Matrix Spike/Matrix Spike Duplicates—Additional sample volume was collected from select field sample locations to evaluate accuracy and precision using MS/MSD analyses. MS/MSDs are aliquots of environmental samples to which known concentrations of certain target analytes have been added before sample preparation, cleanup, and determinative procedures have been implemented (SW-846 Chapter One). Accuracy was expressed as the percent recovery (%R) of each added compound. Precision was expressed as the relative percent difference (RPD) between the MS and the MSD results. MS/MSD samples were collected and analyzed at a frequency of 1 for every 20 samples of similar matrix received at the laboratory.

Laboratory Control Samples**—**LCSs were analyzed to evaluate the accuracy of the analysis in the absence of sample matrix impacts. A known concentration of select compounds were added to the LCS. The spiked samples were analyzed in the same manner as the environmental samples. Accuracy was expressed as the %R of each added compound. An LCS was analyzed with each SDG.

4.3.2 Field Quality Assurance/Quality Control

Table 4-1 summarizes the frequency of field QC samples that were collected during the RBAAP field investigation. The requirements for field QC were established on Worksheet #20 of the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b).

Table 4-1. Frequency of Field QC Samples for RBAAP Field Investigation

QC Sample	Frequency
Field Blank	1 per water source used as final rinse of equipment
Source Water Blank	1 per bulk rinse water source
Equipment Rinsate Blank	1 for every 10 or fewer investigative samples
Field Duplicate	1 for every 10 or fewer investigative samples
Reagent Blank	1 per drinking water sampling event; none required for this event
MS/MSD	1 per every 20 or fewer investigative samples

4.4 DATA REPORTING AND VALIDATION

The Leidos QA Manager or designee initiated a validation of the analytical data packages. One hundred percent of the data were validated using objective criteria taken from the requirements of the Programmatic UFP-QAPP (Leidos 2022a) and DoD QSM Version 5.4 (DoD 2021) and qualified in accordance with the DoD Data Validation Guidelines Module 3 (DoD 2020) and the revised table for sample qualification in the presence of blank contamination (DoD 2022b).

Reported laboratory data were reviewed in accordance with DoD QSM Stage 2B validation guidelines to ensure that the QC results fell within appropriate QC limits for holding times, blank contamination, EISs, calibrations, MS/MSDs, LCSs, and ion ratios. Any data validation qualifiers resulting from outlier QC results were applied and a data validation report, as previously described, was prepared. In addition, 10 percent of the data were validated in accordance with DoD QSM Stage 3 guidelines, and analytical results were checked and recalculated from raw data.

Equipment rinsate blanks and field blanks were associated with the corresponding environmental samples. These blanks were evaluated following the same criteria as method blanks, and the associated environmental samples were appropriately qualified as needed. After the data validation for the project was completed, a project DUA (Appendix H) was prepared.

4.5 QUALITY ASSURANCE SUMMARY

A comprehensive QA/QC program was implemented during the sampling event at RBAAP in August and September 2022. Samples and associated QC samples (e.g., field duplicates, equipment rinsate blanks, source water blanks, MSs, MSDs) were collected and analyzed for PFAS using methods specified in the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b). Consistent with the data quality requirements established in the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b) and DQOs, all sample data and associated QC data were evaluated during the review and validation process. Individual sample results were qualified, as necessary, to designate usability of the data toward meeting project objectives. Data qualifiers were applied based on deviations from the measurement performance criteria in the Programmatic UFP-QAPP (Leidos 2022a). Results of the validation are provided in the DUA (Appendix H). The analyses associated with each data quality indicator are summarized below, with details of the results of the QC checks provided in the DUA (Appendix H).

4.5.1 Precision

Precision was evaluated by the analysis of MS/MSDs and field duplicate samples and the RPD between the duplicate spike results.

4.5.2 Accuracy

Bias introduced due to blank contamination (in method, instrument, or field blanks) and any impact on accuracy were evaluated during validation. Analytical accuracy was measured through the use of LCSs, MS/MSDs, isotope dilution standards, initial and continuing calibration, and target compound quantitation requirements.

4.5.3 Sensitivity

Sensitivity requirements were evaluated against minimum required limits of quantitation and LODs in the Programmatic UFP-QAPP (Leidos 2022a).

4.5.4 Representativeness

Representativeness was satisfied by ensuring that the Programmatic UFP-QAPP (Leidos 2022a) and RBAAP UFP-QAPP Addendum (Leidos 2022b) protocols were followed, appropriate sampling techniques were used, established analytical procedures were implemented, and analytical holding times of the samples were not exceeded.

4.5.5 Comparability

Comparability was achieved by using consistent, documented, and UFP-QAPP-approved methods and meeting project accuracy and precision objectives.

4.5.6 Completeness

Completeness measures the amount of valid data obtained from the sampling and analysis effort. For analytical data to be usable, each data point must be validated and meet criteria without significant non-conformance. Due to sampling and permitting logistics, the alternative sampling approach outlined in FCR 2022-02 was implemented. All soil and groundwater samples proposed were collected; one surface water sample could not be collected as the location had no water, and the sediment sample was reclassified to soil. Field completeness was 97 percent. Analytical completeness was impacted by 2 data points, qualified as R by the project team, out of 910 total data points for primary and field duplicate samples; therefore, analytical completeness was 99.8 percent. Overall, combined completeness was 97 percent per the revised sampling plan.

4.5.7 Data Usability Assessment

Data that have been qualified as estimated (i.e., J, J+, J-, UJ) during validation indicate accuracy, precision, or sensitivity QC measurements may have exceeded criteria, but the results are considered valid. Data that were recommended for exclusion during validation (qualified X) and subsequently rejected (qualified R) by the project decision team were not used during the evaluation of project objectives.

5. SITE INSPECTION SCREENING LEVELS

Detected concentrations of Target PFAS in samples collected during this SI are compared to residential scenario SLs calculated using the USEPA RSL calculator for soil and the tap water criteria for groundwater, as published in the July 6, 2022, OSD Memorandum (DoD 2022a). This SI uses the SLs and a target hazard quotient (HQ) of 0.1 to evaluate Target PFAS concentrations. These SLs (Table 5-1) are used to evaluate the data and determine if further investigation is warranted at each AOPI.

Table 5-1. Screening Levels from the 2022 OSD Memorandum

Chemical	Residential Tap Water HQ = 0.1 (ng/L or ppt)	Residential Soil HQ = 0.1 (μg/kg or ppb)
HFPO-DA	6	23
PFBS	601	1,900
PFHxS	39	130
PFNA	6	19
PFOA	6	19
PFOS	4	13

Note: The residential tap water SLs are used to evaluate groundwater and surface water data. The residential soil SLs are used to evaluate soil and sediment data. The surface water and sediment data are qualitatively evaluated against the SLs. Laboratory results are reported to two significant figures.

6. SITE INSPECTION RESULTS

This section presents the background, summary of analytical results, and a CSM for each AOPI at RBAAP. Sampled media and QA/QC samples were analyzed for the list of 26 PFAS specified in the Programmatic UFP-QAPP (Leidos 2022a). The sample results discussed below focus on the six Target PFAS outlined in the 2022 OSD Memorandum (DoD 2022a): PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA. Analytical data tables for all PFAS analyzed using approved methods are provided in Appendix I.

6.1 CONCEPTUAL SITE MODELS

The preliminary CSMs developed for each AOPI during the PA were further refined for each AOPI where Target PFAS were detected greater than the LOD in sampled media. Based on the SI sample results, CSMs presented for each AOPI represent the current understanding of site conditions with respect to known or suspected sources of PFAS-containing materials, potential transport mechanisms and migration pathways, and potentially exposed human receptors.

The CSMs evaluate ingestion, dermal contact, and inhalation exposure routes for human receptors. The exposure pathways are evaluated as complete, potentially complete, or incomplete in the CSMs presented in figures in each AOPI-specific CSM section. In the absence of toxicity information for the inhalation route, the inhalation exposure pathway of PFAS (via dust) is considered potentially complete for soil where Target PFAS are detected. The remaining exposure pathway designations are determined as follows:

- ***Complete*** – Human exposure pathways are considered complete where Target PFAS have been detected at concentrations exceeding SLs and no land use controls (LUCs) are in place restricting access or use of the media.
- ***Potentially Complete*** – Human exposure pathways are considered potentially complete if Target PFAS have been detected at concentrations below SLs for soil, groundwater, surface water, or sediment or if SLs have been exceeded along the migration pathway. For example, if Target PFAS are not detected in soil but are detected at concentrations exceeding SLs in groundwater, the exposure pathway for soil is considered potentially complete. In addition, a groundwater exposure pathway is considered potentially complete where Target PFAS have been detected and could migrate from the AOPI source area to offsite groundwater that is used for drinking water. Exposure pathways are also potentially complete for media where existing LUCs are in place for non-PFAS, because the LUCs are not Target PFAS specific. No LUCs are currently in place for any parcels at RBAAP.
- ***Incomplete*** – Human exposure pathways are considered incomplete for media where Target PFAS have not been detected at concentrations above the LODs.

6.2 METAL PLATING LINE 6 AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the Metal Plating Line 6 AOPI.

6.2.1 AOPI Background

Metal Plating Line 6 produced 3-inch/59, 5-inch/38, and 5-inch/54 naval cartridge cases periodically from 1952 until 2009. Metal Plating Line 6 included an automated plater and continuous chromium reduction system with associated trenches in Building 6 and a batch process chromium reduction unit in the southeastern corner of Building 13. The AOPI includes a suspected industrial wastewater pipe leak between Buildings 6 and 13. PFAS-containing mist suppressants were likely used during the plating process given the period of operation of the metal plating. The Line 6 plating operations were surrounded by two trench systems. Each trench was 2 feet wide, 2 feet deep, and led to 4-foot-deep sumps on the northern side of the Line 6 plating operations. Liquid wastes from the metal plating process were discharged from the trenches to the IWTP by underground piping. Decommissioning and decontamination of the plating operations occurred between June 4 and August 21, 2012, and between August 24 and October 8, 2015 (Ahtna 2016).

6.2.2 SI Sampling and Results

Soil and groundwater samples were collected from the Metal Plating Line 6 AOPI at the following locations (Figure 6-1):

- Three soil samples and one QC duplicate were collected within the suspected release area of the Metal Plating Line 6 AOPI from beneath the building slab at three locations (RBAAP-PL6-01, RBAAP-PL6-02, and RBAAP-PL6-03). Surface soil samples were not collected at the AOPI due to concrete at the surface.
- Three groundwater samples were collected from three existing wells (RBAAP-PL6-MW145A’, RBAAP-Pl6-MW148A’, and RBAAP-PL6-MW149A’) downgradient from the AOPI. RBAAP-PL6-MW148A’ and RBAAP-PL6-MW149A’ were downstream from the industrial wastewater piping flow from the suspected release area.

The Target PFAS analytical results for soil and groundwater samples collected at the Metal Plating Line 6 AOPI are summarized below and presented in Table 6-1 and Figure 6-2. Sediment and surface water are not present at this AOPI.

6.2.2.1 Soil

Target PFAS were not detected at concentrations above the LODs in any of the soil samples collected at the Metal Plating Line 6 AOPI.

6.2.2.2 Groundwater

Target PFAS were not detected at concentrations above the LODs in any of the groundwater samples collected at the Metal Plating Line 6 AOPI.

6.2.3 CSM

No changes were warranted to the preliminary CSM presented in the PA because no Target PFAS were detected in soil or groundwater at this AOPI.

6.2.4 Recommendation

Target PFAS were not detected at the Metal Plating Line 6 AOPI in soil or groundwater; therefore, further investigation is not recommended.

Table 6-1. Target PFAS Results and Screening for the Metal Plating Line 6 AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA	PFBS	PFHxS	PFNA	PFOA	PFOS
Soil				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**1900**	**130**	**19**	**19**	**13**
RBAAP-PL6-01	RBPL601-SB01	BORE	3.50-4.50	08/29/2022	1.9 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U
	RBPL601-SB01FD	BORE	3.50-4.50 (D)	08/29/2022	2.2 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U
RBAAP-PL6-02	RBPL602-SB01	BORE	4.00-5.00	08/29/2022	2 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U
RBAAP-PL6-03	RBPL603-SB01	BORE	4.00-5.00	08/30/2022	1.9 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**601**	**39**	**6**	**6**	**4**
RBAAP-PL6-01	RBPL6-MW145A’	WELL	85.00-85.00	09/14/2022	3.8 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
RBAAP-PL6-MW148A’	RBPL6-MW148A’	WELL	75.00-75.00	09/14/2022	4.3 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U
RBAAP-PL6-MW149A’	RBPL6-MW149A’	WELL	84.00-84.00	09/14/2022	3.8 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U

The SLs are the Residential Scenario SLs calculated using the USEPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water using an HQ = 0.1.
(D) = Field duplicate sample.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

6.3 METAL PLATING LINE 1 AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the Metal Plating Line 1 AOPI.

6.3.1 AOPI Background

Metal Plating Line 1 produced 105mm cartridge cases from 1952 until 1954; production was scaled back between 1954 and 1958. Production ceased following the Korean War, and the plant was placed on layaway status until 1963. The facility was reactivated in 1966 to produce 105mm cartridge cases until 1976. After machine upgrades to Line 1, production of 105mm cartridge casings resumed and continued until approximately 1992. Production of the cartridge casings involved the metal plating operations in Line 1 and batch process chromium reduction tank plating wastes in Building 180. PFAS-containing mist suppressants were likely used during the plating process given the period of operation of the metal plating. Liquid wastes from the metal plating process were discharged to the IWTP by underground piping.

6.3.2 SI Sampling and Results

Soil and groundwater samples were collected from the Metal Plating Line 1 AOPI at the following locations (Figure 6-3):

- Two subsurface soil samples were collected beneath the building slab from two locations. RBAAP-PL1-01 was located near the suspected area of metal plating near the chrome reduction tank, and RBAAP-PL1-02 was located within the eastern portion of the AOPI near the subsurface IWTP piping. Surface soil samples were not collected at the AOPI due to concrete at the surface.
- Eight groundwater samples and two QC duplicate samples were collected from eight existing monitoring wells at and downgradient from the suspected release area. Monitoring well RBAAP-PL1-MW150A’ was located near the location of the chrome reduction tank, and RBPL1-MW147B was located upgradient of the suspected release area. The other six monitoring wells (RBAAP-PL1-IW131B, RBAAP-PL1-IW132B, RBAAP-PL1-125B, RBAAP-PL1-143A’, RBAAP-PL1-144A’, and RBPL1-MW126A’) were located downgradient from the suspected release area.

The Target PFAS analytical results for soil and groundwater at the Metal Plating Line 1 AOPI are summarized below and presented in Table 6-2 and Figure 6-4.

6.3.2.1 Soil

Target PFAS were not detected at concentrations above the LODs in any of the soil samples collected at the Metal Plating Line 1 AOPI.

6.3.2.2 Groundwater

PFOA was detected at concentrations exceeding the SL of 6 ng/L near the location of the chrome reduction tank at RBAAP-PL1-MW150A’ (18 ng/L) and at downgradient well RBPL1-MW126A’ (8.2 ng/L). PFOA was detected below the SL in five additional downgradient wells (RBAAP-PL1-IW131B, RBAAP-PL1-IW132B, RBAAP-PL1-MW125B, RBAAP-PL1-MW143A’, and RBAAP-PL1-MW144A’), with decreasing concentrations moving downgradient from (southwest of) the AOPI.

A single detection of PFBS below the SL occurred at RBPL1-MW126A’. PFOS, PFNA, PFHxS, and HFPO-DA were not detected at concentrations above the LODs in groundwater at the AOPI.

6.3.3 CSM

The Metal Plating Line 1 AOPI is approximately 0.86 acres. The building is a steel structure on a concrete foundation. None of the metal processing infrastructure remains in the building. Several small floor drains that feed underground piping, which led to the IWTP, run west to east along the line and are believed to be sealed. The ground surface elevation at Line 1 is approximately 140 feet amsl. Stormwater runoff is collected by the facility stormwater drain system, which leads to the Northwest Stormwater Reservoir.

The surficial and subsurface geology at RBAAP consists of unconsolidated Pleistocene non-marine sedimentary deposits that consist of gray to brown and yellow to red cross-bedded sands that are hundreds of feet thick. These sands contain minor amounts of clay and silt with some pebbles (CH2M Hill 2008). Regionally, the groundwater table is lowering, and many of the shallowest wells (i.e., A and A' wells) at RBAAP are dry. Groundwater has recently been encountered at approximately 71 feet bgs and flows to the southwest (Ahtna 2021).

The primary release mechanism is the potential release of PFAS-containing materials to subsurface soils resulting from leaks in the subsurface piping leading from the metal plating operations. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from soil to groundwater through leaching and percolation.

No surface soil exposure pathway exists because the area is covered with either concrete or asphalt. The subsurface soil exposure pathway at the Metal Plating Line 1 AOPI is potentially complete because Target PFAS were detected at concentrations above the SLs in groundwater at the site and subsurface soil data are limited. The groundwater exposure pathway for onsite workers is complete because Target PFAS were detected above the SLs in groundwater and RBAAP uses onsite wells for drinking water. In addition, the offsite exposure pathway for groundwater is potentially complete because domestic wells are in the vicinity of RBAAP. No surface water and sediment exposure pathway exists because the media are not present at the Metal Plating Line 1 AOPI. However, due to the limited soil data, potential release/migration from subsurface soil to stormwater (e.g., through cracks in underground lines) may warrant investigation of stormwater conveyance lines and the stormwater reservoir. Figure 6-5 presents the CSM for the Metal Plating Line 1 AOPI.

6.3.4 Recommendation

Detected concentrations of Target PFAS in groundwater at the Metal Plating Line 1 AOPI exceed the SLs; therefore, further investigation is recommended.

Table 6-2. Target PFAS Results and Screening for the Metal Plating Line 1 AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA	PFBS	PFHxS	PFNA	PFOA	PFOS
Soil				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**1900**	**130**	**19**	**19**	**13**
RBAAP-PL1-01	RBPL101-SB01	BORE	4.00-5.00	08/30/2022	1.9 U	0.47 U	0.47 U	0.47 U	0.47 U	0.47 U
RBAAP-PL1-02	RBPL102-SB01	BORE	4.00-5.00	08/31/2022	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**601**	**39**	**6**	**6**	**4**
RBAAP-PL1-IW131B	RBPL1-IW131B	WELL	95.00-95.00	09/12/2022	4.2 U	2.1 U	2.1 U	2.1 U	**5.6**	2.1 U
	RBPL1-IW131B-FD	WELL	95.00-95.00	09/12/2022 (D)	4 U	2 U	2 U	2 U	**6**	2 U
RBAAP-PL1-IW132B	RBPL1-IW132B	WELL	95.00-95.00	09/12/2022	3.7 U	1.9 U	1.9 U	1.9 U	**4.3**	1.9 U
RBAAP-PL1-MW125B	RBPL1-MW125B	WELL	92.00-92.00	09/13/2022	4 U	2 U	2 U	2 U	**3.8 J**	2 U
RBAAP-PL1-MW143A’	RBPL1-MW143A’	WELL	85.00-85.00	09/13/2022	3.5 U	1.7 U	1.7 U	1.7 U	**3 J**	1.7 U
RBAAP-PL1-MW144A’	RBPL1-MW144A’	WELL	88.00-88.00	09/13/2022	3.7 U	1.8 U	1.8 U	1.8 U	**1.5 J**	1.8 U
	RBPL1-MW144A’-FD	WELL	88.00-88.00	09/13/2022 (D)	4.7 U	2.4 U	2.4 U	2.4 U	**2.2 J**	2.4 U
RBAAP-PL1-MW150A’	RBPL1-MW150A’	WELL	87.00-87.00	09/14/2022	4.2 U	2.1 U	2.1 U	2.1 U	**18**	2.1 U
RBPL1-MW126A’	RBPL1-MW126A’	WELL	82.50-82.50	09/14/2022	4 U	**1.5 J**	2 U	2 U	**8.2**	2 U
RBPL1-MW147B	RBPL1-MW147B	WELL	95.00-95.00	09/14/2022	3.6 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U

The SLs are the Residential Scenario SLs calculated using the USEPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water using an HQ = 0.1.
Bolded values denote detected concentrations.
Highlighted values indicate an exceedance of the SL.
(D) = Field duplicate sample.
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

6.4 IWTP AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the IWTP AOPI.

6.4.1 AOPI Background

The IWTP treated all industrial wastewater generated at the facility. The IWTP was a system of tanks, sumps, filters, pipes, and equipment for coagulation, flocculation, clarification, sludge thickening, and sludge/liquid separation. The treated effluent water was discharged via underground 21-inch-diameter vitreous clay pipe to the E/P Ponds. Construction of the IWTP began in 1951, and configuration has remained nearly unchanged since the start-up in 1952 until 1972. Zinc-cyanide solution tanks were added in 1955 to treat the wastewater produced from the zinc-plating of the naval shells produced on Metal Plating Line 6 and continued to be used until 1958 (CH2M Hill 2002). From 1973 to 1980, the IWTP was upgraded. The IWTP was decommissioned in 2013 (U.S. Army 2017).

6.4.2 SI Sampling and Results

Soil and groundwater samples were collected from the IWTP AOPI at the following locations (Figure 6-6):

- One soil sample was collected from one boring (RBAAP-WPT-01) near the subsurface piping entering the IWTP.
- Three groundwater samples were collected from three existing monitoring wells. Well RBAAP-WPT-MW17B is upgradient of the suspected release area, RBAAP-WPT-MW62B is cross-gradient and immediately adjacent to the suspected release area, and RBAAP-WPT-MW34B is downgradient from the suspected release area.

The Target PFAS analytical results for soil and groundwater at the IWTP AOPI are summarized below and presented in Table 6-3 and Figure 6-7.

6.4.2.1 Soil

Target PFAS were not detected at concentrations above the LODs in the soil sample collected at the IWTP AOPI.

6.4.2.2 Groundwater

PFOS, PFOA, PFNA, and PFHxS were detected in groundwater samples collected at the IWTP AOPI. PFOS concentrations exceeded the SL of 4 ng/L at one existing monitoring well, RBAAP-WPT-MW62B, located cross-gradient and immediately adjacent to the suspected release area (10 ng/L). Due to the proximity of MW62B to the former IWTP and its underground structures (e.g., piping), the PFOS concentration in this well is considered to be associated with the former IWTP. PFOS was not detected above the LOD in any other groundwater samples. PFOA, PFNA, and PFHxS were detected below SLs. PFBS and HFDO-DA were not detected above the LODs.

6.4.3 CSM

The IWTP AOPI is approximately 1.15 acres. None of the IWTP infrastructure currently remains, and the area has been covered with asphalt or gravel. The ground surface elevation at the IWTP AOPI is approximately 140 feet amsl. Stormwater runoff is collected by the facility stormwater drain system, which leads to the Northwest Stormwater Reservoir.

The surficial and subsurface geology at RBAAP consists of unconsolidated Pleistocene non-marine sedimentary deposits that consist of gray to brown and yellow to red cross-bedded sands that are hundreds of feet thick. These sands contain minor amounts of clay and silt with some pebbles (CH2M Hill 2008). Regionally, the groundwater table is lowering, and many of the shallowest wells in Zone A at RBAAP are dry. Groundwater has recently been encountered at approximately 71 feet bgs and flows to the southwest (Ahtna 2021).

Given the period of operation of the metal plating processes at the facility, PFAS-containing mist suppressants were likely used and included in the waste stream processed at the IWTP. The subsurface soil at the IWTP AOPI is the source media for potential PFAS contamination. The primary release mechanism is the potential release of PFAS-containing materials to subsurface soils resulting from leaks beneath the IWTP. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from soil to groundwater through leaching and percolation. Surface water and sediment are not present at the IWTP AOPI.

No surface soil exposure pathway exists because the area is covered with either concrete or asphalt. The onsite subsurface soil exposure pathway at the IWTP AOPI is potentially complete because Target PFAS were detected at concentrations above the SLs in groundwater and subsurface soil data are limited. The groundwater exposure pathway for onsite workers is complete because Target PFAS were detected above the SLs in groundwater and RBAAP uses onsite wells for drinking water. In addition, the offsite exposure pathway for groundwater is potentially complete because domestic wells are in the vicinity of RBAAP. No surface water and sediment exposure pathway exists because the media are not present at the IWTP AOPI. However, due to the limited soil data, potential release/migration from subsurface soil to stormwater may warrant investigation of stormwater conveyance lines and the stormwater reservoir. Figure 6-8 presents the CSM for the IWTP AOPI.

6.4.4 Recommendation

Detected concentrations of Target PFAS in groundwater exceed the SLs; therefore, further investigation is recommended.

Table 6-3. Target PFAS Results and Screening for the IWTP AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA	PFBS	PFHxS	PFNA	PFOA	PFOS
Soil				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**1900**	**130**	**19**	**19**	**13**
RBAAP-WPT-01	RBWPT01-SB01	BORE	4.00-5.00	08/30/2022	2 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**601**	**39**	**6**	**6**	**4**
RBAAP-WPT-MW17B	RBWPT-MW17B	WELL	88.00-88.00	09/14/2022	4.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U
RBAAP-WPT-MW34B’	RBWPT-MW34B’	WELL	95.00-95.00	09/13/2022	4 U	2 U	2 U	2 U	**4**	2 U
RBAAP-WPT-MW62B	RBWPT-MW62B	WELL	95.00-95.00	09/14/2022	3.6 U	1.8 U	**5.6**	**3.7**	**5.5**	**10**

The SLs are the Residential Scenario SLs calculated using the USEPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water using an HQ = 0.1.
Bolded values denote detected concentrations.
Highlighted values indicate an exceedance of the SL.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

6.5 IWTP SEWER LINE BREAK AREA (EFFLUENT FORCE MAIN) AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the IWTP Sewer Line Break Area (Effluent Force Main) AOPI.

6.5.1 AOPI Background

In 1972, a break occurred in the effluent sewer line that conveyed treated water to the E/P Ponds, referred to as SWMU 12 the IWTP Sewer Line Break Area (Effluent Force Main). The break was discovered approximately 7 days after the line ruptured in the northeastern corner of the property within the easement near the Hetch-Hetchy Aqueduct. It is unknown how much liquid was lost through the leak; however, during that time period, the IWTP was processing approximately 1,000,000 gallons per day (Weston 1991).

An RI, not related to PFAS, was conducted in 1990 and 1991 under the authority of the U.S. Army Toxic and Hazardous Materials Agency as part of the Installation Restoration Program. Soil samples near the break were analyzed for inorganic substances listed in Title 22, Article 11 Section 66699 of the California Environmental Health Regulations (in effect in 1990). None of the results exceeded the total threshold limit concentration levels, and the soil was not considered to be contaminated (Weston 1991). Remedial action for soil was not necessary, as determined in the ROD (USAEC 1994).

6.5.2 SI Sampling and Results

A groundwater sample was collected from one existing well (RBEFL-MW66B) downgradient from the IWTP Sewer Line Break Area (Effluent Force Main) AOPI (Figure 6-9). Subsurface soil is considered the source media at this AOPI, but no subsurface soil samples were collected per FCR 2022-02 (see Section 3.4.7). The Target PFAS analytical results for the groundwater sample collected at the IWTP Sewer Line Break Area (Effluent Force Main) AOPI are summarized below and presented in Table 6-4 and Figure 6-10.

6.5.2.1 Groundwater

Target PFAS were not detected at concentrations above the LODs in any of the groundwater samples collected at the IWTP Sewer Line Break Area (Effluent Force Main) AOPI.

6.5.3 CSM

No changes were warranted to the preliminary CSM presented in the PA because no Target PFAS were detected in groundwater at this AOPI.

6.5.4 Recommendation

Target PFAS were not detected at the IWTP Sewer Line Break Area (Effluent Force Main) AOPI in groundwater; therefore, further investigation is not recommended.

Table 6-4. Target PFAS Results and Screening for the IWTP Sewer Line Break Area (Effluent Force Main) AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA	PFBS	PFHxS	PFNA	PFOA	PFOS
Groundwater				Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
				Screening Levels	6	601	39	6	6	4
RBEFL-MW66B	RBEFL-MW66B	WELL	100.00-100.00	09/14/2022	4.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U

The SLs are the Residential Scenario SLs calculated using the USEPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water using an HQ = 0.1.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

6.6 E/P PONDS AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the E/P Ponds AOPI.

6.6.1 AOPI Background

The E/P Ponds are four unlined ponds constructed in 1952 for the disposal of treated effluent generated by the RBAAP IWTP. The E/P Ponds are located approximately 1.5 miles north of the main facility along the Stanislaus River. The treated water from the IWTP was discharged through a force main into a 21-inch-diameter clay pipe before emptying into the ponds. The ponds were operated independently based on the volume of flow, with flow diverted to subsequent ponds as the first became full. The effluent discharged to the ponds evaporated and/or percolated through the sediment into the groundwater (CH2M Hill 2002). At the time of sampling during this SI, no surface water was present in the E/P Ponds.

6.6.2 SI Sampling and Results

Soil and groundwater samples were collected from the E/P Ponds AOPI at the following locations (Figure 6-11):

- Four surface soil samples and one field duplicate sample were collected from four locations (RBAAP-EPP-01, RBAAP-EPP-02, RBAAP-EPP-03, and RBAAP-EPP-04) at the southern portion of the AOPI. Surface soil at location RBAAP-EPP-04 was collected from soil found on a concrete erosion bar beneath the pipe that discharged from the IWTP into the ponds. No water discharge was present in the pipe during the sampling event. Soil sampling deeper than the shallow soil interval was not performed per FCR 2022-02 (see Section 3.4.7).
- Two groundwater samples were collected from two existing monitoring wells, one upgradient of the suspected release area (RBAAP-EPP-MW-5) and one downgradient from the suspected release area (RBAAP-EPP-MWP-1).

The Target PFAS analytical results for soil and groundwater samples collected at the E/P Ponds AOPI are summarized below and presented in Table 6-5 and Figure 6-12.

6.6.2.1 Soil

Target PFAS were not detected at concentrations above the LODs in any of the surface soil samples collected at the E/P Ponds AOPI.

6.6.2.2 Groundwater

Target PFAS were not detected at concentrations above the LODs in any of the groundwater samples collected at the E/P Ponds AOPI.

6.6.3 CSM

No changes were warranted to the preliminary CSM presented in the PA because no Target PFAS were detected at this AOPI.

6.6.4 Recommendation

Target PFAS were not detected at the E/P Ponds AOPI in soil or groundwater; therefore, further investigation is not recommended.

Table 6-5. Target PFAS Results and Screening for the E/P Ponds AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA or GenX	PFBS	PFHxS	PFNA	PFOA	PFOS
Soil				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**1900**	**130**	**19**	**19**	**13**
RBAAP-EPP-01	RBEPP01-SS01	SURF	0.00-1.00	09/01/2022	1.7 U	0.43 U	0.43 U	0.43 U	0.43 U	0.43 U
RBAAP-EPP-02	RBEPP02-SS01	SURF	0.00-1.00	09/01/2022	1.9 U	0.47 U	0.47 U	0.47 U	0.47 U	0.47 U
RBAAP-EPP-03	RBEPP03-SS01	SURF	0.00-1.00	09/01/2022	1.9 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U
RBAAP-EPP-04	RBEPP04-SD01	SURF	0.00-1.00	09/01/2022	1.9 U	0.48 U	0.48 U	0.48 U	0.48 U	0.48 U
	RBEPP04-SD01FD	SURF	0.00-1.00 (D)	09/01/2022	2 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**600**	**39**	**5.9**	**6**	**4**
RBAAP-EPP-MWP-1	RBEPP-MWP-1	WELL	30.00-30.00	09/01/2022	3.6 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U
RBAAP-EPP-MWP-5	RBEPP-MWP-5	WELL	30.00-30.00	09/01/2022	3.7 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U
	RBEPP-MWP-5FD	WELL	30.00-30.00	09/01/2022 (D)	3.7 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U

The SLs are the Residential Scenario SLs calculated using the USEPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water using an HQ = 0.1.
(D) = Field duplicate sample.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

6.7 NORTH LANDFILL AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the North Landfill AOPI.

6.7.1 AOPI Background

Two landfill areas were present on the RBAAP facility. The area identified as the South Landfill was used from 1941 through 1952. Wastes were placed in trenches, and the trenches were filled with demolition debris, general refuse, and possible cyanide wastes. When the plant was converted to cartridge and projectile manufacturing operation by the Army in 1952, the South Landfill was closed and the North Landfill was constructed and operated by the Army.

The North Landfill was used by the Army from 1952 through 1966. Historical documentation indicates the landfill consisted of eight pits. Typical wastes buried in the pits included construction debris; paper; oils; greases; solvents; hospital wastes; and industrial sludges, including zinc, chromium, phosphates, and nitrates. In 1966, the North Landfill was closed and filled in with dirt and construction rubble. However, review of a 1967 aerial photograph noted a new trench in the central portion of the landfill (USAEC 1994). A landfill cover system, consisting of a clay and topsoil cap, was constructed in 1995 over the North Landfill, and no further action was required (CH2M Hill 2002).

6.7.2 SI Sampling and Results

Three groundwater samples were collected from three wells downgradient from the suspected release area (RBAAP-NLF-MW124A', RBNLF-MW146A', and RBNLF-MW14B), as shown in Figure 6-13. The Target PFAS analytical results for groundwater collected at the North Landfill AOPI are summarized below and presented in Table 6-6 and Figure 6-14.

6.7.2.1 Groundwater

Target PFAS were not detected at concentrations above the LODs in any of the groundwater samples collected at the North Landfill AOPI.

6.7.3 CSM

No changes were warranted to the preliminary CSM presented in the PA because no Target PFAS were detected in groundwater at this AOPI.

6.7.4 Recommendation

Target PFAS were not detected at the North Landfill AOPI in groundwater; therefore, further investigation is not recommended.

Table 6-6. Target PFAS Results and Screening for the North Landfill AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA	PFBS	PFHxS	PFNA	PFOA	PFOS
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**601**	**39**	**6**	**6**	**4**
RBAAP-NLF-MW124A’	RBNLF-MW124A’	WELL	90.00-90.00	09/13/2022	3.9 U	2 U	2 U	2 U	2 U	2 U
RBNLF-MW146A’	RBNLF-MW146A’	WELL	89.00-89.00	09/14/2022	3.5 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U
RBNLF-MW14B	RBNLF-MW14B	WELL	92.00-92.00	09/15/2022	3.9 U	2 U	2 U	2 U	2 U	2 U

The SLs are the Residential Scenario SLs calculated using the USEPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water using an HQ = 0.1.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

7. CONCLUSIONS AND RECOMMENDATIONS

An SI is conducted when the PA determines an AOPI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multimedia sampling at AOPIs to determine whether a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required (40 CFR §300.420(5)). The SI Report used the findings from the PA in conjunction with soil and groundwater sampling data for each AOPI to determine whether Target PFAS have been released to the environment and whether a release has affected or may affect specific human health targets.

Before the SI sampling, a preliminary CSM was developed in the PA for each AOPI based on an evaluation of existing records, personnel interviews, and site reconnaissance. The preliminary CSMs identified potential human receptors and exposure pathways for groundwater and surface water that are known to be used, or could realistically be used in the future, as a source of drinking water and identified potential soil exposure pathways. All AOPIs were sampled during the SI at the former RBAAP to further evaluate PFAS-related releases and identify the presence or absence of Target PFAS.

Target PFAS were detected at 2 of the 6 AOPIs (Metal Plating Line 1 and the IWTP) and in samples collected from 9 of 20 total groundwater wells. Only PFOS or PFOA concentrations exceeded the SLs at three monitoring wells located at these AOPIs.

Target PFAS were not detected above the LODs in surface soil or subsurface soil samples collected at any of the AOPIs. HFPO-DA was not detected above the LOD in any samples.

The CSMs were updated for each AOPI where Target PFAS were detected above the SLs. The updated CSMs detail site geological conditions; determine primary and secondary release mechanisms; identify potential human receptors; and detail complete, potentially complete, and incomplete exposure pathways for current and reasonably anticipated future exposure scenarios. The soil exposure pathway for onsite workers is potentially complete at two AOPIs where Target PFAS exceeded the SLs in groundwater, as the SL exceedances in groundwater could indicate a source in soil that has not been identified.

The onsite groundwater exposure pathway is complete at two AOPIs where Target PFAS were detected above the SLs. The groundwater exposure pathway for offsite residents is potentially complete for AOPIs in which Target PFAS were detected in groundwater due to the potential for migration to offsite groundwater wells in the vicinity of RBAAP.

Surface water and sediment were not present at any of the AOPIs; therefore, no surface water or sediment samples were collected.

SI sampling results were compared to the OSD risk-based SLs presented in Section 5 to determine if further investigation is warranted at each AOPI as follows:

- If the maximum detected concentration for a given analyte in soil or groundwater exceeds the SL, it is concluded that further investigation is warranted.
- If the maximum detected concentration is less than the SL, it is concluded that further investigation is not warranted.

Table 7-1 summarizes the conclusions and recommendations for each AOPI. The following two AOPIs are recommended for further investigation or evaluation:

- Metal Plating Line 1
- IWTP.

Additional investigation of subsurface soil may be warranted at these two AOPIs to identify the source of release to groundwater and to determine if migration from subsurface soil to the stormwater conveyances may have impacted the stormwater reservoirs.

Table 7-1. Summary of Target PFAS Detected and Recommendations

AOPI	Detection of HFPO-DA, PFBS, PFHxS, PFNA, PFOS, and/or PFOA		Recommendation and Rationale
	Groundwater	Soil	
Metal Plating Line 6	ND	ND	PFAS not detected above LODs; further investigation not recommended at this time
Metal Plating Line 1	Exceeds SL	ND	SLs exceeded in groundwater; further investigation recommended
IWTP	Exceeds SL	ND	SLs exceeded in groundwater; further investigation recommended
IWTP Sewer Line Break Area (Effluent Force Main)	ND	–	PFAS not detected above LODs; further investigation not recommended at this time
E/P Ponds	ND	ND	PFAS not detected above LODs; further investigation not recommended at this time
North Landfill	ND	ND	PFAS not detected above LODs; further investigation not recommended at this time

Highlighted cells are recommended for further investigation
– Not Collected
ND = Not Detected

8. REFERENCES

Ahtna Engineering (Ahtna). 2015. *Groundwater Treatment Plant Operations Status Report, Riverbank Army Ammunition Plant, Riverbank, California*. January.

Ahtna. 2016. *Closure Certification Report Hazardous Waste Management Unit #4 Chromium Reduction Unit – Continuous Process RCRA Hazardous Waste Facility Permit Closure Riverbank Army Ammunition Plant Riverbank, California*. January.

Ahtna. 2021. *Semiannual Groundwater Monitoring, Landfill, and Groundwater Treatment Report (2020 Second Quarter), Riverbank Army Ammunition Plant, Riverbank, California.* May.

Ahtna. 2022. *Well Survey Public Outreach, Riverbank Army Ammunition Plant, Riverbank California.* January 18.

ASTM (ASTM International). 2017. ASTM D2488, 2017 Edition, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*. July 15.

CA DWR (California Department of Water Resources). 2021. Well Completion Report Database. Available online at: https://water.ca.gov/Programs/Groundwater-Management/Wells/Well-Completion-Reports. Accessed December 13.

CH2M Hill. 2002. *RCRA Facility Investigation Current Condition Report.* October.

CH2M Hill. 2006. *BRAC 2005 Environmental Condition of Property Phase I Report, Riverbank Army Ammunition Plant.* November.

CH2M Hill. 2008. *Site Investigation Report, RBAAP*. March.

DoD (U.S. Department of Defense). 2020. *Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by Quality Systems Manual for Environmental Laboratories (QSM) Table B-15*. Environmental Data Quality Working Group. May.

DoD. 2021. *Quality Systems Manual for Environmental Laboratories.* Version 5.4.

DoD. 2022a. *Memorandum for Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program*. July 6.

DoD. 2022b. *Data Validation Guidelines Modules 1, 2, 3, and 4 Revised Table for Sample Qualification in the Presence of Blank Contamination.* February.

EDR (Environmental Data Resources). 2021. *The EDR Radius Map™ Report with GeoCheck®*. August 23.

ITRC (Interstate Technology Regulatory Council). 2020. *History and use of Per- and Polyfluoroalkyl Substances (PFAS). Washington, DC.* April. Available online at: https://pfas-1.itrcweb.org/fact_sheets_page/PFAS_Fact_Sheet_History_and_Use_April2020.pdf.

Jennings, C.W. with modifications by C. Gutierrez, W. Bryant, G. Saucedo, and C. Wills. 2010. Geologic map of California: California Geological Survey, Geologic Data Map No. 2, scale 1:750,000.

Kjeldsen, Sinnock & Neudeck, Inc. 2021. *2020 Urban Water Management Plan.* City of Riverbank California. October.

Leidos. 2022a. *Programmatic Uniform Federal Policy-Quality Assurance Project Plan, Per- and Polyfluoroalkyl Substances Site Inspections at Multiple Base Realignment and Closure Installations, Nationwide*. Final. June.

Leidos. 2022b. *Per- and Polyfluoroalkyl Substances Site Inspection Uniform Federal Policy-Quality Assurance Project Plan Addendum at Riverbank Army Ammunition Plant, California*. Final. June.

Leidos. 2022c. *Programmatic Accident Prevention Plan (APP) for Preliminary Assessments/Site Inspections (PA/SIs) of Per- and Polyfluoroalkyl Substances (PFAS) at Multiple Base Realignment and Closure (BRAC) Installations, Nationwide*. Final. March.

Leidos. 2023. *Preliminary Assessment of Per- and Polyfluoroalkyl Substances at Riverbank Army Ammunition Plant, California.* Final. August.

MDEQ (Michigan Department of Environmental Quality). 2018. *General PFAS Sampling Guidance.* Revised. October 16.

NWI (National Wetlands Inventory). 2023. Wetlands Mapper. Accessed March 8, 2023. Available online at: https://www.fws.gov/wetlands/Data/Mapper.html.

U.S. Army. 2006. *Second Five Year Review Report of Riverbank Army Ammunition Plant – Final*. September.

U.S. Army. 2017. *Update of the Environmental Condition of Property Phase I Report, Riverbank Army Ammunition Plant*. March.

U.S. Army. 2018a. *Final Action Memorandum Parcel A Soil/Sediment Time-Critical Removal Action Former Riverbank Army Ammunition Plant, City of Riverbank, Stanislaus County, California*. February.

U.S. Army. 2018b. *Army Guidance for Addressing Releases of Per- and Polyfluoroalkyl Substances*. September 4. Available online at: https://www.fedcenter.gov/admin/itemattachment.cfm?attachmentid=1150.

U.S. Army. 2020. *Legacy Base Realignment and Closure Installations Conveyance Progress Reports*. October.

U.S. Census Bureau. 2022. Cities of Riverbank and Modesto, Stanislaus County, California. Available online at: https://data.census.gov/. Accessed August 3, 2023.

USA.com 2021. Stanislaus *County, California Weather*. Accessed on December 23, 2021. Available online at: http://www.usa.com/stanislaus-county-in-weather.htm.

USACE (U.S. Army Corps of Engineers). 2009. Environmental Assessment for BRAC 05 Disposal and *Reuse of the Riverbank Army Ammunition Plant, California*. U.S. Army Corps of Engineers, Mobile District. March.

USACE. 2013. *Draft Final EDC Property and Sale Parcels 2 and 2A – Soil Investigation Report, RBAAP, Riverbank, California.* U.S. Army Corps of Engineers, Sacramento District. January.

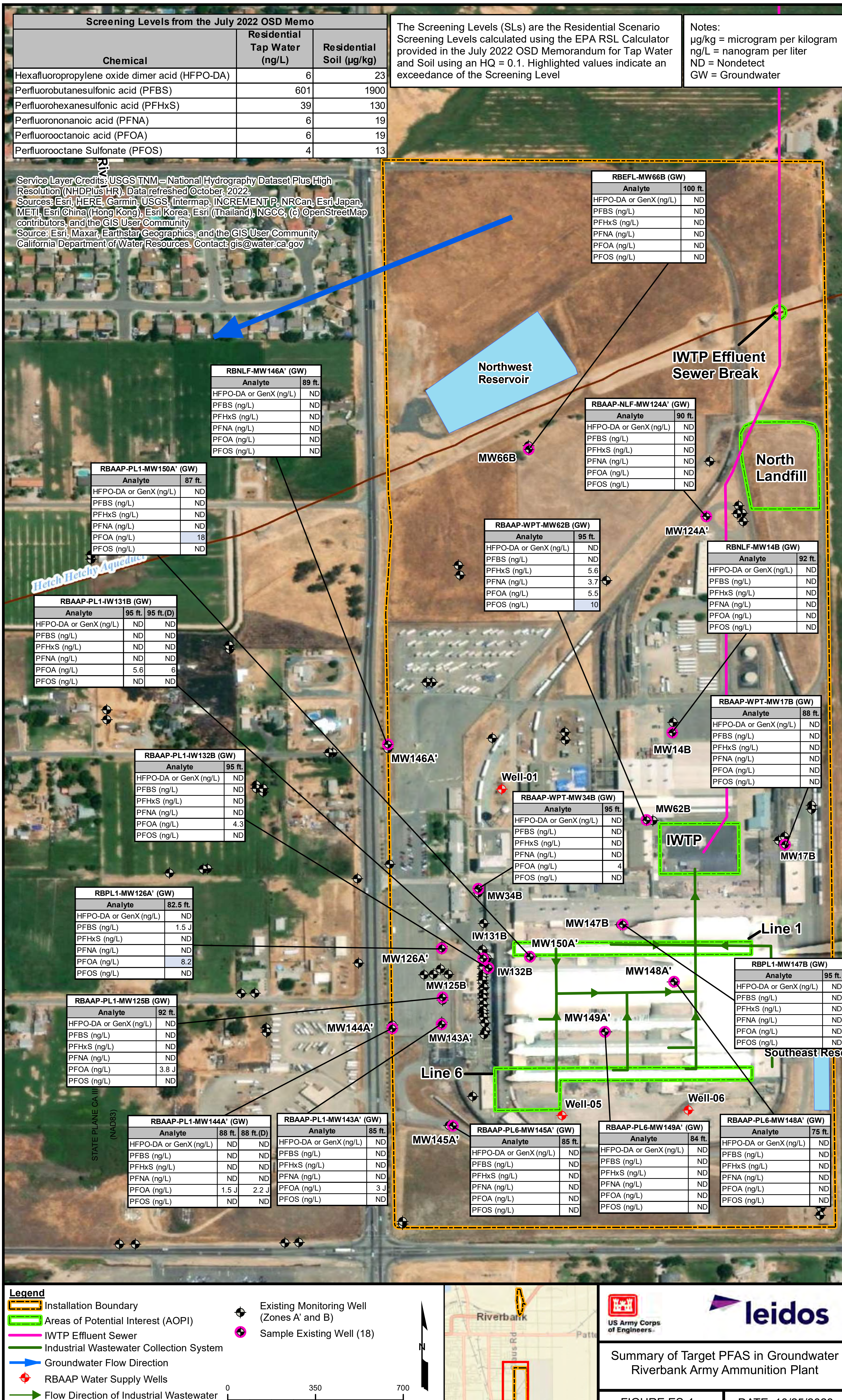
USAEC (U.S. Army Environmental Center). 1994. *Record of Decision, Riverbank Army Ammunition Plant*. March.

USFWS (U.S. Fish and Wildlife Service). 2023. Environmental Conservation Online System for Information for Planning and Consultation (IPaC) website. Accessed March 8, 2023. Available online at: https://ecos.fws.gov/ipac/.

West Yost. 2021. *Water Conservation Plan Update.* City of Modesto, California. July.

Weston (Roy F. Weston). 1991. *Remedial Investigation Report RBAAP*. July.

FIGURES



Screening Levels from the July 2022 OSD Memo

Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6	23
Perfluorobutanesulfonic acid (PFBS)	601	1900
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	6	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

RBEFL-MW66B (GW)

Analyte	100 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBNLF-MW146A' (GW)

Analyte	89 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL1-MW150A' (GW)

Analyte	87 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	18
PFOS (ng/L)	ND

RBAAP-NLF-MW124A' (GW)

Analyte	90 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-WPT-MW62B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	5.6
PFNA (ng/L)	3.7
PFOA (ng/L)	5.5
PFOS (ng/L)	10

RBNLF-MW14B (GW)

Analyte	92 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL1-IW131B (GW)

Analyte	95 ft.	95 ft.(D)
HFPO-DA or GenX (ng/L)	ND	ND
PFBS (ng/L)	ND	ND
PFHxS (ng/L)	ND	ND
PFNA (ng/L)	ND	ND
PFOA (ng/L)	5.6	6
PFOS (ng/L)	ND	ND

RBAAP-WPT-MW17B (GW)

Analyte	88 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL1-IW132B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	4.3
PFOS (ng/L)	ND

RBAAP-WPT-MW34B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	4
PFOS (ng/L)	ND

RBPL1-MW126A' (GW)

Analyte	82.5 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	1.5 J
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	8.2
PFOS (ng/L)	ND

RBPL1-MW147B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL1-MW125B (GW)

Analyte	92 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	3.8 J
PFOS (ng/L)	ND

RBAAP-PL1-MW144A' (GW)

Analyte	88 ft.	88 ft.(D)
HFPO-DA or GenX (ng/L)	ND	ND
PFBS (ng/L)	ND	ND
PFHxS (ng/L)	ND	ND
PFNA (ng/L)	ND	ND
PFOA (ng/L)	1.5 J	2.2 J
PFOS (ng/L)	ND	ND

RBAAP-PL1-MW143A' (GW)

Analyte	85 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	3 J
PFOS (ng/L)	ND

RBAAP-PL6-MW145A' (GW)

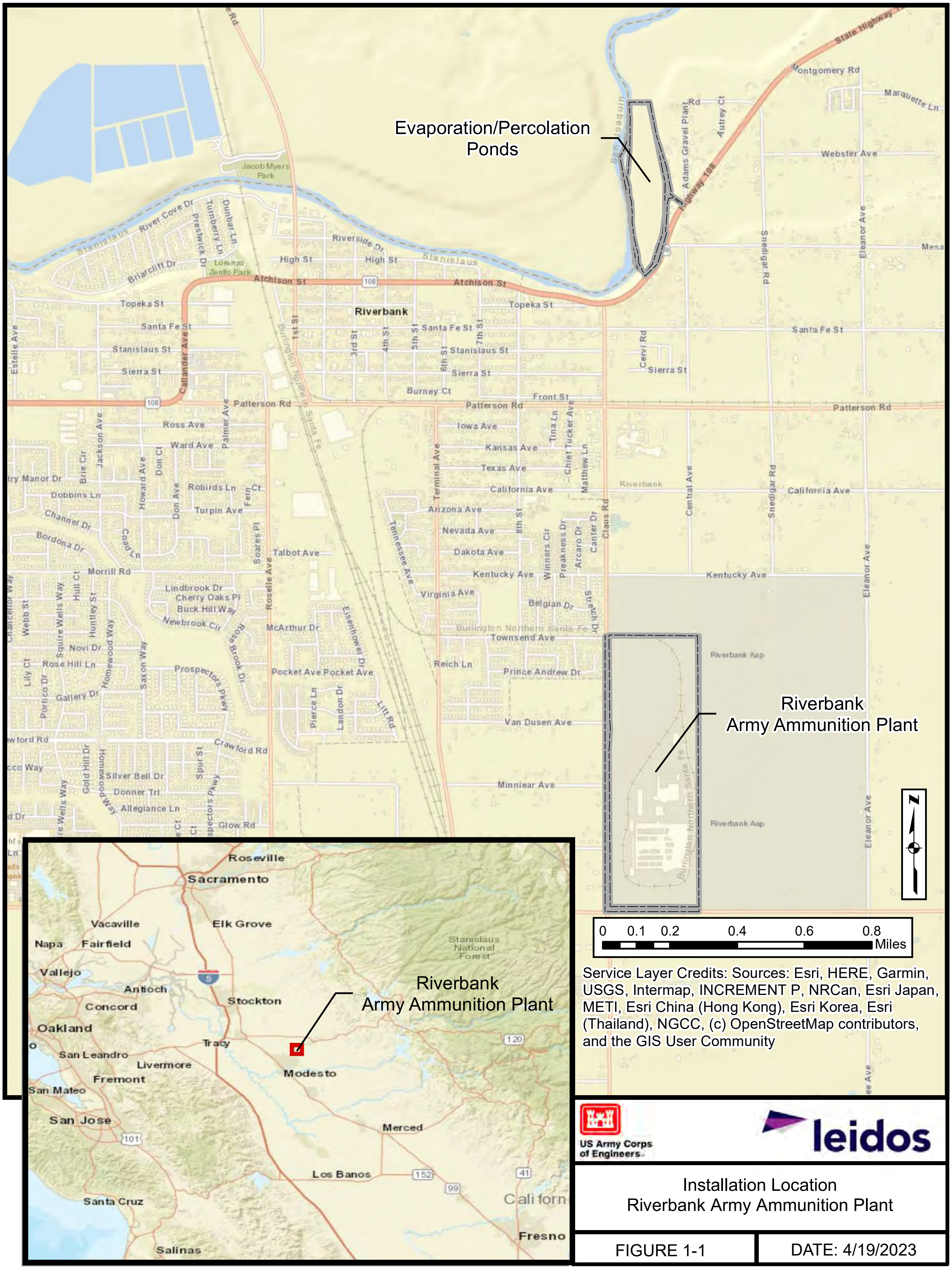
Analyte	85 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL6-MW149A' (GW)

Analyte	84 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

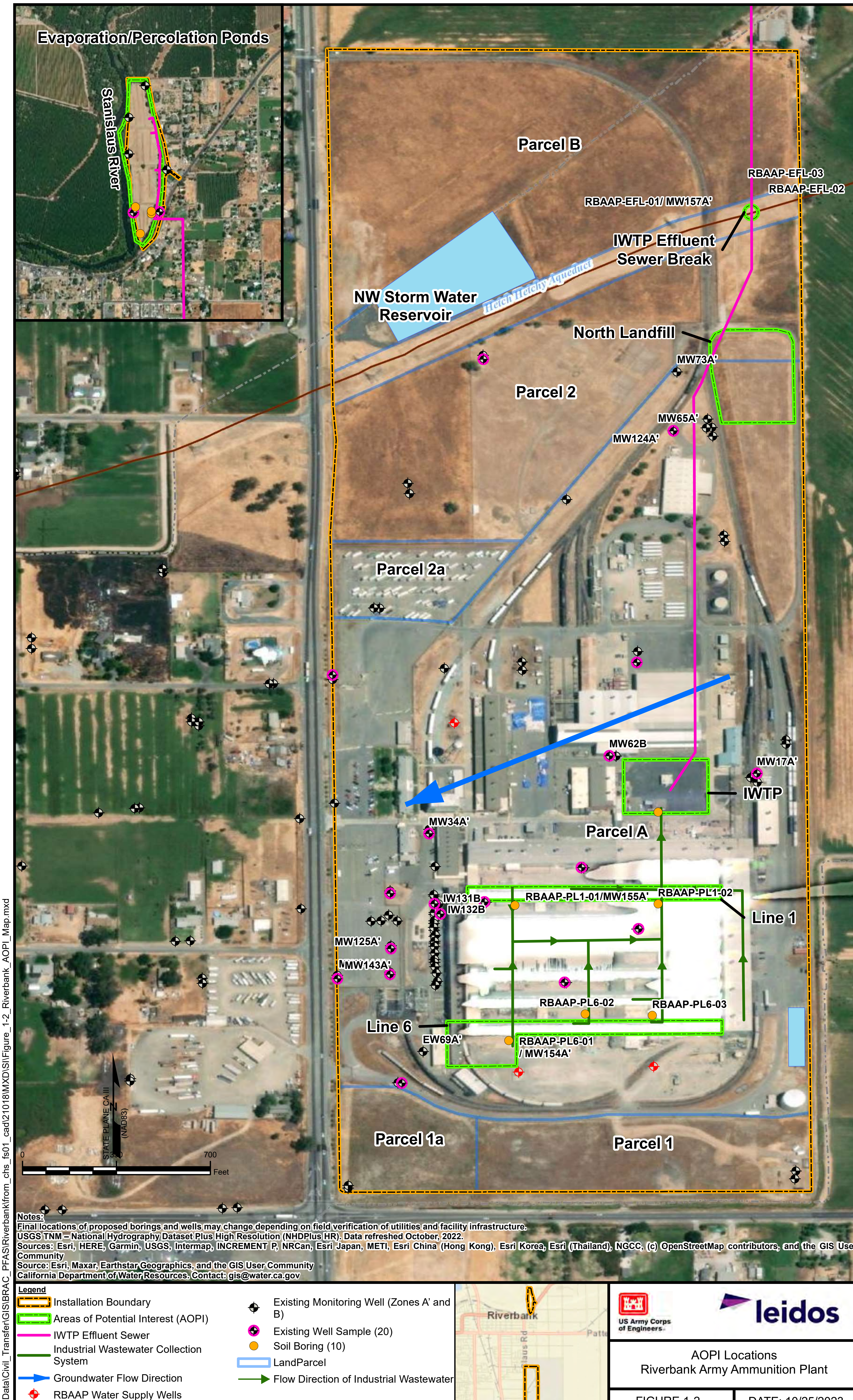
RBAAP-PL6-MW148A' (GW)

Analyte	75 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND



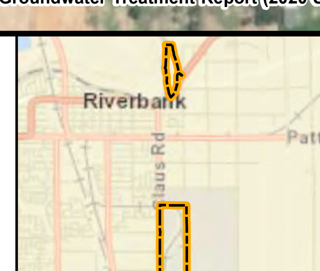
Installation Location
Riverbank Army Ammunition Plant

FIGURE 1-1 | DATE: 4/19/2023


Evaporation/Percolation Ponds
Stanislaus River
Parcel B
RBAAP-EFL-03
RBAAP-EFL-02
RBAAP-EFL-01/ MW157A'
IWTP Effluent Sewer Break
NW Storm Water Reservoir
Hetch Hetchy Aqueduct
North Landfill
MW73A'
Parcel 2
MW65A'
MW124A'
Parcel 2a
MW62B
MW17A'
IWTP
MW34A'
Parcel A
IW131B
IW132B
RBAAP-PL1-01/MW155A'
RBAAP-PL1-02
Line 1
MW125A'
MMW143A'
RBAAP-PL6-02
RBAAP-PL6-03
Line 6
EW69A'
RBAAP-PL6-01 / MW154A'
Parcel 1a
Parcel 1
STATE PLANE CA III (NAD83)
N
0
350
700
Feet
Notes:
Final locations of proposed borings and wells may change depending on field verification of utilities and facility infrastructure.
USGS TNM – National Hydrography Dataset Plus High Resolution (NHDPlus HR). Data refreshed October, 2022.
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
California Department of Water Resources. Contact: gis@water.ca.gov
Legend
Installation Boundary
Areas of Potential Interest (AOPI)
IWTP Effluent Sewer
Industrial Wastewater Collection System
Groundwater Flow Direction
RBAAP Water Supply Wells
Existing Monitoring Well (Zones A' and B)
Existing Well Sample (20)
Soil Boring (10)
LandParcel
Flow Direction of Industrial Wastewater
Riverbank
US Army Corps of Engineers
leidos
AOPI Locations
Riverbank Army Ammunition Plant
FIGURE 1-2
DATE: 10/25/2023
C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_1-2_Riverbank_AOPI_Map.mxd

Notes:
USGS TNM – National Hydrography Dataset Plus High Resolution (NHDPlus HR). Data refreshed October, 2022.
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Groundwater contours from Ahtna Global, LLC. 2021. Semiannual Groundwater Monitoring, Landfill, and Groundwater Treatment Report (2020 Second Quarter) Riverbank Army Ammunition Plant, Riverbank California. Final. May.

Legend
- Installation Boundary
- Buildings
- Storm Water Reservoirs
- Canals
- Topographic Contour (USGS)
- RBAAP Water Supply Wells



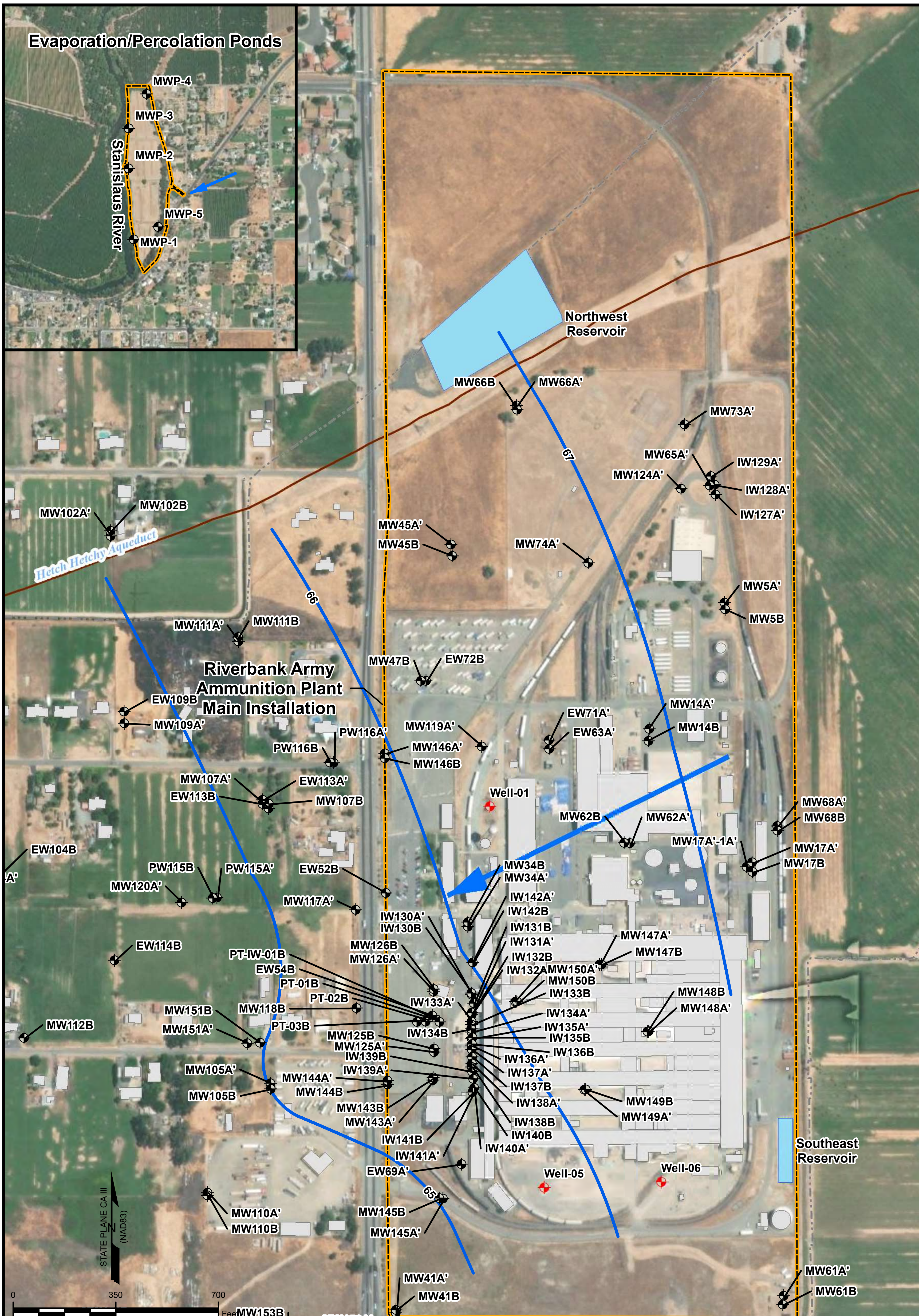
US Army Corps of Engineers

leidos

Site Features
Riverbank Army Ammunition Plant

FIGURE 2-1 | DATE: 4/19/2023

C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_2-1_Riverbank_Site_Features.mxd



Notes:
USGS TNM – National Hydrography Dataset Plus High Resolution (NHDPlus HR). Data refreshed October, 2022.
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Groundwater contours from Ahtna Global, LLC. 2021. Semiannual Groundwater Monitoring, Landfill, and Groundwater Treatment Report (2020 Second Quarter) Riverbank Army Ammunition Plant, Riverbank California. Final. May.

Legend
- Installation Boundary
- Buildings
- Groundwater Contour (ft)
- Groundwater Flow Direction
- Existing Monitoring Well
- RBAAP Water Supply Wells

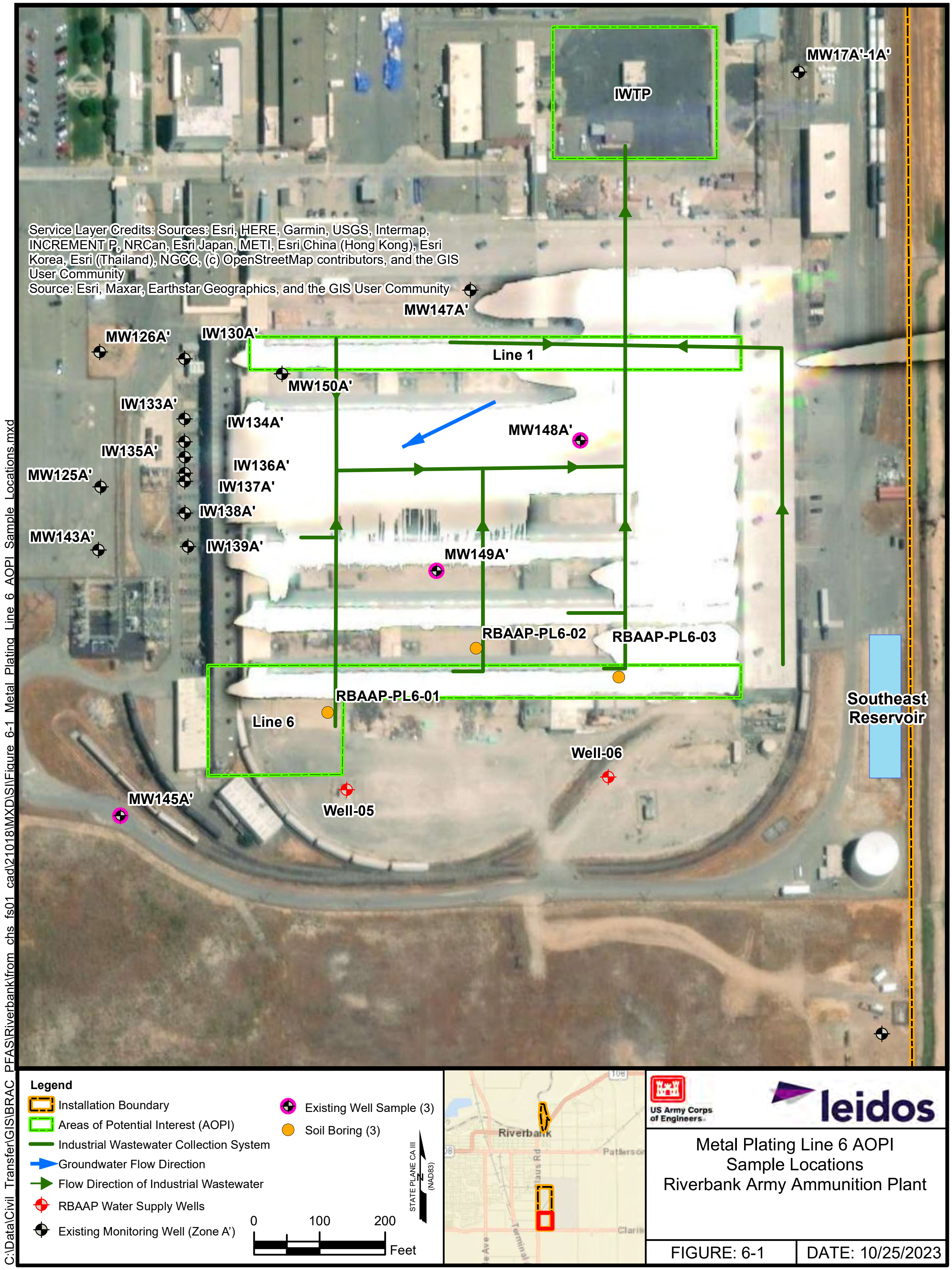
US Army Corps of Engineers

leidos

Groundwater Contours
Riverbank Army Ammunition Plant

FIGURE 2-2 | DATE: 4/19/2023

C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_2-2_Riverbank_Groundwater_Contour_Map.mxd



C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_6-1_Metal_Plating_Line_6_AOPI_Sample_Locations.mxd
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
IWTP
MW17A'-1A'
MW147A'
MW126A'
IW130A'
Line 1
MW150A'
IW133A'
IW134A'
MW148A'
IW135A'
IW136A'
MW125A'
IW137A'
IW138A'
MW143A'
IW139A'
MW149A'
RBAAP-PL6-02
RBAAP-PL6-03
RBAAP-PL6-01
Line 6
Southeast Reservoir
Well-06
MW145A'
Well-05
Legend
Installation Boundary
Areas of Potential Interest (AOPI)
Industrial Wastewater Collection System
Groundwater Flow Direction
Flow Direction of Industrial Wastewater
RBAAP Water Supply Wells
Existing Monitoring Well (Zone A')
Existing Well Sample (3)
Soil Boring (3)
0 100 200
Feet
STATE PLANE CA III (NAD83)
N
Riverbank
Patterson
US Army Corps of Engineers
leidos
Metal Plating Line 6 AOPI
Sample Locations
Riverbank Army Ammunition Plant
FIGURE: 6-1
DATE: 10/25/2023

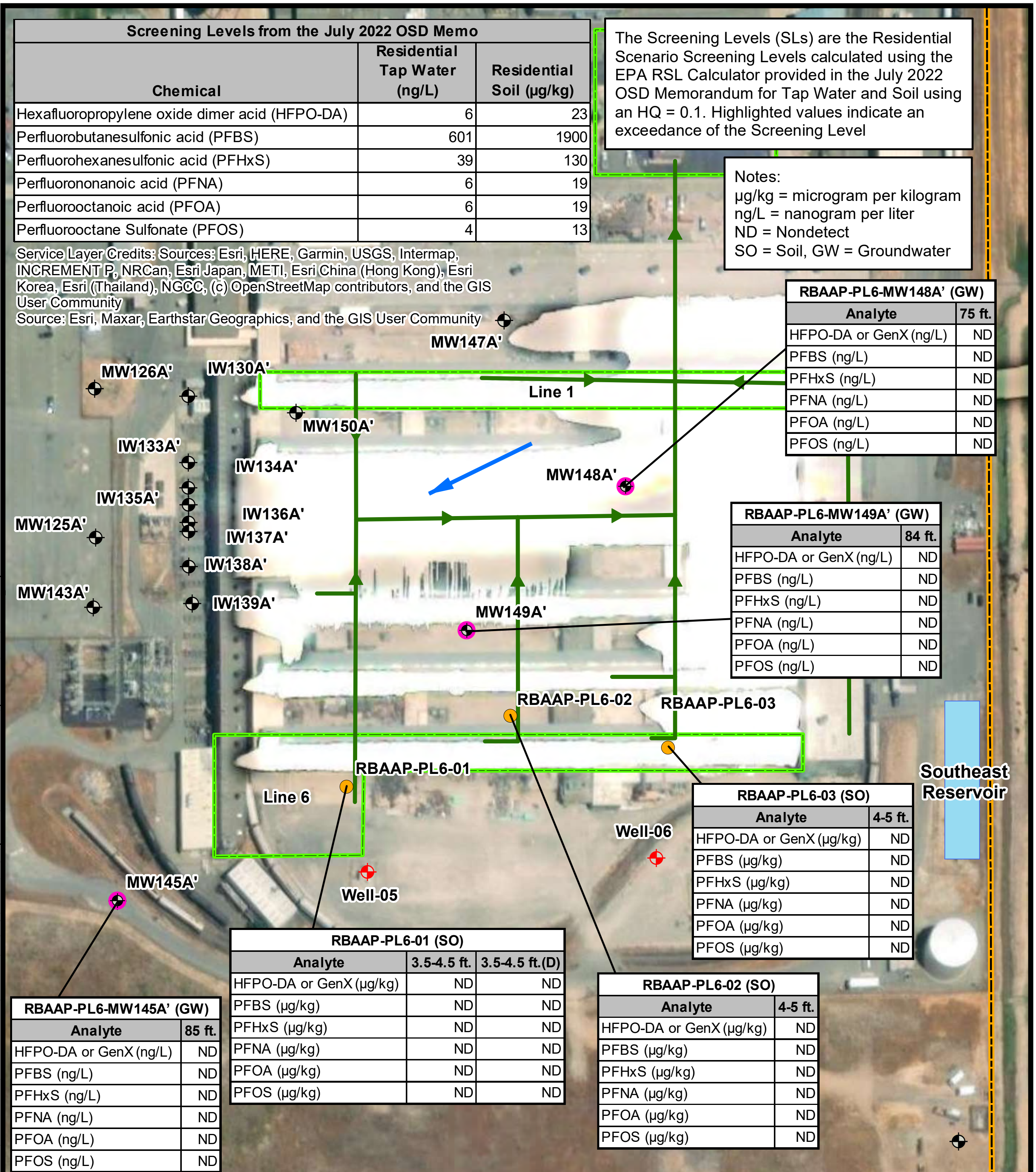
Screening Levels from the July 2022 OSD Memo

Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6	23
Perfluorobutanesulfonic acid (PFBS)	601	1900
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	6	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
ND = Nondetect
SO = Soil, GW = Groundwater

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community



RBAAP-PL6-MW148A' (GW)	
Analyte	75 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL6-MW149A' (GW)	
Analyte	84 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL6-03 (SO)	
Analyte	4-5 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

RBAAP-PL6-01 (SO)		
Analyte	3.5-4.5 ft.	3.5-4.5 ft.(D)
HFPO-DA or GenX (µg/kg)	ND	ND
PFBS (µg/kg)	ND	ND
PFHxS (µg/kg)	ND	ND
PFNA (µg/kg)	ND	ND
PFOA (µg/kg)	ND	ND
PFOS (µg/kg)	ND	ND

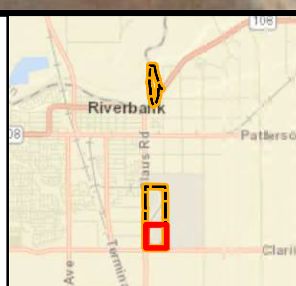
RBAAP-PL6-02 (SO)	
Analyte	4-5 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

RBAAP-PL6-MW145A' (GW)	
Analyte	85 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

Legend
- Installation Boundary
- Areas of Potential Interest (AOPI)
- Industrial Wastewater Collection System
- Groundwater Flow Direction
- Flow Direction of Industrial Wastewater
- RBAAP Water Supply Wells
- Existing Monitoring Well (Zone A')
- Existing Well Sample (3)
- Soil Boring (3)

0 100 200 Feet

STATE PLANE CA III (NAD83)



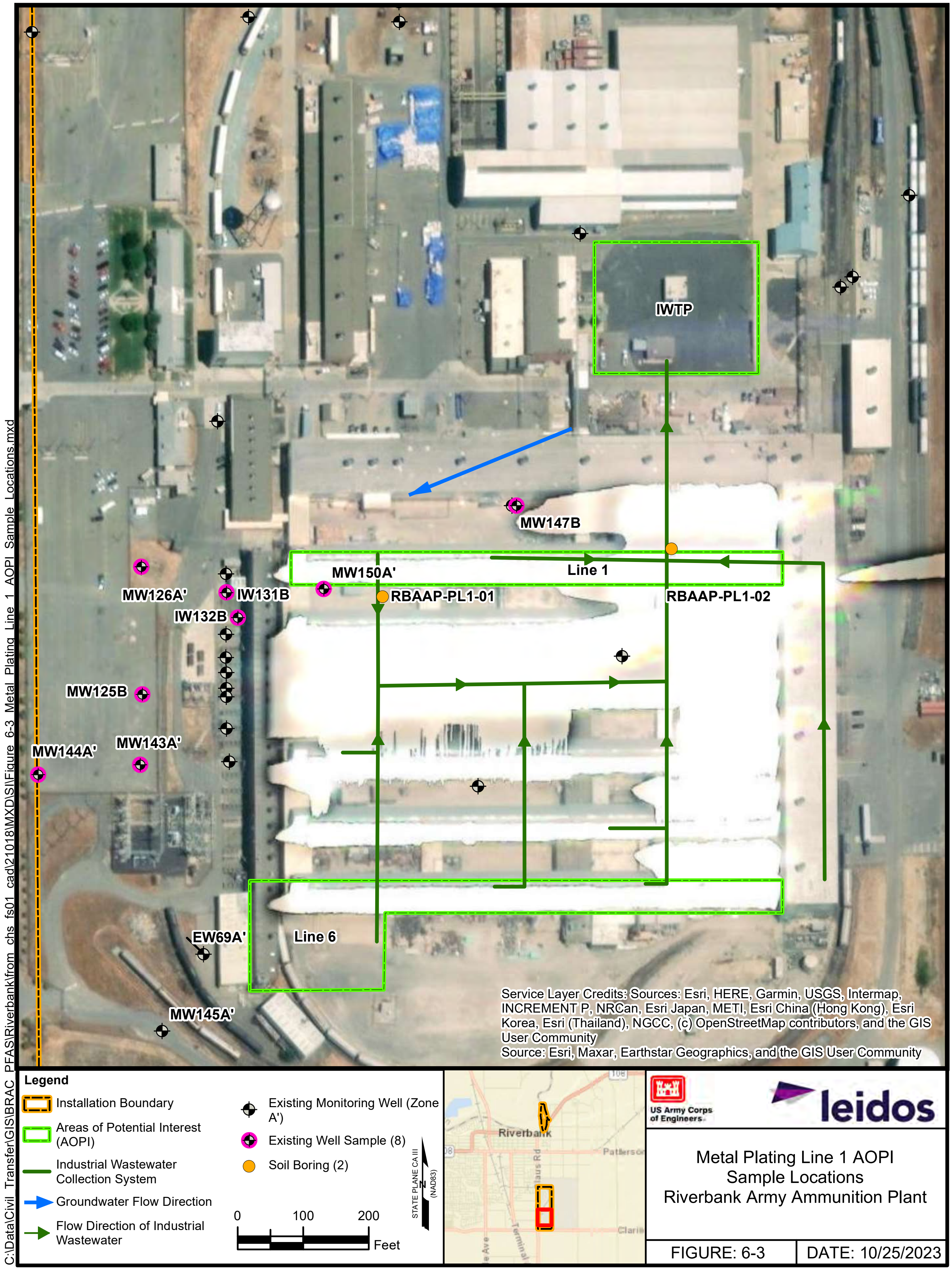
US Army Corps of Engineers

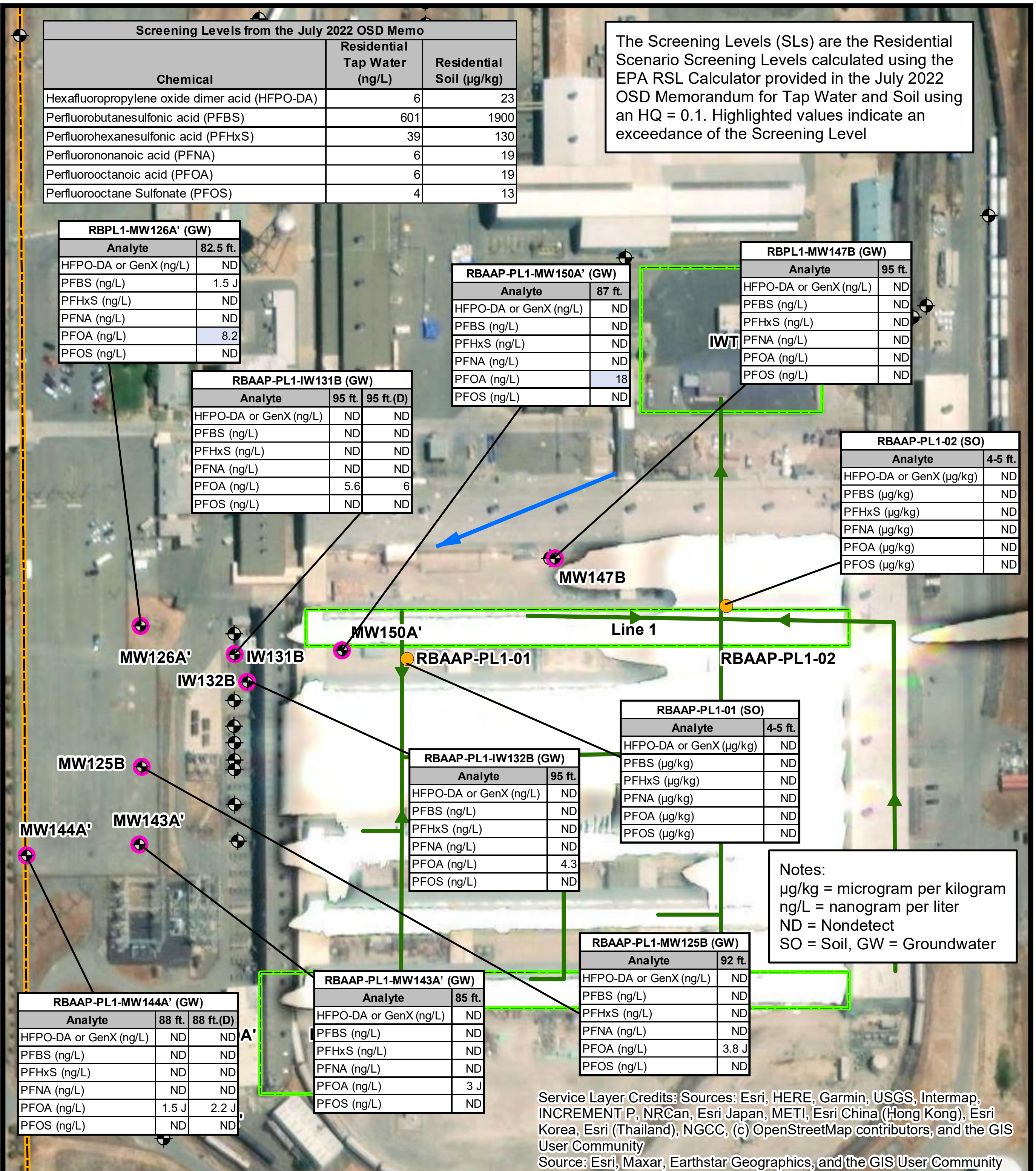
leidos

Metal Plating Line 6 AOPI
Sample Results
Riverbank Army Ammunition Plant

FIGURE: 6-2 | DATE: 10/25/2023

C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_6-2_Metal_Plating_Line_6_AOPI_Sample_Results.mxd


IWTP
MW147B
MW150A'
Line 1
RBAAP-PL1-01
RBAAP-PL1-02
MW126A'
IW131B
IW132B
MW125B
MW144A'
MW143A'
EW69A'
Line 6
MW145A'
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_6-3_Metal_Plating_Line_1_AOPI_Sample_Locations.mxd
Legend
Installation Boundary
Areas of Potential Interest (AOPI)
Industrial Wastewater Collection System
Groundwater Flow Direction
Flow Direction of Industrial Wastewater
Existing Monitoring Well (Zone A')
Existing Well Sample (8)
Soil Boring (2)
0 100 200
Feet
STATE PLANE CA III (NAD83)
N
Riverbank
Patterson
US Army Corps of Engineers
leidos
Metal Plating Line 1 AOPI
Sample Locations
Riverbank Army Ammunition Plant
FIGURE: 6-3
DATE: 10/25/2023



Screening Levels from the July 2022 OSD Memo

Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6	23
Perfluorobutanesulfonic acid (PFBS)	601	1900
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	6	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

RBPL1-MW126A' (GW)

Analyte	82.5 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	1.5 J
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	8.2
PFOS (ng/L)	ND

RBAAP-PL1-MW150A' (GW)

Analyte	87 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	18
PFOS (ng/L)	ND

RBPL1-MW147B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBAAP-PL1-IW131B (GW)

Analyte	95 ft.	95 ft.(D)
HFPO-DA or GenX (ng/L)	ND	ND
PFBS (ng/L)	ND	ND
PFHxS (ng/L)	ND	ND
PFNA (ng/L)	ND	ND
PFOA (ng/L)	5.6	6
PFOS (ng/L)	ND	ND

RBAAP-PL1-02 (SO)

Analyte	4-5 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

RBAAP-PL1-01 (SO)

Analyte	4-5 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

RBAAP-PL1-IW132B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	4.3
PFOS (ng/L)	ND

Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
ND = Nondetect
SO = Soil, GW = Groundwater

RBAAP-PL1-MW125B (GW)

Analyte	92 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	3.8 J
PFOS (ng/L)	ND

RBAAP-PL1-MW143A' (GW)

Analyte	85 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	3 J
PFOS (ng/L)	ND

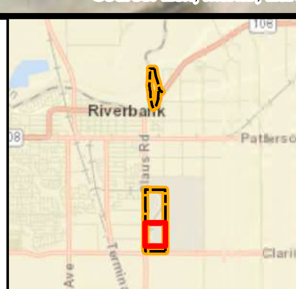
RBAAP-PL1-MW144A' (GW)

Analyte	88 ft.	88 ft.(D)
HFPO-DA or GenX (ng/L)	ND	ND
PFBS (ng/L)	ND	ND
PFHxS (ng/L)	ND	ND
PFNA (ng/L)	ND	ND
PFOA (ng/L)	1.5 J	2.2 J
PFOS (ng/L)	ND	ND

Legend
- Installation Boundary
- Areas of Potential Interest (AOPI)
- Industrial Wastewater Collection System
- Groundwater Flow Direction
- Flow Direction of Industrial Wastewater
- Existing Monitoring Well (Zone A')
- Existing Well Sample (8)
- Soil Boring (2)

0 100 200 Feet

STATE PLANE CA III (NAD83)



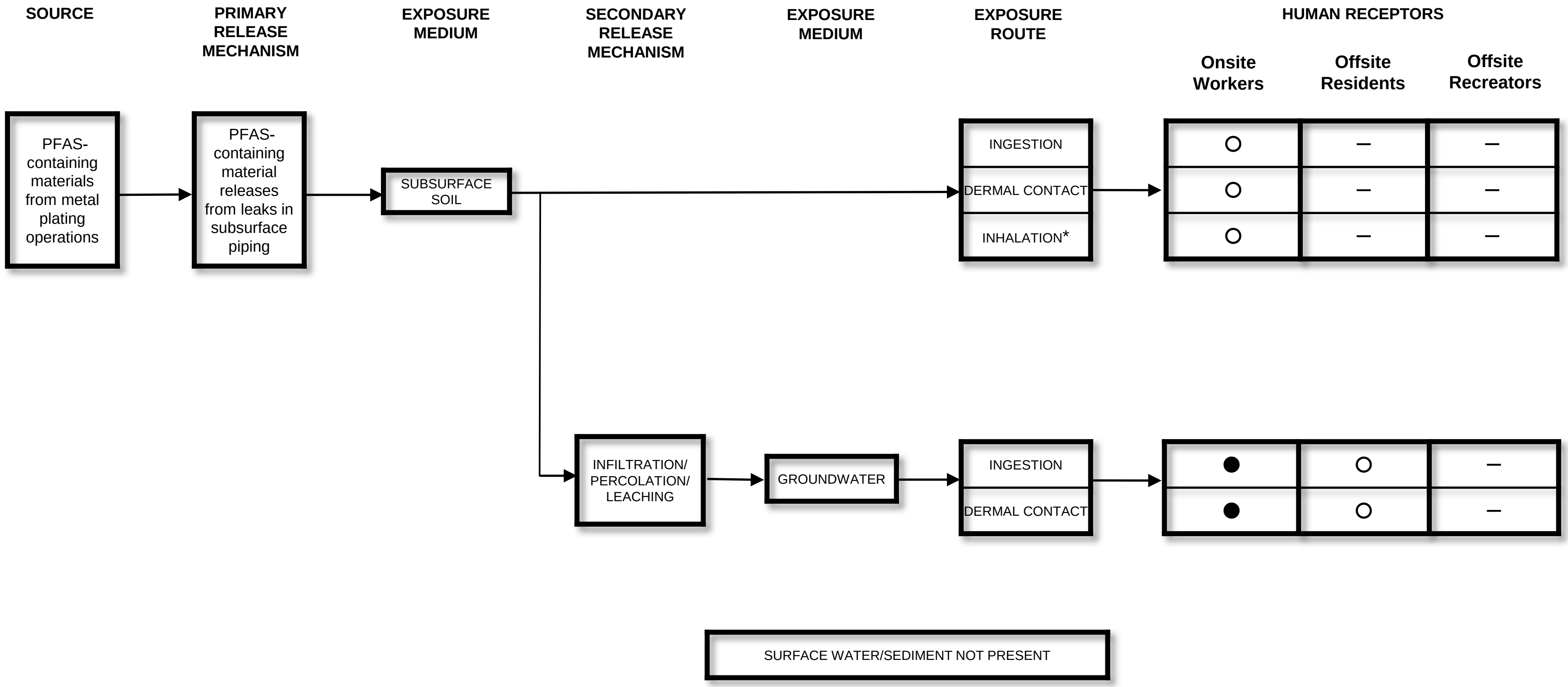
US Army Corps of Engineers

leidos

Metal Plating Line 1 AOPI
Sample Results
Riverbank Army Ammunition Plant

FIGURE: 6-4 DATE: 10/25/2023

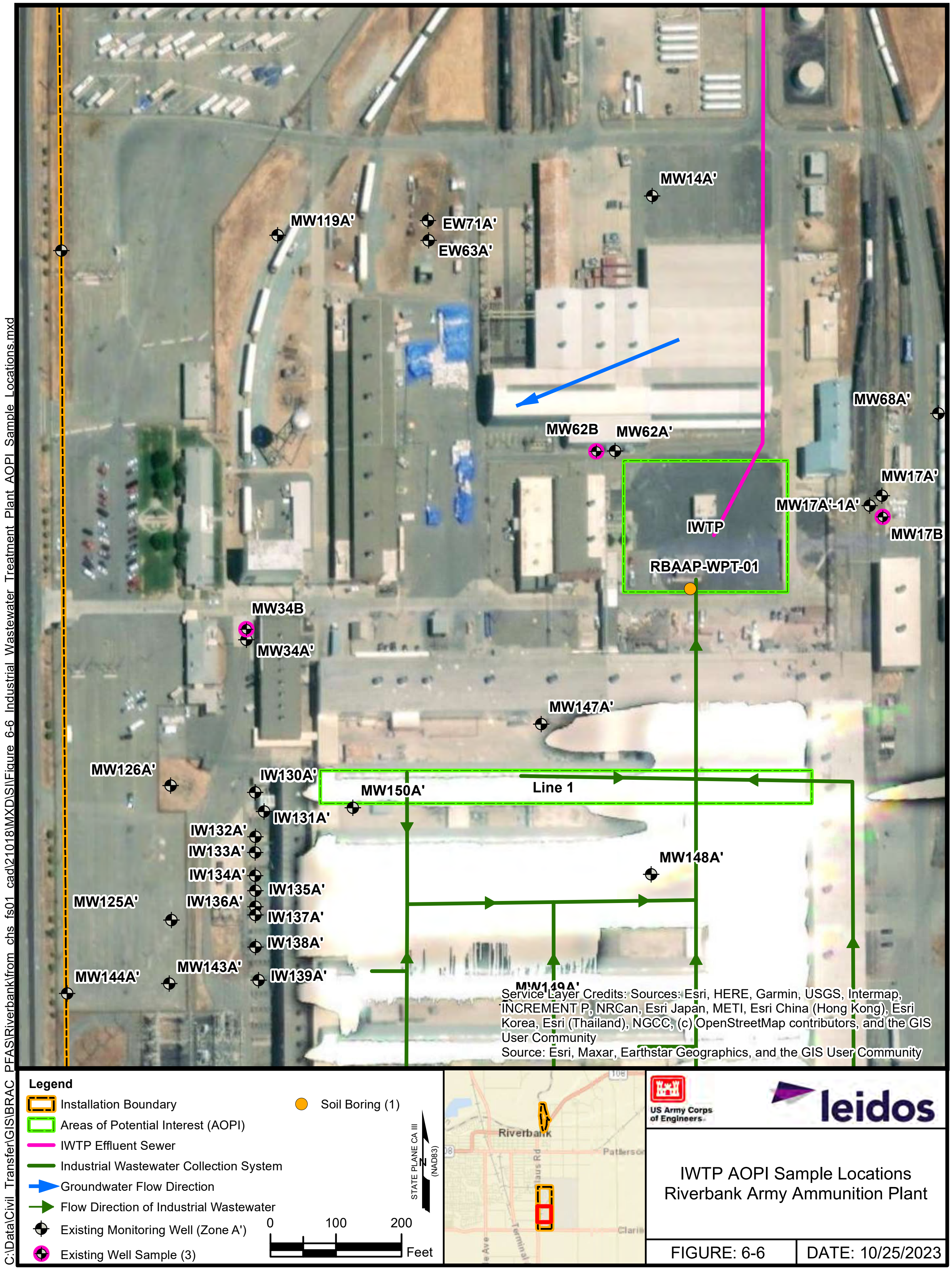
C:\Data\Civil Transfer\GIS\BRAC PFAS\Riverbank\from chs fs01 cad\21018\MXD\SI\Figure 6-4 Metal Plating Line 1 AOPI Sample Results.mxd

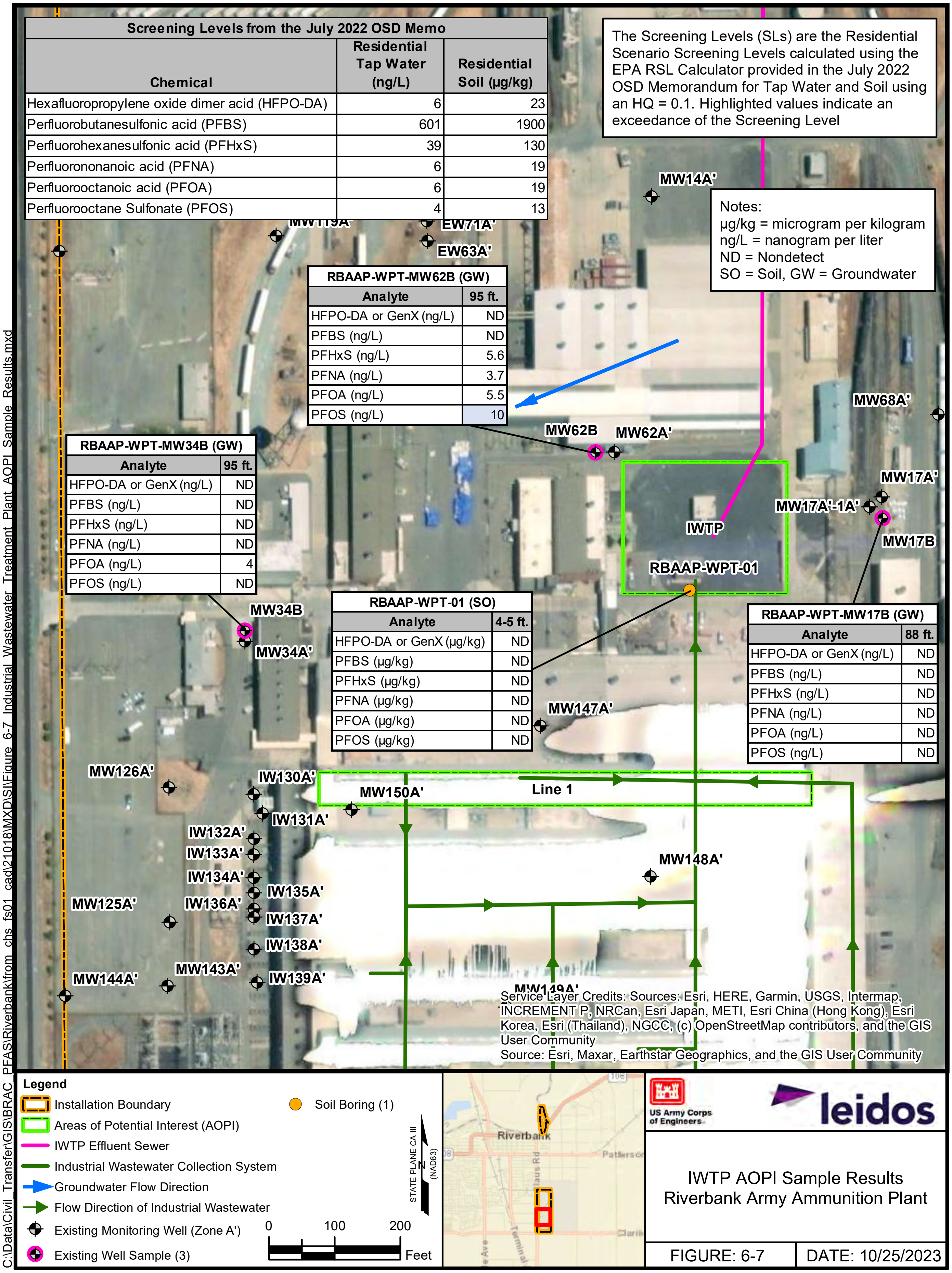


● Complete exposure pathway
○ Potentially complete exposure pathway
— Incomplete exposure pathway

* Inhalation of PFAS is considered potentially complete because no toxicity information is available for the inhalation route

Figure 6.5. Human Health CSM for Metal Plating Line 1 AOPI


MW14A'
MW119A'
EW71A'
EW63A'
MW68A'
MW62B
MW62A'
MW17A'
MW17A'-1A'
MW17B
IWTP
RBAAP-WPT-01
MW34B
MW34A'
MW147A'
MW126A'
IW130A'
MW150A'
Line 1
IW131A'
IW132A'
IW133A'
IW134A'
IW135A'
MW148A'
MW125A'
IW136A'
IW137A'
IW138A'
MW144A'
MW143A'
IW139A'
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_6-6_Industrial_Wastewater_Treatment_Plant_AOPI_Sample_Locations.mxd
Legend
Installation Boundary
Areas of Potential Interest (AOPI)
IWTP Effluent Sewer
Industrial Wastewater Collection System
Groundwater Flow Direction
Flow Direction of Industrial Wastewater
Existing Monitoring Well (Zone A')
Existing Well Sample (3)
Soil Boring (1)
STATE PLANE CA III (NAD83)
N
0
100
200
Feet
Riverbank
US Army Corps of Engineers
leidos
IWTP AOPI Sample Locations
Riverbank Army Ammunition Plant
FIGURE: 6-6
DATE: 10/25/2023



Screening Levels from the July 2022 OSD Memo

Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6	23
Perfluorobutanesulfonic acid (PFBS)	601	1900
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	6	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
ND = Nondetect
SO = Soil, GW = Groundwater

RBAAP-WPT-MW62B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	5.6
PFNA (ng/L)	3.7
PFOA (ng/L)	5.5
PFOS (ng/L)	10

RBAAP-WPT-MW34B (GW)

Analyte	95 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	4
PFOS (ng/L)	ND

RBAAP-WPT-01 (SO)

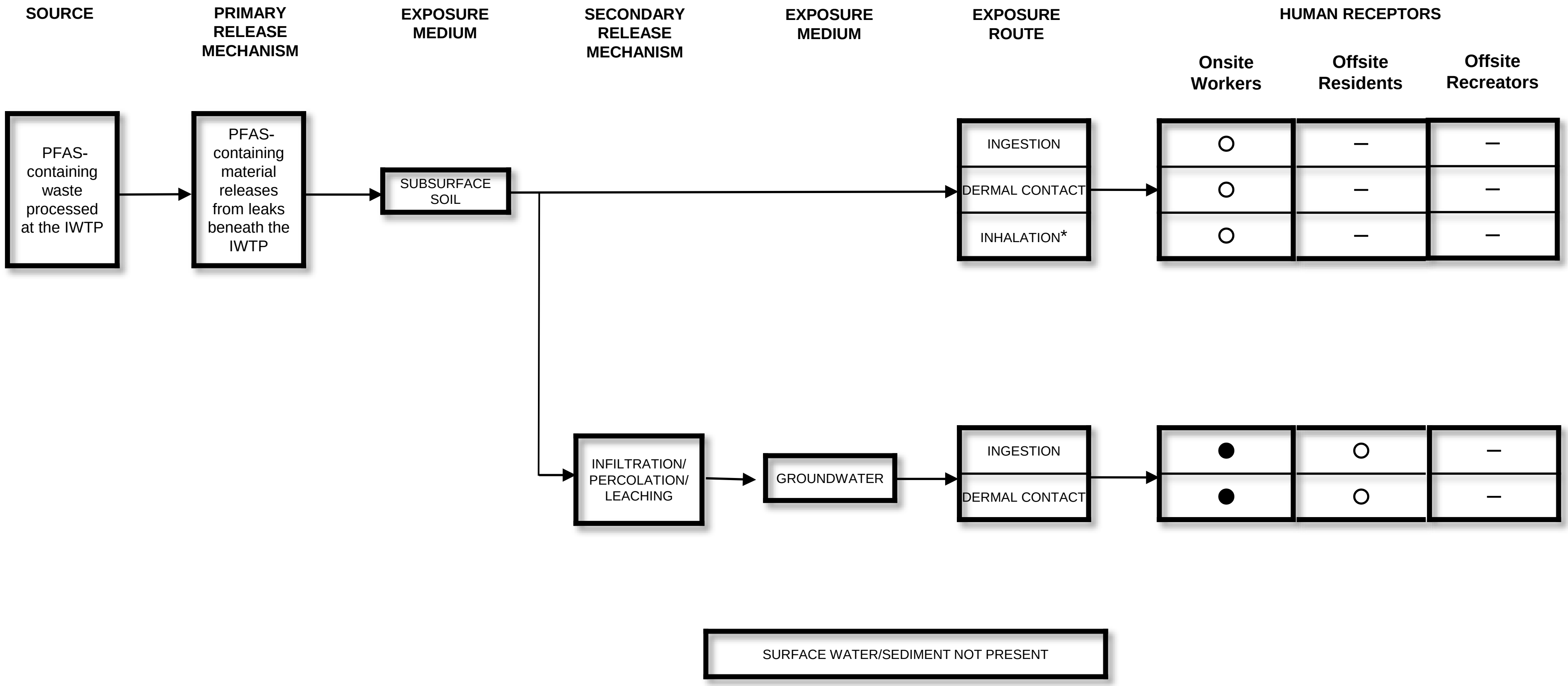
Analyte	4-5 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

RBAAP-WPT-MW17B (GW)

Analyte	88 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

IWTP AOPI Sample Results
Riverbank Army Ammunition Plant

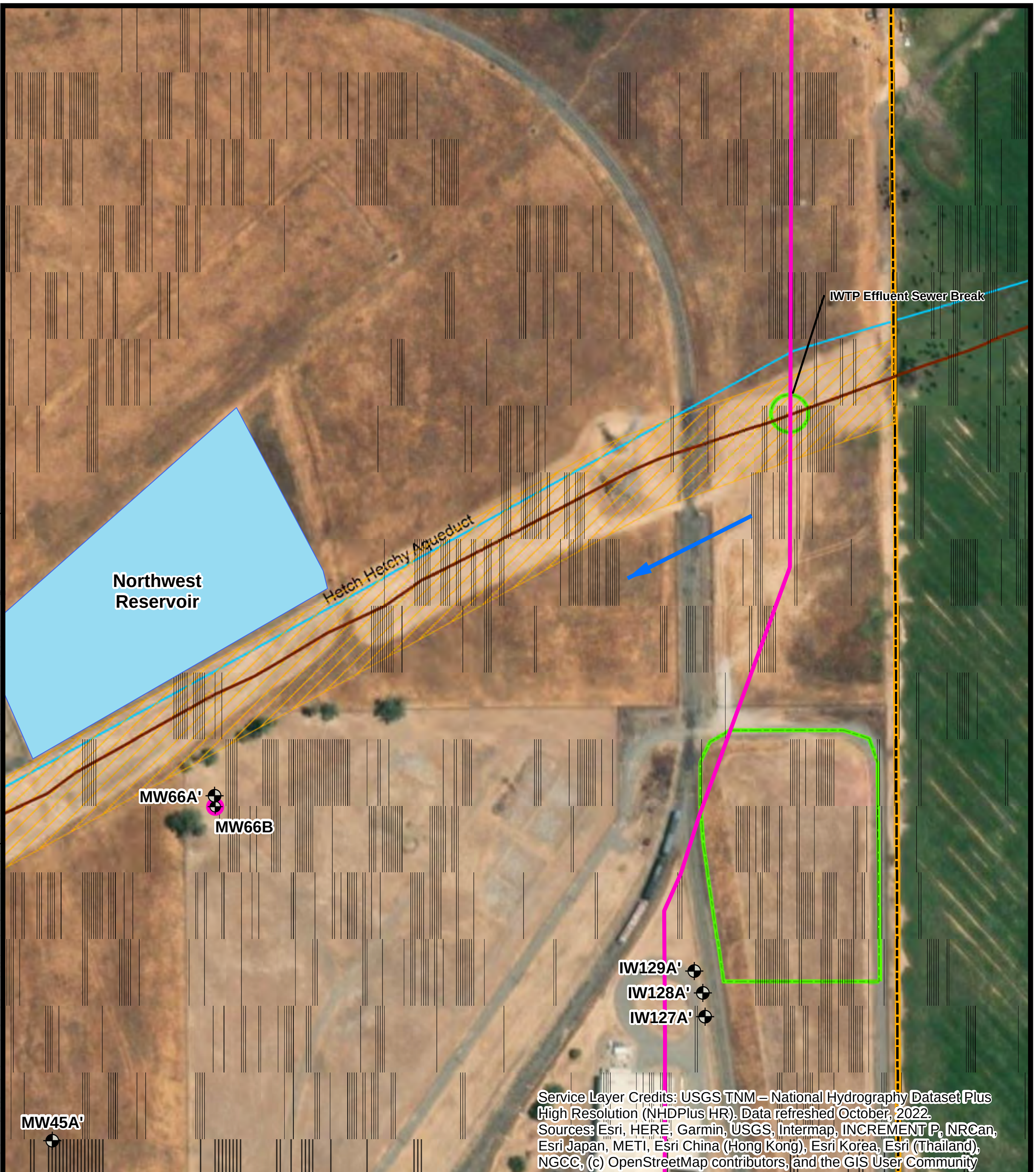
FIGURE: 6-7 DATE: 10/25/2023



● Complete exposure pathway
○ Potentially complete exposure pathway
— Incomplete exposure pathway

* Inhalation of PFAS is considered potentially complete because no toxicity information is available for the inhalation route

Figure 6-8. Human Health CSM for IWTP AOPI

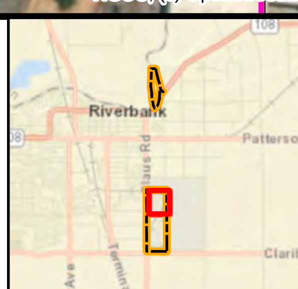


Legend

- Installation Boundary
- Areas of Potential Interest (AOPI)
- Hetch Hetchy ROW
- IWTP Effluent Sewer
- Aqueduct
- Groundwater Flow Direction
- Existing Well Sample (1)

STATE PLANE CA III (NAD83)

0 100 200 Feet



US Army Corps of Engineers

leidos

IWTP Sewer Line Break Area
(Effluent Force Main) AOPI
Sample Locations
Riverbank Army Ammunition Plant

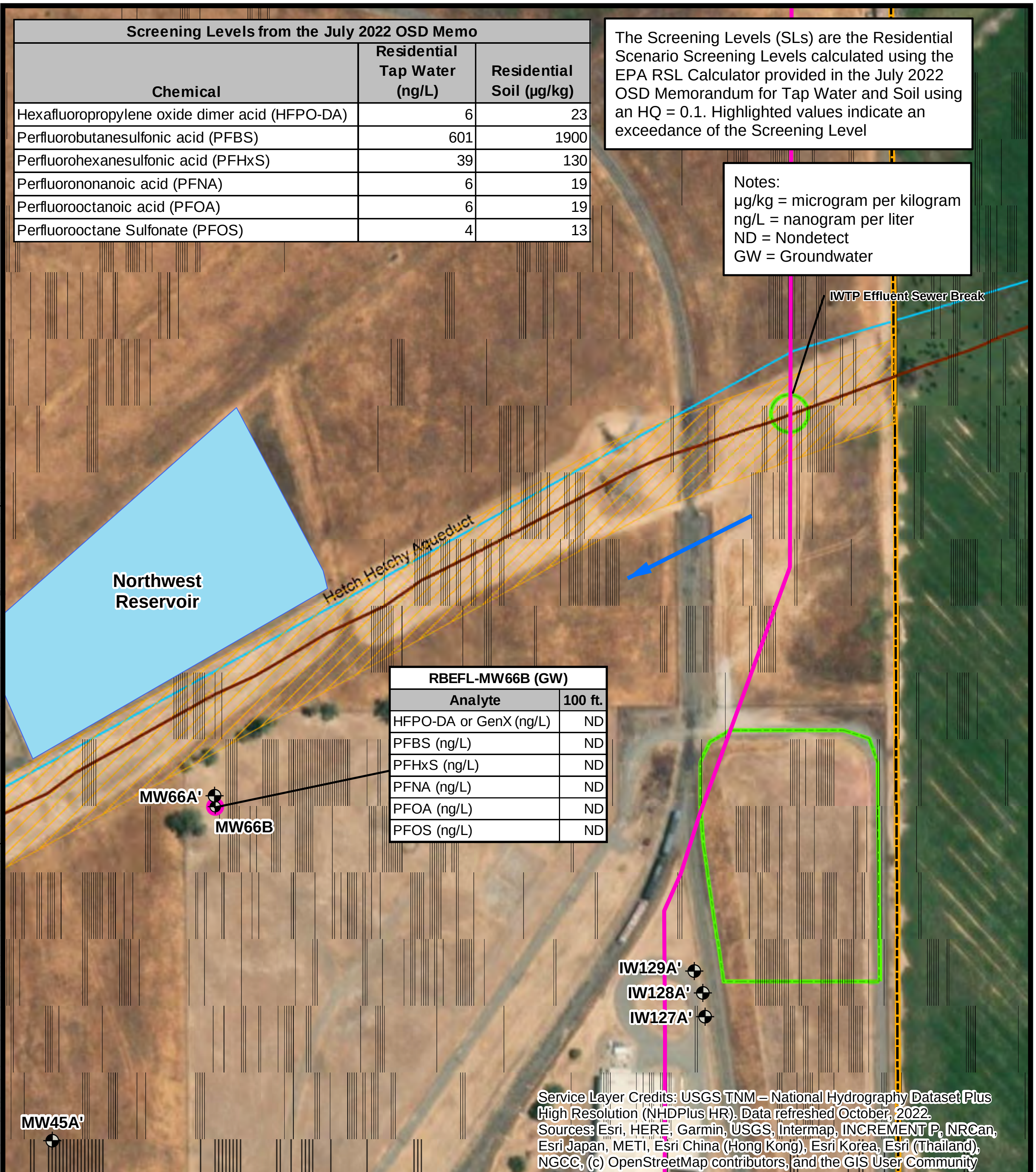
FIGURE: 6-9 | DATE: 4/25/2023

C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_6-9_IWTP_Sewer_Line_Break_Area_AOPI_Sample_Locations.mxd

Screening Levels from the July 2022 OSD Memo		
Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6	23
Perfluorobutanesulfonic acid (PFBS)	601	1900
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	6	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
ND = Nondetect
GW = Groundwater



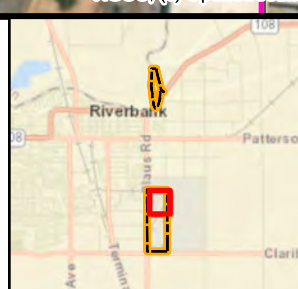
RBEFL-MW66B (GW)	
Analyte	100 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

Service Layer Credits: USGS TNM – National Hydrography Dataset Plus High Resolution (NHDPlus HR). Data refreshed October, 2022.
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Legend
- Installation Boundary
- Areas of Potential Interest (AOPI)
- Hetch Hetchy ROW
- IWTP Effluent Sewer
- Aqueduct
- Groundwater Flow Direction
- Existing Well Sample (1)

STATE PLANE CA III (NAD83) N

0 100 200 Feet



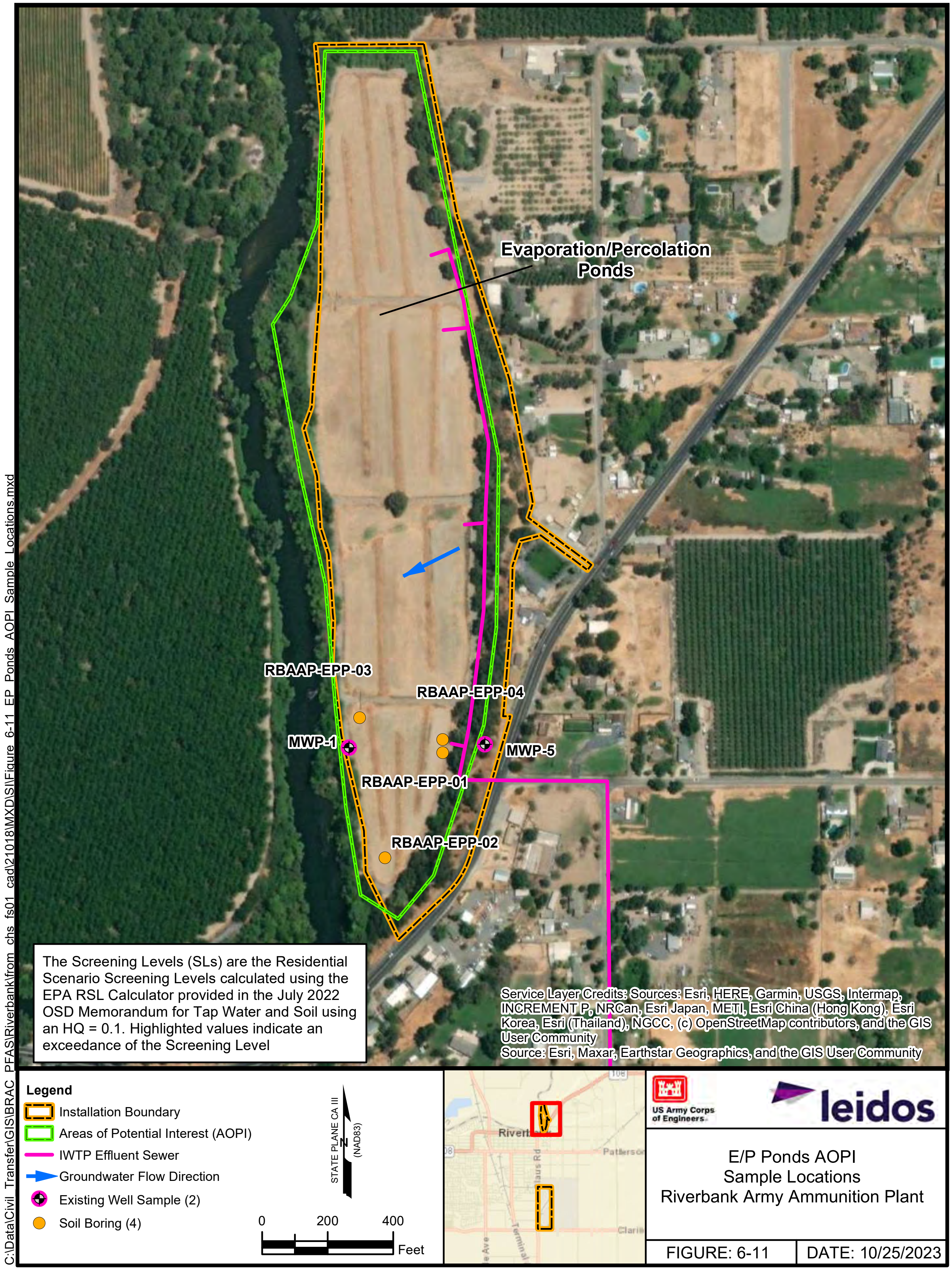
US Army Corps of Engineers

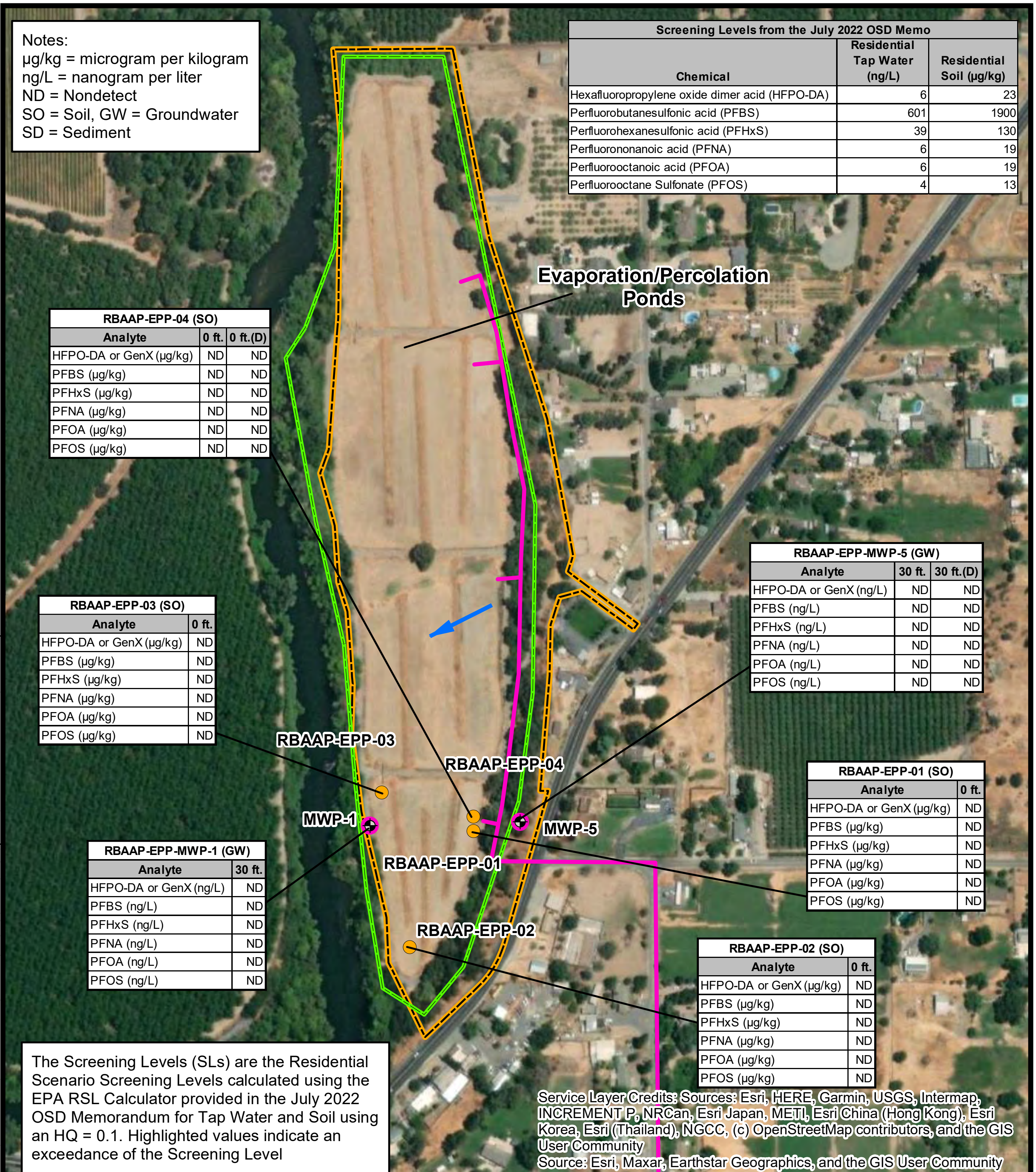
leidos

IWTP Sewer Line Break Area (Effluent Force Main) AOPI Sample Results
Riverbank Army Ammunition Plant

FIGURE: 6-10 | DATE: 4/25/2023

C:\Data\Civil Transfer\GIS\BRAC PFAS\Riverbank\from chs fs01 cad\21018\MXD\SI\Figure 6-10 IWTP Sewer Line Break Area AOPI Sample Results.mxd


Evaporation/Percolation Ponds
RBAAP-EPP-03
RBAAP-EPP-04
MWP-1
MWP-5
RBAAP-EPP-01
RBAAP-EPP-02
The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_6-11_EP_Ponds_AOPI_Sample_Locations.mxd
Legend
Installation Boundary
Areas of Potential Interest (AOPI)
IWTP Effluent Sewer
Groundwater Flow Direction
Existing Well Sample (2)
Soil Boring (4)
STATE PLANE CA III (NAD83)
N
0
200
400
Feet
US Army Corps of Engineers
leidos
E/P Ponds AOPI
Sample Locations
Riverbank Army Ammunition Plant
FIGURE: 6-11
DATE: 10/25/2023



Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
ND = Nondetect
SO = Soil, GW = Groundwater
SD = Sediment

Screening Levels from the July 2022 OSD Memo		
Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6	23
Perfluorobutanesulfonic acid (PFBS)	601	1900
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	6	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

RBAAP-EPP-04 (SO)		
Analyte	0 ft.	0 ft.(D)
HFPO-DA or GenX (µg/kg)	ND	ND
PFBS (µg/kg)	ND	ND
PFHxS (µg/kg)	ND	ND
PFNA (µg/kg)	ND	ND
PFOA (µg/kg)	ND	ND
PFOS (µg/kg)	ND	ND

RBAAP-EPP-03 (SO)	
Analyte	0 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

RBAAP-EPP-MWP-5 (GW)		
Analyte	30 ft.	30 ft.(D)
HFPO-DA or GenX (ng/L)	ND	ND
PFBS (ng/L)	ND	ND
PFHxS (ng/L)	ND	ND
PFNA (ng/L)	ND	ND
PFOA (ng/L)	ND	ND
PFOS (ng/L)	ND	ND

RBAAP-EPP-01 (SO)	
Analyte	0 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

RBAAP-EPP-MWP-1 (GW)	
Analyte	30 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

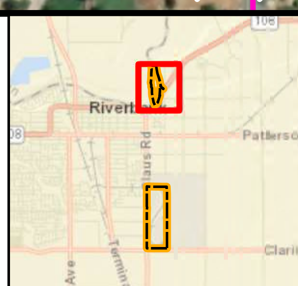
RBAAP-EPP-02 (SO)	
Analyte	0 ft.
HFPO-DA or GenX (µg/kg)	ND
PFBS (µg/kg)	ND
PFHxS (µg/kg)	ND
PFNA (µg/kg)	ND
PFOA (µg/kg)	ND
PFOS (µg/kg)	ND

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the July 2022 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

Legend
- Installation Boundary
- Areas of Potential Interest (AOPI)
- IWTP Effluent Sewer
- Groundwater Flow Direction
- Existing Well Sample (2)
- Soil Boring (4)

STATE PLANE CA III (NAD83)

0 200 400 Feet



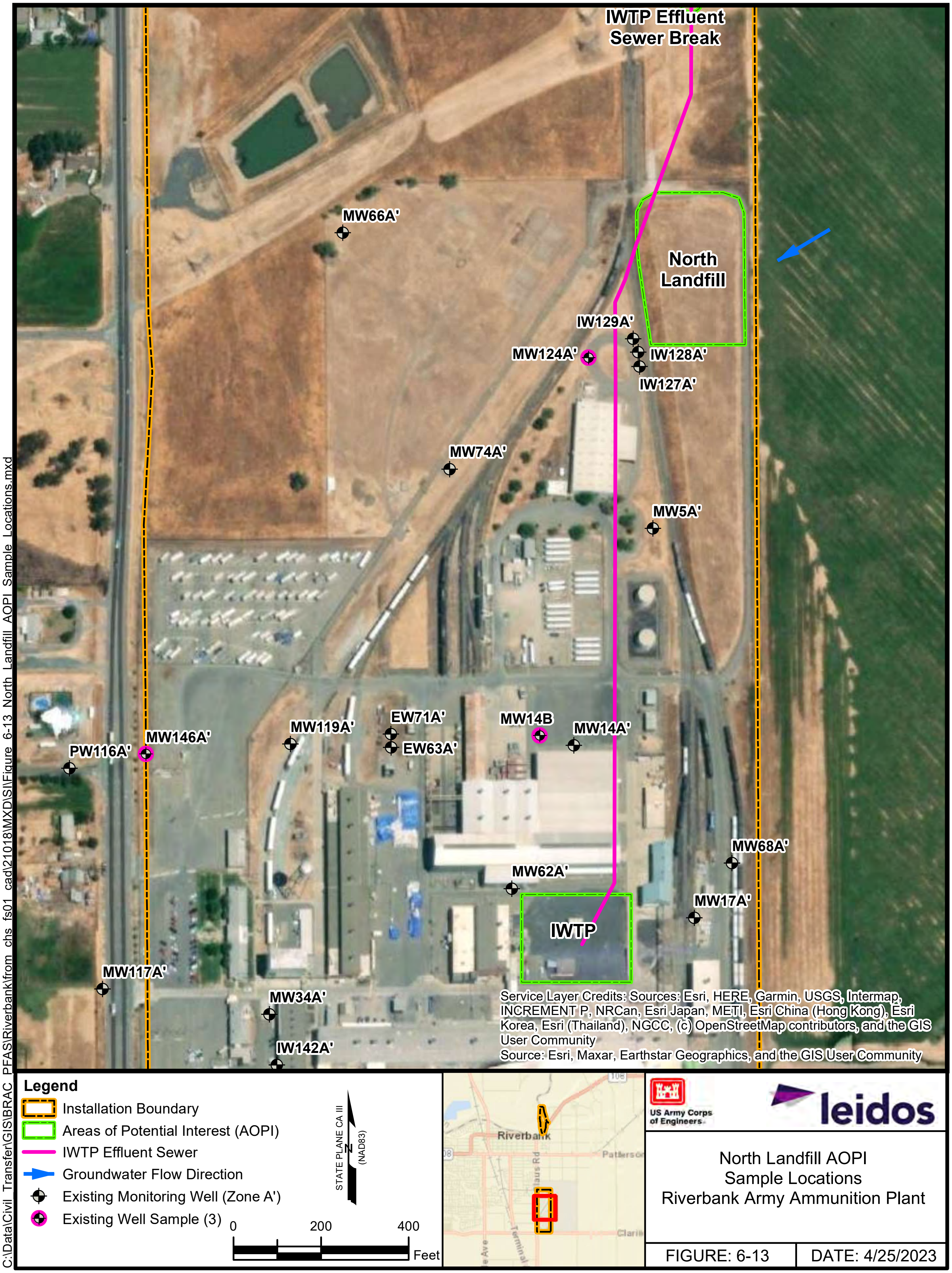
US Army Corps of Engineers

leidos

E/P Ponds AOPI
Sample Results
Riverbank Army Ammunition Plant

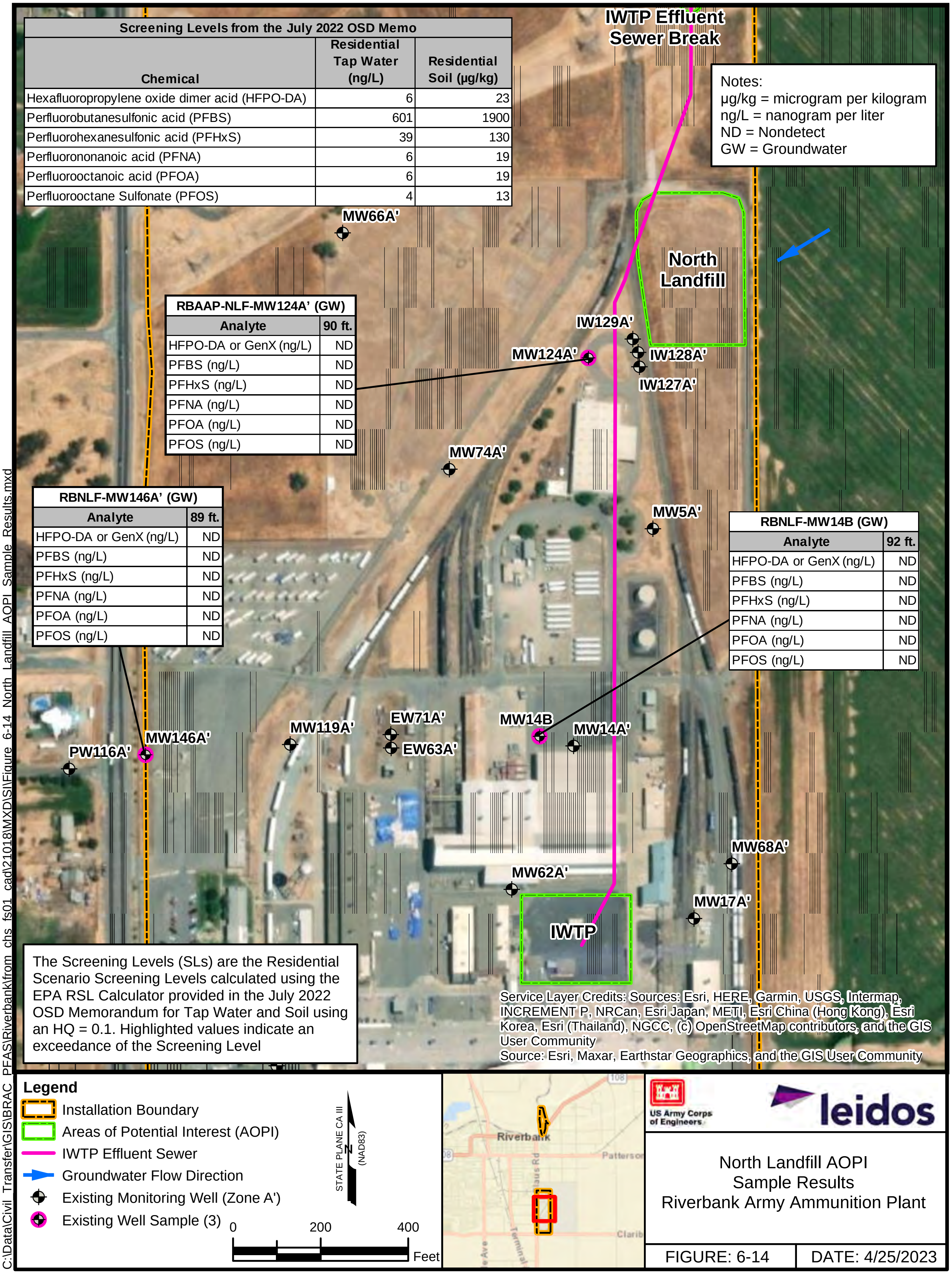
FIGURE: 6-12 DATE: 10/25/2023

C:\Data\Civil_Transfer\GIS\BRAC_PFAS\Riverbank\from_chs_fs01_cad\21018\MXD\SI\Figure_6-12_EP_Ponds_AOPI_Sample_Results.mxd



North Landfill AOPI
Sample Locations
Riverbank Army Ammunition Plant

FIGURE: 6-13 | DATE: 4/25/2023



Screening Levels from the July 2022 OSD Memo		
Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	6	23
Perfluorobutanesulfonic acid (PFBS)	601	1900
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	6	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

RBAAP-NLF-MW124A' (GW)	
Analyte	90 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBNLF-MW146A' (GW)	
Analyte	89 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

RBNLF-MW14B (GW)	
Analyte	92 ft.
HFPO-DA or GenX (ng/L)	ND
PFBS (ng/L)	ND
PFHxS (ng/L)	ND
PFNA (ng/L)	ND
PFOA (ng/L)	ND
PFOS (ng/L)	ND

North Landfill AOPI
Sample Results
Riverbank Army Ammunition Plant

FIGURE: 6-14 | DATE: 4/25/2023