EXPANDED SITE INSPECTION REPORT

FOR

FANSTEEL METALS / FMRI
10 TANTALUM PLACE
MUSKOGEE, MUSKOGEE COUNTY, OKLAHOMA

Prepared for

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EXECUTIVE SUMMARY

Weston Solutions, Inc. (WESTON®), the EPA Region 6 Superfund Technical Assessment and Response Team (START-3) contractor, has prepared this Expanded Site Inspection (ESI) Report to provide the U.S. Environmental Protection Agency (EPA) Region 6 with the background information collected for the site; discuss the ESI sampling activities; and present the analytical data obtained as part of the investigation performed at the Fansteel Metals/FMRI (Fansteel) Site in Muskogee, Muskogee County, Oklahoma.

The Site was identified as a potential hazardous waste site and entered into the Superfund Enterprise Management System (SEMS) under identification number OKD007221831. EPA contractors conducted a Site Inspection (SI) on 7 October 1981 that included the collection of one soil and one sediment sample from the Site, at outfall and seepage locations from the Site to the Arkansas River. These samples were analyzed for metals, fluorides, and polychlorinated biphenyls (PCBs). Based on the analytical results, an observed release to surface water was documented. On 12 June 2018, the Oklahoma Department of Environmental Quality (ODEQ) performed a Preliminary Reassessment, the results of which indicated that further sampling at the Site was warranted.

Upon technical review of the draft SI report, the EPA identified a number of potential issues that would need to be addressed before the process for inclusion on the National Priority List could proceed. The EPA determined that an Expanded Site Inspection (ESI) of the Site would be necessary to more completely evaluate the Site using the EPA Hazard Ranking System (HRS) criteria. START executed the ESI in April 2019 under the EPA-approved Fansteel ESI Quality Assurance Sampling Plan (QASP).

Based on the START 2019 ESI surface water and sediment sampling results, a release of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values) has been documented: benz(a)anthracene; benzo(a)pyrene; dibenz(a,h)anthracene; fluoranthene; phenanthrene; pyrene; aroclor-1254; arsenic; chromium; cobalt; manganese; zinc; and mercury to the surface water pathway, as defined by the HRS. For HRS purposes, a release to surface water is documented when a

hazardous substance is detected in a downstream water or sediment sample at a concentration significantly above background levels (i.e., a contaminant is detected downstream when not detected upstream; a chemical contaminant is detected at a concentration greater than or equal to three times the background concentration when detected upstream). In addition, fishing occurs within the surface water pathway and has been documented within the target distance limit.

This report was prepared as part of the requirements of the Technical Direction Document (TDD) No. 0001/18-173 and serves as documentation of work completed to date.

☐ The EPA Site Assessment Manager did not provide final approval of this report prior to the completion date of the work assignment. Therefore, Weston Solutions, Inc. has submitted this report absent the Site Assessment Manager's approval.

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LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CoC	contaminant of concern
EPA	United States Environmental Protection Agency
ESI	Expanded Site Inspection
GIS	Geographical Information System
HRS	Hazard Ranking System
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
NELAP	National Environmental Laboratory Accreditation Program
NPL	National Priority List
ODEQ	Oklahoma Department of Environmental Quality
PA	Preliminary Assessment
pCi/L	picocuries per liter
PPE	Probable Point of Entry
QASP	Quality Assurance Sampling Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SCDM	Superfund Chemical Data Matrix
SEMS	Superfund Enterprise Management System
SI	Site Inspection
START-4	EPA Region 6 Superfund Technical Assessment and Response Team
TAL	Target Analyte List
TDD	Technical Direction Document
TDL	target distance limit
USGS	United States Geological Survey
WESTON	Weston Solutions, Inc.

1. INTRODUCTION

Under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), Weston Solutions, Inc. (WESTON®), the Environmental Protection Agency (EPA) Region 6 Superfund Technical Assessment and Response Team (START) contractor, has been tasked to perform an Expanded Site Inspection (ESI) of the Fansteel Metals/FMRI (Fansteel) site ("the Site") located in Muskogee, Muskogee County, Oklahoma (Figure 1-1). EPA Region 6 retained WESTON to complete this investigation under Contract Number EP-S5-17-02, Technical Direction Document (TDD) No. 0001/18-173 (Appendix H).

1.1 BACKGROUND

The Site was identified as a potential hazardous waste site and entered into the Superfund Enterprise Management System (SEMS) under identification number OKD007221831. EPA contractors conducted a Site Inspection (SI) on 7 October 1981 that included the collection of one soil and one sediment sample from the Site, at outfall and seepage locations from the Site to the Arkansas River. These samples were analyzed for metals, fluorides, and polychlorinated biphenyls (PCBs). Based on the analytical results, an observed release to surface water was documented (Ref. 4, pp. 1, 2, 4, 5). On 12 June 2018, the Oklahoma Department of Environmental Quality (ODEQ) performed a Preliminary Reassessment, the results of which indicated that further sampling at the Site was warranted (Ref. 5, pp. 1, 10).

The purpose of this report is to provide the background information collected for the Site, discuss the ESI sampling activities, and present the analytical data obtained as part of the investigation.

1.2 OBJECTIVES OF THE INVESTIGATION

The ESI is intended to be part of an on-going screening process of known and potential hazardous waste sites. Expanding on the information documented during the SI, the purpose of this ESI is to further identify immediate or potential threats that hazardous substances, attributable to the Site, may pose to human health and the environment. This is done by documenting the existence and migration of hazardous substances related to the Site and by

identifying the receptors, or targets, potentially exposed to the hazardous substances. EPA will use the information obtained during the ESI to evaluate the Site using the Hazard Ranking System (HRS) and to help determine whether the Site is a potential candidate for inclusion on the National Priorities List (NPL). The intent of the ESI is to provide the documentation necessary to either rank the Site on the NPL or assign a "No Further Remedial Action Planned" status to the Site.

1.3 SCOPE OF WORK

The ESI Scope of Work is intended to describe the tasks requiring completion in order to evaluate the site using the HRS (Reference 1). As part of this ESI, START performed the following major tasks:

- Prepared a site-specific Quality Assurance Sampling Plan (QASP), approved by the EPA, and Health and Safety Plan (HASP) prior to sampling activities.
- Gathered information documenting the environmental setting of the areas of concern to characterize the groundwater, surface water, soil exposure, and air pathways.
- Reviewed available regulatory compliance files from federal, state, and local government agencies.
- Conducted ESI field sampling activities on 7 April 2019 through 12 April 2019. Samples were collected within groundwater and surface water locations at the Site and within potential pathways of migration. The samples were collected in general accordance with the site-specific QASP and HASP to document the presence and migration of hazardous substances attributable to the site.
- Evaluated the available information from the on-site observations, historical aerial photographs, property ownership records, interviews, area environmental information, and area demographic characteristics.
- Submitted the ESI samples to National Environmental Laboratory Accreditation Program (NELAP) certified laboratories for analysis, and conducted data validation, reviewed and tabulated the resulting data.
- Compared the laboratory results to Superfund Chemical Data Matrix (SCDM) benchmark concentrations and three times the background concentrations to establish an observed release as defined by the HRS (Appendix G; Ref. 1; Ref. 2).
- Prepared this report to present the findings of the ESI.

1.4 REPORT FORMAT

The ESI report is presented in a format that is intended to facilitate evaluation of the site using the HRS (Ref. 1). The report contains the following sections:

- Section 1 – Introduction
- Section 2 – Site Characteristics
- Section 3 – Investigative Efforts
- Section 4 – Analytical Results Reporting and Background Samples
- Section 5 – Hazard Ranking System Factors
- Section 6 – Summary
- Section 7 – References

Additional information is provided in the appendices following the text of the report. The appendices are as follows:

- Appendix A Digital Photographs
- Appendix B START Site Logbooks
- Appendix C START Quality Assurance Sampling Plan
- Appendix D Laboratory Data Packages
- Appendix E Laboratory Data Validation Packages
- Appendix F START Sampling Data Sheets
- Appendix G Reference Documentation
- Appendix H TDD No. 0001/18-173

The tables referred to throughout sections of this report are provided within the sections in which they are first cited or as separate portable document format (PDF) files. Figures cited in this report are provided as separate PDF files. Photographs taken during the ESI field sampling activities are provided as Appendix A. The START site logbooks are provided as Appendix B.

2. SITE CHARACTERISTICS

2.1 LOCATION

The Site is located at 10 Tantalum Place in Muskogee, Muskogee County, Oklahoma. The Site is located on the northeast corner of East Shawnee Avenue (US-62) and Muskogee Turnpike (OK-165) and can be reached by taking the East Harris Road exit, east off the Muskogee Turnpike, heading south on North 43rd Street, and heading east on Tantalum Place (Ref. 3, p. 1). The Site geographic coordinates are Latitude 35.77388° North and Longitude 95.305086° West (Ref. 5, p. 3). Site coordinates were taken from the southeast corner of the Service Building located onsite. A Site Area Map is provided as Figure 2-1.

2.2 SITE DESCRIPTION

The Site was once ~140 acres in size, but ~35 acres in the northwest portion of the site was transferred to the Muskogee City-County Port Authority in 1999 (Ref. 5, p. 3; Ref. 6, pp. 62, 215; Ref. 7, p. 5). The site is currently ~105-acres and contains 14 buildings. Three buildings are leased out; 1 used as office space, file storage, and a maintenance workshop; 1 is a small guard house; 1 contains functioning outfall equipment; and the remaining 8 are used to store old equipment, files, chemicals, and Work- in-Progress (WIP) material (Ref. 7, pp. 4, 7-14). In addition, there are 5 ponds containing water, 4 former pond areas, a borrow pit, a soil stockpile, a railroad spur, an interceptor trench with sumps and cleanouts, and other old equipment located throughout the site (Ref. 7, pp. 16-17, 46, 48, 49). At the time of the ESI sampling event, there were several cylinders, an empty poly tank, a hopper filled with lime, and several drums in various stages of deterioration containing unknown chemicals. In addition, Pond 2 was only partially excavated, with a large portion of the radioactive WIP still present, and approximately 2000 1-ton sacks of contaminated soils are in storage within the Sodium Reduction Building and have been there since 1995 (Appendix A, Photos 29, 36, 37, 42, 53, 54; Appendix B, p. 4). The Site Layout Map is shown in Figure 2-2.

The Site is bound to the east by the Arkansas River (Webber Falls Reservoir), to the south by the East Shawnee Bypass, to the west by the Muskogee Turnpike, and to the north by undeveloped land

owned by the Muskogee City-County Port Authority (Figure 1-1; Ref. 5, p. 3; Ref. 8, p. 9). The remaining surrounding area consists of a state college, industrial/commercial properties, and residential properties (Figure 1-1, Ref. 3, p. 1). Fencing secures the site but can be accessed through a main entrance on the western boundary of the property (Ref. 5, p. 3). The Cherokee Nation and Muscogee (Creek) Nation, are within a four mile radius of the site and may have areas of cultural significance (Ref. 19, p.1).

2.3 OPERATIONAL HISTORY

Prior to the construction of the Fansteel facility, the area had not been developed and no previous structures existed (Ref. 8, p. 10). Fansteel operated a metal processing facility which produced tantalum and columbium metal products from 1956 to 1989 (Ref. 6, p. 4). The raw material (ore) used for tantalum and columbium production contained uranium and thorium as naturally occurring trace constituents. The concentrations of natural uranium and natural thorium were sufficient to cause the ores and slags to be classified as source materials by the Atomic Energy Commission (AEC), which originally issued License No. SMB-911 in 1967 to Fansteel, Inc. (Ref. 5, p. 4; Ref. 6, p. 32).

In 1981, EPA contractors performed a SI and conducted sediment sampling of the runoff outfall and seepage coming from ponds located on the facility at the time. Both runoff samples taken during the inspection contained increased levels of aroclor 1254, chromium, nickel and beryllium. The samples were taken from downdip runoff paths which then flow directly into the Arkansas River. It was not determined where the aroclor contamination originated from (Ref. 4, pp. 2, 4, 5).

On 18 June 1989, a large supernatant discharge from Pond No. 3 occurred (Ref. 5, p. 4). Pond No. 3 was constructed in 1979 as a total retention structure for ore/slag residue produced during the digestion and liquid/liquid exchange processes (Ref. 7, p. 17). Pond No. 3 was constructed at the top of the local shale and since groundwater was encountered within the alluvium, a french drain network was installed around it to collect the groundwater and route it to a wet well (sump). A single synthetic liner was installed in the pond (Ref. 8, p. 12). In 1989, portions of the French drain system collapsed, with a failure of the pond liner. The pond fluid, containing digested ores and slags and comprised of hydrofluoric acid, sulfuric acid, methyl

isobutyl ketone (MIBK), heavy metals, and low-level radioactive species, was released to Outfall 003 (Ref. 8, p. 12). Approximately 90,000 gallons of pond fluid was released to the Arkansas River before the discharge was arrested (Ref. 5, p. 4; Ref. 8, p. 13).

Chemical processing equipment used in the extraction of tantalum and columbium from ores and slags were sold and removed from the property in 1990-1992 (Ref. 8, p. 10). In 1992, a remedial assessment work plan was developed by Fansteel to determine the magnitude and extent of potential contaminants of concern at the Site. In 1993, the remediation assessment was conducted at Fansteel under an amended license approved by the Nuclear Regulatory Commission (NRC). The work performed as part of the remediation assessment included the installation of soil borings, monitoring wells, and test pits; the collection and analysis of soil, sediment, surface water, groundwater, air and pond residue samples; and the performance of a radioactivity scoping survey. The results of these activities indicated that chemical and radiological contamination was present in the site soils and groundwater, particularly in plant areas formerly used for the processing of tantalum and columbium bearing ores (Ref. 8, p. 7).

From 1999-2001, Fansteel attempted to resume operations and a new chemical extraction process was implemented and then suspended in late 2001 due to process difficulties and a decline in the price of tantalum (Ref. 7, p. 5). In 2004, Fansteel went into bankruptcy. As part of a court-ordered reorganization, a separate subsidiary, FMRI, was formed for the sole purpose of site cleanup and decommissioning (Ref. 5, p. 4).

In 2003, a Decommissioning Plan (DP) was prepared to describe the remediation activities proposed for FMRI. The purpose of the DP was to decommission the facility safely and meet NRC requirements for unrestricted use (Ref. 9, p. 18).

FMRI began Phase I decommissioning in 2005 in accordance with the DP. Phase I included removal of the byproducts of the tantalum and columbium digestion process, also call Work in Progress (WIP) materials, from Pond No. 2 and Pond No. 3. The excavated material from Pond No. 3 was transferred to an out-of-state uranium mill for use as alternative feedstock (Ref. 7, p. 26). All residual WIP from Pond No. 3 was removed in 2010, with the berms and interior reshaped for erosion control. However, no confirmation sampling or radiological

surveys had been conducted during this process. In 2011, approximately 200 tons of WIP was removed from a drying bed near the southeast corner of Pond No. 3 (Ref. 8, p. 27). Excavation of Pond No. 2 began in August 2011 and hasn't been completed to date. FMRI has estimated that 3,000 tons of WIP had been removed from Pond No. 2, and that roughly 5,000 tons of material remained (Ref. 7, p. 27). In 2016, excavated and bagged WIP material appeared to be stored in the Chem A building, the Chem C building. Later that same year, the bagged WIP was shipped off-site. Currently there is no bagged WIP left at the site. Excavated and bagged contaminated soils where stored in the Sodium Reduction building, and Phase I activities had been halted prior to completion (Ref. 7, pp. 27, 89, 94). Phase II activities, remediation of the calcium fluoride (CaF_2) settling ponds, and Phase III activities, remediation of the buildings and soils, had not begun (Ref. 5, p. 5; Ref. 7, pp. 27, 28).

The ODEQ confirmed the presence of trichloroethene (TCE) on the property in late 2006. Site controls have been in place related to the observed radiological impacts, however no controls were in place related to the observed chemical impacts (Ref. 5, p. 5).

In 2015, contractors for the Muskogee City-County Port Authority conducted a Limited Site Investigation (LSI) and Sub-Slab Vapor Investigation in response to the 2006 ODEQ TCE discovery. As a result of this investigation, it was found that a TCE groundwater plume appeared to be most concentrated near the Sintering Building with the plume continuing northeastward onto the north portion of the FMRI property. The results reported exceedances of TCE levels for soil, groundwater, and sub-slab vapor samples collected beneath the Sintering Building, Electron Beam Building, and Service Building (Ref. 10, pp. 4, 14, 15).

The parent corporation of FMRI, Fansteel, was required to make scheduled payments to FMRI for decommissioning the site. Fansteel defaulted on its obligation and went into bankruptcy again in 2016 (Ref. 5, p. 4).

2.4 REGULATORY INVOLVEMENT

The following license, regulatory, and permit numbers are related to the Site:

- The Site operates under NRC License No. SMB-911 for decommissioning of the radiological contaminants (Ref. 9, p. 14).

- Contaminated groundwater is collected in an inceptor trench and treated by neutralization prior to discharge to the Arkansas River. Discharges to the river are regulated through Oklahoma Pollutant Discharge Elimination System (OPDES) Permit No. OK0001643 (Ref. 5, pp. 5, 28).
- The Site is listed in SEMS as OKD007221831 (Ref. 11, p. 1).

3. INVESTIGATIVE EFFORTS

3.1 PREVIOUS SAMPLING

3.1.1 Remediation Assessment Efforts

Fansteel conducted a remediation assessment, under the approval of the NRC in 1993. The work performed as part of this assessment included the installation of 96 soil borings, 29 monitoring wells, and 13 test pits; the collection and analysis of soil, sediment, surface water, groundwater, air, and pond residue samples; and the performance of a radioactivity scoping survey (Ref. 8, pp. 7, 15, 18, 21, 22). The samples were analyzed for total metals, total fluoride, total ammonia, total sulfate, nitrate, gross alpha, gross beta, and methyl isobutyl ketone (MIBK) (Ref. 8, p. 30). During this assessment, the most pervasive contaminants of concern within soils included MIBK, ammonia, columbium, fluoride, and tin. The vast majority of these constituents were located in plant areas surrounding Pond No. 3 and east of Pond No. 2 and Pond No. 3, the Chem A building, and the Chem C building (Ref. 8, p. 80). Similar to site soils, the shallow groundwater zone is most significantly impacted in the area of the site east of Pond No. 2 and Pond No. 3, Chem A Building, and Chem C Building. Concentrations of a variety of metals are also generally higher, as well as elevated radioactivity (Ref. 8, p. 80). Surface water in the southwest Borrow Pit area exhibited concentrations of barium, cadmium, lead, columbium, and tantalum. Surface water was also affected by radioactivity at Outfall 002 and from the southwest plant area (Ref. 8, p. 81).

3.1.2 Supplemental Characterization Efforts

In 2011, FMRI conducted a supplemental site characterization plan to provide additional data necessary to support decommissioning operations (Ref. 12, p. 9). As part of this plan, FMRI contractors conducted additional characterization of soil to a depth of 1 meter; characterization of subsurface soils near Pond No. 2 and Pond No. 3; and a summary of groundwater monitoring investigations from 1993 to 2010 (Ref. 12, p. 9). Thirty-four one-meter soil borings were collected around Pond No. 2 and Pond No. 3 and from the Borrow Pit (Ref. 12, pp, 21, 66). Soil samples were collected and analyzed for thorium isotopes, radium isotopes, total uranium, as well as metals and inorganic non-metallic compounds (fluoride, nitrate, and ammonia) (Ref. 12, p. 20). The metals antimony, arsenic, cadmium, chromium, lead, and thallium, as well as fluoride, nitrate and ammonia

were detected in each of the 34 one-meter soil samples (Ref. 12, pp. 22, 23). The following is a summary of the radiological results in the one-meter soil borings.

Radionuclide	Average Concentration (pCi/g)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)
Ra-226	2.54 ± 3.23	0.27	10.5
Ra-228	1.68 ± 1.99	-1.28	8.38
Th-228	1.21 ± 2.32	0.11	11.0
Th-230	1.87 ± 3.55	0.08	15.0
Th-232	1.19 ± 2.39	-0.47	10.6
Total-U	8.43 ± 10.46 ug/g	1.58 ug/g	45.4 ug/g

Note:
pCi/g – picocurie per gram
PCi/L – picocurie per liter
ug/g – microgram per gram

Subsurface samples, with the exception of four specific co-located surface/subsurface points, occurred after the one-meter samples were acquired (Ref. 12, p. 23). Most of the deep soil borings were located in the eastern half of the former Pond No. 3 basin and its perimeter berms. Several additional soil boring locations were selected hydraulically down gradient of former Pond No. 2 (Ref. 12, p. 23). The metals antimony, arsenic, cadmium, chromium, lead, and thallium were detected in each of the 69 subsurface soil sampling intervals. Volatile Organic Compounds (VOCs) were analyzed in the subsurface samples, and five VOCs were detected in one or more of the sampling intervals. These compounds were MIBK, acetone, carbon disulfide, methylene chloride, and toluene (Ref. 12, p. 26). The following is a summary of the radiological results in the subsurface soil sampling intervals.

Radionuclide	Average Concentration (pCi/g)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)
Ra-226	1.35 ± 3.77	-0.04	30.5
Ra-228	1.04 ± 0.98	-0.50	5.73
Th-228	1.57 ± 4.47	-0.34	36.9
Th-230	1.89 ± 5.02	-0.11	40.4
Th-232	1.49 ± 4.08	-0.21	33.3
Total-U	9.61 ± 20.62 ug/g	1.52 ug/g	165.0 ug/g

Note:
pCi/g – picocurie per gram
pCi/L – picocurie per liter
ug/g – microgram per gram

Water quality monitoring was routinely conducted on the groundwater inceptor trench (GIT) system in 1999 through 2010. The identification of trends in contaminant concentrations was limited by the availability of data for some constituents of concern (Ref. 12, pp. 37, 38). The following trends were observed based on the information collected:

- Radionuclides – GIT sumps were routinely evaluated for Thorium-228, Thorium-230, Thorium-232, Uranium-234, Uranium-235, and Uranium-238. Throrium-232, and total uranium and generally show a decreasing trend in the sumps over time, but higher total uranium activities were observed in sumps 1 and 2 (Ref. 12, p. 38).
- Total Metals – Total metals in routine monitoring included arsenic, cadmium, chromium, and lead. With the exception of arsenic, elevated concentrations of metals were not detected in sumps. Arsenic was detected at a peak concentration of 12.6 mg/L in August 1999, however a decreasing trend was observed over the 1999 to 2010 time period (Ref. 12, p. 38).
- VOCs – Only MIBK and TCE were part of the groundwater quality evaluation of the GIT. TCE was never analyzed in sumps 1, 2, or 4, and only analyzed twice in sump 3, where it was not detected. MIBK was only included in routine monitoring conducted in sumps 1 and 3. Maximum concentrations in sump 1 were observed from 1999 to 2000. After that period, MIBK concentrations in sump 1 exhibited a decreasing trend, with the last detection occurring in March 2009. MIBK concentrations in sump 2 were highly variable, and did not exhibit an identifiable trend over time, suggesting that there is a continuing source of MIBK contamination located up gradient of the GIT area of sump 2 (Ref. 12, p. 38).

Conclusion from the supplemental characterization efforts indicated radioactivity and chemical contamination existed in the soil and subsurface soils of the site and additional characterization of groundwater was necessary since data was limited (Ref. 12, p. 49).

3.1.3 Limited Site Investigation (LSI) and Sub-Slab Vapor Investigation

In April 2015, Terracon, contractors for the Muskogee City-County Port Authority, conducted a LSI to evaluate impacts to soil and groundwater on the site and to evaluate whether the facility was at risk of intrusion of chlorinated vapors. The objectives of the LSI were: to collect soil and groundwater samples to better define the extent and concentrations of TCE, tetrachloroethene (PCE), 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, and other VOCs, semi-volatile organic compounds (SVOCs), antimony, arsenic, barium, beryllium, chromium, lead, and thallium; to evaluate if PCBs were released to site soils; and to evaluate the potential encroachment of VOC vapors into buildings (Ref. 10, pp. 2, 4, 5). This investigation focused only on the northwest corner of the Site, in an area the Port Authority was considering for purchase and not the entire Site (Ref. 10, pp. 4, 25). Based on the results of the investigation, it was concluded that soils and

groundwater were impacted by PCE, TCE, cis-1,2-dichloroethene, 1,1-dichloroethene, 1,1-dichloroethane (soils only), and/or 1,1,1-trichloroethane, with small areas of groundwater also impacted by vinyl chloride and thallium. In addition, it was found that the Sintering Building, Service Building, and Electron Beam Building were impacted by sub-slab vapors of chloroform, ethylbenzene, PCE, and/or TCE (Ref. 10, p. 17).

3.1.4 ODEQ Preliminary Assessment/Reassessment (PA) and Site Investigation (SI)

EPA contractors completed a SI in October 1981, which included the collection and sampling of two sediment samples from a runoff outfall and an area of seepage. The results of the SI indicated the presence of hazardous substances at the Site, as well as a release of hazardous substances from the Site to surface water (Ref. 4, pp. 2, 4, 5, 20, 29).

ODEQ conducted a PA at the Site in June 2018, the scope included the review of available information from ODEQ and other State agencies' files and a comprehensive target survey. As a result of the information gathered during the PA, further investigation at the Site was recommended (Ref. 5, pp. 3, 10).

3.2 EXPANDED SITE INSPECTION SAMPLING

START was tasked to conduct an ESI of the Site, including the collection of environmental samples. The specific sampling objectives were to collect data that could be used to document a release of hazardous substances to the surface water pathway. The site-specific Contaminants of Concern (CoCs) include isotopic uranium, isotopic thorium, total metals, MIBK, and TCE (Ref. 5, p. 4). For HRS purposes, a release is documented when a hazardous substance is detected at a concentration equal to or greater than three times the background concentration. If the background concentration is not detected, then a release is documented when the sample measurement equals or exceeds the sample quantitation limit. The field work was conducted in accordance with the START QASP, approved by the EPA in April 2019 (Appendix C).

START implemented the QASP during 7 through 12 April 2019. START collected groundwater samples from existing monitoring wells around the Site. Additionally, surface water and sediment samples were collected from the Site ponds and outfalls to the Arkansas River, and a soil sample was collected from a pile located onsite. Background groundwater, surface water, and sediment samples were collected from locations up-gradient from former facility operations. To support the

ESI, samples were collected from 24 groundwater locations, 11 soil/sediment locations, and 13 surface water locations. Sample locations are listed in Table 3-1 and are presented in Figure 3-1.

Surface water, groundwater, soil, and surface sediment samples were collected and submitted to a NELAP certified laboratory for the following analyses: isotopic uranium (including isotopes 234, 235, and 238) and isotopic thorium (including isotopes 228, 230, and 232) by SOP 714; radium-226 by Method 903.1 radon emanation; radium-228 by GFPC, SOP 724 Rev. 13; total metals (TAL) including mercury by SW846 Methods 6020 and 7470/7471; radium 226 +228 by EPA Method 903.1; total compound list (TCL) VOCs by SW846 Methods 5035/8260B; TCL SVOCs by SW846 Method 8270D; Total Cyanide by SW846 Method 9014; and PCBs by SW846 Method 8082.

The analytical data were validated by START. Data are presented in Figure 3-2 and Tables 4-1 through 4-5. The laboratory data packages and data validation reports are included in Appendices D and E, respectively.

3.2.1 Deviations from the QASP

The following deviations from the QASP occurred during the field work:

- Monitoring wells OW-7 and 74S were not sampled because they were dry.
- An additional surface water sample was collected from the stormwater catchment basin.
- No sediment sample was collected from OF1 (Outfall 1) since no sediment could be found.

None of these deviations are expected to have any adverse impact on the data or conclusions of this report.

Table 3-1
ESI Sample Locations and Sampling Rationale

Sample Name	Sample Matrix	Sample Location (refer to Figure 3-2)	Rationale
MW-51S-20190410	Groundwater	MW-51S located west of Sintering Building	Collected to establish if there is contamination in the groundwater.
MW-54S-20190409	Groundwater	MW-54S located east of Sintering Building	Collected to establish if there is contamination in the groundwater.
MW-53S-20190409	Groundwater	MW-53S located south of Service Building	Collected to establish if there is contamination in the groundwater.
MW-52S-20190410	Groundwater	MW-52S located on west side of Borrow Pit	Collected to establish if there is contamination in the groundwater.
MW-56S-20190410	Groundwater	MW-56S located east side of Borrow Pit	Collected to establish if there is contamination in the groundwater.
MW-OW9-20190411	Groundwater	MW-OW9 located to southeast of Borrow Pita and west of Pond No. 9	Collected to establish if there is contamination in the groundwater.
MW-OW8-20190410	Groundwater	MW-OW8 located to north of inceptor trench	Collected to establish if there is contamination in the groundwater.
MW-68S-20180410	Groundwater	MW-68S located to west of Pond No. 3	Collected to establish if there is contamination in the groundwater.
MW-69S-20190410	Groundwater	MW-69S located to north of Pond No. 3	Collected to establish if there is contamination in the groundwater.
MW-75S-20190410	Groundwater	MW-75S located on northeast corner of property	Collected to establish if there is contamination in the groundwater.
MW-72S-20190410	Groundwater	MW-72S located northeast of Pond No. 3 within former Basin 5	Collected to establish if there is contamination in the groundwater.
MW-71S-20190411	Groundwater	MW-71S located northwest of former Pond 2	Collected to establish if there is contamination in the groundwater.
MW-OW4-20190412	Groundwater	MW-OW4 located east of former Pond No. 2	Collected to establish if there is contamination in the groundwater.
MW-70S-20190411	Groundwater	MW-70S located between Former Tank Farm and Chem C Building	Collected to establish if there is contamination in the groundwater.
MW-55S-20190410	Groundwater	MW-55S located southeast of former tank farm	Collected to establish if there is contamination in the groundwater.

Table 3-1
ESI Sample Locations and Sampling Rationale

Sample Name	Sample Matrix	Sample Location (refer to Figure 3-2)	Rationale
MW-64S-20190409	Groundwater	MW-64S located between Chem A and Chem C Buildings	Collected to establish if there is contamination in the groundwater.
MW-65S-20190412	Groundwater	MW-65S located within former Basin 1	Collected to establish if there is contamination in the groundwater.
MW-67S-20190411	Groundwater	MW-67S located east of Chem A Building	Collected to establish if there is contamination in the groundwater.
MW-OW5-20190412	Groundwater	MW-OW5 located east MW- 67S and Chem A Building near inceptor trench	Collected to establish if there is contamination in the groundwater.
MW-OW3-20190410	Groundwater	MW-OW3 located northwest side of Pond No. 8	Collected to establish if there is contamination in the groundwater.
MW-63S-20190411	Groundwater	MW-63S located east of former Pond No. 5	Collected to establish if there is contamination in the groundwater.
MW-62S-20190411	Groundwater	MW-62S located east of former Pond No. 5	Collected to establish if there is contamination in the groundwater.
MW-57S-20190411	Groundwater	MW-57S located east of former Pond No. 7	Collected to establish if there is contamination in the groundwater.
MW-OW6-20190411	Groundwater	MW-OW6 located east of the Thermite Building and inceptor trench	Collected to establish if there is contamination in the groundwater.
MW-DUP1-20190409	Groundwater	Field Duplicate of MW53S	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
MW-DUP2-20190410	Groundwater	Field Duplicate of MW69S	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
MW-DUP3-20190411	Groundwater	Field Duplicate of MW57S	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
SED-OF2-20180409	Sediment	Outfall 2	Collected to establish if there is contamination in the sediment of Outfall 2.
SED-OF3-20190409	Sediment	Outfall 3	Collected to establish if there is contamination in the sediment of Outfall 3.
SED-OF5-2019409	Sediment	Outfall 5	Collected to establish if there is contamination in the sediment of Outfall 5.
SED-P3-20190408	Sediment	Pond No. 3	Collected to establish if there is contamination in the sediment of Pond No. 3. Source Sampling.

Table 3-1
ESI Sample Locations and Sampling Rationale

Sample Name	Sample Matrix	Sample Location (refer to Figure 3-2)	Rationale
SED-P6-20190408	Sediment	Pond No. 6	Collected to establish if there is contamination in the sediment of Pond No. 6. Source Sampling.
SED-P7-20190408	Sediment	Pond No. 7	Collected to establish if there is contamination in the sediment of Pond No. 7. Source Sampling.
SED-P8-20190408	Sediment	Pond No. 8	Collected to establish if there is contamination in the sediment of Pond No.8. Source Sampling.
SED-P9-20190408	Sediment	Pond No. 9	Collected to establish if there is contamination in the sediment of Pond No. 9. Source Sampling.
SED-N-DRNG-20190409	Sediment	North Drainage ditch	Collected to establish if there is sediment contamination in the north drainage ditch to the Arkansas River pond.
SED-BKG-20190409	Sediment	Background	Collected to establish background concentrations of Arkansas River sediment.
SED-DUP1-20190408	Sediment	Field Duplicate of Pond No. 8	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
SED-DUP2-20190408	Sediment	Field Duplicate of Outfall 3	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
SS-STP-20190408	Soil	Soil Stockpile	Collected to check if any contamination exists within the stockpiled soil onsite. Source Sampling.
SS-DUP1-20190408	Soil	Field Duplicate of Soil Stockpile	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
SW-SB-20190408	Surface Water	Sump below Sintering Building	Collected to establish if there is contamination in the water under the Sintering Building. Source Sampling.
SW-OF1-20190409	Surface Water	Outfall 1	Collected to establish if there is contamination in the water of Outfall 1.
SW-OF2-20190409	Surface Water	Outfall 2	Collected to establish if there is contamination in the water of Outfall 2.
SW-OF3-20190409	Surface Water	Outfall 3	Collected to establish if there is contamination in the water of Outfall 3.
SW-OF5-20190409	Surface Water	Outfall 5	Collected to establish if there is contamination in the water of Outfall 5.
SW-P3-040908	Surface Water	Pond No. 3	Collected to establish if there is contamination in the water of Pond No. 3. Source Sampling.
SW-P6-20190408	Surface Water	Pond No. 6	Collected to establish if there is contamination in the water of Pond No. 6. Source Sampling.

Table 3-1
ESI Sample Locations and Sampling Rationale

Sample Name	Sample Matrix	Sample Location (refer to Figure 3-2)	Rationale
SW-P7-20190408	Surface Water	Pond No. 7	Collected to establish if there is contamination in the water of Pond No. 7. Source sampling.
SW-P8-20190408	Surface Water	Pond No. 8	Collected to establish if there is contamination in the water of Pond No. 8. Source Sampling.
SW-P9-20190408	Surface Water	Pond No. 9	Collected to establish if there is contamination in the water of Pond No. 9. Source Sampling.
SW-N-DRNG-20190409	Surface Water	North Drainage ditch	Collected to establish if there is surface water contamination in the north drainage ditch to the Arkansas River pond.
SW-SCB-20190410	Surface Water	Storm water Collection Basin located east of the Service building	Collected to establish if there is contamination in the water of Storm water Collection Basin. Source Sampling.
SW-BKG-20190409	Surface Water	Background	Collected to establish background concentrations of Arkansas River surface water.
SW-DUP1-20190408	Surface Water	Field Duplicate of Pond No. 8	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
SW-DUP2-20190709	Surface Water	Field Duplicate of Outfall 3	To check reproducibility of lab and field procedure. To indicate non-homogeneity.
20190408-TB1	Water	Trip Blank	Trip Blank sample for VOCs.
20190408-TB2	Water	Trip Blank	Trip Blank sample for VOCs.
20190409-TB3	Water	Trip Blank	Trip Blank sample for VOCs.
20190408-TB4	Water	Trip Blank	Trip Blank sample for VOCs.
20190408-TB5	Water	Trip Blank	Trip Blank sample for VOCs.
20190409-TB6	Water	Trip Blank	Trip Blank sample for VOCs.
20190410-TB7	Water	Trip Blank	Trip Blank sample for VOCs.
20190408-TB8	Water	Trip Blank	Trip Blank sample for VOCs (mislabeled, sample date 20190411)
20190412-TB9	Water	Trip Blank	Trip Blank sample for VOCs.

4. ESI ANALYTICAL RESULTS FOR SOURCES AND PATHWAYS

4.1 SOURCE SAMPLING

For HRS purposes, a source is defined as an area where a hazardous substance has been deposited, stored, disposed, or placed, plus those soils that have become contaminated from migration of a hazardous substance (Reference 1).

START collected 9 surface water samples, 7 sediment samples, and two soil samples (including one duplicate sample of each matrix) as part of the ESI to document source contamination at the Site. The sources sampled included ponds, a soil pile, and storm water retention basin. The samples were submitted to a NELAP certified laboratory for the following analyses: isotopic uranium (including isotopes 234, 235, and 238) by SOP 714 alpha spectrometry; radium-226 by Method 903.1 radon emanation; radium-228 by GFPC, SOP 724 Rev. 13; isotopic thorium (including isotopes 228, and 230) by SOP 714 alpha spectrometry; total metals including mercury by SW846 Methods 6020 and 7470/7471; PCBs by SW846 Method 8082; SVOCs by SW846 Method 8270; and VOCs by SW846 Method 8260 (Appendix D). The surface water and/or sediment and soil sample locations are presented in Table 3-1 and Figure 3-1. Analytical results are presented in Tables 4-1 and 4-2 and Figure 3-2.

4.1.1 Pond No. 3

Pond No. 3 is located on the northeast side of the property, and during the facility's operation, it contained sludge residue left over from the extraction of columbium and tantalum compounds from the ore and slag feedstock (Figure 2-2; Ref. 6, p. 19). The pond was placed into service in 1979 and is 400 feet (ft) long, 250 ft wide, and 25 ft deep. A synthetic liner failure of the pond occurred in 1989 and in 1990, and the use of the pond was discontinued (Ref. 7, p. 17). According to interviews with a former employee and regulatory agencies, the material from Pond No. 3 was excavated out beginning in 2006 and concluded in 2010. However, not all contamination was removed, and no confirmation sampling was conducted during the process (Ref. 7, pp. 18, 20, 27).

Analytical results from Pond No. 3 indicate concentrations of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values):

- Contaminants in surface water above background concentrations (Table 4-1; Appendices D and E);
  - Metals – manganese.
- Contaminants in sediment above background concentrations (Table 4-2; Appendices D and E);
  - Metals- chromium, cobalt, manganese, zinc, mercury; and
  - Radionuclides - radium-226, uranium-234, and uranium-238.

4.1.2 Pond No. 6

Pond No. 6 is located on the southeast side of the property and is used to treat process wastewater (Figure 2-2; Ref. 6, p. 19). It is a clarification pond and is the last pond before Outfall 1. The pond was placed into service in 1973 and is still in operation. Pond No. 6 is 200 ft long, 100 ft wide, and 9 ft deep with a clay liner (Ref. 7, p. 17).

Analytical results from Pond No. 6 indicate concentrations of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values):

- Contaminants in surface water above background concentrations (Table 4-1; Appendices D and E);
  - Metals – arsenic, chromium, zinc;
  - Radionuclides - uranium-234, uranium-235, and uranium-238.
- Contaminants in sediment above background concentrations (Table 4-2; Appendices D and E);
  - SVOCs - benzo(b)fluoranthene, fluoranthene;
  - PCBs – aroclor-1254;
  - Metals - chromium, cobalt, manganese, zinc, mercury; and
  - Radionuclides - radium-226, radium-228, uranium-234, uranium-235, and uranium-238.

4.1.3 Pond No. 7

Pond No. 7 is located on the southeast side of the property is used as a basic residue settling pond (Figure 2-2; Ref. 7, p. 17). The pond was placed into service in 1975 and is still in operation. Pond No. 7 is 250 ft long, 150 ft wide, and 7 ft deep with a clay liner (Ref. 7, p. 17).

Analytical results from Pond No. 7 indicate concentrations of following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values):

- Contaminants in surface water above background concentrations (Table 4-1; Appendices D and E);
  - Metals - arsenic, chromium; and
  - Radionuclides - thorium-230, thorium-232, uranium-234, and uranium-238.
- Contaminants in sediment above background concentrations (Table 4-2; Appendices D and E);
  - SVOCs - anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene;
  - PCBs – aroclor-1254;
  - Metals - antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, selenium, silver, zinc, mercury; and
  - Radionuclides - radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238.

4.1.4 Pond No. 8

Pond No. 8 is located on the south side of the property and is used as a basic residue settling pond (Figure 2-2; Ref. 7, p. 17). The pond was placed into service in 1978 and is still in operation. Pond No. 8 is 350 ft long, 350 ft wide, and 25-27 ft deep with a synthetic 30-millimeter liner (Ref. 7, p. 17).

Analytical results from Pond No. 8 indicate concentrations of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values):

- Contaminants in surface water above background concentrations (Table 4-1; Appendices D and E);
  - Metals - arsenic, beryllium, chromium, iron, manganese, nickel, zinc; and
  - Radionuclides – thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238.
- Contaminants in sediment above background concentrations (Table 4-2; Appendices D and E);
  - SVOCs – fluoranthene, phenanthrene, and pyrene;
  - Metals - arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, selenium, silver, zinc, mercury; and
  - Radionuclides - radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238.

4.1.5 Pond No. 9

Pond No. 9 is located on the southeast side of the property and is used as a basic residue settling pond (Figure 2-2; Ref. 7, p. 17). The pond was placed into service in 1985 and is still in operation. Pond No. 9 is 600 ft long, 250 ft wide, and 20-25 ft deep with a synthetic 30-millimeter liner (Ref. 7, p. 17). The liner was observed to be torn in several areas during sampling and reconnaissance activities (Appendix A).

Analytical results from Pond No. 9 indicate concentrations of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values):

- Contaminants in surface water above background concentrations (Table 4-1; Appendices D and E);
  - Metals - arsenic, chromium, iron, manganese, nickel, zinc; and
  - Radionuclides – thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238.
- Contaminants in sediment above background concentrations (Table 4-2; Appendices D and E);
  - SVOCs – fluoranthene, phenanthrene;
  - Metals - arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, selenium, silver, zinc, mercury; and
  - Radionuclides - radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238.

4.1.6 Sintering Building

The Sintering Building is located on the west side of the facility property and contained offices, a machine shop, as well as sintering furnaces and vacuum press equipment used to create tantalum or columbium products such as bars, ingots, wires, and sheets of metal (Figure 2-2; Ref. 7, p. 7). A cooling water reservoir (sump) is set within the concrete slab under the Sintering Building. The cooling water contained additives to inhibit rust formation, however, no records of what these additives contained is available (Ref. 7, pp. 7-8).

Analytical results from the Sintering Building sump indicate concentrations of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values): arsenic, chromium, iron, lead, and zinc, in surface water above background concentrations (Table 4-1; Appendices D and E).

4.1.7 Stormwater Collection Basin

The stormwater collection basin is located on the eastern edge of the property and is a basic residue settling pond (Figure 2-1; Ref. 7, p. 17). The basin is 35 ft in diameter, was placed into service in the early 1990s, and is still in operation (Ref. 7, p. 17).

Analytical results from the stormwater collection basin indicate concentrations of arsenic, chromium, and zinc in surface water above background (Table 4-1; Appendices D and E).

4.1.8 Soil Stockpile

A stockpile of soil is located under a tarp and south of the R&D Building. The stockpile is made up of excavated soil from the installation of the inceptor trench in 1999 (Figure 2-2; Ref. 7, p. 41).

Analytical results from Soil Stockpile indicate concentrations of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values):

- SVOCs –acenapthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3)pyrene, naphthalene, phenanthrene, pyrene;
- Metals – arsenic, chromium, iron, lead, magnesium, manganese, selenium, silver, zinc, mercury;
- PCBs – aroclor 1254; and
- Radionuclides – radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238 above background (Table 4-2; Appendices D and E).

4.2 GROUNDWATER PATHWAY SAMPLING

Twenty-seven groundwater samples (including three duplicates) were collected from existing monitoring wells. The groundwater samples were submitted to a NELAP certified laboratory, for the same analyses as the source samples (Appendix D). Sampling locations are presented in Table 3-1 and Figure 3-1. Sample results are presented in Table 4-3 and Figure 3-2.

The following were all present in groundwater at concentrations significantly above background:

- VOCs - 1,1-Dichloroethene, 4-methyl-2-pentanone (MIBK), trichloroethene;

- Metals - arsenic, antimony, barium, beryllium, cadmium, chromium, cobalt, iron, magnesium, manganese, nickel, potassium, silver, sodium, zinc; and
- Radionuclides - radium-228, thorium-228, uranium-234, uranium-235, and uranium-238 (based on the three times criteria, not radioactive isotope criteria as shown below).

In accordance with the HRS, significantly above background is defined as exceeding three times the background concentration for volatiles and metals or exceeding two standard deviations above the mean background concentration for radioactive isotopes. If the background concentration is not detected, a sample measurement is considered significantly above background when the sample measurement equals or exceeds the sample quantitation limit (Reference 1).

4.3 SURFACE WATER PATHWAY SAMPLING

START collected 7 surface water and 6 sediment samples (including 1 background and 1 duplicate sample of each matrix) as part of the ESI to document an observed release to the surface water pathway attributable to the Site. The surface water and/or sediment sample locations are presented in Table 3-1 and Figure 3-1. Analytical results are presented in Tables 4-4 and 4-5 and Figure 3-2.

The following were all present in surface water samples at concentrations significantly above background:

- Metals - arsenic, beryllium, chromium, cobalt, iron, manganese, nickel, potassium, zinc; and
- Radionuclides - thorium-228, thorium-230, thorium-232, uranium-234, and uranium-238 (based on the three times criteria, not radioactive isotope criteria as shown below).

The following were present in sediment samples at concentrations significantly above background:

- SVOCs - 2,3,4,6-Tetrachlorophenol, 2-methylnaphthalene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, pentachlorophenol, phenanthrene, pyrene;
- PCBs - aroclor-1254;
- Metals - arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, zinc, mercury; and

- Radionuclides - radium-226, uranium-234, uranium-235, and uranium-238 (based on the three times criteria, not radioactive isotope criteria as shown below).

In accordance with the HRS, significantly above background is defined as exceeding three times the background concentration for metals or exceeding two standard deviations above the mean background concentration for radioactive isotopes. If the background concentration is not detected, a sample measurement is considered significantly above background when the sample measurement equals or exceeds the sample quantitation limit (Reference 1).

5. MIGRATION PATHWAYS AND RECEPTORS

5.1 GROUNDWATER MIGRATION PATHWAY

In determining a score for the groundwater migration pathway, the HRS evaluates: 1) the likelihood that sources at a site actually have released, or potentially could release hazardous substances to groundwater; 2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, mobility, and quantity); and 3) the people (targets) who actually have been, or potentially could be, impacted by the release. For the targets component of the evaluation, the HRS focuses on the number of people who regularly obtain their drinking water from wells that are located within four miles of the site. The HRS emphasizes drinking water usage over other uses of groundwater (e.g., food crop irrigation and livestock watering) because, as a screening tool, it is designed to give the greatest weight to the most direct and extensively studied exposure routes.

5.1.1 Hydrological Setting

The Fansteel Site is located on the Quaternary alluvium associated with the Arkansas River (Ref. 6, p. 10). According to Marcher (1969), bedrock below the alluvium is Pennsylvanian Boggy Formation, which consists of shale, sandstone, and coal. Logs of borings and monitoring wells installed by Fansteel show the alluvium to consist predominantly of silty or sandy clays, with occasional beds or lenses of sand, mostly just above the top of the bedrock, identified as the McCurtain Shale. Boring logs showed bedrock to be predominantly light grey to dark grey shale and silty shale, with occasional zones of sandy shale and thin layers of coal (Ref. 6, p. 10).

The groundwater under the Site is found approximately 20 feet below ground surface (Ref. 5, p. 6). The alluvium directly beneath the Site is not considered an aquifer because the groundwater yields are not significant enough to use, and the groundwater quality generally ranges from poor to fair (greater than 500 parts per million total dissolved solids) (Ref. 5, p. 34). The Pennsylvanian Boggy Formation will yield only limited amounts of water of poor to fair quality. There are no major bedrock aquifers under the site and the site is not a major recharge area for any major bedrock aquifers (Ref. 5, p. 35).

Groundwater flow in the alluvium is typically through the sandy layers at the base and is generally eastward toward the Arkansas River. On the eastern side of the property, an inceptor trench was installed between 2002 and 2003 to capture groundwater affected by the operation of the various ponds and settling basins before it can reach the Arkansas River. Potentiometric surface maps show eastward gradients in the alluvium of approximately 0.004 ft/ft towards the inceptor trench (Ref. 6, p. 11). The fate of groundwater beneath the Fansteel property is predominantly discharged to the Arkansas River and by evapotranspiration (Ref. 7, p. 7; Ref. 12, p. 72).

5.1.2 Groundwater Targets

A search of the Oklahoma Water Resources Board (OWRB) database showed fifty-four privately owned wells within a 4-mile radius of the property boundary and seven within 1-mile (Figure 5-1). The nearest domestic well is located 0.45-mile northwest of the property boundary (Figure 5-1; Ref. 5, p. 7).

An observed release to groundwater attributable to the Site is documented based on the results of the ESI. In accordance with the HRS, an observed release is documented when a hazardous substance is present at a concentration significantly above background. Although an observed release is documented, there is a lack of targets. The groundwater quality in the vicinity of the site is considered poor to fair with yields not significant enough for use (Ref. 5, pp. 34-25).

5.2 SURFACE WATER MIGRATION PATHWAY

In determining the score for the surface water pathway, the HRS evaluates: (1) the likelihood that sources at a site actually have released, or potentially could release, hazardous substances to surface water (e.g., streams, rivers, lakes, and oceans); (2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, persistence, bioaccumulation potential, and quantity); and (3) the people or sensitive environments (targets) who actually have been, or potentially could be, impacted by the release. For the targets component of the evaluation, the HRS focuses on drinking water intakes, fisheries, and sensitive environments associated with surface water bodies within 15 miles downstream of the site.

5.2.1 Overland Route

On the northern half of the site, surface water drainage appears to flow in a northeast direction towards the Arkansas River. On the southern half of the site, surface water drainage appears to flow south-southeast towards the Arkansas River (Ref. 6, p. 14). Although the Site is located approximately 15 feet above the floodplain, there are small portions of the Site within the 1% annual chance floodplain boundary (Ref. 5, p. 53).

The Probable Point of Entry (PPE) is the estimated point at which the overland flow segment leading from the source areas reaches a perennial surface water body. The perennial surface water body for the site is the Arkansas River. The Arkansas River fronts the eastern side of the Site, and constitutes the entire 15-mile target distance limit (TDL) (Figure 5-2).

The PPEs for the Fansteel Site are located to the east, northeast and southeast of the sources. There are four outfalls which serve as PPEs associated with surface water drainage from the site. Outfall 3 is located on the northeast corner of the property, Outfall 2 is located east of Chem A Building, Outfall 1 is located east of Pond No. 6, and Outfall 5 is located on the southeast corner of the property (Figure 2-2; Ref. 7, pp. 230, 250-251). Outfall 1 releases treated water, and Outfalls 2, 3, and 5 are for stormwater release (Outfall 4 was removed in the 1990s) (Appendix B). In addition, there is a runoff path located on the northeastern end of the property which leads to a low-lying floodplain connected to the Arkansas River (Figure 2-2; Appendix A)

5.2.2 Surface Water Targets

The potential targets of the surface water pathway includes the population relying on surface water within the TDL as a source of drinking water, as well as downstream fisheries, sensitive environments, and surface water resources. No surface water intakes are present within the 15-mile TDL. Drinking water in the City of Muskogee is provided by Fort Gibson Lake (Ref. 13, p. 1). Fort Gibson Lake, and its intake are located upstream of the Fansteel Site (Ref. 14, p. 1).

Fishing does occur in the Arkansas River. There is an OWRB fish monitoring site located on the Arkansas River at the US 62 bridge, at the southeast corner of the Site (Figure 5-2; Ref. 15, p. 2). This gauge has shown Black Crappie, Bluegill Sunfish, Bullhead Minnow, Channel Catfish, Common Carp, Freshwater Drum, Gizzard Shad, Green Sunfish, Hybrid Sunfish, Inland Silverside,

Largemouth Bass, Logperch, Longear Sunfish, Longnose Gar, Red Shiner, Redear Sunfish, River Carpsucker, Smallmouth Buffalo, Spotted Bass, Threadfin Shad, Shiner, Warmouth Sunfish, White Bass, White Crappie, Hybrid Striped Bass, and Yellow Bass being caught (Ref. 15, pp. 3-4). These species are commonly caught for human consumption. In addition, the McClellan-Kerr Wildlife Management Area and Waterfowl Refuge is located within the TDL (Figure 5-2; Ref. 16, p. 1; Ref. 17, p. 1).

5.2.3 Surface Water Pathway Conclusion

Based on the ESI surface water and sediment sampling results, and the presence of these compounds in source samples, a release of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values) has been documented: benzo(a)anthracene; benzo(a)pyrene; dibenz(a,h)anthracene; fluoranthene; phenanthrene; pyrene; aroclor-1254; arsenic; chromium; cobalt; manganese; zinc; and mercury to the surface water pathway was documented, as defined by the HRS. For HRS purposes, a release to surface water is documented when a hazardous substance attributable to the site is detected in a surface water or sediment sample at a concentration significantly above background levels (i.e., a chemical contaminant is detected at a concentration greater than or equal to three times background). Although radium-226, uranium-234, and uranium-238 were also detected, there were not enough samples for HRS comparison to background (a radionuclide is detected at an activity greater than or equal to two standard deviations above the mean of the background). ESI sampling locations for the surface water pathway are presented in Tables 3-1 and Figure 3-1. Results of the ESI sampling event relating to a release to surface water are presented in Tables 4-4, and 4-5 and Figure 3-2.

The TDL for the Site is 15 miles downstream from the Site in the Arkansas River. The Arkansas River runs adjacent and to the east of the facility property, and there are outfalls and runoff pathways from the property into the Arkansas River. Further, surface water is used for fishing and wildlife consumption within the TDL (Refs. 15, 16, and 17).

5.3 SOIL EXPOSURE AND AIR MIGRATION PATHWAYS

In determining the score for the soil exposure pathway, the HRS evaluates: (1) the likelihood that surficial contamination is associated with the site (e.g., contaminated soil that is not covered by

pavement or at least 2 feet of clean soil); (2) the characteristics of the hazardous substances in the surficial contamination (i.e., toxicity and quantity); and (3) the people or sensitive environments (targets) who actually have been, or potentially could be, exposed to the contamination. For the targets component of the evaluation, the HRS focuses on populations that are regularly and currently present on or within 200 feet of surficial contamination. The four populations that receive the most weight are residents, students, daycare attendees, and terrestrial sensitive environments.

In determining the score for the air migration pathway, the HRS evaluates: (1) the likelihood that sources at a site actually have released, or potentially could release, hazardous substances to ambient outdoor air; (2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, mobility, and quantity); and (3) the people or sensitive environments (targets) who actually have been, or potentially could be, impacted by the release. For the targets component of the evaluation, the HRS focuses on regularly occupied residences, schools, and workplaces within 200 feet of the site. Transient populations, such as customers and travelers passing through the area, are not counted.

No people are known to reside within the site boundaries of the Fansteel Site, but there are workers present. The nearby population within 4 miles of the site is as follows (Ref. 18, p. 1):

Radius (miles)	Total Population
0 – 0.25	0
0.25 – 0.5	23
0.5 – 1	929
1 – 2	3,932
2 - 3	11,104
3 - 4	24,235

The site is fenced and gate access is limited.

6. GAMMA-RAY SCANNING

In July 2019, the EPA National Center for Radiation Field Operations (NCRFO) and EPA Region 6 conducted qualitative gamma survey scans at the Fansteel Site using the NCRFO Environmental Radiation Buggy Scanning System. These scans were conducted to contribute to the dataset collected during the ESI sampling by collecting gamma-ray measurements at or near settling ponds and other site locations and assist the region in identifying possible anomalous locations that may warrant further radiologic investigation (Ref. 20, p. 4). The result of the scans indicated that the soil stockpile, Pond No. 8, the nearby lawn areas around the Machine Shop, and former Pond No. 2 had the highest readings above background. Site personnel explained that contaminated soil has been handled for removal in the area around the Machine Shop Building. No buildings were entered during the scanning. The highest readings (45 times background) were found along the length of former Pond No. 2 (Ref. 20, p. 6).

7. SUMMARY

START conducted an ESI sampling event in April 2019 that included sampling and chemical/radiological analyses of groundwater, surface water, soil, and sediments. The specific sampling objectives for the ESI were to collect data that could be used to document a release of hazardous substances to the surface water pathway. Based on the results of the ESI sampling event, an observed release to the surface water pathway attributable to the Site was documented.

Based on the 2019 ESI, the following pertinent HRS factors are associated with the Site:

- Estimated quantities of wastes in Site sources include 381,944 cubic yards of material in surface impoundments (ponds).
- Manganese was detected in Site sources at concentrations significantly above background, up to 15,000 milligrams per kilogram (mg/kg), during the April 2019 ESI sampling. Sources also contained arsenic and chromium at concentrations significantly above background.
- 1,1-Dichloroethene, 4-methyl-2-pentanone (MIBK), trichloroethene, arsenic, barium, beryllium, cadmium, chromium, cobalt, iron, magnesium, manganese, nickel, potassium, zinc, radium-228, thorium-228, uranium-234, uranium-235, and uranium-238 were all present in groundwater at concentrations significantly above background. Observed releases in groundwater have been documented in 22 monitoring wells located on site.
- Based on the START 2019 ESI surface water and sediment sampling results, a release of the following HRS significant contaminants (contaminants considered a hazardous substance with high toxicity/bioaccumulation factor values) has been documented: benzo(a)anthracene; benzo(a)pyrene; dibenz(a,h)anthracene; fluoranthene; phenanthrene; pyrene; aroclor-1254; arsenic; chromium; cobalt; manganese; zinc; and mercury to the surface water pathway, as defined by the HRS. Observed releases in surface water have been documented in 5 locations within the surface water pathway TDL.
- Radionuclides radium-226, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238 were detected in the surface water pathway. Currently, there is not enough background data to determine if the concentrations detected meet the HRS definition of an observed release.
- TDL for the Site is 15 miles downstream from the Site in the Arkansas River. Surface water is used for fishing within the TDL.

8. REFERENCES

The following reference documents are found as separate files in Appendix G.

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