FINAL

Corrective Action Decision

Former Schilling Air Force Base Site
Salina, Kansas

July 2019

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
FINAL CORRECTIVE ACTION DECISION
SCHILLING AIR FORCE BASE SITE
SALINA, KANSAS

DECLARATION OF CORRECTIVE ACTION DECISION

SITE NAME AND LOCATION

Schilling Air Force Base Site
Salina, Saline County, Kansas

STATEMENT OF BASIS AND PURPOSE

The Final Corrective Action Decision document presents the corrective action selected by the Kansas Department of Health and Environment (KDHE) for the Schilling Air Force Base Site (Site) located four miles south of the intersection of I-70 and I-135, on the southwest side of the City of Salina.

The Schilling Air Force Base was built in 1942 under the original name of Smoky Hill Airfield and was used to train heavy bomber crews for the U.S. Army Air Force. The base was renamed Smoky Hill Air Force Base in 1948, following establishment of the U.S. Air Force as an independent branch of the military. The base was deactivated in 1949 but remained Air Force property under control of Air Material Command. The base was reactivated in 1951, and the name was changed to Schilling Air Force Base in 1957. In 1966 the base was deactivated and the property transferred to the Salina Public Entities. Since 1966 the Salina Airport Authority has used the Site in operating the Salina Regional Airport; the Salina Airport Authority owns greater than 80% of the property. Other major landowners include the Kansas State University (KSU, ownership by the State of Kansas), Saline County, Schwan's Food Manufacturing, the Kansas National Guard, and USD No. 305. Over 100 businesses and organizations are currently present at the former SAFB representing a diverse range of business and organization types. Residential housing is located directly east of Schilling; the surrounding land to the west, north, and south, and some open land inside the facility boundary, is used for agriculture. Military activities left widespread impacted soil and groundwater. Multiple large volatile organic contaminant plumes are present, with the contaminant trichloroethylene present at the highest concentrations. Other contaminants of concern for the Site include tetrachloroethylene, cis-1, 2-dichloroethylene, vinyl chloride, carbon tetrachloride, chloroform, petroleum compounds, metals, and per- and polyfluoroalkyl substances.

In November 2012, the Salina Public Entities entered into a Consent Agreement and Final Order with KDHE to conduct a site investigation and evaluate remedial alternatives.

DESCRIPTION OF THE SELECTED REMEDIAL ACTION

KDHE has determined that the selected corrective action, as described and evaluated in the Final Corrective Action Decision, meets the criteria established for selection and will be protective of human health and the environment. KDHE has selected pre-design data acquisition, five-year reviews, receptor surveys and management, land use controls, excavation, in-situ thermal treatment, directed groundwater recirculation, emplaced permeable reactive barriers, and injected permeable reactive barriers as the preferred remedy for the Site.

DECLARATION

The selected remedial actions are protective of human health and the environment; attain state, federal and local requirements that are applicable or relevant and appropriate to this corrective action; and provide cost-effective performance. The remedial actions will reduce the mass, mobility, and volume of contaminated groundwater and prevent exposure to contamination that is above applicable levels. In selecting and declaring this corrective action, KDHE believes implementation of the remedial actions will have a beneficial effect on heath and the environment.

Lee A. Norman MD aly

07/29/2019

Lee A. Norman, M.D.
Secretary

Date

Attachment: Final Corrective Action Decision

TABLE OF CONTENTS

Kansas Department of Health and Environment Environmental Remediation

ACRONYMS AND ABBREVIATIONS USED IN THIS DOCUMENT

ARARs	Applicable or Relevant and Appropriate Requirements
ATG	Alternate Treatment Goal
bgs	below ground surface
CAD	Corrective Action Decision
CAFO	Consent Agreement and Final Order
DCE	Dichloroethylene
COC	Contaminant of Concern
CT	Carbon Tetrachloride
DGR	Directed Groundwater Recirculation
DNAPL	Dense Non-Aqueous Phase Liquid
EPA	United States Environmental Protection Agency
EU	Exposure Unit
EUC	Environmental Use Control
FS	Feasibility Study
HHRA	Human Health Risk-Assessment
HI	Hazard Index
HQ	Hazard Quotient
IRM	Interim Remedial Measure
ISTD	*In-Situ* Thermal Desorption
KDHE	Kansas Department of Health and Environment
KSU	Kansas State University
LOX	Liquid Oxygen Plant
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
OU	Operable Unit
PCE	Tetrachloroethene
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanesulfonic Acid
PRB	Permeable Reactive Barrier
RAO	Remedial Action Objective
RG	Remedial Goal
RI	Remedial Investigation
RSK	Risk-Based Standards for Kansas
SAA	Salina Airport Authority
SAFB	Schilling Air Force Base
SATC	Salina Area Technical College
SPE	Salina Public Entities
SRI	Supplemental Remedial Investigation
SWMP	Soil Waste Management Plan
TCE	Trichloroethene
USACE	United States Army Corps of Engineers
USD	Unified School District
VI	Vapor Intrusion
VOC	Volatile Organic Compound
ZVI	Zero-Valent Iron
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
ng/L	nanograms per liter

GLOSSARY

Administrative Record – The body of documents that form the basis for selection of a particular response. Parts of the administrative record are available in an information repository near the site to permit interested individuals to review the documents and to allow meaningful participation in the remedy selection process.

Adsorption – Groundwater remediation mechanisms in which contaminants are adsorbed out of groundwater onto a material. Adsorption can be physical, chemical, or electrostatic.

Advanced Oxidative Processes – The use of ultraviolet radiation, ozone, and/or hydrogen peroxide to destroy organic contaminants in water.

Air Stripping – The process of forcing air through polluted water to remove harmful chemicals. The air causes the chemicals to change from a liquid to a gas. The gas is collected and treated if necessary.

Aquifer – An underground layer of rock, sand, or gravel capable of storing water within cracks and pore spaces or between grains. When water contained within an aquifer is of sufficient quantity and quality, it can be used for drinking or other purposes. The water contained in the aquifer is called groundwater.

Applicable or Relevant and Appropriate Requirements (ARARs) – The federal and state environmental laws that a remedy will meet. These requirements may vary among sites and alternatives.

Capital Costs – Expenses associated with the initial construction of a project.

Corrective Action Decision (CAD) – The decision document in which KDHE selects the remedy and explains the basis for selection for a site.

Directed Groundwater Recirculation – A refined version of pump and treat whereby the treated groundwater is strategically injected back into the aquifer through injection wells to expedite remediation.

Engineered Cap – An impermeable barrier that limits migration or exposure between contaminated media and the surface as well as prevents surface-water infiltration.

Exposure – Contact made between a chemical, physical, or biological agent and the outer boundary of an organism. Exposure is quantified as the amount of an agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut).

Feasibility Study (FS) – A study conducted to evaluate alternatives for cleanup of contamination.

Groundwater – Underground water that fills pores in soils or openings in rocks to the point of saturation. Groundwater is often used as a source of drinking water via municipal or domestic wells.

Hydraulic Containment – Use of pump and treat groundwater remediation systems to hydraulically control the movement of contaminated groundwater in order to prevent continued expansion of the contamination zone.

Institutional Control – Administrative or legal restrictions on land use or access to prevent unacceptable exposures. Examples include restrictive covenants and zoning limitations.

Maximum Contaminant Levels (MCLs) – The maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

Monitoring – Ongoing collection of information about the environment that helps gauge the effectiveness of a cleanup action. For example, monitoring wells drilled to different depths can be used to detect any migration of the plume.

Monitored Natural Attenuation (MNA) – Allowing natural processes to remediate pollution in soil and groundwater while site conditions are routinely monitored.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP) – The federal regulations that guide the Superfund program. These regulations can be found at 40 Code of Federal Regulations, Part 300.

National Pollutant Discharge Elimination System (NPDES) – As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches.

Operations and Maintenance – Activities conducted at a site after the construction phase to ensure that the cleanup continues to be effective.

Plume – A body of contaminated groundwater flowing from a specific source.

Pump and Treat – A remediation technology where contaminated groundwater is extracted from the aquifer, treated ex situ to remove or break down the contaminants, and then discharged.

Remedial Investigation (RI) – A study of the source, nature, and extent of contamination.

Risk – The probability of adverse health effects resulting from exposure to an environmental agent or mixture of agents.

Superfund – Federal authority established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), to respond directly to releases or threatened releases of hazardous substances that may endanger health or welfare. Also, the common name given by the press for CERCLA because the program was well funded in the beginning.

Thermal Treatment –A remedial process where direct heat or electrical resistance heating is used to increase the volatilization rate of volatile and semi-volatile contaminants in the soil to facilitate extraction.

Tier 2 Level – Calculated risk-based cleanup value for a specific contaminant. These values can be found in Appendix A of the *Risk-Based Standards for Kansas (RSK) Manual.*

Threshold – The dose or exposure below which no harmful effect is expected to occur.

Toxicity – A measure of degree to which a substance is harmful to human and animal life.

Vapor Intrusion (VI) – The migration of contaminants from the subsurface into overlying and/or adjacent buildings.

Volatile Organic Compounds (VOCs) – Carbon compounds, such as solvents, which readily volatilize at room temperature and atmospheric pressure. Most are not readily dissolved in water, but their solubility is above health-based standards for potable use. Some VOCs can cause cancer.

Underground Injection –The technology of placing fluids underground, in porous formations of rocks, through wells or other similar conveyance systems. While rocks such as sandstone, shale, and limestone appear to be solid, they can contain significant voids or pores that allow water and other fluids to fill and move through them. Man-made or produced fluids (liquids, gases or slurries) can move into the pores of rocks by the use of pumps or by gravity. The fluids may be water, wastewater, or water mixed with chemicals.

1. PURPOSE OF THE FINAL CORRECTIVE ACTION DECISION

The primary purposes of the Final Corrective Action Decision (CAD) for the Former Schilling Air Force Base Site (Schilling Site) are to: 1) summarize information from the key site documents including the Remedial Investigation[1,2] (RI) and Feasibility Study[3] (FS) reports; 2) briefly describe the alternatives for soil and groundwater remediation detailed in the FS report; 3) identify and describe the Kansas Department of Health and Environment's (KDHE) preferred remedy for soil and groundwater; and, 4) document public comments and KDHE's responses on the preferred remedy.

KDHE has selected a final remedy for the Site after reviewing and considering all information submitted during the 30-day public comment period. The public was encouraged to review and comment on the preferred remedy presented in the draft CAD. Section 11.0 reflects the comments received during the public comment period and KDHE's responses. KDHE held a public availability session and a public hearing on May 1, 2019, during the public comment period to present information regarding the preferred remedy and solicit public participation. The public was provided the opportunity to submit written comments to KDHE during the public comment period (April 8 to May 8, 2019).

Dragun Corporation (Dragun) performed the RI and FS for the Schilling Site on behalf of the City of Salina, the Salina Airport Authority, Kansas State University, and Unified School District (USD) No. 305, collectively known as the Salina Public Entities (SPE) in general accord with the Consent Agreement and Final Order (CAFO) between KDHE and the SPE executed November 15, 2012. The public was encouraged to review and comment on the technical

Highlight 1-1: Public Information

Administrative Record File

Kansas Department of Health and Environment
Bureau of Environmental Remediation
1000 SW Jackson Street; Suite 410
Topeka, Kansas 66612-1367
Contact: Alex Richards
Phone: 785-296-0969
E-mail: alexandra.richards@ks.gov
Web:
http://www.kdheks.gov/remedial/Schilling_AFB/index.html

Local Information Repository

Salina Public Library
301 West Elm Street
Salina, Kansas 67401
Phone: 785-825-4624
E-mail: support@salpublib.org

Library Hours:
Monday – Thursday: 9 a.m. – 9 p.m.
Friday & Saturday: 9 a.m. – 6 p.m.
Sunday: 1 p.m. – 6 p.m.

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[1] Dragun, 2018, *Remedial Investigation Report (Revision 1), Former Schilling Air Force Base, Salina, Kansas*, prepared on behalf of the Salina Public Entities, finalized and approved May 2018.
[2] Dragun, 2018, *Supplemental Remedial Investigation #3 Report, Revision 1, Groundwater Testing for Additional Contaminants of Concern, Former Schilling Air Force Base, Salina, Kansas,* prepared on behalf of the Salina Public Entities, finalized and approved April 2018.
[3] Dragun, 2018, *Feasibility Study Report, Revision 2, Former Schilling Air Force Base, Salina, Kansas*, prepared on behalf of the Salina Public Entities, finalized and approved November 2018.

information presented in the RI and FS reports and other documents contained in the Administrative Record file. The Administrative Record file includes all pertinent documents and site information that form the basis and rationale for selecting the final remedy. The Administrative Record File is available for public review during normal business hours at the location shown in Highlight 1-1. Also, as shown, the Salina Public Library maintains a local information repository for the Schilling Site. The Salina Library repository is available for review and copying during normal business hours.

2. SITE BACKGROUND

The Schilling Site is a Formerly-Used Defense Site located four miles south of the intersection of I-70 and I-135, on the southwest side of the city of Salina (Figure 2-1). The Salina Regional Airport, which is owned and operated by the Salina Airport Authority (SAA), occupies a significant portion of Schilling; industrial, aviation, military, and educational facilities are also present. Residential housing is located directly east of Schilling; the surrounding land to the west, north, and south, and some open land inside the facility boundary, is used for agriculture. Military activities left widespread impacted soil and groundwater. Multiple large volatile organic contaminant (VOC) plumes are present, with the contaminant trichloroethylene (TCE) present at the highest concentrations. Other contaminants of concern (COCs) for the Site include tetrachloroethylene (PCE), cis-1, 2-dichloroethylene (cis-1, 2-DCE), vinyl chloride, carbon tetrachloride (CT), chloroform, petroleum compounds, metals, and per- and polyfluoroalkyl substances (PFAS).

2.1. Site Location

The Schilling Site occupies over 4,000 acres in southwest Salina, Kansas. The Site has been divided into three Operable Units (OUs) to facilitate development and evaluation of remedial strategies for areas with similar chemical and physical properties. The Site boundary and OU boundaries are shown on Figure 2-1. Within each OU, one or more individual source areas have been identified. Figures 3-4 through 3-12 identify the various source areas and their primary contaminants of concern. Additional information regarding the status of various source area investigation and cleanup activities is available in the RI, FS, and summarized later in this document.

2.2. Site History

The Schilling Air Force Base (SAFB) was built in 1942 under the original name of Smoky Hill Airfield and was used to train heavy bomber crews for the U.S. Army Air Force. The base was renamed Smoky Hill Air Force Base in 1948, following establishment of the U.S. Air Force as an independent branch of the military. The base was deactivated in 1949 but remained Air Force property under control of Air Material Command. The base was reactivated in 1951, and the name was changed to Schilling Air Force Base in 1957. In 1966 the SAFB was deactivated and the property transferred to the SPE.

Since 1966 the SAA has used the Site in operating the Salina Regional Airport; the SAA owns greater than 80% of the property (Figure 2-3). Other major landowners include the Kansas State University (KSU, ownership by the State of Kansas), Saline County, Schwan's Food Manufacturing, the Kansas National Guard, and USD No. 305. Over 100 businesses and organizations are currently present at the former SAFB representing a diverse range of business and organization types.

The SPE, United States Environmental Protection Agency (EPA), United States Army Corps of Engineers (USACE), and KDHE have conducted numerous environmental investigations and some limited remedial actions at SAFB beginning in the 1980's. An environmental assessment performed in June 1993 found low levels of hydrocarbon compounds in the groundwater. A follow-on investigation confirmed the presence of gasoline constituents in soils and groundwater at the site. In addition, TCE was found in groundwater above the EPA's 5 microgram per liter (µg/L) maximum contaminant level (MCL).

Subsequent investigations have documented extensive contamination of the groundwater within the boundaries of the SAFB as well as the groundwater underlying residential areas to the east and northeast of the Site. There are multiple TCE plume areas and the highest concentrations at the Site are over 100,000 µg/L. In addition, soil, surface water, and groundwater analysis has documented the presence of multiple contaminants including other VOCs, PFAS, petroleum-related compounds, and metals.

The USACE with KDHE oversight performed various Site Investigations at multiple areas of interest and completed a Remedial Investigation at OU-1. In 2007 the USACE approached the SPE about transferring the project responsibility. The District Court of Kansas issued a Consent Decree on May 2, 2013, that split the costs of completing the requirements of the 2012 CAFO between the SPE and the United States of America.

3. Remedial Investigation

Dragun, environmental consultants for the SPE, conducted the RI and Supplemental Remedial Investigations (SRIs) between June 2014 and November 2017. The RI included sampling 149 historical monitoring wells, installing and sampling 73 new permanent monitoring wells, installing and sampling 207 temporary monitoring wells, collecting groundwater samples from 185 screen point wells, collecting groundwater samples from 3 pumping wells, collecting samples from 3 domestic well, installing over 400 soil borings, collecting surface water and sediment samples, and investigating the indoor air of numerous buildings. SRI #3 assessed additional contaminants of concern (PFAS and 1,4-dioxane) between June and November 2017, by collecting groundwater samples from existing monitoring wells and installed temporary monitoring wells, as well as collecting soil samples.

3.1. Hydrogeological Setting

Soil samples and lithologic logs collected during the RI indicate the presence of four primary geological frameworks (Figure 3-1) within the Schilling Site. Area 1 is characterized by thin silty clay overburden, most common on the west side of OU-1 and OU-2. The soil is residual from the Wellington Shale and/or alluvial deposits from Dry Creek. Area 2 is characterized by thickening overburden to the east with sporadic, discontinuous sandy lenses that progressively become thicker and more continuous to the east. The eastward sloping bedrock subcrop is the edge of the bedrock valley, and the sandy lenses are meander deposits associated with the Smoky Hill River. Area 3 is characterized by thick, continuous sand, and extends eastward from near I-135 to the Smoky Hill

River. The sandy soil originates from meander deposits of the Smoky Hill River. Finally, Area 4 represents the shale bedrock (Wellington Shale) and is considered the basal lithologic unit for work conducted at the Schilling Site. The bedrock subcrop falls from west to east, with the eastern area being the bedrock valley of the Smoky Hill River. The Wellington Shale in the area is mostly massive but has some areas with significant fracturing. Geologic cross-sections and the conceptual site model can be reviewed in the RI and the FS.

Groundwater is found in both the overburden and the bedrock. The uppermost aquifer (overburden) consists of unconsolidated alluvial deposits, and is heavily used for livestock, domestic, irrigation, industrial, and municipal water supply wells. Well yields range from 50 to 1,700 gallons per minute.[4] Groundwater also occurs in the fractured and weathered bedrock within the Wellington Aquifer. The Wellington Aquifer generally contains poor-quality groundwater of high salinity. The Wellington Aquifer does not serve as a source of drinking water in this area and is used as a reservoir for oilfield brine and liquefied petroleum gas (not within the Former SAFB Site). The depth to groundwater varies across the Site ranging from approximately 10 feet to 32 feet below ground surface (bgs) in the overburden. The bedrock subcrop slopes from near surface in the southwest to approximately 100 feet bgs in the northeast portion of the site. In some areas of OU-3, bedrock is encountered as shallow as 1 foot bgs and is above the water table. Groundwater flow is predominantly to the northeast with northerly flow in the western extents of OU-3. Local overburden groundwater-flow patterns exist throughout the Site due to the meander deposits in the area. Figures 3-2 and 3-3 depict the potentiometric surface in the vicinity in the Schilling Site and the locations of drainage ditches and other surface water bodies within the Site.

The main surface water bodies are Dry Creek and several drainage ditches (Tony's Road Ditch, Centennial Ditch, Derussy Ditch, Scanlan Ditch, and others). All ditches except Tony's Road Ditch have intermittent flow that is usually negligible or stagnant. All ditches eventually discharge to Dry Creek. The Smoky Hill River is located approximately three miles east of the Site and Mulberry Creek is approximately four miles north of the Site.

3.2. Summary of Site-Wide Investigation Results

The data collected through the RI and other investigations identifies eleven chlorinated solvent plumes (A-K), all extending from their respective source areas toward the north, northeast, and east (Figures 3-3 through 3-6). OU-1 contains a large, more dilute (<100 µg/L) plume, with four higher concentration source-area plumes (A-D). The OU-1 plume extends past I-135 into a residential area. Plume E is also contained within OU-1.

Plumes F and G are in OU-2. Source areas in Plume F, for the purpose of remedial alternatives, have been split into three sub-plumes due to three separate suspected source areas present: F_1, F_2, and F_3. F_1 is the most upgradient (west) sub-plume and consists of CT and TCE. F_2 is located to the east of F_1. F_3 is downgradient (northeast) of F_1 and north of F_2.

[4] Dragun, 2018, *Groundwater Modeling Report, Revision 2, Former Schilling Air Force Base, Salina, Kansas,* May 21, 2018.

Plume G consists of TCE and CT impacted groundwater that originates from the former Fire Training Burn Area. Plume H is a relatively low-concentration (15.6 µg/L TCE maximum) plume contained within OU-2. Plumes I, J, and K, located in OU-3, are associated with historic landfills. Bedrock groundwater is impacted in Plumes A (TCE and associated degradation products) and G (TCE, CT, and associated degradation products). The overburden sources in Plume A and Plume G are the sources of the bedrock groundwater impacts. Soil source areas were identified for Plumes A, B, C, and G.

Although the Site has many contaminants, for the purposes of site-wide remediation a list of groundwater target compounds was developed based on their frequency of detection, exceedance of applicable threshold levels, extent of contamination, usability in source identification, and importance as a biodegradation product. Tables 3-1 through 3-4 present a summary of analytical results for these contaminants. It should be noted that all chemicals detected at concentrations above KDHE's Tier 2 levels[5] are COCs; this includes contaminants associated with individual source areas but not widespread throughout the Site (e.g., metals, etc.). This report contains only figures depicting chlorinated VOC concentrations, the most prevalent contaminants. Figures 3-4 through 3-6 show the orientation of the VOC plumes, emanating from various source areas and trending northeast in the predominant groundwater flow direction. Additional tables and figures are available in the FS report.

Dragun conducted sampling for natural attenuation parameters during the RI by evaluating groundwater samples taken from monitoring wells in each contaminant plume, except for Plume J due to insufficient sample volume. Based on the EPA evaluation protocol[6], except for Plume G, there is likely limited or no biodegradation occurring. In general, the total organic carbon concentration is inadequate to support microbial dechlorination, and dissolved oxygen and oxidation-reduction potential are not conducive for anaerobic dehalogenation.

3.3 Identification of Source Areas

In the RI report, Dragun identified several suspected soil and groundwater source areas. Some of the source areas were able to be confirmed and delineated, while others could not due to numerous reasons including lack of access and current infrastructure.

Figures 3-4 through 3-12 identify the confirmed and suspected source areas. Vadose zone soil contamination was confirmed in Plumes A, B, and G. The Plume A soil source area (TCE exceeding 1,000 micrograms per kilogram (µg/kg)) is located between Buildings 606 and 626, which were formerly used as aircraft maintenance and wash buildings. An area of impacted soil in Plume B (TCE exceeding 65,000 µg/kg) is located south and east of Building 713. In addition, an area south of Building 713 was identified as the source of the Plume B groundwater impacts. Historic TCE releases on the pavement south of Building 713 are the suspected source. Plume G

[5] KDHE, 2010, *Risk-Based Standards for Kansas (RSK) Manual*,5th Version, Kansas Department of Health and Environment, October 2010, Revised September 2015.

[6] EPA, 1998, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128*, United States Environmental Protection Agency, Office of Research and Development, September 1998.

vadose zone impacts were found in previous investigations (TCE maximum of 540 µg/kg), associated with the former Fire Training Burn Area.

Saturated zone soil impacts were confirmed in Plumes A-C and G. Plume C has saturated soil zone impacts at concentrations that indicate the presence of dense non-aqueous phase liquid (DNAPL) (TCE greater than 100,000 µg/kg). The source area for Plume C originates between Building 837 and the KSU Technology Center and are the highest soil impacts observed. Degreasing activities that took place in the armament and electronics shops while the base was in operation are thought to be the source of the contamination. Three unconfirmed saturated soil source areas are suspected within Plume F based on the different COCs present in different plume lobes. Sub-plume F_1 (western-most sub-plume) is CT-dominated and appears to be emanating from beneath 3024 Arnold Avenue, which is currently occupied by the Kansas National Guard. Sub-plume F_2 (central sub-plume) is PCE-dominated and originates beneath the northeast corner of the property that is currently occupied by Schwan's Tony's Pizza Plant. Sub-plume F_3 (northeastern sub-plume), which is TCE-dominated, originates at 2815 Centennial Road, currently occupied by Waddles Manufacturing. The source areas for Plumes I, J, and K are capped former landfills; landfill soil sources were not investigated further.

Soil source areas were not identified for Plumes D, E, or H. The suspected source for Plume D is near the former Liquid Oxygen Plant (LOX), as evidenced by the highest concentrations of TCE in groundwater directly downgradient of the LOX. Despite extensive investigation by both the USACE and Dragun, the source of Plume D in the LOX area could not be located.

The source of in Plume E is unknown. No soil samples analyzed contained COCs above the applicable criteria. Further, only 6 of the 24 groundwater samples collected had exceedances of COCs, indicating the lack of identified source area for Plume E should not greatly impact overall remediation. The groundwater will be addressed through the preferred groundwater remedy with the placement of recovery and injection wells in Plume E.

Impacted groundwater was detected in the Plume H area during previous investigations; however, no defined groundwater plume was identified. Soil and sediment containing elevated lead and TCE concentrations have been removed from a nearby box culvert as an interim measure. Groundwater was only encountered in 3 of 13 soil borings due to shallow bedrock, therefore the investigation did not yield additional information on a source of TCE in Plume H.

3.4 Delineation of Zones

Based on site hydrogeology, RI findings, and other administrative considerations, the SPE proposed to divide the Schilling Site into two zones to streamline the evaluation and eventual selection of remedial actions for the Schilling Site as shown on Figure 2-1.

- *Zone 1*– Zone 1 is generally defined as being west of Centennial Ditch. Land use in Zone 1 is almost exclusively non-residential, and control over much of the property use is defined by ownership by the SPE or existing controls. There are no documented drinking-water wells located within the plumes in Zone 1; Zone 1 is served by City water supply. Zone 1 includes all contaminant plumes onsite, at least in part. Confirmed soil source areas in Zone 1 include Plume A, B, C, and G.

- *Zone 2* – Zone 2 is generally defined as being east of Centennial Ditch. Zone 2 includes significant residential land use. Zone 2 contains the downgradient portions of Plumes D, E, F, and G, at least in part. The majority of Plume E is present in Zone 2. No soil source areas were identified in Zone 2.

3.5 Vapor Intrusion Assessment

Numerous vapor intrusion (VI) investigations were conducted by USACE, EPA, and KDHE from 2002 to 2007 within OU-1. Under the 2012 CAFO, 30 buildings in OU-1 were evaluated for VI during the RI. The investigation concluded that no indoor air exceedances of the applicable criteria are caused by VI associated with the Schilling Site. The indoor air exceedances identified in certain buildings were either non-site related chemicals, or did not correspond to sub-slab samples, indicating other potential confounding sources within the buildings.

The investigation evaluated 32 buildings in OU-2, including 20 residences. The investigation concluded that no indoor air exceedances of the applicable criteria were caused by VI associated with the Schilling Site. The indoor air exceedances identified in certain buildings were non-site related chemicals. VI investigation was not required in OU-3; no complete pathway for VI exists in OU-3 due to lack of building structures and/or distance to the contaminant plumes.

The Human Health Risk Assessment[7] (HHRA) presented an evaluation of the VI risk for COCs. The HHRA found that all residential homes had VI pathways determined to be incomplete or not substantial. For potential future use considerations, all commercial/industrial buildings were evaluated under a residential scenario. Nineteen buildings onsite were found to have potential excess risk and hazard attributable to VI under future potential residential use scenarios. One building onsite, SAA Hangar 626, was found to have a Hazard Index (HI) > 1. Although sub-slab vapor data from SAA Hangar 626 did not conclusively indicate the indoor air issues were a result of vapor intrusion, as a conservative measure, the building was included in the assessment of cumulative risk and hazard.

Metals and PFAS are not considered a VI threat due to low potential for volatilization.

4. SOURCE ABATEMENT AND INTERIM MEASURE IMPLEMENTATION

Interim Remedial Measures (IRMs) are actions or activities taken to quickly prevent, mitigate, or remedy unacceptable risk(s) posed to human health and/or the environment by an actual or potential release of a hazardous substance, pollutant, or contaminant. A summary of the primary IRMs performed to date are detailed below. The SPE has not implemented further Site-wide interim measures to address contamination due to the terms of the CAFO and Consent Decree.

[7] AlterEcho, 2017, Final Part III: Summary of Human Health Risk Assessment, Former Schilling Air Force Base, Salina, Kansas, prepared on behalf of SPE; finalized and approved March 2017.

4.1 Removal of USTs and Underground Piping, Box Culvert, and Transformer

In 1994 and 1995, 107 underground storage tanks (USTs) and the associated piping were removed. The soil was excavated and remediated by land farming. In 1998 a transformer vault and a box culvert that collected drainage near the Hobby Auto Shop were removed; however, the soil and groundwater outside of the culvert and transformer were not sampled at that time.

4.2 Installation of Air Stripper at Salina Tech Sump

In 2006 the USACE installed an air stripper at the Salina Area Technical College (SATC) sump to remove VOCs from groundwater.

4.3 Installation of Ventilation System in Buildings

In 2006 KDHE installed subslab ventilation systems in a classroom building on the KSU campus and a classroom building on the SATC campus.

5. Site Risks

RI data were used to develop a HHRA for the Schilling Site in accordance to the CAFO and Consent Decree. The risk assessment evaluated potential health risks posed by contamination in the absence of remediation. The risk assessment focused on risks associated with exposure to soil, groundwater, surface water, and sediment. The risk assessment divided the Site into 18 soil exposure units (EUs) and 11 groundwater EUs (i.e. plumes A-K). The Site was divided into three EUs for surface water and sediment (Figures 5-1 through 5-3).

Tables 5-1 and 5-2 present a summary of risk assessment findings. In general, the risk assessment found that soil and groundwater at the Schilling Site does not pose excess risk to receptors under current land-use conditions. Under future potential land-use conditions, excess risk and hazard to potential residents based on exposure to soil and/or groundwater was identified at all EUs. Additionally, excess hazard to a construction worker based on exposure to surface and subsurface soil and/or trench air was identified at EU-12, EU-14, and EU-16; and excess risk and hazard to a future farm family based on exposure to surface soil was identified at EU-3. Groundwater is not currently used as drinking water in any of the investigation areas; therefore, it was assumed that only future potential residents and future KSU students could be exposed to groundwater if land-use controls are not implemented to prevent potable use of groundwater in the future. Only adult and child recreational users were assumed to be present at all surface water and sediment area EUs.

The cancer risk posed to future residents using the water for domestic purposes (e.g., drinking, dermal contact, and inhalation) ranged from 4.26×10^{-5} in EU-17 to 8.47×10^{-2} in EU-1, 6, 7, 8, 9, and 16. Fourteen of 18 EUs had a calculated cancer risk in excess of KDHE's target risk range of 1×10^{-6} to 1×10^{-4} in future residential groundwater use scenarios. Non-cancer health risks (i.e., hazard indices, HI) for future residents using the water for domestic purposes exceeded one for TCE in all EUs. Total cancer risk for a future or current farm family that consumes produce, beef, or milk exposed to surface soil also exceeded KDHE's acceptable risk range. Non-cancer health risks for youth trespassers exposed to surface soil were below 1. Non-cancer health risks for recreational users exposed to surface water in Centennial Ditch exceeded 1. However, this calculated non-cancer risk is based on the conservative assumption to use the highest detection from any sampling event conducted at the Centennial Ditch. VOCs were not detected in 15 of 17 samples collected.

Part II of the HHRA evaluated on- and off-site vapor intrusion risks and hazards at 54 buildings selected for evaluation: 33 commercial, industrial, or educational buildings, 20 offsite residences, and a KSU dormitory. The vapor intrusion pathway was determined to be incomplete for all but nine buildings under current land-use conditions. Under future land-use scenarios, 19 buildings were identified as having excess risk and/or hazard to a future lifetime resident. The nine buildings in which excess risk and/or hazard to current occupants was identified were further screened to distinguish between risk and hazard posed by building-specific operations or other indoor VOC sources and vapor intrusion attributable to groundwater sources. Five buildings were subjected to secondary screening. Excess hazard to current occupants was identified in one building: SAA Hangar 626, with an HI of 4.6. The sample indicating the HI of 4.6 was collected from a storage closet. Data collected from other areas of Hangar 626 indicate acceptable exposure levels. At the time of evaluation, the building was the Sports Activity Center (a recreational land use); SAA Hangar 626 was recently converted for use as an aeronautical warehouse.

Addendum to Part III of the HHRA was a supplemental risk assessment to evaluate PFAS groundwater exposures. Hazard estimates were generated assuming residential use of groundwater via the spectrum of domestic water usage at SAFB, and exposure point concentrations were calculated for perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), PFOS+PFOA, and total PFAS. A hazard quotient (HQ) of greater than one was calculated for PFOS at Plume F (HI=2.23), and Plumes F and H (2.23). A HQ of greater than one was calculated for the sum of PFOS and PFOA in Plumes A, B, C, and D (1.87), Plume F (3.55), and Plumes F and H (3.55). HQs for total PFAS exceeded one in all plumes except Plume E when compared to the EPA Lifetime Health Advisory.

6. Remedial Action Objectives

Remedial Action Objectives (RAOs) are media-specific goals for protecting human health and the environment. RAOs are developed through evaluation of applicable and relevant and appropriate requirements (ARARs) and To Be Considered standards with consideration of the findings of the RI and human health risk assessment. RAOs for the site-wide soil, groundwater, and surface water contamination are bulleted below. In addition, should future surface water monitoring data indicate that the discharge of contaminated groundwater to surface water results in elevated contaminant concentrations in surface water, (i.e., as defined by the Kansas Surface Water Quality Standards[8] including the numerical thresholds and the Kansas Antidegradation Policy), KDHE may require additional actions to prevent or minimize further degradation of the surface water resource.

The RAOs for groundwater in all zones are:

- Reduce concentrations in groundwater to be protective of groundwater and indoor air criteria;

[8] Kansas Surface Water Quality Standards, K.A.R. 28-16-28b. et seq.

- To prevent contact with, or inhalation of, volatiles from contaminated groundwater, prevent the discharge of contaminants to surface water, and remove the source of groundwater contamination, as well as prevent future excess risk and hazard exposure of residents and workers;
- Prevent migration of contaminants that would result in groundwater contamination in excess of Alternate Treatment Goals (ATGs);
- Treat hot spots of contamination to ATGs by reducing their concentrations, volume, or mobility;
- Under future potential land-use, prevent excess risk and/or hazard from vapor intrusion to future residents and workers.

The RAOs for groundwater in Zone 2 are:

- Reduce concentrations in groundwater to be protective of all uses, including residential drinking water and indoor air criteria;
- Prevent migration of contaminants that would result in groundwater contamination in excess of Remedial Goals (RGs);
- Treat hot spots of contamination to RGs by reducing their concentrations, volume, or mobility.

The RAOs for soil in all zones are:

- Reduce concentrations to levels that are protective of groundwater (soil-to-groundwater protection) and indoor air criteria;
- Prevent ingestion/direct contact with contaminated soil, prevent inhalation exposure to contaminants volatilizing from soil, and prevent migration of contaminants that would result in groundwater or surface water contamination;
- Prevent future excess risk and hazard exposure of residents and workers;
- Prevent migration of contaminants that would result in groundwater contamination in excess of ATGs;
- Treat hot spots of contamination to ATGs by reducing their concentrations, volume, or mobility;
- Under future potential land-use, prevent vapor intrusion risk and/or hazard to future residents and workers.

The RAOs for surface water are:

- Reduce concentrations to levels above which no excess risk is observed;
- Prevent contact with, or inhalation of, volatiles from contaminated surface water.

6.1. Cleanup Levels

For groundwater cleanups being conducted at sites with drinking water aquifers, federally promulgated MCLs are applicable. Even though groundwater in the vicinity is not currently used for drinking purposes, it is a potential source of drinking water in the future. The final remedial goals for soil and groundwater are MCLs, where available, and KDHE's Tier 2 Levels for Groundwater as specified in the current version (including any subsequent versions) of the *Risk-based Standards for Kansas (RSK) Manual* for those constituents for which EPA has not established MCLs. The remedial goals for PFOS and PFOA compounds are based on the EPA Lifetime Health Advisory of 70 parts per trillion for combined concentrations of PFOS and PFOA for drinking water.[9] Other PFAS compounds currently do not have health advisories and/or regulatory limits. However, since various land-use restrictions are in place precluding the use of groundwater for drinking purposes in Zone 1 (Figure 2-1), and the vapor intrusion pathway was determined to be incomplete, ATGs will be used for the areas of the Schilling Site where active remediation is required. Continued remedial system operations beyond these levels, or cleanup activities in other areas, may be necessary to control plume migration, mitigate impacts to other environmental media, or otherwise be needed to protect human health and the environment. Table 6-1 summarizes soil and groundwater cleanup levels for target compounds.

7. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED

Through the FS process, individual remedial action alternatives were first evaluated with respect to their ability to satisfy the following criteria as specified in the *National Oil and Hazardous Substances Contingency Plan*[10] (NCP): protection of human health and the environment, compliance with ARARs; long-term effectiveness and permanence, reduction of toxicity mobility or volume through treatment; short-term effectiveness; implementability; and, cost. The alternatives for each were then compared against one another to facilitate the identification of the preferred alternative for each remediation grouping. A detailed description of the various remedial action alternatives and the individual and comparative analyses is presented in the FS.

The areas of impacted soil and groundwater are grouped into "Remediation Groupings," each with distinctive remediation requirements based on media, concentrations of COCs, hydrogeological conditions, accessibility, and other factors. The alternatives are evaluated for each remediation grouping. There are common elements among the various alternatives evaluated. While there may be some variation between the alternatives, these common elements are not discussed in detail in the summary below but will be retained in KDHE's preferred remedy. The cost estimates given in this document were provided by SPE and their consultant Dragun, and not reviewed by KDHE.

The NCP requires the evaluation of a No Action alternative to serve as a baseline for comparison to other remedial action alternatives evaluated. Typically, the No Action alternative means the site is left unchanged, and no remedial actions are evaluated or taken. Since no remedial action is taken, risks to human health and environment may not be addressed. The No Action alternative is implicitly evaluated as Alternative 1 for each remedial grouping. Since the No Action alternative will not be an acceptable alternative for any remedial grouping, it will not be formally evaluated in subsequent sections. The present value cost of the No Action alternative (Alternative 1) is $0.

[9] Environmental Protection Agency: Lifetime Health Advisories and Health Effects Support Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate, Vol. 81, No. 101, FR Doc. 2016-12361, Filed May 24, 2016.
[10] National Oil and Hazardous Substances Contingency Plan, 40 CFR 300 et seq.

In addition to the "No Action" alternative, each remedial technology alternative (e.g. excavation, pump and treat, etc.) evaluated in the FS was assessed for the applicable source area or media. Due to the application of the same remedial technology to multiple areas, the remedial alternatives presented are organized by remedial technology.

Note that the design details for all remedial alternatives are based on the preliminary analysis included in the FS. Prior to implementation, additional investigation will be conducted in support of the full remedial design. Accordingly, the quantities and methods by which the alternatives are implemented may change from those listed below.

7.1 Alternative 2: Excavation

Under this alternative, overburden soil would be excavated using a backhoe, excavator, or other typical excavating equipment. Excavated soil would be temporarily stockpiled onsite in a secure area and tested for waste characterization. If the soil is confirmed to be non-hazardous, it would be transported to an appropriate local landfill for disposal. Any soil suspected to be characteristically hazardous would be segregated, tested, and if confirmed, disposed at an appropriate facility. Clean or treated soil would be used to fill in the excavation after the contaminated soil is removed.

Overburden soil in the Plume B source area would be excavated from an area estimated to be approximately 19,000 square feet down to bedrock, for an estimate total soil volume of 8,200 cubic yards. This technology would address saturated and unsaturated soils in Plume B. The cost estimate for excavating the soil source area in Plume B is $3,300,000.

Overburden soil in the Plume C source area would be excavated down to bedrock. Excavation at depth would require extensive sloping, benching, or shoring. This technology would address saturated and unsaturated soils in Plume C. The cost estimate for excavating the soil source area in Plume C is $8,000,000.

7.2 Alternative 3: Large Diameter Borings

Under this alternative, contaminated soils are removed from the Plume A source area using large-diameter augers to create overlapping 5-foot diameter boreholes. This method has the potential ability to reach greater depths than traditional excavation without sloping or benching, which would reduce the total area of the excavation. Excavated soil would be temporarily stockpiled onsite in a secure area and tested for waste characterization. If the soil is confirmed to be non-hazardous, it would be transported to an appropriate local landfill for disposal. Any soil suspected to be characteristically hazardous would be segregated, tested, and if confirmed, disposed at an appropriate facility. Flowable fill would be used to backfill the boreholes after the contaminated soil is removed. The area would then be graded, repaved, and/or seeded to restore it to its original condition.

Contaminated overburden soil from the Plume A source area would be excavated from an area of approximately 1,750 square feet, down to 20 feet bgs using 5-foot diameter auger boreholes. An estimated 2,700 cubic yards of soil would be removed from the Plume A soil source area. This technology would address saturated and unsaturated soils. The cost estimate for Alternative 3 in Plume A is $1,500,000.

Contaminated overburden soil from the Plume C source area would be excavated from an area of approximately 4,400 square feet, down to a depth of 40 feet bgs. This technology would address saturated and unsaturated soils. The cost estimate for Alternative 3 in Plume C using large-diameter borings is $6,500,000.

7.3 Alternative 4: Thermal Treatment

Thermal treatment (ISTD (*in-situ* thermal desorption)) is an *in-situ* remedial process where direct heat or electrical heating is used to increase the volatilization rate of volatile and semi-volatile contaminants in the soil to facilitate extraction. Thermal treatment would treat both the shallow and deep source zone impacts. Heat for the ISTD would be provided by thermal conductive heating. This technology would address saturated and unsaturated soil.

In Plume A, the heating wells would be installed at an approximate 15-foot spacing through the full thickness of the impacted zones, plus five feet. Vapor extraction wells would be co-located with the heater wells and extend to the top of the treatment zone to capture vapors. To prevent the VOCs from cooling and condensing, an insulated cover would be placed at grade and overlap the remediation area by five to eight feet. The thermal treatment is expected to take approximately 154 days to remediate soil in Plume A to ATGs. The estimated cost of Alternative 4 in Plume A soil is $3,900,000.

In Plume C, the heating wells would be installed at an approximate 15-foot spacing through the full thickness of the impacted zones, plus five feet. Vapor extraction wells would be placed strategically among the heater wells and extend to the top of the treatment zone to capture vapors. No insulated cover would be required over the treatment area. The thermal treatment is expected to take approximately 160 days to remediate soil in Plume C to ATGs. The estimated cost of Alternative 4 in Plume C soil is $4,800,000.

7.4 Alternative 5: Pump and Treat

Pump and treat is a common remediation technology where contaminated groundwater is extracted from the aquifer, treated *ex situ* to remove or break down the contaminants, and then discharged (most often to surface water or a storm or sanitary sewer). The water is extracted via extraction wells, piped into a central treatment building, and treated. Treatment methods may include air stripping, which uses air bubbles to transfer VOCs from the water phase to the air phase; adsorption, in which the contaminant is removed from the liquid and sorbed to a solid; or advanced oxidative processes, in which ultraviolet radiation or hydrogen peroxide are used to destroy the organic contaminants in water. The treated water is then discharged to the surface using a National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permit requires regular testing of all discharged waters.

Although this remedy is not typically considered a soil remediation technology, pump and treat can assist in the hydraulic containment of contaminants in the saturated zone, as well as promote diffusion of contaminants from low permeability zones and dissolution of any remaining DNAPL into groundwater, which would ultimately be captured by the pump and treat system. The estimated cost of Alternative 5 for saturated soil remediation for OU-1 and OU-2, not including contingency implementation, is $31,800,000.

Pump and treat would address near-source overburden groundwater impacts in Plumes A-G and bedrock groundwater impacts in Plumes A, B, and G. The estimated cost of Alternative 5 for near-source overburden and bedrock groundwater impacts in OU-1 and OU-2, not including contingency implementation, is $23,600,000.

Pump and treat would address downgradient groundwater in Plumes A-G. The estimated cost of Alternative 5 for downgradient groundwater impacts in OU-1 and OU-2, not including contingency implementation, is $9,700,000.

7.5 Alternative 6: Directed Groundwater Recirculation

Directed Groundwater Recirculation (DGR) is an enhanced version of pump and treat whereby the treated groundwater is strategically injected back into the aquifer through injection wells to expedite remediation. The extraction and injection well locations are periodically optimized to maximize the system's mass removal efficiency. Groundwater modeling is used to strategically design the extraction and injection well layout. This method is especially helpful in promoting diffusive exchanges between higher and lower-permeability zones in the aquifer. Approximately 160 gallons per minute of groundwater would be extracted, treated, amended, and then reintroduced into the subsurface. The extracted water would be treated *ex-situ* using air stripping and carbon adsorption to remove VOCs, and ion exchange to remove PFAS. The extracted groundwater would also be tested for other contaminants and treated appropriately prior to reinjection. Amendments, such as emulsified vegetable oil and lactate, would be added prior to reinjection to enhance the *in-situ* biodegradation of VOCs. Remediation monitoring DGR system operation would monitor the following parameters: groundwater elevations, treatment system water quality, extraction well groundwater quality, monitoring well groundwater quality. Additional temporary wells or Geoprobe® samples would be added to the monitoring program as needed to fill data gaps.

Like pump and treat, this is not intended to directly address saturated soil impacts but would indirectly address the impacts by increasing the rate of leaching of contaminants from soils into groundwater. DGR would address near-source overburden groundwater impacts in Plumes A-G and bedrock groundwater impacts in Plumes A, B, and G, as well as downgradient impacts. The estimated cost of Alternative 6 for saturated soil remediation for OU-1 and OU-2, not including contingency implementation, is $52,500,000.

7.6 Alternative 7: Emplaced Permeable Reactive Barriers

The permeable reactive barriers (PRBs) would be placed by excavating a narrow strip of the overburden and bedrock and replacing it with a permeable zero-valent iron (ZVI) barrier. Two emplaced PRBs approximately three feet thick would be installed immediately downgradient of the F_1 and G source areas by cut-and-fill methods. The trench would be backfilled with a biodegradable slurry of ZVI, clean sand, and guar gum, and covered with a geosynthetic cloth and clean overburden. The barrier would be placed throughout the impacted zone from the water table to the top of the bedrock in Plume F_1 and into the bedrock to the extent possible in Plume G. Strategic groundwater monitoring downgradient of the emplaced reactive barriers would evaluate the performance with time. The estimated cost of Alternative 7 is $10,700,000.

7.7 Alternative 8: Injected Permeable Reactive Barriers

Five PRBs would be installed by injection methods to remediate the leading edges of the OU-1 (Plumes D and E) and OU-2 plumes (Plumes F_2, F_3, and G). Injection would occur over the permeable intervals identified during the pre-treatment barrier investigation. The injected PRBs would have ZVI mixed with xanthan gum and water. The mixture would have a ZVI content of 30% to 35% and would be injected into the subsurface via soil borings advanced to the barrier-specific depth. Injection borings would be spaced at approximately 1.6 to 2.5 feet along the entire length of each barrier with the objective to create a continuous, 10-foot-wide ZVI reaction zone through which the impacted groundwater would pass. In addition to the horizontal intervals, injection would occur at more than one depth interval (two to three intervals per boring). The estimated cost of Alternative 8, not including contingency implementation, is $3,900,000.

7.8 Alternative 9: Land Use Restriction

This alternative does not include any active treatment or source removal; instead, it utilizes institutional controls/land use restrictions to prevent unacceptable exposures by restricting how impacted land may be used. Examples are restrictive covenants, zoning limitations, and Environmental Use Controls (EUCs). The land use restrictions, depending on the type, may include periodic inspections to ensure compliance. The estimated cost of Alternative 9 is $10,000. This cost is based on the typical cost of an EUC and would also cover the fees associated with any additional EUC locations if they are deemed necessary.

7.9 Alternative 10: Monitored Natural Attenuation

This alternative does not include any active treatment or remediation to reduce the toxicity, mobility, or volume of groundwater contamination. Instead, it relies on natural attenuation processes, including biodegradation, dilution, volatilization, adsorption, and chemical reactions with subsurface materials to reduce contaminant concentrations in groundwater. Groundwater would be periodically monitored for contaminant concentrations as well as natural attenuation indicator parameters to evaluate: ongoing reducing anaerobic groundwater conditions; decreasing overall trends in contaminant trends; and, observed degradation of primary contaminants of concern to daughter products (e.g., TCE to cis-1,2-DCE). Existing Monitored Natural Attenuation (MNA) data is limited; therefore, the effectiveness of MNA in groundwater is unknown. Periodic groundwater sampling and site reviews would be conducted throughout the remedial action to document the effectiveness of the groundwater remedial strategy. The timeframe for MNA to achieve the ATGs is indeterminant, but longer than active remediation. The estimated cost of Alternative 10 in OU-3 for an assumed period of 30 years, not including contingency implementation, is $3,600,000.

8. DESCRIPTION OF THE PREFERRED REMEDY

After evaluation of the individual analysis of remedial action alternatives, a comparative analysis of the various alternatives for each remedial grouping was performed with consideration of the threshold and balancing criteria specified in the NCP. The results of the comparative analysis in combination with subsequent correspondence between KDHE and Dragun, on behalf of the SPE, support the preferred remedy for each remedial grouping outlined below and presented in Tables 8-1 and 8-2, and the preliminary configuration of the selected remedies are presented in Figures 8-1 and 8-2. The cost estimates given in this document were provided by SPE and their consultant Dragun, and not reviewed by KDHE.

As discussed above, the design details for all remedial alternatives are based on the preliminary analysis included in the FS. The quantities and methods by which the alternatives are implemented may change from those listed below.

8.1 Selected Remedial Alternatives

- *Pre-design Data Acquisition* – For each remedial grouping in which active remediation measures will take place, pre-design data acquisition activities will be conducted to optimize the selected remedy. A summary of anticipated pre-design data acquisition activities is presented in Table 8-1. Based on pre-design data acquisition findings, the exact number and placement of extraction and injection wells, reactive barriers, and/or excavations may vary, and/or contingency implementation may be required to ensure protection of human health and the environment and satisfy ARARs.

- *Five-year Reviews* – Five-year reviews will be conducted as long as contamination remains at concentrations above levels which would permit unrestricted use. These reviews provide an opportunity to review the overall protectiveness and effectiveness of the remedial strategy.

- *Receptor Surveys and Management* – An annual water well survey will be conducted for the on-Site and off-Site properties to confirm that potential risks associated with exposure to COCs in groundwater and indoor air are adequately mitigated. The surveys will include periodic reviews of property ownership, zoning, and use to evaluate potential changes that may result in excess risk or hazard. Sub-slab vapor or indoor air monitoring will be conducted in structures where warranted based on plume characteristics. KDHE may require installation of vapor mitigation systems if structures are found to be affected by VI. The soil caps on Landfill 1 (Plumes I and J) and Landfill 2 (Plume K) will be inspected annually.

- *Land Use Controls* – EUCs will be formally established through the EUC program administered by KDHE. An EUC protects human health and the environment from risks posed by remaining contaminants by placing restrictions, prohibitions, and conditions on land use to reduce or eliminate potential human exposure. The EUC agreement runs with the property and is binding on the landowner and any other subsequent owners, lessees, and other property users. An important component of the EUC is a Soil Waste Management Plan (SWMP) that describes notification, planning and field procedure requirements including procedures for screening, sampling, handling, and disposal of any impacted soil or unknown waste encountered during soil disturbance activities within the EUC area. An EUC agreement can also place restrictions to prevent exposure to contaminated groundwater. Groundwater restrictions may include a prohibition on the drilling or use of domestic or livestock wells and/or special precautions to be taken during construction activities that may cause an encounter with groundwater. EUCs may also have other requirements such as secure fencing, signage, or on-site security measures to deter trespassers. An EUC will be placed on the property that comprises Plume J (Landfill 1) and may be considered in other areas if deemed necessary to protect human health and the environment. Other land-use controls such as zoning restrictions and municipal ordinances may also be implemented as necessary.

- *Excavation* – The overburden soil source area in Plume B will be excavated using typical construction machinery. The goal for excavation is to remove all soil that is contaminated above the ATGs for soil in Zone 1. An area of approximately 19,000 square feet will be excavated down to bedrock, an and estimated soil volume of 8,200 cubic yards will be removed. The soil will be temporarily stockpiled in a secure area pending characterization. Once characterized as non-hazardous, the soil will be transported to an appropriate local landfill for disposal. If the soil is found to be hazardous, it will be disposed at a special facility that handles hazardous material. The excavation pit will then be backfilled with clean sand and soil and restored to its original condition. As a contingency, the soil may be treated *ex-situ* before disposal if determined necessary.

- *In-Situ Thermal Treatment – In-situ* thermal treatment, in the form of *in-situ* thermal desorption by thermal conductive heating, will be implemented in the Plume A and Plume C soil source areas. The goal of thermal treatment is to treat all soil that is contaminated above the ATGs for soil in Zone 1. Plume A will be treated first, followed by Plume C upon successful completion of the Plume A treatment.

  In Plume A, the treatment zone will be approximately 1,738 square feet down to a depth of approximately 50 feet bgs. The subsurface will be heated to the boiling point of the contaminants using thermal conductive heating combined with vacuum extraction. This will be achieved by installing approximately 22 heater borings with co-located vapor extraction wells at 15-foot spacing. The heater borings will be installed to five feet below the bottom of the treatment area (approximately 55 feet bgs), and any generated steam and volatilized COCs will be captured by vertical vapor extraction wells. Temperatures in the subsurface will be monitored by thermocouples placed every five feet across the treatment depth interval. An insulated vapor cover will be installed over the treatment zone to prevent cooling and condensation, provide a vapor seal, and prevent infiltration. The vapor cover will consist of a combination of concrete and fiber mesh. Extracted condensed vapors and any other liquid discharge will be treated through granular activated carbon prior to discharge into the City of Salina sanitary sewer. Any non-aqueous phase liquid will be separated prior to treatment and transferred to drums for proper disposal. Separated vapors will be treated by a granular activated carbon system and discharged to the atmosphere. The thermal treatment system is expected to operate for approximately 154 days to remediate soil in Plume A to ATGs.

In Plume C, both the shallow vadose zone soil and the deeper saturated soil require treatment. The combined shallow and deep treatment zone is approximately 4,303 square feet, down to a depth of 50 feet bgs. Twenty-seven deep heater borings will be installed to a depth of approximately 55 feet bgs, and eight shallow heater borings will be installed to a depth of approximately 18 feet bgs. Ten vertical and two horizontal vapor extraction wells will be installed between the heater borings. The Plume C treatment area will not require an insulated vapor cover because the shallow treatment area does not extend to the surface. The effluent from Plume C will be treated using the same process discussed for Plume A. The thermal treatment system is expected to operate for approximately 160 days to remediate soil in Plume C to ATGs.

- *Directed Groundwater Recirculation* – DGR will be implemented throughout OU-1 and OU-2 to meet the RGs or ATGs, depending on the location. Groundwater will be extracted via extraction wells, treated, and then strategically injected back into the aquifer through injection wells. Approximately 57 extraction wells and 199 injection wells will be installed throughout the OU-1 and OU-2 plumes (A-G). Approximately 160 gallons per minute of groundwater will be extracted. Injection rates will range between 0.075 and 1.9 gallons per minute per well. The exact number of wells, flow rates, and injection rates will be determined during the pre-design data acquisition activities. Extracted water will be piped to a treatment building for treatment using air stripping, carbon adsorption, and ion exchange. The treated water will then be amended by the addition of emulsified vegetable oil and lactate to enhance *in-situ* biodegradation of VOCs. Bromide will be added as a tracer before injection.

  Groundwater will be monitored to assess the remedy performance and allow for frequent system optimization, which is integral to the success of the remedy. Groundwater monitoring will include real-time measurement of groundwater elevations using in-well transducers, influent and effluent analysis, and sampling from the Site-wide monitoring well network. The preliminary remedial design is shown in Figures 8-1 and 8-2. As a contingency, the extracted groundwater will be treated and then discharged, rather than reinjected, to surface water using a NPDES permit. The DGR system could be considered for decommissioning once the ATGs have been achieved and sustained over a two-year period, after which the remedy would revert to long-term groundwater monitoring until remedial goals are met and maintained. The decision-making process for ending active remediation would include rebound testing and concentration trend analyses.

- *Emplaced Permeable Reactive Barriers* – Emplaced PRBs will be installed near the source areas in Plumes F_1 and G. An emplaced PRB is installed using cut-and-fill trenching methods. The PRBs will be placed by excavating a narrow strip of the overburden and replacing it with a permeable ZVI barrier. The barrier will be placed from the water table down to bedrock, to the extent practicable. The exact dimensions and placement of the barrier will be determined during the pre-design data acquisition activities. The barrier is composed of a biodegradable slurry of ZVI, clean sand, and guar gum. Material from the trench will be placed on each side to create a berm; any extra material will be disposed according to the SWMP. The slurry will be prepared above ground in mixing tanks, placed into the trench with an excavator, and covered by a geosynthetic cloth and clean overburden soil. Groundwater monitoring using strategically placed wells will assess the remedy design effectiveness and performance. The ZVI material may need to be replenished to maintain effectiveness; the cost estimates assume one replenishment event per barrier.

- *Injected Permeable Reactive Barriers* – Injected PRBs will be installed at the leading edges of Plumes D, E, F_2, F_3, and G. The injected PRBs will consist of multiple, closely spaced injection borings installed by a drill rig. The injected PRBs will be composed of ZVI mixed with xanthan gum and water, with a ZVI content of 30-35%. The mixture, which will be mixed in above ground mixing tanks, will be injected into the subsurface via soil borings. The borings will be spaced approximately 1.6 to 2.5 feet apart along the entire length of the treatment barrier to create a 10-foot-wide ZVI reaction zone. The injections will also consist of two to three depths per boring. The exact dimensions and placement of the barriers will be determined during the pre-design data acquisition activities. Groundwater monitoring using strategically placed wells will assess the remedy design effectiveness and performance.

8.2 Contingency Remedies

KDHE will review new information as it becomes available, and if new information suggests that contamination at or emanating from the site poses a threat to human health and the environment, or that the selected alternative(s) will not achieve the RAOs within an acceptable timeframe, contingency remedies identified in this CAD will be considered. Tables 8-1 and 8-2 identify the contingency remedial actions to be considered for each remedial grouping. The following are contingency remedial actions should the proposed remedial alternatives be ineffective or inadequate to address contamination and achieve RAOs: excavation; *ex-situ* treatment of impacted soil; large diameter boring excavation; conventional pump and treat with NPDES discharge; expansion of DGR (increased numbers of extraction/injection wells, horizontal wells, large-diameter wells, and recharge galleries); and PRBs. Note that some of the listed contingency remedial alternatives will be implemented as the primary selected alternatives in other remedial groupings, and that an already selected remedy may be applied to another remedial grouping or location as a contingency remedial action.

9. Community Involvement

A Community Involvement Plan for the Site was developed by KDHE. Public input and comment was encouraged by KDHE throughout the process. Public notice of the availability of the draft CAD was published in *The Salina Journal* on April 8, 2019, and the public comment period was offered from April 8 to May 8, 2019. An additional notice was published in *The Salina Journal* on April 29, 2019, regarding the public availability session held on May 1, 2019, where the public was given an additional opportunity to ask questions about the Draft CAD. In addition, KDHE established a webpage dedicated to the Schilling Site, which has been made available online, and continues to be available online at http://www.kdheks.gov/remedial/Schilling_AFB/index.html. Notice of the public availability session was posted on KDHE's Schilling webpage. Many site documents, including this final CAD, are available on the webpage.

10. Documentation of Minor Changes

In response to comments received and based on further internal review, several minor changes were made to the final CAD. The changes generally consisted of corrections to typographical errors to the text and Tables 3-1, 3-2, and 5-1.

11. Responsiveness Summary

The purpose of this section is to review and provide responses to comments received during the public comment period for the draft CAD. Two comment letters were received by KDHE from the public. The comments (*italics*) and KDHE's responses (**bold**) are shown below. Note that the comments have been paraphrased for brevity.

Comment #1: The commenter provided corrections to typographical errors found in the draft CAD Table of Contents.

Response #1: The revisions were made as appropriate to the Table of Contents.

Comment #2: The commenter provided corrections to typographical errors found in sections 3.1, 5, 6.1, and 8.1 in the text of the draft CAD.

Response #2: The revisions were made as appropriate to the text of the draft CAD.

Comment #3: The commenter provided corrections to some of the values reported in Tables 3-1, 3-2, 5-1, and 6-1 in the draft CAD.

Response #3: The revisions were made as appropriate to the tables in the draft CAD.

Comment #4: The commenter indicates that they believe that the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) remedy selection criteria have not been adequately evaluated in the Corrective Action Decision (CAD).

Response #4: The CAD is consistent with both the NCP and corresponding state guidance. United States Environmental Protection Agency (EPA) Record of Decision (ROD) guidance indicates that a comprehensive analysis of each alternative does not need to be presented in the ROD. It should, however, refer the reader to the Feasibility Study where it was evaluated. Paragraph 1, Section 7 on page 11 of the CAD states: "Through the FS process, individual remedial action alternatives were first evaluated with their ability to satisfy the following criteria… a detailed description of the various remedial action alternatives and the individual comparative analyses is presented in the Feasibility Study (FS)." This referral to the FS in the CAD is consistent with KDHE policy BER-RS-009 *State Cooperative Program Decision Document Development* and KDHE's Superfund Memorandum of Agreement between KDHE and USEPA, Region VII Voluntary Cleanup and Property Redevelopment

Program and State Cooperative Program. The FS is referenced in the CAD and publicly available for review alongside the Draft CAD in the local repository and online. This comment did not result in changes to the CAD.

Comment #5: The commenter indicates that they believe that a better proposed remedial plan includes excavation in Plume C, emplaced permeable reactive barriers (PRBs) in Plume F and G source areas, Environmental Use Controls (EUCs), and monitored natural attenuation (MNA).

Response #5: The proposed remedy from the commenter does not directly address groundwater contaminant migration in a timely manner to prevent the possibility of the completion of additional exposure pathways. The Feasibility Study and Pilot Study Reports demonstrate that the remedy will address the contamination from the Site in a manner consistent with NCP remedy selection. This comment did not result in changes to the CAD.

Comment #6: The commenter indicates that they believe natural attenuation is occurring and that specific tests for MNA processes were not conducted during the Remedial Investigation (RI) or FS. They believe that the CAD should be revised to show the contamination reductions over time.

Response #6: The draft CAD acknowledged that two out of thirteen plumes present at the Site (Plumes H and J) have been reduced to below the proposed Alternative Treatment Goals (ATGs). Specific tests of MNA processes were conducted during the RI (Section 7.2). The test results show that natural attenuation by biological activity is very low to non-existent in all plumes except Plume G. Therefore, MNA is not considered a solely viable alternative. MNA may be used after the main components of the remedy have significantly reduced mass. This comment did not result in changes to the CAD.

Comment #7: The commenter indicates that they believe the technical feasibility of the preferred alternatives were not sufficiently evaluated in the draft CAD. They believe that testing the alternatives during the remedial design phase is inconsistent with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the NCP.

Response #7: It is not the purpose of the draft CAD to detail the technical feasibility of the treatment alternatives(this is accomplished in the Feasibility Study and Pilot Study Report). Discussions of implementability and feasibility of the proposed treatment alternatives are discussed in the FS. KDHE identified contingent remedies so that in the event the remedy is not working as intended, the ability to implement another component of the remedy is not significantly delayed. This helps ensure a timely response and will help limit the time for potential exposure in the event that the remedy does not fully work as intended. KDHE made technical comments on the proposed remedies, including Directed Groundwater Recirculation (DGR), through the various stages of the technical review process. This comment did not result in changes to the CAD.

Comment #8: The commenter submitted long-term trends of monitoring wells in OU-1 from a statistical analysis in addition to iso-concentration maps. They interpret the trends as showing that OU-1 plumes are naturally attenuating, and that the plumes are either contracting or stable. Their trend analysis indicated that cleanup with MNA would take an average of 37 years to clean up, if the five longest lasting timeframes (83-179 years) are subtracted. They also note that attenuation has decreased over time. They state there is insufficient evidence to determine whether the OU-2 plumes are expanding or contracting. Finally, they question how spending $54 million for DGR over a period of 22 years would be cost-effective when their data indicates that it would take about 37 years with MNA. They re-state their preferred remedial alternatives, as mentioned above.

Response #8: The RI presents data collected for MNA parameters in all three OUs. Based on the scores presented in the RI, adequate evidence for anaerobic biodegradation was only found in Plume G. This indicates that further natural attenuation of TCE will rely on dispersion, dilution, and abiotic processes. As noted in the comment letter, attenuation has decreased over time; therefore, the commenter's forecasted remediation timeframes presented are likely based on previous, more rapid attenuation rates. Due to slowed degradation rates as noted in the RI, natural attenuation may not reliably restrict future migration, or be sufficient to result in timely degradation of contamination. The OU-1 Plume has moved well past I-135 into the residential area. The iso-contours provided in the comments submitted do not demonstrate shrinking of the plume. Based on the hydrogeology of the Site, it is reasonable to expect that the plume will continue to expand at an accelerated rate due to the higher permeability sands encountered east of I-135.

Plume F has already migrated under the adjacent residential area. Based on the limited trend data (since 2015), downgradient well concentrations are increasing, especially PCE. The TCE concentrations under the residential area are low currently (5-7 µg/L); however, they are increasing, and the remedial goal for Zone 2 is the MCLs. Concentrations in Plume G of TCE and carbon tetrachloride (CT) in groundwater were as high as 19,500 and 48,700 µg/L, respectively. The furthest downgradient well in Plume G has also seen an increase in TCE concentrations from 4.4 to 9.4 µg/L over the past 3 years (10.3 µg/L in April 2017). DMW1211G-32, near the source area, also has an increasing TCE trend, from January 2015 concentration of 615 µg/L to April 2018 concentration of 3,280 µg/L. PCE and CT have also increased in the same well.

MNA may be occurring due to physical processes in some areas, but rates of degradation, as noted in previous comments, appear to be slowing. Therefore, predictions related to timeframe before wells are impacted are difficult to accurately evaluate. The additional migration of contamination into residential areas risks completion of further potential exposure pathways, including residents drilling wells and vapor intrusion, which does not meet KDHE's desired short-term effectiveness. With the slowing of natural attenuation rates, the lack of source controls will allow the plumes to continue to expand as mass continues to leach from the source area.

Source DK software was used to evaluate concentration trends. KDHE has not evaluated nor confirmed the results using Source DK software. Instead, KDHE reviewed Mann-Kendall analyses of contamination trends and determined that in general, concentrations have decreased, but the plumes are migrating. Additionally, the statistical analyses presented exclude the five longest-lasting timeframes (83-179 years) in their averages.

Soil excavation was screened out as an alternative for Plume C due to soil contamination being present deep in the saturated soil. Thermal treatment is suited to treat both saturated and unsaturated soil impacts. This comment did not result in changes to the CAD.

Comment #9: The commenter indicates that they believe the implementability of DGR was not sufficiently evaluated and that the pumping test data indicate that DGR will likely not work at the Site. They believe that re-injection is not viable due to the low permeability of the overburden, and that the proposed addition emulsified vegetable oil to the injectate would exacerbate biological fouling, citing a previous in-situ bioremediation pilot test performed by the USACE at the Schilling Atlas S-5 Site. They believe that the inclusion of a contingency remedy for DGR indicates that the technical feasibility is in question.

Response #9: KDHE requested that contingencies be identified in the FS so that KDHE could appropriately identify contingency remedies in the draft CAD. The inclusion of contingencies does not indicate that the success of the proposed remedy is in question. This is consistent with most sites within the State Cooperative Program and allows us to quickly address situations in which the remedy is not functioning as intended. This information is included so the public knows that if this remedy does not work as intended, there are other alternatives and the public water supply will be protected. KDHE will use all efforts to prevent the public water supply from being impacted.

As previously stated, the CAD is not intended to evaluate technical feasibility within the document; all criteria are weighted in the FS. Nothing contained in the FS indicates that DGR is likely to fail.

The commenter notes that Emulsified Vegetable Oil (EVO) may exacerbate biological fouling. This is not considered a necessary part of the CAD. It was proposed as a potential additional mechanism if the system was to need EVO as a nutrient. The Remedial Design and Remedial Action will evaluate whether any additional amendments are required based on the remedial actions selected to address contamination. This comment did not result in changes to the CAD.

Comment #10: The commenter states that because the Human Health Risk Assessment (HHRA) found no excess risk based on current land use for vapor intrusion, and only one building had excess risk based on a future residential land use scenario, that the semi-annual sampling of the nine buildings selected is unnecessary.

Response #10: Although the HHRA found no excess risk for vapor intrusion based on indoor air testing, the vapor intrusion exposure pathway is complete based on the proximity to the

plume and the contaminant concentrations. The CAD specifies that VI monitoring will be conducted when warranted. The potential for vapor intrusion is not static; therefore, ongoing evaluation should continue if a complete exposure pathway is present. The vapor intrusion pathway may need to be periodically re-evaluated at sites with expanding plumes to ensure that site risks are under control. Additionally, buildings may shift/settle over time, which may result in newly completed exposure pathways. This comment did not result in changes to the CAD.

Comment #11: The commenter states that they believe soil excavation is not necessary in the Plume A and B source areas. They state that only 30% of the samples collected were above the soil Alternate Treatment Goal (ATG). They believe that remediation of soil areas that do not pose a direct risk is not necessary and inconsistent with the NCP.

Response #11: It is KDHE's position that any contaminant mass in soil that is above the Soil-To-Groundwater RSK value may contribute to groundwater contamination. Source abatement significantly reduces the remediation timeframe and associated groundwater monitoring costs. The RI reported Plume B perimeter concentrations of TCE in soil above the zone's soil ATG. The commenter states that 30% of the soil samples collected from the proposed excavation area were greater than the ATG of 842 µg/L, which has been determined to be the value to which the soil will no longer contribute enough contamination to bring groundwater above the ATG. This is still considered a significant amount of mass that will contribute long-term to groundwater contamination at the Site. Furthermore, the purpose of the RI was to further delineate/confirm the soil source areas in OU-1. The RI states that DNAPL is still likely present in the center of the soil source areas; the majority of samples were taken around the perimeter to identify the extent and boundaries of the contamination to assist in delineation of source areas. Historic data indicates that high TCE concentrations are present in the center of the plume, and this contamination is assumed to be still in place as no source area remediation has occurred to date. As a point of clarification, excavation was not selected as a preferred remedy in Plume A. This comment did not result in changes to the CAD.

Comment #12: The commenter states that based on the pilot tests conducted to date, they believe that soil vapor extraction (SVE) will not likely be viable without expensive modifications such as hydraulic fracturing or horizontal drilling in Zone 1. They believe that the SVE systems proposed to remove vaporized VOCs generated by thermal treatment may not be effective, and that the vapors produced from thermal treatment may cause excess risk for exposed receptors. They believe that the Draft CAD does not describe or account for costs associated with capturing the mobilized soil vapors. They believe that SVE would not likely be feasible or contribute to protectiveness and that additional pilot studies should be performed before selecting the remedy.

Response #12: Traditional SVE is not considered a selected alternative for soil at the Site, but SVE will be used as part of the thermal treatment process. The production of vapors was considered in the remedial alternative, and there are plans to address the effluent by vapor phase granular activated carbon (VGAC). The cost of 9,000 lbs of VGAC substrate is included in the cost estimate and can be found in the Basis of Design Report prepared by

TerraTherm, which is in Appendix F of the Pilot Study Report. The concerns regarding vapor intrusion during the thermal treatment process in Plume C are specifically discussed in regard to the KSU buildings (Pilot Study Report, 2017). TerraTherm concluded in their report that no vapor intrusion threat would be initiated by the remedy due to the distance between the treatment area and the building. Two horizontal vapor extraction wells will be placed between the treatment area and the building as a conservative measure. Vapor covers will be installed on top of the treatment area to prevent vapors from condensing in the vadose zone. The vapor extraction wells in Plume A will be collocated with the heater wells; the vapor extraction wells in Plume C will be generally arranged 10 feet or less from the heater wells. All vapor collection piping will be operated under a net negative pressure, preventing any leaks from escaping. KDHE's position is that the Basis of Design Report provides enough justification to move towards remedy implementation and that SVE will contribute to protectiveness. This comment did not result in changes to the CAD.

Comment #13: The commenter states that they agree with the concept of emplaced PRBs but believe that the injected PRBs proposed to be installed at the leading edges of the plumes are unnecessary since they believe the plumes are no longer migrating downgradient. They state that there is a lack of evidence of the necessity and effectiveness of the injected PRBs, and they should be included as a contingent element of the remedy if groundwater monitoring does not show reductions in concentrations after the emplaced PRBs are installed.

Response #13: Analytical results over the last 3 years (2015-2018) have shown that Plume G and Plume F are migrating downgradient, therefore an injected PRB installed on the plume boundary is appropriate to prevent further migration of the distal edge. As contamination continues to migrate further into residential areas, additional exposure pathways are a possibility, such as private wells or vapor intrusion. Preventing further migration to allow for short-term protectiveness weighs heavily when evaluating the NCP criteria. This comment did not result in changes to the CAD.

Comment #14: The commenter states that a statement should be added to the CAD that the Per- and Polyfluoroalkyl Substances (PFAS) contamination did not originate from operations during the period the Air Force was present at the Site because PFAS was not used by the Department of Defense until after 1970. They believe that the source of PFAS releases should be identified and considered for treatment.

Response #14: KDHE does not make claims in the CAD about the origins of contamination at each individual source area. Through the soil investigation conducted to date, PFAS soil contamination has not been identified. However, the analytical results in groundwater indicate that PFAS impacts are present and need to be addressed. MNA does not address PFAS and therefore methods to address it are required, including the selected remedy, DGR. This comment did not result in changes to the CAD.

TABLES

Kansas
Department of Health and Environment
Environmental Remediation

Table 3-1 – Analytical Results Summary for Soil Target Compounds in Each Plume

Plume	Maximum Concentration† TCE (µg/kg)	Maximum Concentration† PCE (µg/kg)	Maximum Concentration† Carbon Tetrachloride (µg/kg)	Maximum Concentration† cis-1,2-DCE (µg/L)	Maximum Concentration† Vinyl Chloride (µg/L)	Maximum Concentration† Chloroform (µg/L)	Maximum Concentration† Methylene Chloride (µg/L)	Maximum Concentration† Benzene (µg/kg)	Maximum Concentration† Naphthalene (µg/kg)
KDHE RSK Soil to Groundwater Value (µg/kg)	*84.2*	*121*	*73.4*	*855*	*20.5*	*850*	42.9	*168*	*659*
Plume A	**74,800 QC**	ND (3,000)	ND (3,000) QC	**17,000 QC**	ND (3,000) QC	ND (3,000) QC	ND (3,000) QC	ND (3,000) ED QC	**9,500 SR**
Plume B	**1,400**	ND (40)	ND (40)	**480**	ND (40) QC	ND (40)	ND (40)	ND (40)	ND (40)
Plume C	**451,000 QC**	ND (60,000) QC	ND (60,000) QC	**28,900**	**10,700**	ND (6,000) QC	ND (60,000) QC	ND (6,000) QC	ND (60,000) QC
Plume D	**250 SR**	ND (40)	ND (40)	ND (40)	ND (40) SR	ND (40) SR	ND (40) SR	ND (40) SR	ND (40) SR
Plume E	NS	50	ND (40) SR	ND (40) SR	ND (40) QC SR	ND (40) SR	ND (40) SR	ND (40) SR	ND (40) SR
Plume F	NS	ND (60) M	ND (40)	ND (40)	ND (60) M	ND (60) M	ND (60) M	ND (60) M	ND (60) M
Plume G	**8,760**	ND (40) SR	**17,200**	20	ND (200)	400	ND (200) SR	ND (50) SR	ND (50) QC SR
Plume H	NS	NS	NS	NS	NS	NS	NS	NS	NS
Plume I	NS	NS	NS	NS	NS	NS	NS	NS	NS
Plume J	NS	NS	NS	NS	NS	NS	NS	NS	NS
Plume K	NS	NS	NS	NS	NS	NS	NS	NS	NS

†Maximum concentration identified in the Remedial Investigation Report, Revision 1 (2018)
‡KDHE Tier 2 Levels default to MCLs where available. Tier 2 Level for groundwater provided from KDHE's Risk-based Standards for Kansas (RSK) Manual, October, 2010, revised September 2015, and any subsequent revisions.
Bold *indicates the concentration detected exceeds the KDHE RSK Tier 2 Level.*
ND analyte was not detected above the laboratory method detection limit
NS indicates a sample was not collected
ED due to matrix interferences, dilution was required. Detectable amounts in the sample were not within the optimal quantification range of the instrument calibration curve
QC data qualifiers were noted
SR one or more surrogate recoveries for this analysis did not meet quality control limits
M reporting limit higher than normal due to matrix interferences
YV the sample was not preserved to a pH <2

Table 3-2 – Analytical Results Summary for Groundwater Target Compounds in Each Plume

Plume	Maximum Concentration† TCE (µg/L)	Maximum Concentration† PCE (µg/L)	Maximum Concentration† Carbon Tetrachloride (µg/L)	Maximum Concentration† cis-1,2-DCE (µg/L)	Maximum Concentration† Vinyl Chloride (µg/L)	Maximum Concentration† Chloroform (µg/L)	Maximum Concentration† Methylene Chloride (µg/L)	Maximum Concentration† Benzene (µg/L)	Maximum Concentration† Naphthalene (µg/L)
KDHE RSK Value/EPA MCL Value (µg/L)	*5*	*5*	*5*	*70*	*2*	*80*	*5*	*5*	*1.11*
Plume A	**8,220 YV**	ND (100)	**911**	**2,790 YV**	**220 YV**	ND (100)	**140 YV**	**121**	ND (100)
Plume B	**3,490**	ND (30)	ND (30)	**300**	ND (30)	ND (30)	ND (30)	ND (30)	ND (30)
Plume C	**30,100**	ND (2,000)	ND (2,000)	**147,000**	**13,000**	ND (2,000)	ND (2,000)	ND (2,000)	ND (2,000)
Plume D	**7,650**	ND (50)	ND (50)	**3,060**	ND (50)	10	**49**	ND (50)	ND (50)
Plume E	**40**	**46.8**	1	23.9	ND (1)	ND (1)	ND (2)	ND (1)	ND (1)
Plume F	**440**	**138**	**942**	**77.7**	ND (30)	78.9	ND (30)	ND (30)	ND (30)
Plume G	**21,600**	ND (500)	**24,100**	ND (500)	ND (500)	**6,800**	ND (500)	ND (500)	ND (500)
Plume H	**10**	ND (1)	ND (1)	2.9	ND (1)	ND (1)	ND (2)	ND (1)	ND (5)
Plume I	**31.5**	**188**	ND (2)	7.1 YV	ND (2)	ND (2)	ND (2)	ND (2)	ND (5)
Plume J	**24.8**	ND (5)	ND (5)	**142**	**2.2**	ND (5)	ND (5)	ND (5)	ND (6) L
Plume K	**110**	**5.7**	**97.4**	2.8	ND (2)	21.6	ND (2)	ND (2)	ND (2)

†Maximum concentration identified in the Remedial Investigation Report, Revision 1 (2018)
‡KDHE Tier 2 Levels default to MCLs where available. Tier 2 Level for groundwater provided from KDHE's Risk-based Standards for Kansas (RSK) Manual, October, 2010, revised September 2015, and any subsequent revisions.
Bold *indicates the concentration detected exceeds the KDHE RSK*
ND analyte was not detected above the laboratory method detection limit
NS indicates a sample was not collected
ED due to matrix interferences, dilution was required. Detectable amounts in the sample were not within the optimal quantification range of the instrument calibration curve
QC data qualifiers were noted
SR one or more surrogate recoveries for this analysis did not meet quality control limits
L Reporting limit higher than normal due to limited sample volume available. If a result is provided it may be less accurate than normal
M reporting limit higher than normal due to matrix interferences
YV the sample was not preserved to a pH <2

Table 3-3 – Analytical Results Summary for PFOS, PFOA, and 1,4-Dioxane in Groundwater in Each Plume

Plume	Maximum Concentration† PFOS (ng/L)	Maximum Concentration† PFOA (ng/L)	Maximum Concentration† 1,4-Dioxane (µg/L)
KDHE RSK Level (µg/L)/EPA Drinking Water Health Advisory Level (ng/L)*	*70*	*70*	*8.49*
Plume A	55	13	ND (1)
Plume B	16	9.5	ND (1)
Plume C	**350**	**600 E**	ND (1)
Plume D	30	7.2	ND (1)
Plume E	ND (4.2)	ND (1.7)	ND (1)
Plume F	**470**	**270**	3.9
Plume G	4.4	ND (1.7)	ND (1)
Plume H	NS	NS	NS
Plume I	47	5.6	ND (1)
Plume J	NS	NS	NS
Plume K	19	3.9	ND (1)

† *Maximum concentration identified in the Supplemental Remedial Investigation #3 Report, Revision 1 (2018)*
‡ *KDHE Tier 2 Levels default to MCLs where available. Tier 2 Level for groundwater provided from KDHE's Risk-based Standards for Kansas (RSK) Manual, October, 2010, revised September 2015, and any subsequent revisions.*
* *EPA's health advisories are non-enforceable and non-regulatory and provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination*
µg/L micrograms per liter (parts per billion)
ng/L nanograms per liter (parts per trillion)
Bold *indicates the concentration detected exceeds the KDHE RSK Level or EPA Drinking Water Health Advisory Level*
ND analyte was not detected above the laboratory method detection limit
NS indicates a sample was not collected
E indicates the value is above quantitation range

Table 3-4 – Analytical Results Summary for Surface Water Target Compounds

Surface Water ID	Maximum Concentration† TCE (µg/L)	Maximum Concentration† PCE (µg/L)	Maximum Concentration† Carbon Tetrachloride (µg/L)	Maximum Concentration† cis-1,2-DCE (µg/L)	Maximum Concentration† Vinyl Chloride (µg/L)	Maximum Concentration† Chloroform (µg/L)	Maximum Concentration† Methylene Chloride (µg/L)	Maximum Concentration† Benzene (µg/L)
Kansas Surface Water Quality Standards (µg/L)	*2.7*	*0.8*	*0.25*	*70*	*2*	*5.7*	5	*1.2*
Centennial Ditch (OU-1)	0.9	ND (1)	ND (1)	1	ND (1)	ND (1)	ND (10)	ND (1)
Derussy Ditch	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Scanlan Ditch	**8.2**	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Dry Creek (OU-1)	0.7	ND (0.5)	ND (0.5)	1.2	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Tony's Ditch	ND (1)	ND (1)	ND (1)	10.4	ND (1)	ND (1)	ND (10)	ND (1)
Centennial Ditch (OU-2)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Jumper Ditch	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Dry Creek (OU-2)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)

Surface Water ID	Maximum Concentration† Arsenic (µg/L)	Maximum Concentration† Barium (µg/L)	Maximum Concentration† Chromium (µg/L)	Maximum Concentration† Copper (µg/L)	Maximum Concentration† Lead (µg/L)	Maximum Concentration† Manganese (µg/L)	Maximum Concentration† Mercury (µg/L)	Maximum Concentration† Zinc (µg/L)
Kansas Surface Water Quality Standards (µg/L)	*10*	*2,000*	*100*	*1,000*	*15*	*NA*	2	*5,000*
Centennial Ditch (OU-1)	NS	NS	NS	NS	NS	NS	NS	NS
Derussy Ditch	NS	NS	NS	NS	NS	NS	NS	NS
Scanlan Ditch	NS	NS	NS	NS	NS	NS	NS	NS
Dry Creek (OU-1)	NS	NS	NS	NS	NS	NS	NS	NS
Tony's Ditch	NS	NS	NS	NS	NS	NS	NS	NS
Centennial Ditch (OU-2)	ND (5)	213	ND (5)	ND (10)	7	347	ND (0.2)	23
Jumper Ditch	7	90	ND (5)	ND (10)	9	38	ND (0.2)	15
Dry Creek (OU-2)	8	115	ND (5)	ND (10)	12	529	ND (0.2)	35

†Maximum concentration identified in the Remedial Investigation Report, Revision 1 (2018)
‡Surface water quality standards provided from the Kansas Surface Water Quality Standards: Tables of Numeric Criteria, December 2017
Bold *indicates the concentration detected exceeds the KDHE RSK*
ND analyte was not detected above the laboratory method detection limit
NS indicates a sample was not collected
NA not applicable

Kansas Department of Health and Environment
Environmental Remediation

*Table 5-1 – Summary of Risk Assessment Findings**

Receptor and Exposure Scenario	EU-1		EU-2		EU-3		EU-4		EU-5		EU-6		EU-7	
	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)
Resident – Surface Soil							6.13x10^{-5}	N/A						
Resident – Total Soil							6.13x10^{-5}	N/A						
Indoor Worker – Surface Soil	3.63x10^{-5}	0.01			2.35x10^{-7}	N/A	N/A	0.4	8.21 x10^{-7}	0.102	4.69x10^{-6}	0.17	2.60 x10^{-5}	0.00047
Outdoor Worker – Surface Soil	**1.01x10^{-4}**	0.01			6.28x x10^{-7}	N/A	N/A	0.7	2.28 x10^{-6}	0.184	1.30 x10^{-5}	0.31	7.21 x10^{-5}	0.00085
KSU Student – Surface Soil	2.42x10^{-5}	0.004												
SATC Student – Surface Soil													3.66 x10^{-6}	0.000512
Farm Family – Surface Soil					Produce Ingestion: **4.3x10^{-3}** Beef Ingestion: **2.26x10^{-3}** Milk Ingestion: **6.51x10^{-3}**	**269** N/A N/A								
Youth Trespasser – Surface Soil							N/A	0.0512	3.41 x10^{-8}	0.0137	1.94 x10^{-7}	0.0234	7.34 x10^{-7}	N/A
Future Resident – Surface Soil	**2.06x10^{-3}**	0.05			2.90x10^{-6}	N/A	N/A	**3.45**	4.68 x10^{-5}	0.926	**2.67 x10^{-4}**	**1.58**	**1.48 x10^{-3}**	0.00429
Future Resident – Total Soil	**2.18x10^{-3}**	**1.12**			4.8x10^{-7}	**N/A**	N/A	0.9	3.20 x10^{-5}	0.926	**2.67 x10^{-4}**	**1.58**	**1.48 x10^{-3}**	0.00429
Future Resident - Groundwater	**8.47x10^{-2}**	**992**	**2.52x10^{-2}**	**1,020**	**2.52x10^{-2}**	**1,020**	3.26 x10^{-5}	**4.31**	3.26 x10^{-5}	**4.31**	**8.47 x10^{-2}**	**992**	**8.47 x10^{-2}**	**992**
Future Construction Worker – Total Soil	5.2x10^{-6}	0.114			4.87x10^{-7}	N/A	N/A	**3.42**	7.54 x10^{-8}	0.243	6.28 x10^{-7}	0.41	3.49 x10^{-6}	0.0011
Future Construction Worker – Trench Air	1.38x10^{-7}	0.536	3.74x10^{-7}	0.671	3.74x10^{-7}	0.671	2.44x10^{-10}	0.00196	2.44x10^{-10}	0.00196	1.38x10^{-7}	0.536	1.38x10^{-7}	0.536

Table 5-1 – Summary of Risk Assessment Findings (continued)*

Receptor and Exposure Scenario	EU-8		EU-9		EU-10		EU-11		EU-12		EU-13		EU-14	
	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME))	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)
Resident – Surface Soil							$6.13x10^{-5}$	N/A						
Resident – Total Soil							$6.13x10^{-5}$	N/A						
Indoor Worker – Surface Soil			$2.97x10^{-5}$	N/A			$1.08x10^{-6}$	N/A	$7.23x10^{-7}$	0.0325	$5.04x10^{-7}$	0.014	$1.61x10^{-6}$	N/A
Outdoor Worker – Surface Soil			$8.24x10^{-5}$	N/A					$1.99x10^{-6}$	0.0581	$1.39x10^{-6}$	0.025	$4.46x10^{-6}$	N/A
KSU Student – Surface Soil														
SATC Student – Surface Soil														
Farm Family – Surface Soil														
Youth Trespasser – Surface Soil			$1.2x10^{-6}$	N/A					$2.96x10^{-8}$	0.00431	$2.06x10^{-8}$	0.00131	$6.64x10^{-8}$	N/A
Future Resident – Surface Soil			**$1.69x10^{-3}$**	N/A			$6.13x10^{-5}$	N/A	$4.08x10^{-5}$	0.292	$2.84x10^{-5}$	0.125	$9.01x10^{-5}$	N/A
Future Resident – Total Soil			**$2.11x10^{-3}$**	N/A			$6.13x10^{-5}$	N/A	**$2.57x10^{-3}$**	**227**	$3.03x10^{-5}$	0.121	$9.43x10^{-5}$	0.205
Future Resident - Groundwater	**$8.47x10^{-2}$**	**992**	**$8.47x10^{-2}$**	**992**	**$8.47x10^{-2}$**	**992**	**$6.30x10^{-4}$**	**26.1**	**$5.39x10^{-4}$**	**22.6**	**$3.37x10^{-4}$**	**19.9**	**$7.66x10^{-2}$**	**3,420**
Future Construction Worker – Total Soil			$4.96x10^{-6}$	N/A			$1.44x10^{-7}$	N/A	$3.96x10^{-6}$	N/A	$7.13x10^{-8}$	0.032	$2.27x10^{-7}$	0.019
Future Construction Worker – Trench Air	$1.38x10^{-7}$	0.536	$1.38x10^{-7}$	0.536	$1.38x10^{-7}$	0.536	$7.72x10^{-9}$	0.0165	$6.60x10^{-9}$	0.0142	$3.18x10^{-9}$	0.0129	$1.10x10^{-6}$	**2.26**

Table 5-1 – Summary of Risk Assessment Findings (continued)*

Receptor and Exposure Scenario	EU-15 Total Risk (RME)	EU-15 Adjusted Total Hazard Index (RME)	EU-16 Total Risk (RME)	EU-16 Adjusted Total Hazard Index (RME)	EU-17 Total Risk (RME)	EU-17 Adjusted Total Hazard Index (RME)	EU-18 Total Risk (RME)	EU-18 Total Risk (RME)
Resident – Surface Soil								
Resident – Total Soil								
Indoor Worker – Surface Soil			1.79×10^{-5}	0.0175			1.56×10^{-5}	N/A
Outdoor Worker – Surface Soil			4.79×10^{-5}	0.0378			4.32×10^{-5}	N/A
KSU Student – Surface Soil								
SATC Student – Surface Soil								
Farm Family – Surface Soil								
Youth Trespasser – Surface Soil			5.03×10^{-7}	0.00237			6.43×10^{-7}	N/A
Future Resident – Surface Soil			**8.90×10^{-4}**	0.179			**8.86×10^{-4}**	N/A
Future Resident – Total Soil			**4.72×10^{-4}**	**6.34**			**2.77×10^{-4}**	5.96×10^{-5}
Future Resident - Groundwater	3.26×10^{-5}	**4.31**	**8.47×10^{-2}**	**992**	4.26×10^{-5}	**3.85**	**6.30×10^{-4}**	**26.1**
Future Construction Worker – Trench Air	2.44×10^{-10}	0.00196	1.38×10^{-7}	0.536	3.00×10^{-10}	0.00245	7.72×10^{-9}	0.0165
Future Construction Worker – Total Soil			1.26×10^{-6}	0.61			6.53×10^{-7}	1.57×10^{-5}

*AlterEcho, 2017, *Final Part III: Summary of Human Health Risk Assessment, Former Schilling Air Force Base, Salina, Kansas*, prepared on behalf of SPE; finalized and approved March 2017.

Bold indicates value exceeds Risk Level of 10^{-4} or the Hazard Index is greater than 1.
N/A indicates the value was not applicable for the receptor and exposure scenario.
Shading indicates the value was not calculated for the receptor and exposure scenario.

Kansas Department of Health and Environment
Environmental Remediation

*Table 5-2 – Summary of Risk Assessment Findings (Surface Water and Sediment) **

Receptor and Exposure Scenario	Centennial Ditch		Dry Creek	
	Total Risk (RME)	Adjusted Total Hazard Index (RME)	Total Risk (RME)	Adjusted Total Hazard Index (RME)
Recreational User - Sediment	4.66×10^{-6}	0.0852		
Recreational User – Surface Water	5.68×10^{-5}	**2**	8.48×10^{-5}	1

*AlterEcho, 2017, *Final Part III: Summary of Human Health Risk Assessment, Former Schilling Air Force Base, Salina, Kansas*, prepared on behalf of SPE; finalized and approved March 2017.

Bold indicates value exceeds Risk Level of 10^{-4} or the Hazard Index is greater than 1.
N/A indicates the value was not applicable for the receptor and exposure scenario.
Shading indicates the value was not calculated for the receptor and exposure scenario.

Table 6-1 – Cleanup Levels for VOCs and PFAS in Soil, Overburden Groundwater, and Bedrock Groundwater

			Remedial Goals (RGs)			Alternative Treatment Goals (ATGs, Zone 1 only)		
Compound	*KDHE Soil-to-GW RSK Value (µg/kg)*	*KDHE Groundwater RSK Value (µg/L)*	Soil (µg/kg)	Overburden Groundwater (µg/L)	Bedrock Groundwater (µg/L)	Soil (µg/kg)	Overburden Groundwater (µg/L)	Bedrock Groundwater (µg/L)
PCE	*121*	*5*	121	5	5	1,210	50	50
TCE	*84.2*	*5*	84.2	5	5	842	50	50
cis-1,2-Dichloroethene	*855*	*70*	855	70	70	8,550	700	700
Vinyl chloride	*20.5*	*2*	20.5	2	2	205	20	20
trans-1, 2-DCE	*1,220*	*100*	1,220	100	100	12,200	1,000	1,000
Carbon Tetrachloride	*734*	*5*	73.4	5	5	734	50	50
Chloroform	*850*	*80*	850	80	80	8,500	800	800
PFOS + PFOA	---	---	Not Established	0.07*	0.07*	---	---	---

µg/kg   micrograms per kilogram
µg/L   micrograms per liter
‡KDHE Tier 2 Levels default to MCLs where available. Tier 2 Level for groundwater provided from KDHE's Risk Based Standards for Kansas (RSK) Manual, October, 2010, revised September 2015, and any subsequent revisions
**Based on the EPA Lifetime Health Advisory Level of 70 parts per trillion (nanograms per liter, ng/L) for drinking water*

Table 8-1 – Summary of the Preferred Alternatives for Soil Remediation

Remedial Grouping	Preferred Alternatives	Pre-Design Data Acquisition	Contingency
Unsaturated Source Area Soil in Plumes A and B	Thermal treatment (Plume A); excavation and off-site disposal (Plume B)	Study to support remedial system design	Conventional excavation (Plume A); *ex-situ* treatment of impacted soil (Plumes A and B); land-use restrictions
Saturated Source Area Soil in Plumes A and B	Directed groundwater recirculation	Study to support remedial system design; hydraulic conductivity studies.	Conventional excavation; *ex-situ* treatment of impacted soil; additional extraction/injection wells, large diameter wells, recharge galleries, horizontal wells; pump and treat with NPDES discharge; land-use restrictions
Saturated and Unsaturated Source Area Soil in Plume C	Thermal treatment; Directed groundwater recirculation	Study to support remedial system design	Large diameter boring excavation; *ex-situ* treatment of impacted soil; additional extraction/injection wells, large diameter wells; land-use restrictions
Saturated Soil in Plumes D, E, F_2 and F_3	Directed groundwater recirculation	Study to support remedial system design; hydraulic conductivity studies.	Additional extraction/injection wells, large diameter wells, recharge galleries, horizontal wells; pump and treat with NPDES discharge; land-use restrictions

Table 8-2 – Summary of the Preferred Alternatives for Groundwater Remediation

Remedial Grouping	Preferred Alternatives	Pre-Design Data Acquisition	Contingency
Near Source and Mid-Plume Overburden Groundwater in Plumes A-G, and Bedrock in Plumes A, B, and G	Directed groundwater recirculation; emplaced permeable reactive barriers	Study to support remedial system design; hydraulic conductivity studies.	Additional extraction/injection wells, large diameter wells, recharge galleries, horizontal wells; pump and treat with NPDES discharge
Downgradient Groundwater in Overburden in Plumes A-G	Directed groundwater recirculation; injected permeable reactive barriers	Study to support remedial system design; hydraulic conductivity studies.	Additional extraction/injection wells, large diameter wells, recharge galleries, horizontal wells; pump and treat with NPDES discharge
Plumes I, J, and K	Monitored natural attenuation; land use controls	Not Applicable.	Permeable reactive barriers

Table 8-3 – Estimated Cost of the Preferred Alternatives

Remedial Grouping	Preferred Alternative	Present Value Cost†
Unsaturated Soil – Plume A	Thermal treatment	$3,900,000
Unsaturated Soil - Plume B	Excavation and off-site disposal	$3,300,000
Saturated and Unsaturated Soil – Plume C	Thermal Treatment	$4,800,000
Near Source Overburden Groundwater Plumes F and G	Emplaced Reactive Barriers	$10,700,000
Downgradient Groundwater in Plumes D, E, F and G	Injected Reactive Barriers	$3,900,000
Groundwater in OU1 and OU2	Directed Groundwater Recirculation	$54,500,000
Plumes I, J, and K	Environmental Use Control	$10,000
Groundwater in OU1 and OU2 (22 years)	Groundwater Monitoring and Well Maintenance	$6,800,000
Indoor Air	Indoor Air Monitoring	$1,500,000
-----	Administrative and Professional Fees	$5,800,000
$95,210,000		

†Present Value Cost includes engineering, project management, QA/QC, and 15% contingency.
‡Cost estimates prepared by Dragun Corporation and/or Olssen Associates based on conceptual remediation design. Costs will be refined during the Corrective Action Plan/Remedial Design Phase. The subtotals and totals are rounded to reflect the budgetary nature and level of certainty inherent in this cost estimate. The cost estimate has been prepared for budgetary purposes only and should not be considered a quote for the scope of work discussed above. Prior to commencement of the work, firm bids shall be taken from and contracts signed with a qualified environmental contractor and laboratory for the pay items listed. Cost estimates were not reviewed by KDHE.

FIGURES

Figure 2-1 – Site Location

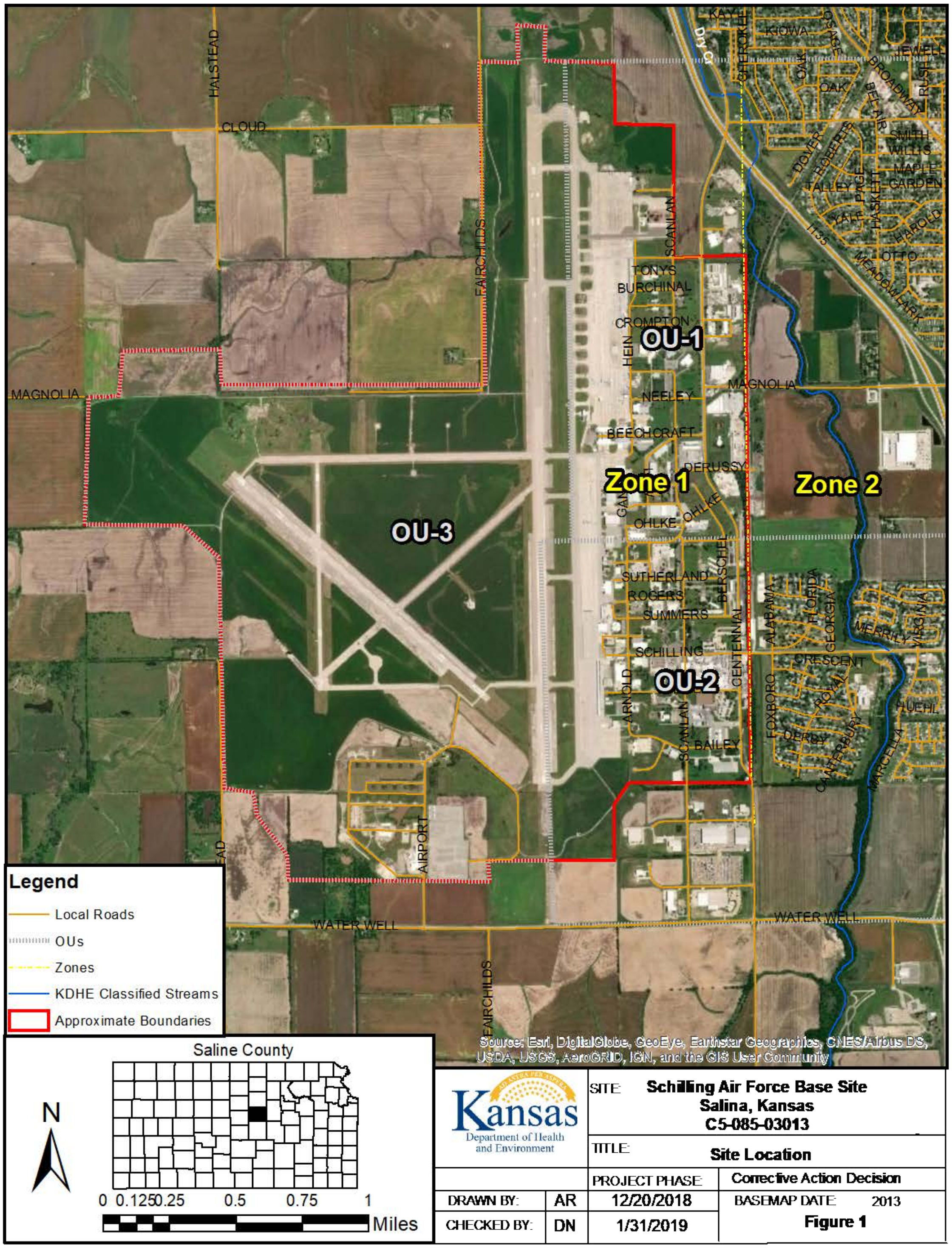


Figure 2-2 – Site Zoning Districts

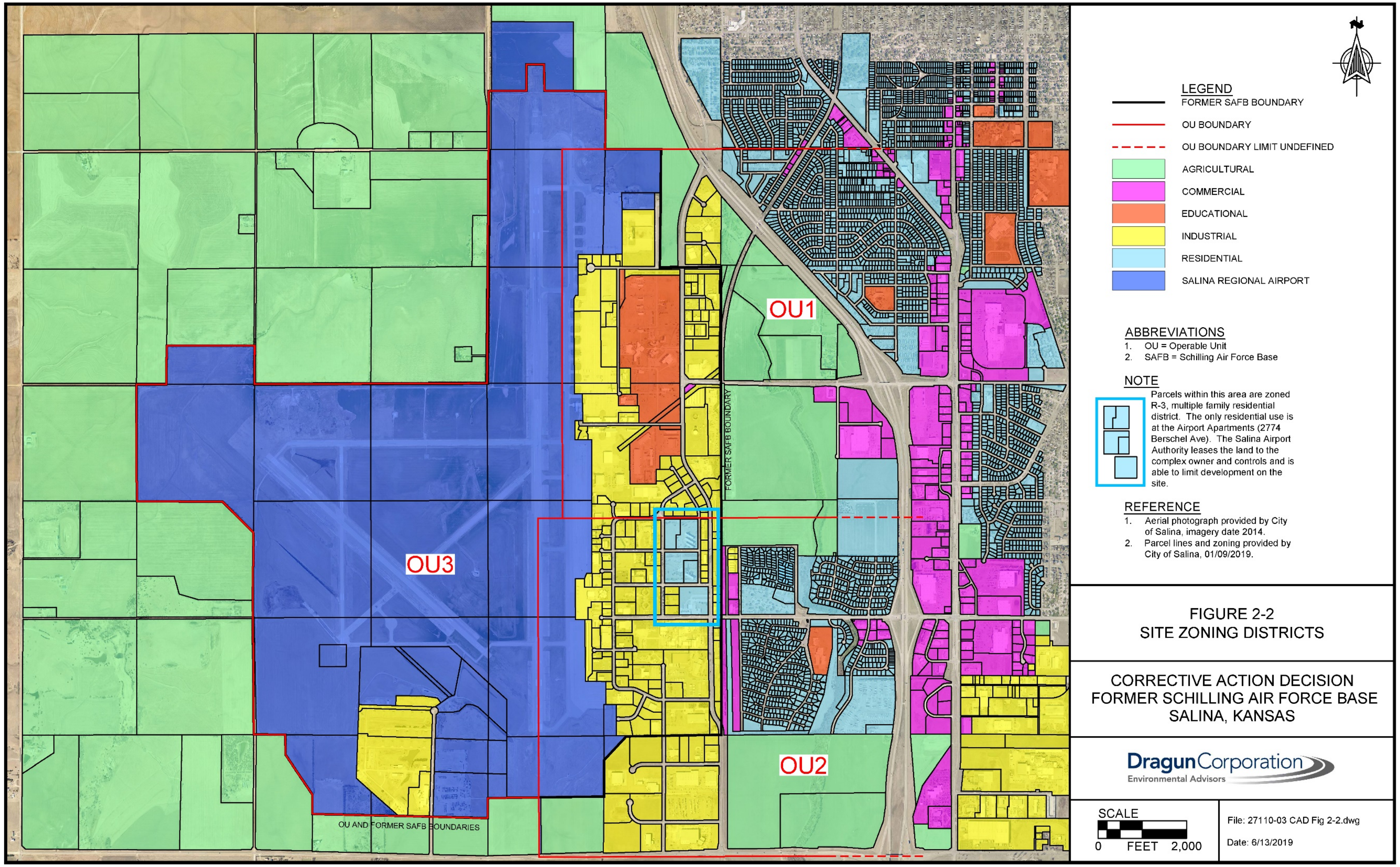


Figure 2-3 – Property Ownership

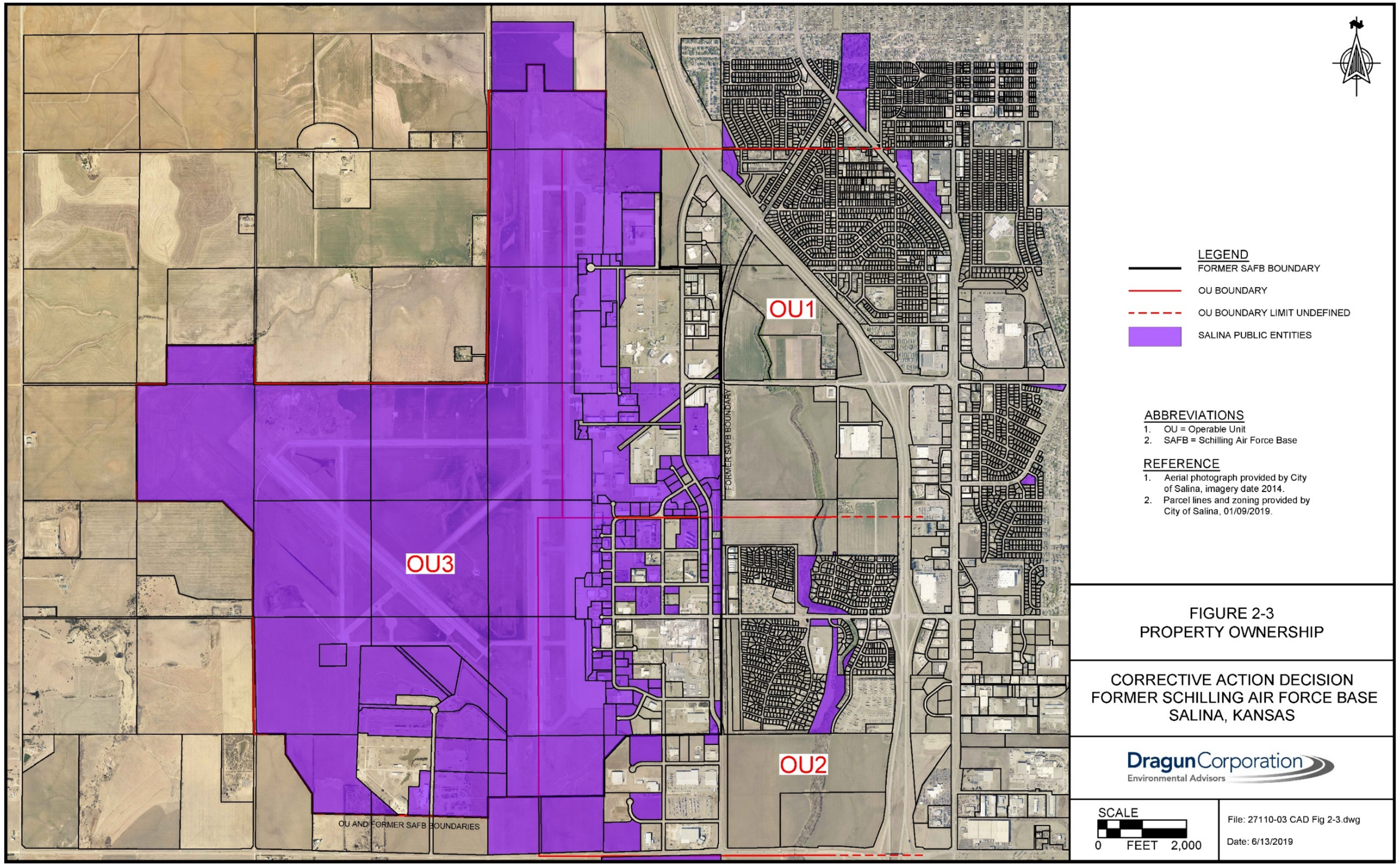
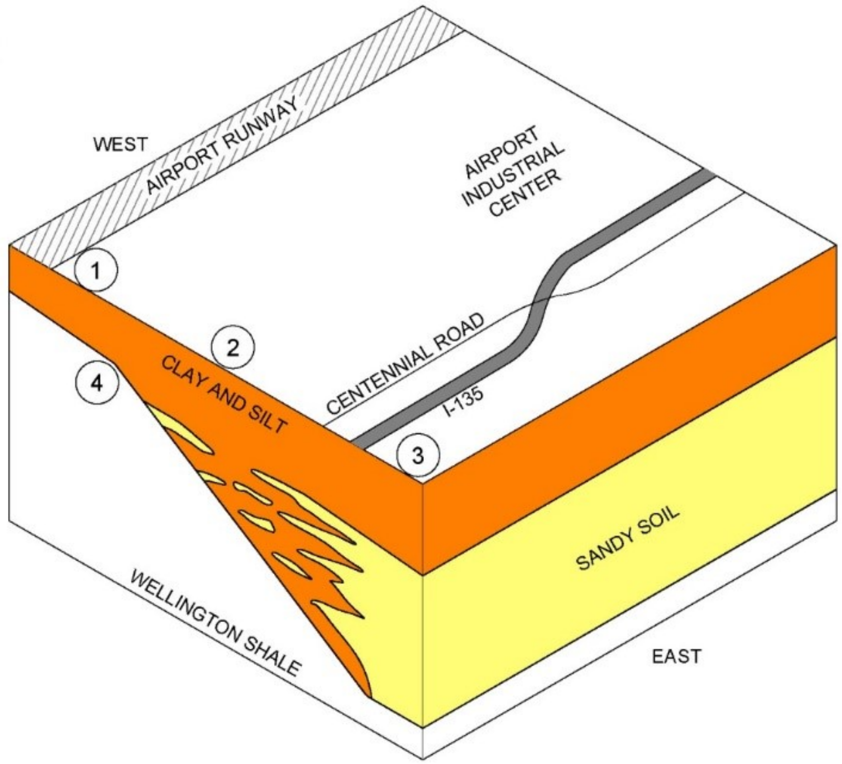


Figure 3-1 – Conceptual Site Model: Geology



GEOLOGY	
AREA	DESCRIPTION
1	Silty clay overburden
2	Meander deposits, dominantly silty clay transitioning to dominantly sandy soil
3	Meander deposits dominantly sandy soil
4	Wellington Shale

Figure 3-2 – Overburden Potentiometric Surface

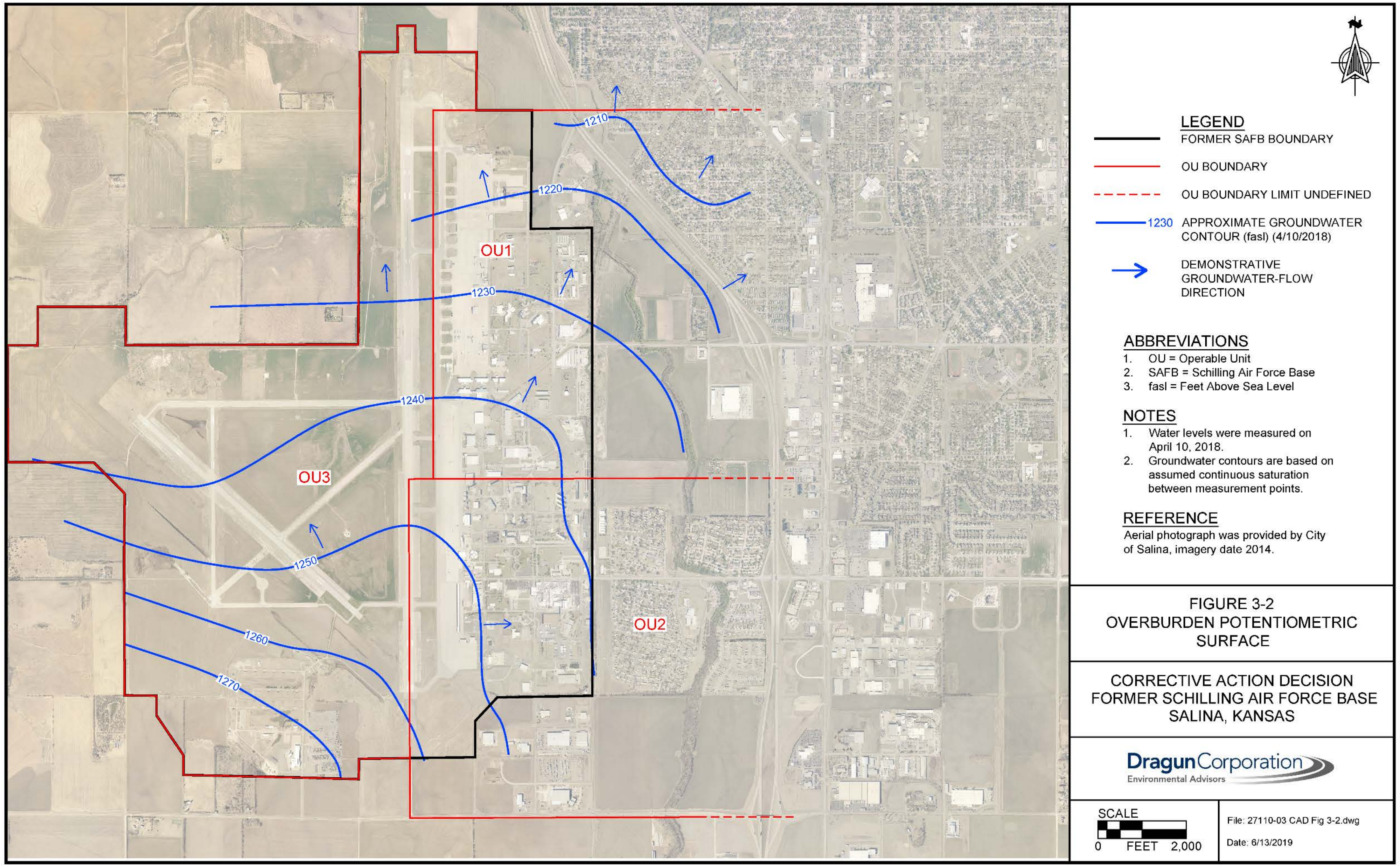


Figure 3-3 – Bedrock Potentiometric Surface

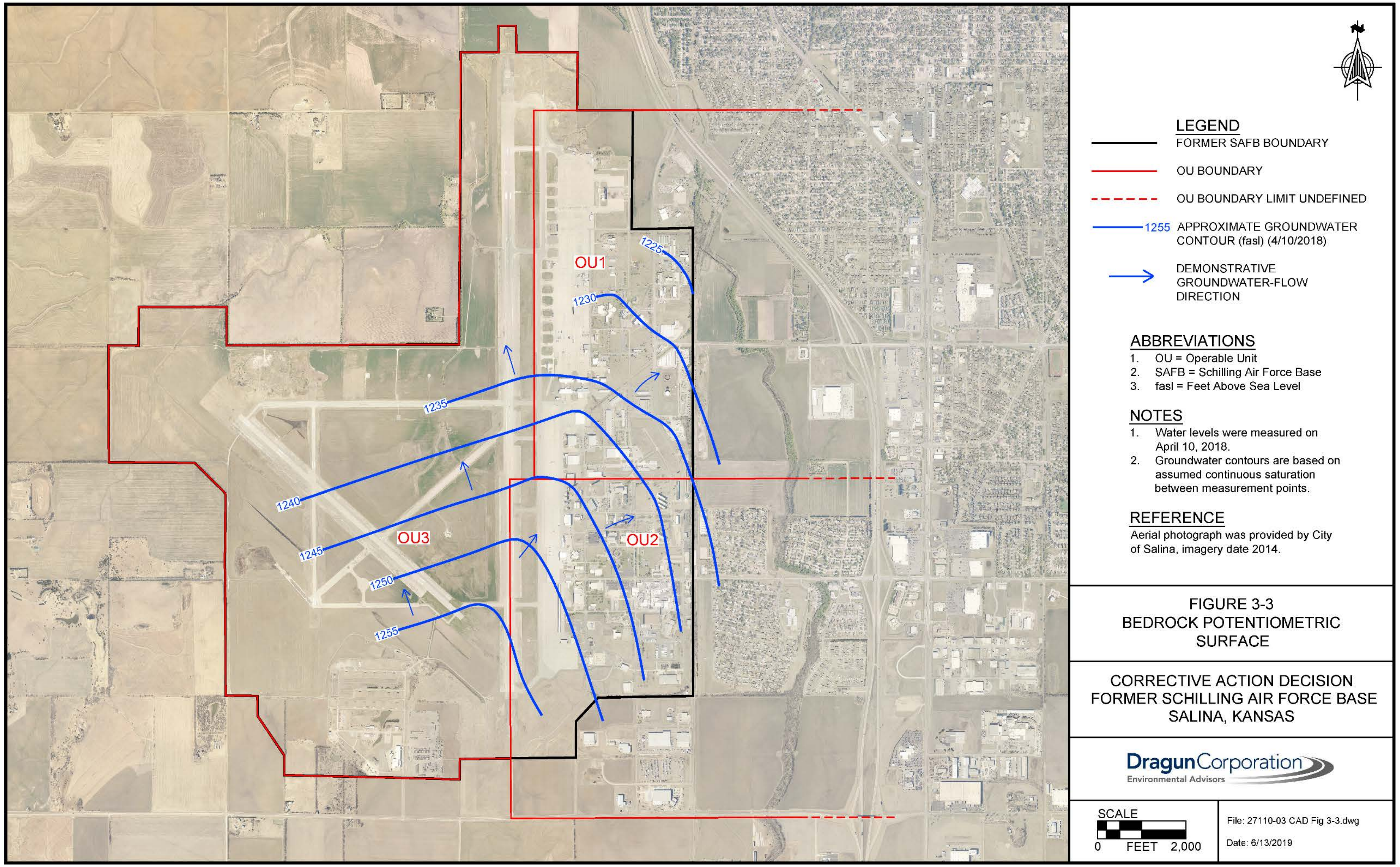


Figure 3-4 – OU-1 Overburden Groundwater Plumes and Source Areas

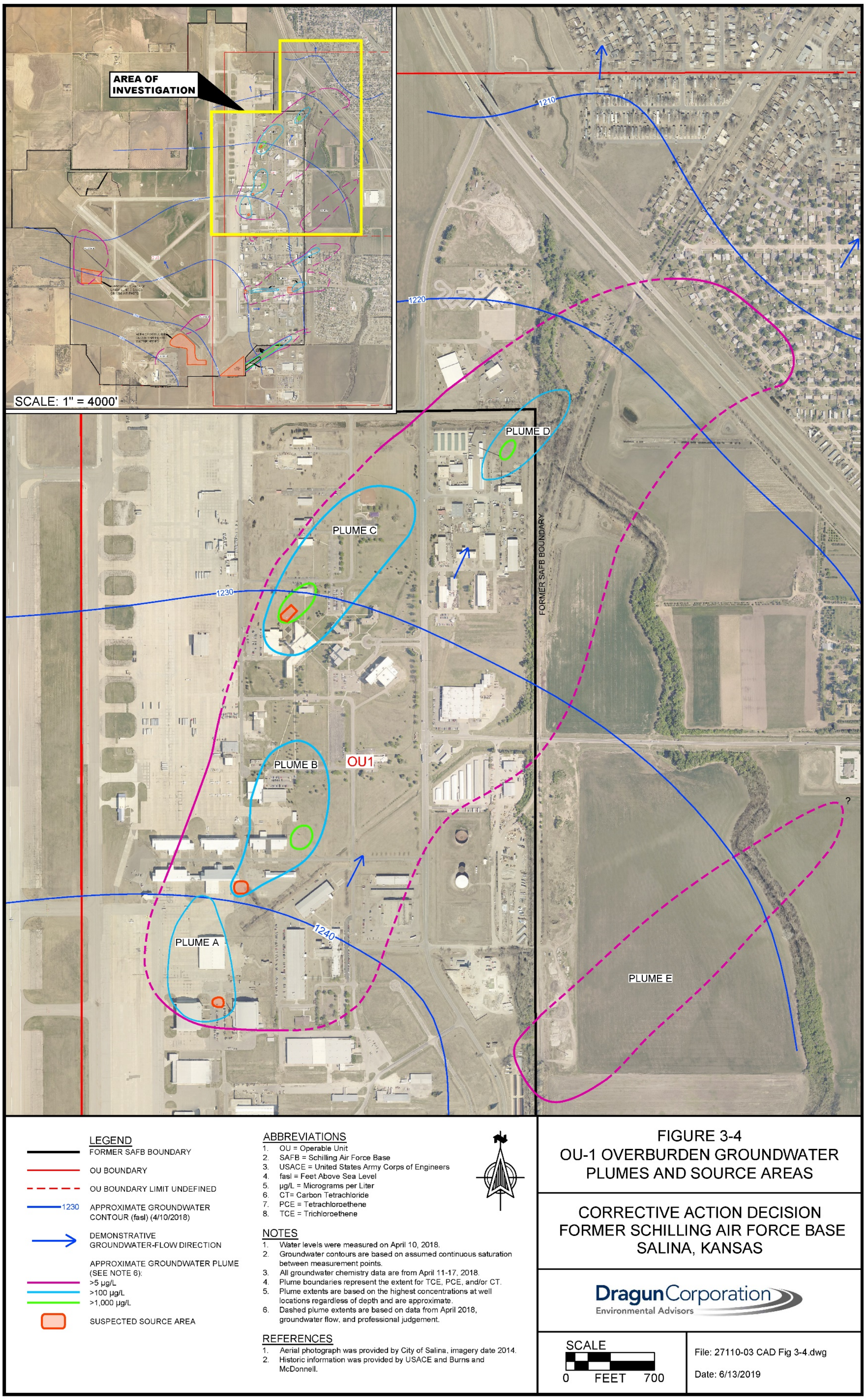
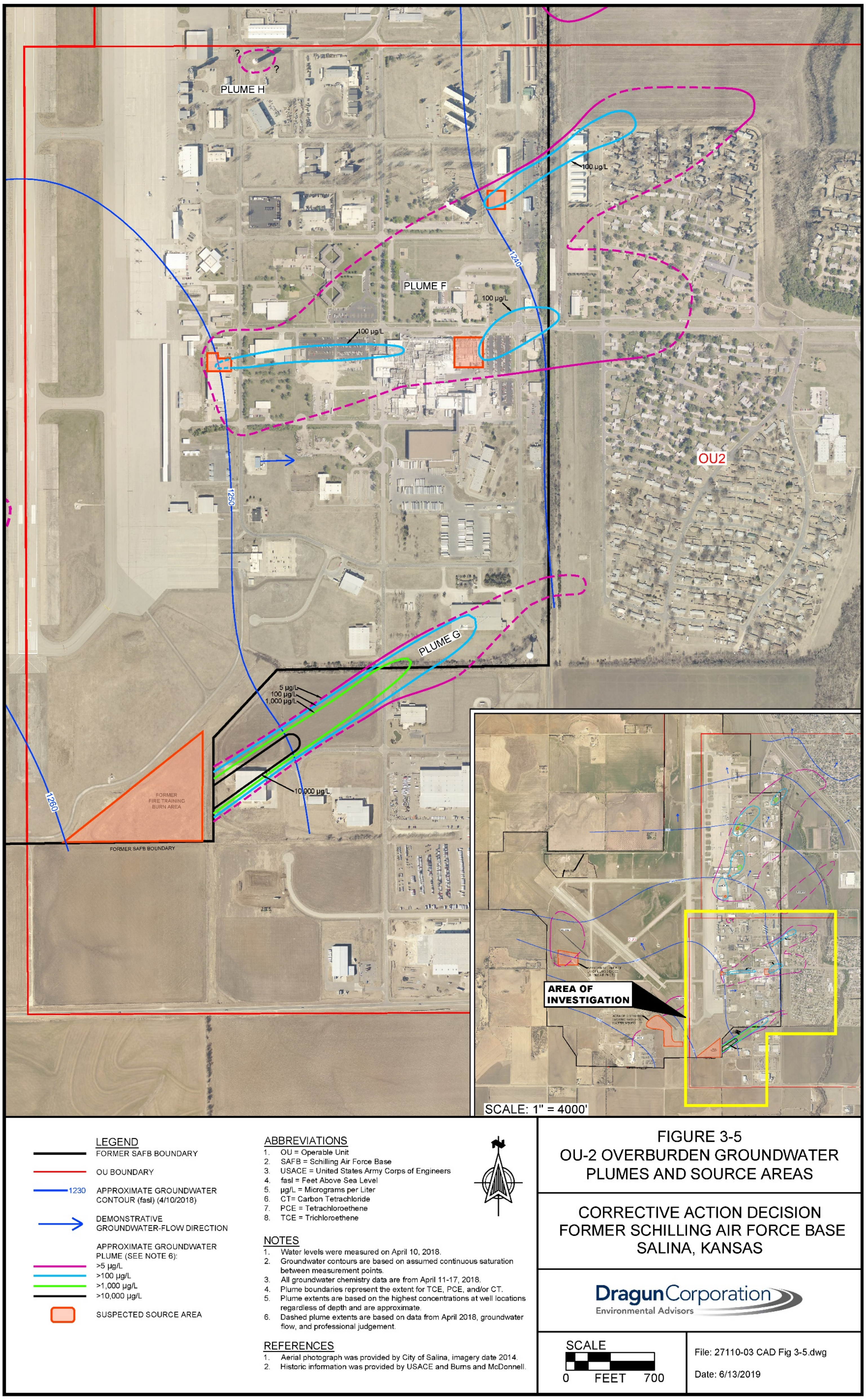


Figure 3-5 – OU-2 Overburden Groundwater Plumes and Source Areas



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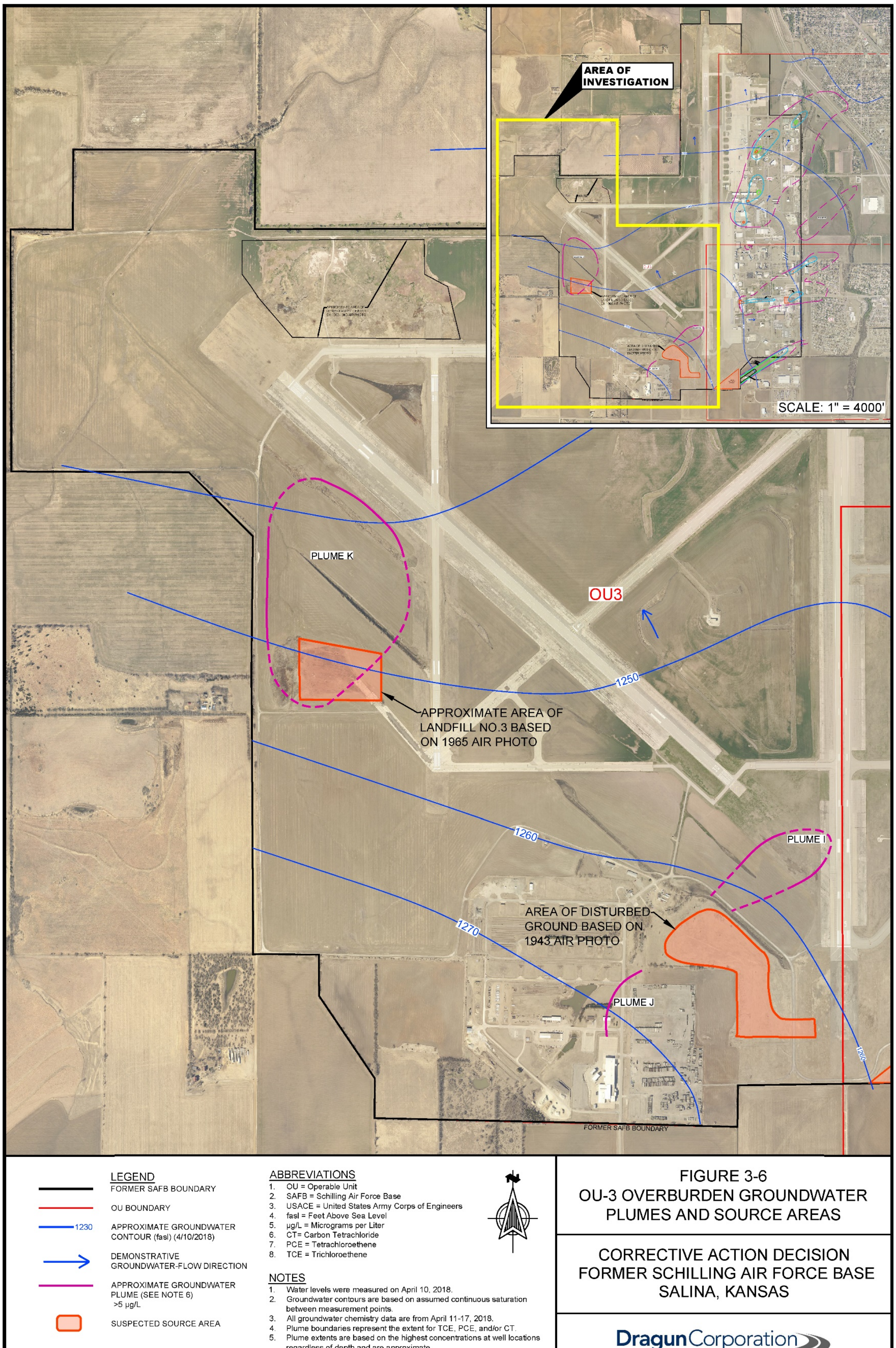
Environmental Remediation

Figure 3-6 – OU-3 Overburden Groundwater Plumes and Sources



ABBREVIATIONS
1. OU = Operable Unit
2. SAFB = Schilling Air Force Base
3. USACE = United States Army Corps of Engineers
4. fasl = Feet Above Sea Level
5. µg/L = Micrograms per Liter
6. CT= Carbon Tetrachloride
7. PCE = Tetrachloroethene
8. TCE = Trichloroethene

NOTES
1. Water levels were measured on April 10, 2018.
2. Groundwater contours are based on assumed continuous saturation between measurement points.
3. All groundwater chemistry data are from April 11-17, 2018.
4. Plume boundaries represent the extent for TCE, PCE, and/or CT.
5. Plume extents are based on the highest concentrations at well locations regardless of depth and are approximate.
6. Dashed plume extents are based on data from April 2018, groundwater flow, and professional judgement.

REFERENCES
1. Aerial photograph was provided by City of Salina, imagery date 2014.
2. Historic information was provided by USACE and Burns and McDonnell.

FIGURE 3-6
OU-3 OVERBURDEN GROUNDWATER PLUMES AND SOURCE AREAS

CORRECTIVE ACTION DECISION
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

DragunCorporation
Environmental Advisors

SCALE
0 FEET 1,000

File: 27110-03 CAD Fig 3-6.dwg

Date: 6/13/2019

Figure 3-7 – OU-1 Contaminants in Soil

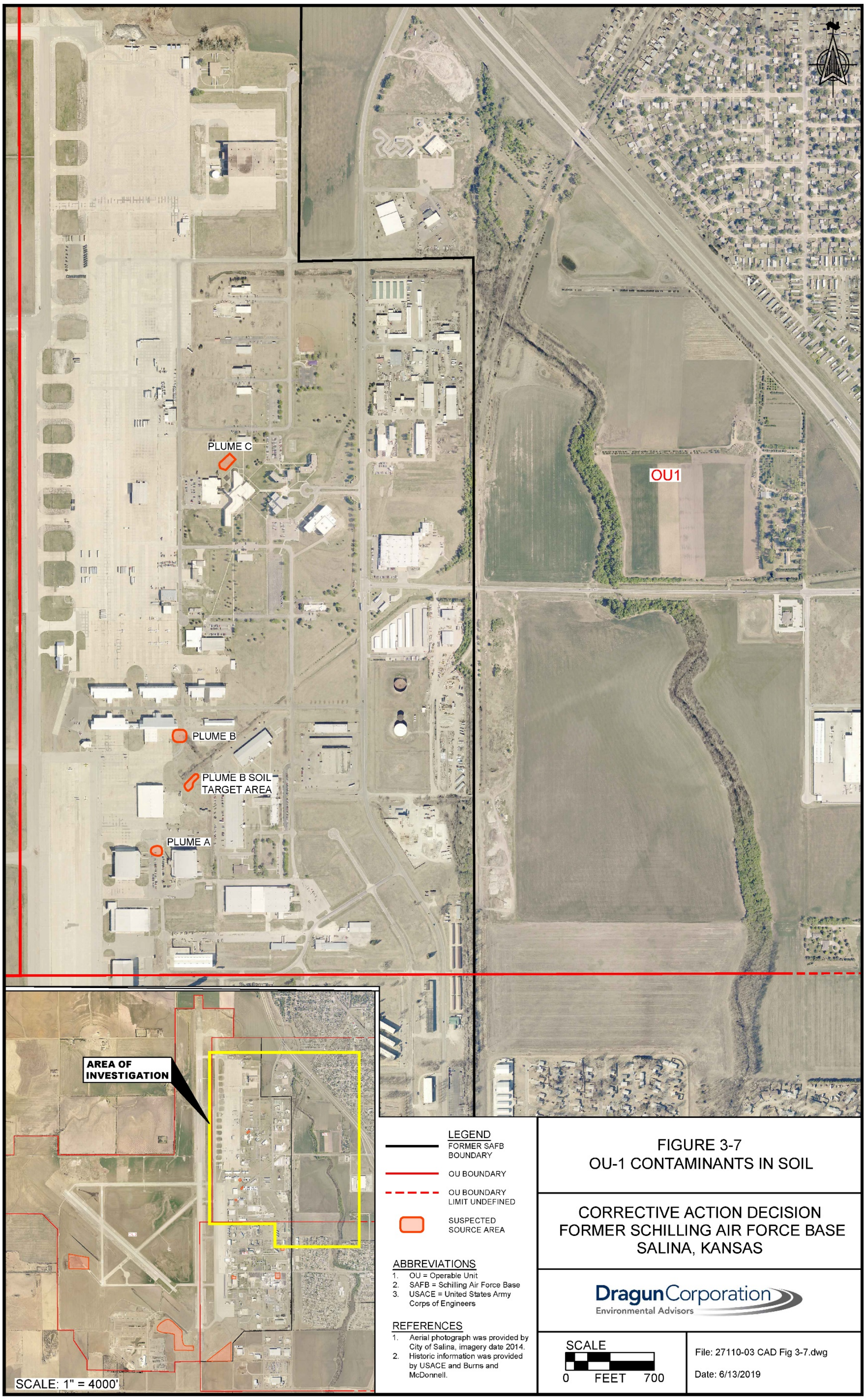


Figure 3-8 – OU-2 Contaminants in Soil

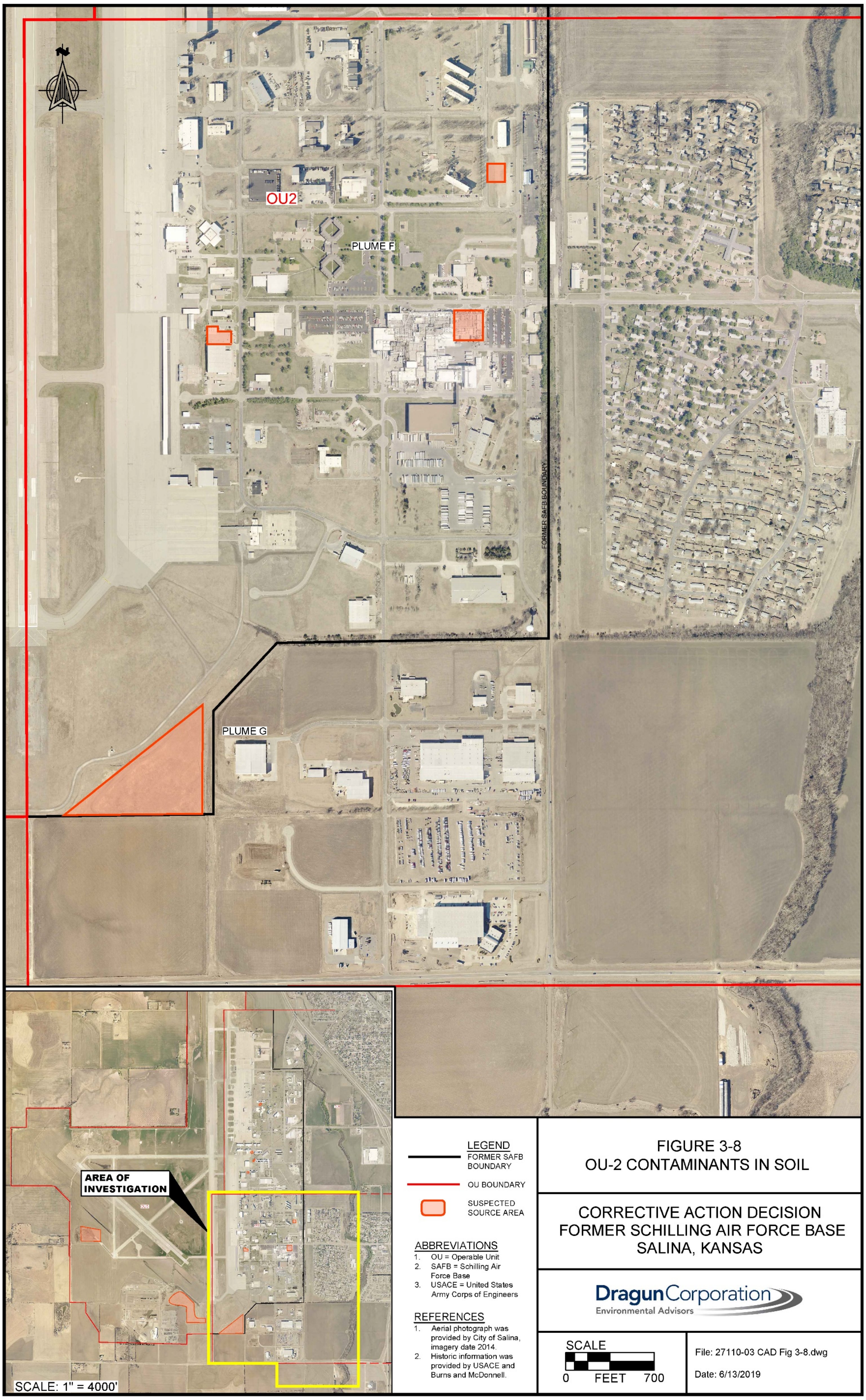


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Figure 3-9 – OU-3 Contaminants in Soil

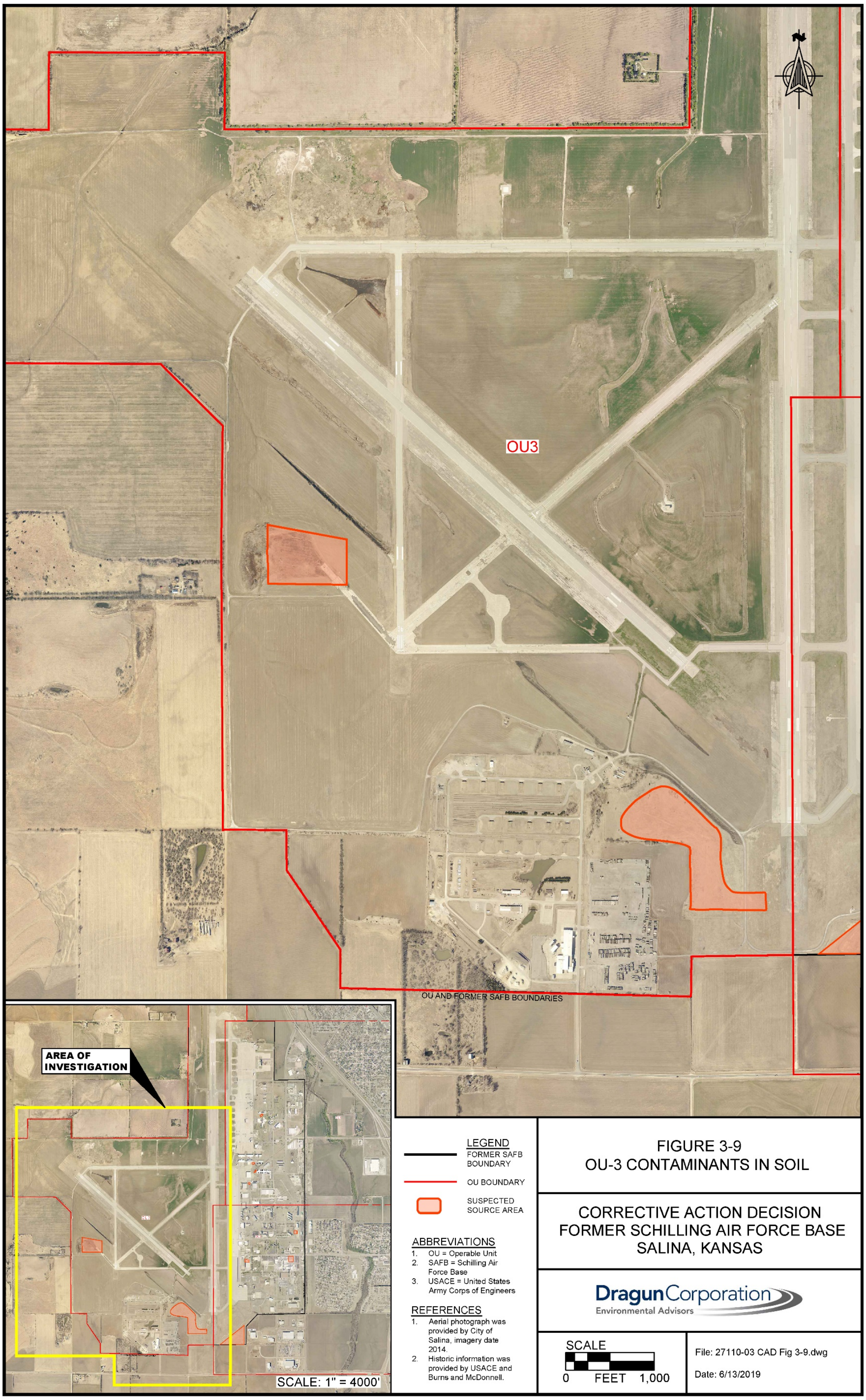

Figure 3-10 – OU-1 Contaminants in Overburden Groundwater

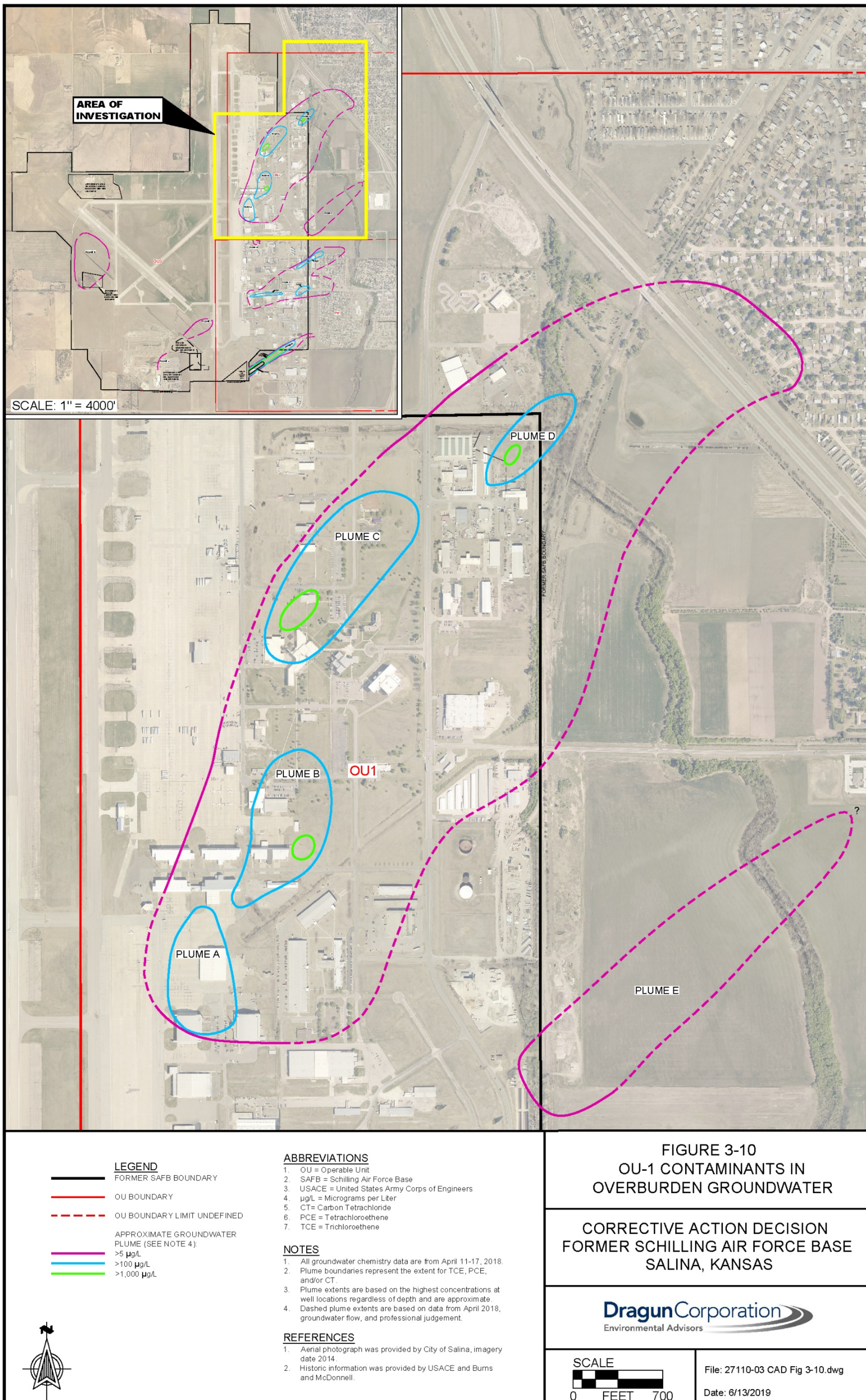

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Figure 3-11 – OU-2 Contaminants in Overburden Groundwater

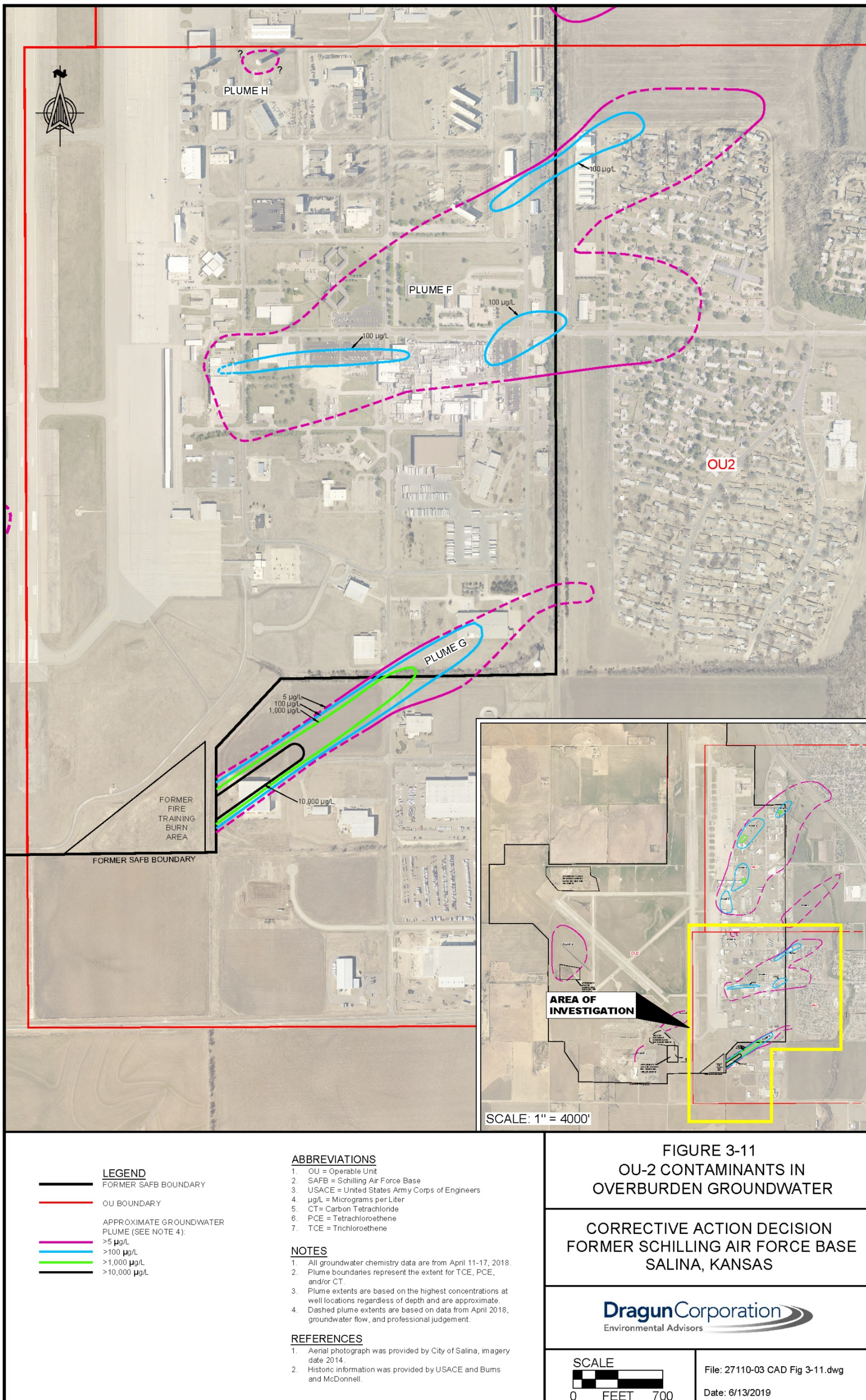

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Figure 3-12 – OU-3 Contaminants in Groundwater

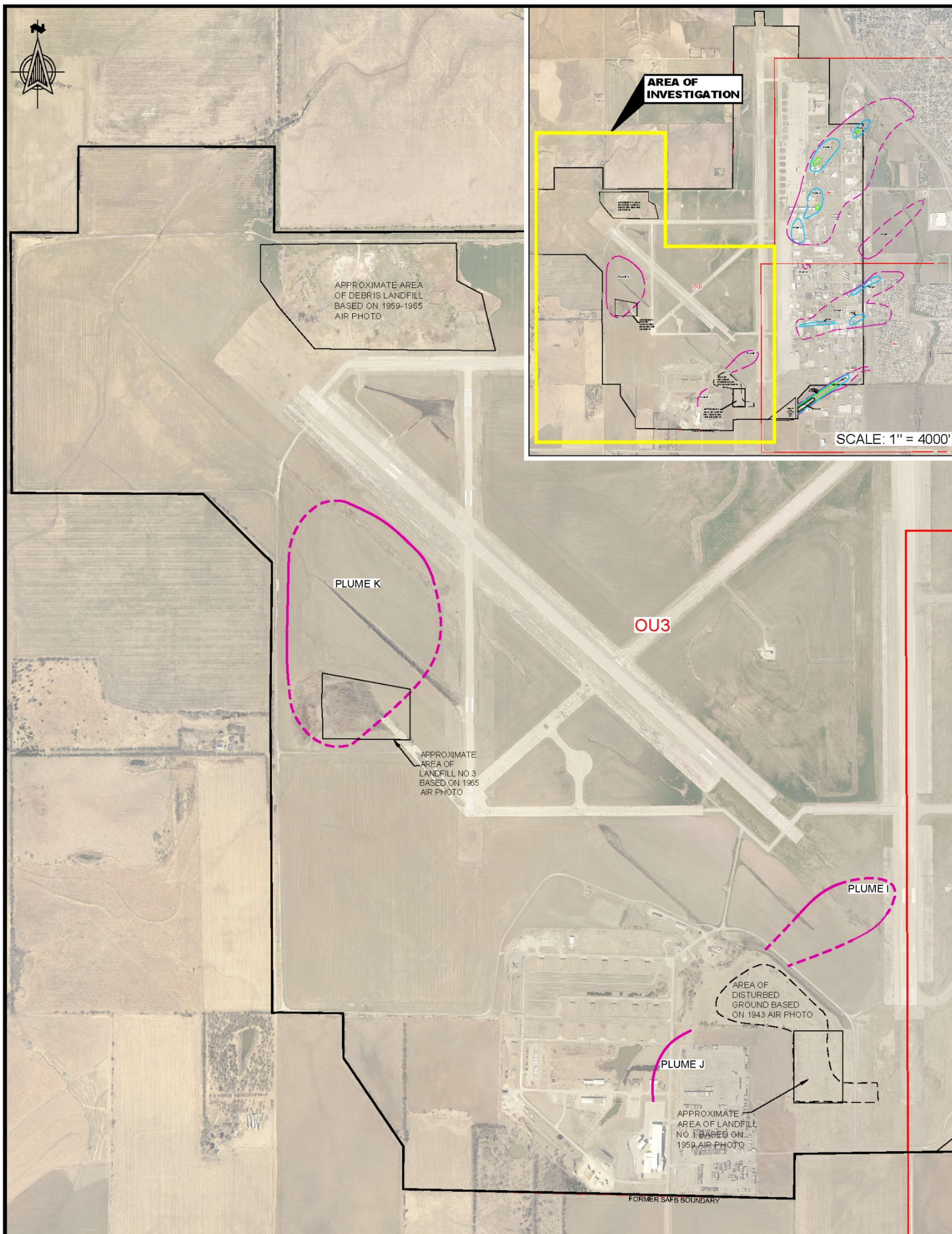


FIGURE 3-12
OU-3 CONTAMINANTS IN OVERBURDEN GROUNDWATER

CORRECTIVE ACTION DECISION
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Dragun Corporation
Environmental Advisors

SCALE
0 FEET 1,000

File: 27110-03 CAD Fig 3-12.dwg

Date: 6/13/2019

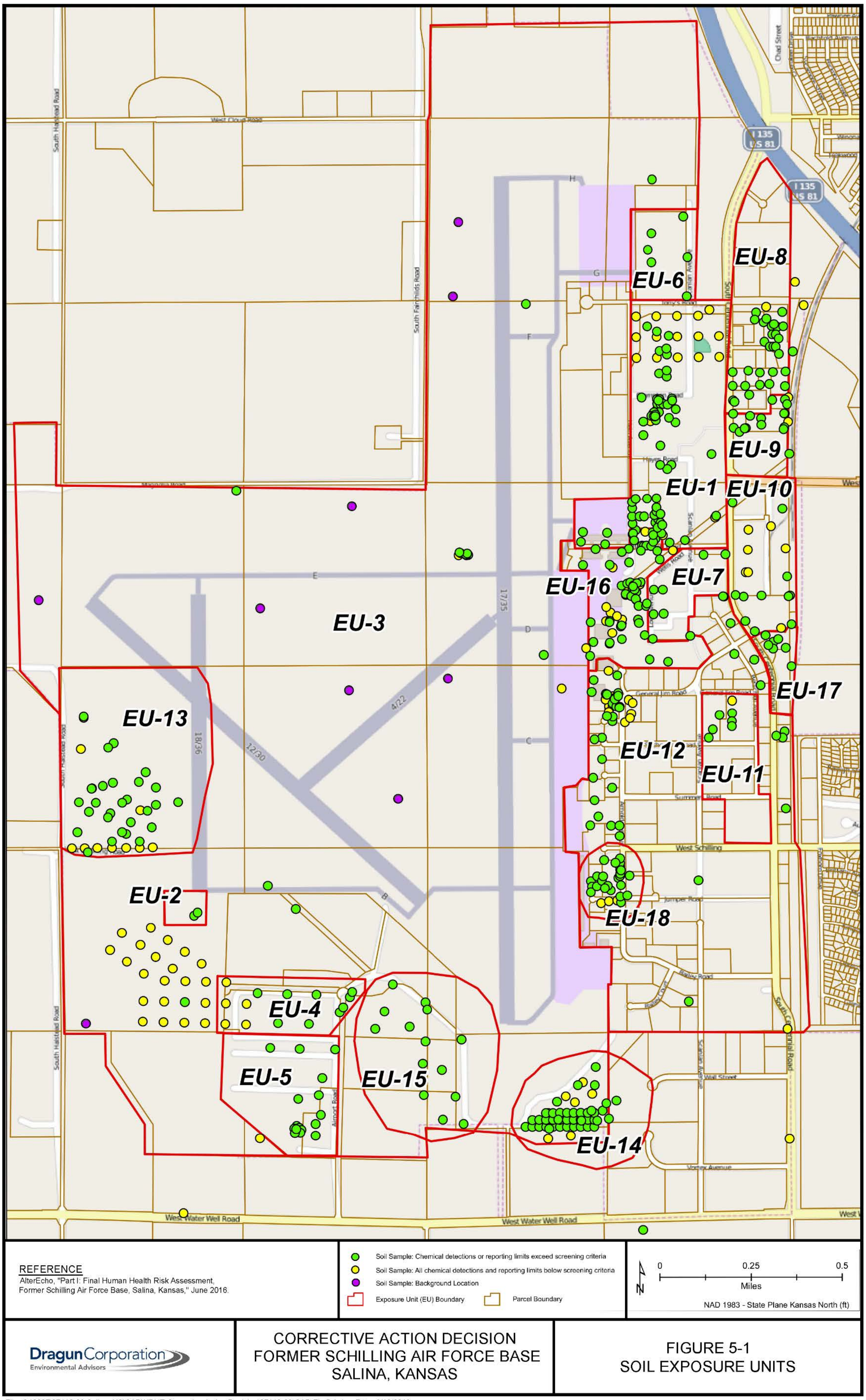
LEGEND
FORMER SAFB BOUNDARY
OU BOUNDARY
APPROXIMATE GROUNDWATER PLUME (SEE NOTE 4) >5 µg/L

ABBREVIATIONS
1. OU = Operable Unit
2. SAFB = Schilling Air Force Base
3. USACE = United States Army Corps of Engineers
4. µg/L = Micrograms per Liter
5. CT= Carbon Tetrachloride
6. PCE = Tetrachloroethene
7. TCE = Trichloroethene

NOTES
1. All groundwater chemistry data are from April 11-17, 2018.
2. Plume boundaries represent the extent for TCE, PCE, and/or CT.
3. Plume extents are based on the highest concentrations at well locations regardless of depth and are approximate.
4. Dashed plume extents are based on data from April 2018, groundwater flow, and professional judgement.

REFERENCES
1. Aerial photograph was provided by City of Salina, imagery date 2014.
2. Historic information was provided by USACE and Burns and McDonnell.

Figure 5-1 – Soil Exposure Units



File: O:\2007\27110-03 Salina, KS\CAD\KDHE Corrective Action Decision\27110-03 CAD Fig 5-1.dwg Date: 6/13/2019

Figure 5-2 – Soil Exposure Units and Groundwater Plumes

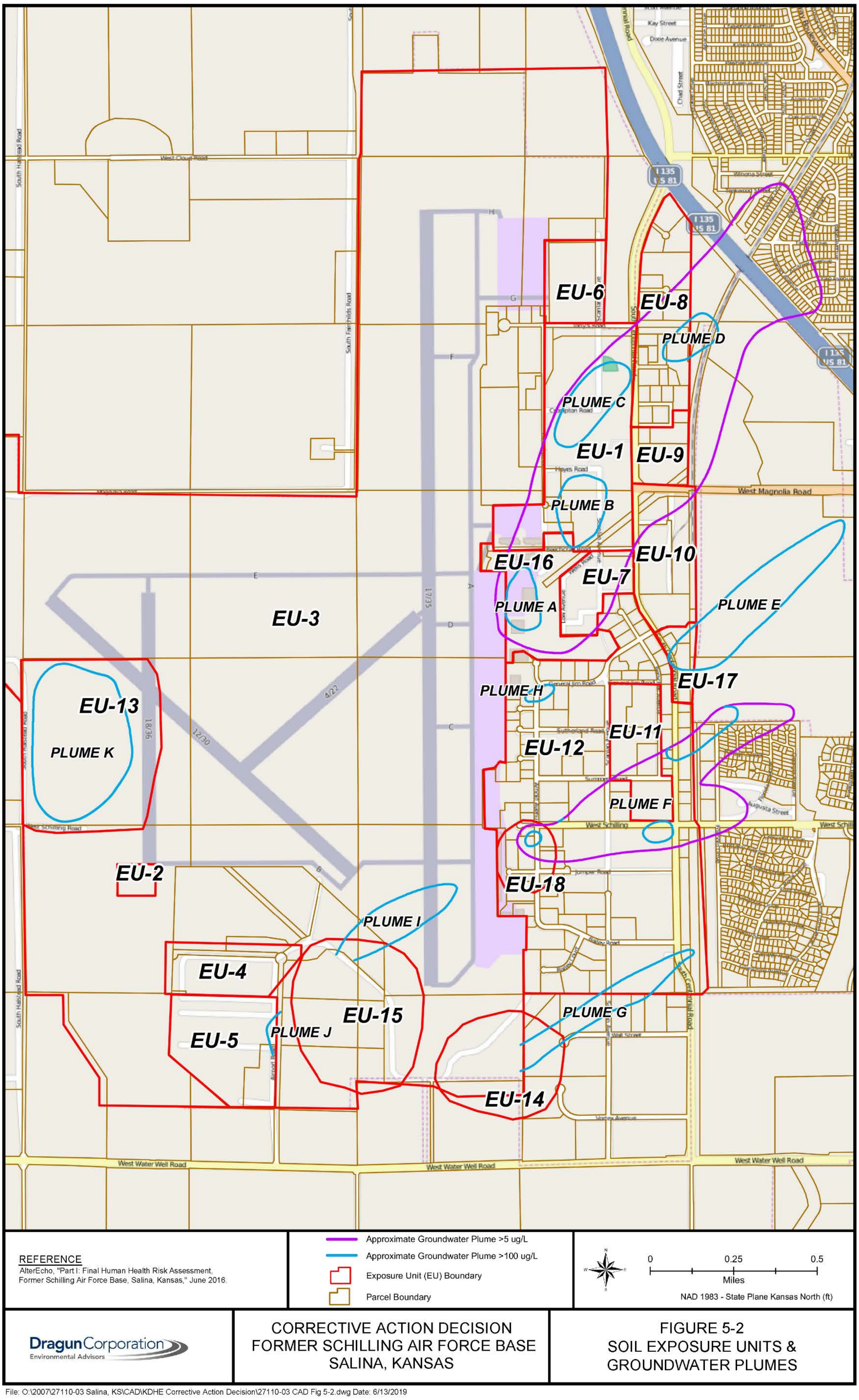


Figure 5-3 – Surface Water and Sediment Exposure Units

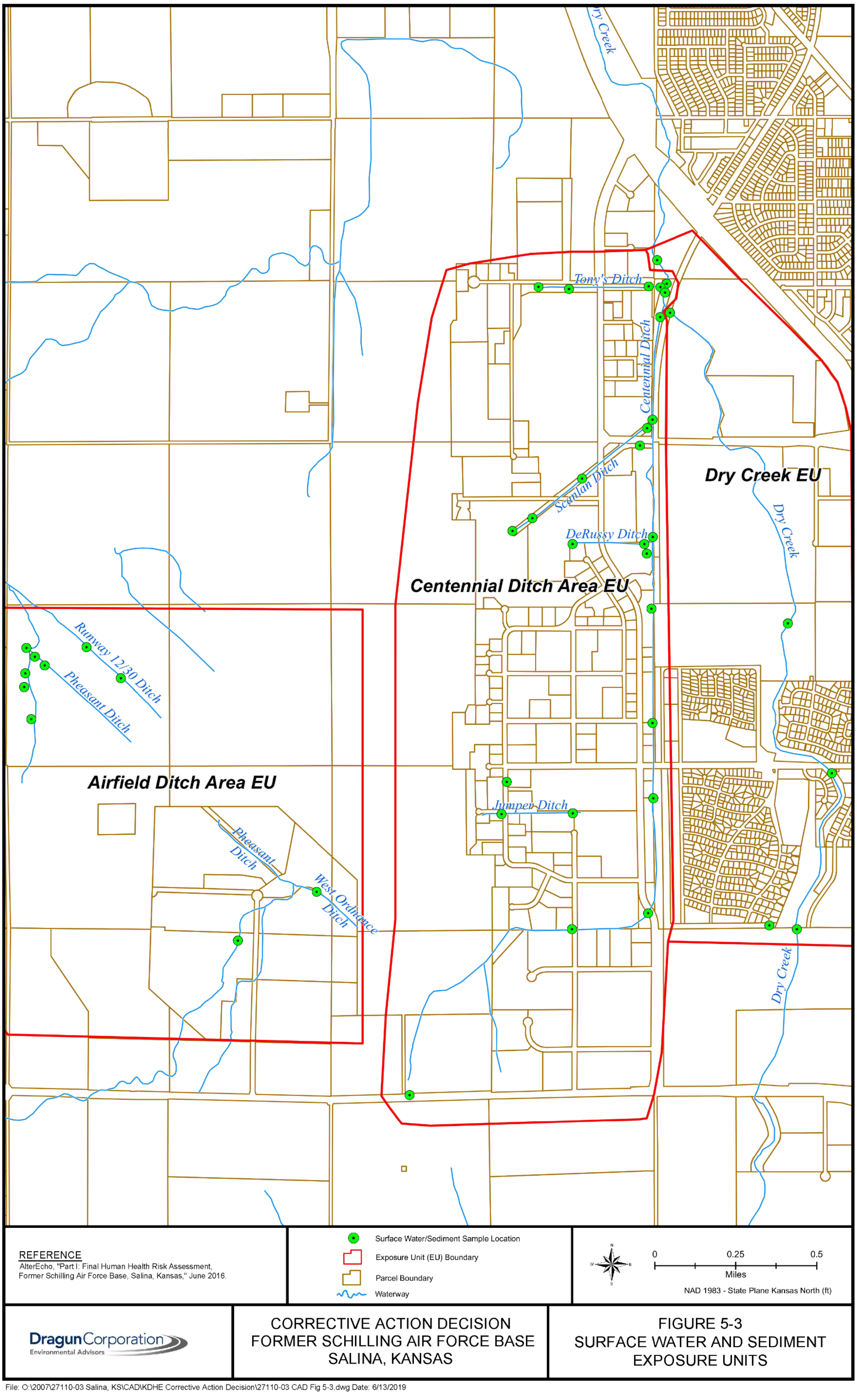


Figure 8-1 – Preliminary Configuration of Selected Remedy: Overburden Soil and Groundwater

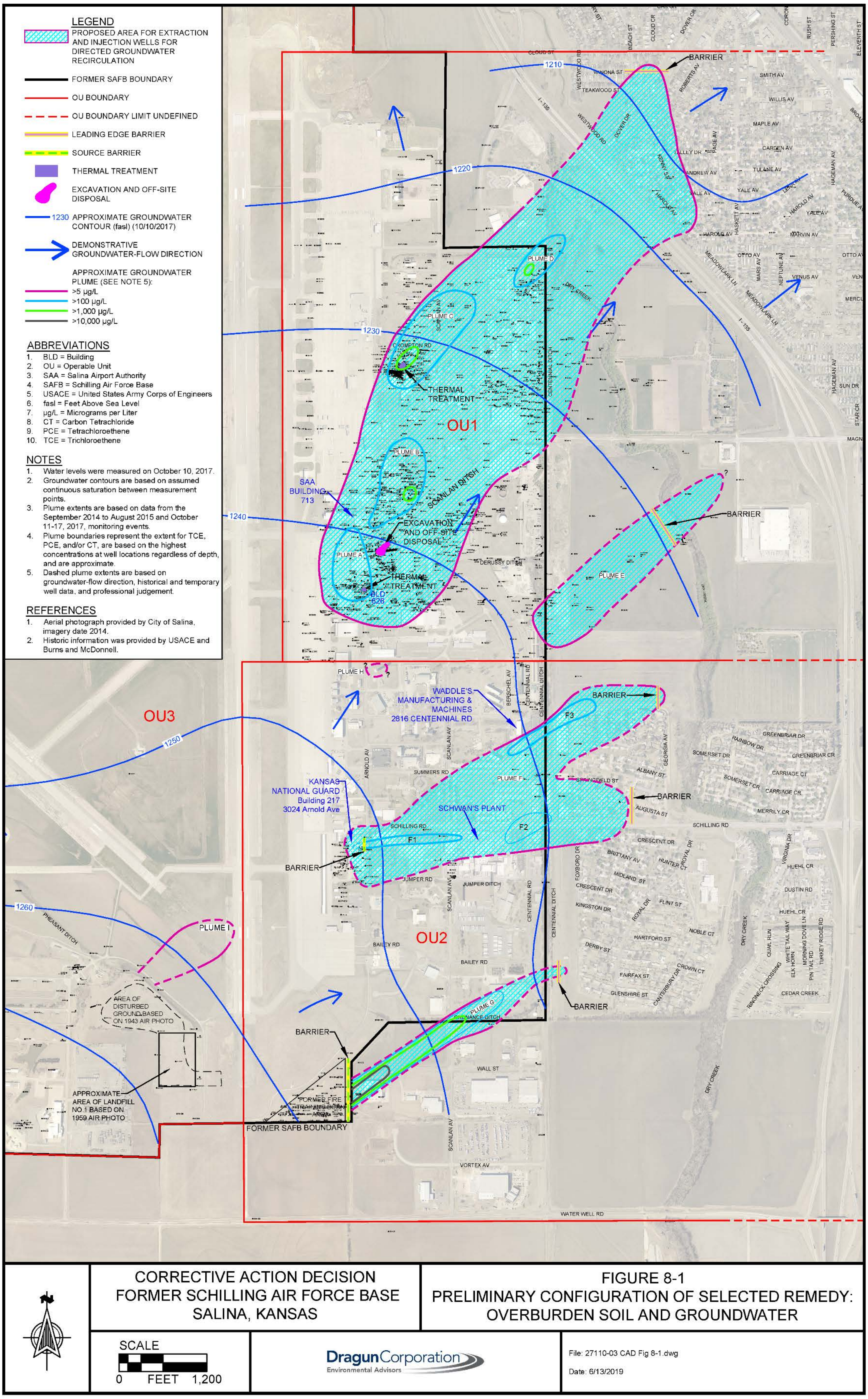


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Figure 8-2 – Preliminary Configuration of Selected Remedy: Bedrock Groundwater