DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER

December 21, 2016

MEMORANDUM FOR: New York State Department of Environmental Conservation
Attn: Mr. Daniel Eaton
Bureau of Eastern Remedial Action
625 Broadway, 12th Floor
Albany, NY 12233-7015

FROM: AFCEC/CIBE-Plattsburgh
8 Colorado Street, Suite 121
Plattsburgh, NY 12903

SUBJECT: Final Corrective Action Plan: UST-2009, UST-2704, and UST-3580, Former Plattsburgh Air Force Base

Attached for your information is the Final Corrective Action Plan: UST-2009, UST-2704, and UST-3580 for the Former Plattsburgh Air Force Base. Per your December 15, 2016 email, the NYSDEC had no questions or comments on the work proposed in the draft plan.

If you have any questions, please contact me at 518-563-2871 or david.farnsworth@us.af.mil.

DAVID S. FARNSWORTH
Program Manager/BRAC Environmental Coordinator
BRAC Program Execution Branch

Attachments:
1. Final Corrective Action Plan
2. Distribution List

Former Plattsburgh Air Force Base

FINAL CORRECTIVE ACTION PLAN: UST-2009, UST-2704, AND UST-3580

Former Plattsburgh Air Force Base

Plattsburgh, New York

December 2016

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FINAL CORRECTIVE ACTION PLAN: UST-2009, UST-2704, AND UST-3580

Plattsburgh Air Force Base

Plattsburgh, New York

Prepared for:

United States Air Force

Prepared by:

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CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AHA	Activity Hazard Analysis
Arcadis	Arcadis of New York, Inc.
bgs	Below ground surface
BRAC	Base Realignment and Closure
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	Chemicals of concern
DOT	Department of Transportation
DPT	Direct push technology
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
IC	Institutional controls
ISCO	In-situ chemical oxidation
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
MNA	Monitored natural attenuation
MS/MSD	Matric spike/matric spike duplicate
PA/SI	Preliminary assessment/site investigation
PAH	Polycyclic aromatic hydrocarbons
PID	Photo-ionization detector
POTW	Publicly-Owned Treatment Works
PPE	Personal protective equipment
psi	Pounds per square inch
PVC	Polyvinyl chloride
QA/QC	Quality assurance/quality control
RI	Remedial investigation
SCG	Standards, criteria and guidance

SCOs	Soil Cleanup Objectives
SDS	Safety Data Sheet
SSHP	Site Safety and Health Plan
SVOCs	Semi-Volatile organic compounds
TCLP	Toxicity Characteristic Leaching Procedure
TOGs	Technical and Operational Guidance Series
TWP	Temporary well points
μg/L	Micrograms per liter
USAF	United States Air Force
UST	Underground storage tank
VOCs	Volatile organic compounds

1 INTRODUCTION

Arcadis of New York, Inc. (Arcadis) has prepared this Corrective Action Plan (CAP) on behalf of United States Air Force (USAF) to present a feasibility evaluation and remedial action plan for soil and groundwater at the underground storage tank (UST) sites UST-2009, UST-2704, and UST-3580 located at the former Plattsburgh Air Force Base (AFB), Plattsburgh, New York (site, **Figure 1**).

The former Plattsburgh AFB was closed in 1995 as part of the third round of base closures mandated by the Base Realignment and Closure (BRAC) process. The Installation Restoration Program is being implemented according to Federal Facilities Agreement, Docket No. II-CERCLA-FFA-10201, signed between the Air Force, the United States Environmental Protection Agency, and the New York State Department of Environmental Conservation (NYSDEC) on July 10, 1991. The former Plattsburgh AFB was placed on the National Priorities List on November 21, 1989 (USEPA ID# NY4571924774). The USAF's programmatic goal is to achieve unrestricted use for the UST sites under the NYSDEC tank closure guidance.

As reported in previously performed Remedial Investigation Reports (Tetra Tech 2015b, Tetra Tech 2015d, and Tetra Tech 2015f), constituents were detected at concentrations that exceed the NYSDEC standards for soil at sites UST-2009 and UST-2704 and for groundwater at UST-2009 and UST-3580. To remediate the residual concentrations in soil, an in-situ chemical oxidation (ISCO) injection approach will be implemented at UST-2009 and UST-2704. To address constituents in groundwater at UST-3580, a monitored natural attenuation (MNA) approach will be used.

This CAP conforms to the standards established in the NYDEC Technical Guidance for Site Investigation and Remediation (DER-10). The following standards, criteria and guidance (SCGs) were selected for the soil and groundwater for the UST sites:

- Title 6 of the New York Codes, Rules, and Regulations (NYCRR) Part 703.6, Groundwater effluent limitations for discharges to Class GA waters;
- NYCRR Part 375, Environmental Remediation Programs;
- NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1, Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations;
- NYSDEC Commissioners Policy – 51, Soil Cleanup Guidance; and
- Soil Cleanup Objectives (SCOs), 6 NYCRR Table 375-6.8(a); Unrestricted Use SCOs.

This CAP provides a brief evaluation of the selection and description of the remedial approach for each of the UST sites. Accordingly, it includes site description and history (Section 2), feasibility evaluation (Section 3), a description of the selected remedial action for each UST site (Section 4), schedule (Section 5) and references (Section 6).

2 SITE DESCRIPTION AND HISTORY

2.1 Site Setting

The former Plattsburgh AFB is located in the Champlain Lowlands in Plattsburgh, New York. The topography at the former Plattsburgh AFB generally slopes gently to the east toward Lake Champlain with a portion to the Saranac River to the north and the Salmon River to the south. Shallow groundwater flow is generally parallel to the ground surface topography with some exceptions due to subsurface structures and utilities. The average annual rainfall for Plattsburgh is 29.4 inches. The average annual temperature at Plattsburgh is 44 degrees Fahrenheit.

The lithological units at the former Plattsburgh AFB are glaciomarine and glaciolacustrine sand, glaciomarine and glaciolacustrine silt and clay, glacial till, and bedrock, with varying thicknesses throughout the base (USAF 2004). At site UST-2009, shallow groundwater flows generally to the southeast and the water table is approximately eight feet below ground surface (bgs). At site UST-2704, shallow groundwater flows generally to the southeast and the water table is approximately four to six feet bgs. Shallow geology at site UST-2704 consists of sandy loam at the surface to approximately one foot bgs, underlain by layers of gray and brown sand to six feet bgs. At site UST-3580, shallow groundwater flows generally to the southwest and the water table is approximately one to two feet bgs. Shallow geology at site UST-3580 consists of asphalt at the surface, underlain by layers of gray and brown sand from approximately 6 inches to 15 feet bgs.

2.2 Environmental Investigations

2.2.1 Site UST-2009

Site UST-2009 is a 200-square foot facility that housed a classified documents incinerator. The site contained a 300-gallon UST (UST-2009), which was located adjacent to Building 2009. UST-2009 was installed in 1970 to store Number 2 fuel oil for the incinerator (USAF 1994). On October 24, 1988, Plattsburgh AFB discovered that the UST-2009 was leaking. The former Plattsburgh AFB estimated that 300 gallons of fuel oil leaked because of the release (NYSDEC Hazardous Material Spill Register number 8806223) (USAF 1994).

As a response to the 1988 release of fuel oil, the USAF installed two product recovery wells in December 1988 and operated them until September 1989. During their operation, the wells recovered 150 gallons of fuel oil (USAF 1997b). The recovery efforts terminated when no additional fuel oil was recoverable. In 1989, USAF removed UST-2009 and associated piping as shown by a 25-square feet excavation in the Final Site Characterization of Underground Storage Tanks Report (Fanning, Phillips & Molnar 1999). The USAF installed an aboveground storage tank (AST-2009) next to the north wall of the building to replace the UST (USAF 1994).

In October and November 1996, the USAF conducted an environmental investigation to characterize groundwater for potential contamination at the site UST-2009. Four groundwater samples from temporary well points (TWPs), three downgradient and one upgradient of the former UST-2009 location, were analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). The groundwater analytical results for these samples showed exceedances of some VOCs and polycyclic aromatic hydrocarbons (PAHs) based on the groundwater cleanup objectives at the time. These groundwater cleanup objectives are equivalent to the current cleanup standards in NYCRR Section 703.6 (Fanning, Phillips & Milnar 1999). Therefore, in May 1997 the USAF installed an additional temporary well point approximately 100 feet downgradient of the observed groundwater contamination. No VOCs and SVOCs were detected in the groundwater sample collected from this temporary well (Fanning, Phillips & Milnar 1999). Soil samples were not collected during these investigations.

In 2013, the USAF performed a preliminary assessment/site investigation (PA/SI) for site UST-2009 (Tetra Tech 2013). The PA/SI recommended the collection of additional groundwater and soil samples to delineate concentrations of VOCs and PAHs at the site. Accordingly, a remedial investigation (RI) was conducted in 2014 and 2015 (Tetra Tech 2015a; Tetra Tech 2015b). The RI identified an area of soil contamination approximately 25 feet to 50 feet downgradient from the former UST with primarily un-impacted soil closer to the former UST location. The distribution of the contamination was in the direction of the groundwater flow to the southeast. One of the groundwater sample locations that was identified to have clean up objective exceedances during the 1996 investigation (03-05-A UST 2009), was found to have no groundwater exceedances based on 2014 samples (UST-2009-04). Additionally, acetone was detected in several soil samples, however, this is considered a laboratory contaminant and not associated with former Plattsburg AFB operations. The soil and groundwater delineation was completed for both horizontal and vertical extent based on the non-impacted sample results. **Figure 2** shows the locations with soil and groundwater exceedances based on the latest results at site UST-2009. The soil and groundwater data were presented in the RI reports (Tetra Tech 2015a and 2015b), and the RI reports recommended a feasibility evaluation for this site to remediate the impacted soil and groundwater in order to achieve site closure.

2.2.2 Site UST-2704

Site UST-2704 contained a 1,500-gallon diesel fuel UST, coated with coal tar enamel. The UST was located north of Building 2704, on a concrete slab. The 1994 Environmental Baseline Survey stated “only storage of hazardous substances or petroleum products occurred in or near the building, but no release or disposal occurred.” The area consists of a manicured lawn that slopes to the southeast. No known Air Force environmental sites are upgradient of site UST-2704.

On April 11, 1996, the USAF excavated and removed the UST and piping from the north side of Building 2704. The excavation perimeter was approximately 94 feet and the depth around the UST was three feet bgs. Groundwater entering the excavation was observed at a depth of three feet bgs. The USAF collected one composite soil sample from the sidewalls of the excavation and one groundwater sample from the bottom of the excavation. These samples were analyzed for VOCs and PAHs. Additional soil was removed on August 14, 1996 after xylenes and naphthalene were detected in a soil waste classification sample at concentrations above the New York State Toxicity Characteristic Leaching Procedure (TCLP) Alternative Guidance Values. In the second confirmation sample, ethylbenzene and xylenes exceeded the New York State TCLP Alternative Guidance Values. No additional soil was removed and the excavation was backfilled. No constituents were detected in the two groundwater samples collected from the excavation.

In 2013, the USAF performed a PA/SI that included a visual site inspection and a records review (Tetra Tech 2013). The PA/SI reported that no active subsurface or overhead utilities are present within the area of investigation (Tetra Tech 2013), and recommended additional soil sampling to evaluate xylene concentrations in soil with respect to the current NYSDEC UST screening criteria. A RI was performed in 2014 and 2015 to determine the presence of xylene in site soils and the distribution of contaminated soil near and downgradient of the former UST (Tetra Tech 2015c; Tetra Tech 2015d).

Figure 3 shows the location of soil samples with analytical results exceeding SCOs based on the latest results at site UST-2704. Analytical results indicated that petroleum constituents from the former UST have migrated downgradient. Additionally, the analytical results of soil samples collected from boring UST-2704-8 suggest that the currently used 500-gallon AST has not contributed to the observed exceedances (Tetra Tech 2015d). Based on the location of soil borings where exceedances of applicable SCOs were observed, petroleum-impacted soil is likely present beneath the building foundation (Tetra Tech 2015d). The RI Report recommended a feasibility evaluation for this site to remediate the impacted soil beneath the building in order to achieve site closure. The RI Report noted that the building, which currently houses two emergency generators, prevents soil excavation as a remedy.

2.2.3 Site UST-3580

Site UST-3580 contained a 1,000-gallon fuel oil UST (UST-3580). The PA/SI report recommended a magnetometer survey to verify that the UST and piping were removed and that groundwater and soil samples should be collected to evaluate naphthalene and polycyclic aromatic hydrocarbons (PAH) concentrations in soil and groundwater. In 2014 and 2015, the USAF performed a RI to confirm the petroleum-related contamination at and downgradient of the former UST at Building 3580 (Tetra Tech 2015e; Tetra Tech 2015f).

Figure 4 shows the temporary well point (TWP) locations with groundwater exceedances based on the latest results at site UST-3580. The analytical results of the 2014/2015 RI indicated that naphthalene concentrations in groundwater near the former UST-3580 and 60 feet downgradient of the tank exceeded NYSDEC TOGS 1.1.1 standards. Constituents detected in the TWP groundwater samples exceeded TOGS 1.1.1 standards or 6 NYCRR Part 703.6 criteria for eight PAH compounds; however, no PAH compounds exceeded standards in groundwater samples collected from the permanent monitoring wells. Based on the RI, the presence of elevated PAH concentrations in the TWP samples was attributed to the higher turbidity associated with the TWP samples and the PAH compounds' affinity for soil (Tetra Tech 2015f).

The analytical results suggest that attenuation of naphthalene in groundwater has occurred. Naphthalene concentrations, measured using VOC method 8260B and PAH method 8270SIM, in groundwater samples from monitoring wells UST-3580-MW-1 and UST-3580-MW-3 were reported at 330/190 micrograms per liter (µg/L) and 240/440 µg/L, respectively, in July 2014, but only 18/12 µg/L and 1.4/1.1 µg/L, respectively, in June 2015. This decrease in concentration provides evidence for natural attenuation and additional monitoring should confirm the complete attenuation.

2.3 Constituents of Concern

Select VOCs and SVOCs at concentrations greater than NYSDEC unrestricted use SCOs and/or NYSDEC TOGS 1.1.1 groundwater standards were identified during previous investigation activities. The remedial activities described in the following sections were developed with the goal of achieving unrestricted use determination. The specific constituents of concern (COCs) for each of the sites include the following:

Constituent of Concern	Site UST-2009	Site UST-2704	Site UST-3580
Groundwater			
1,2,4-trimethylbenzene	X	--	--
1,2-xylene	X	--	--
1,3,5-trimethylbenzene	X	--	--
1,3-xylene & 1,4-xylene	X	--	--
4-isopropyltoluene	X	--	--
ethylbenzene	X	--	--
isopropylbenzene	X	--	--
naphthalene	X	--	X
n-butylbenzene	X	--	--
n-propylbenzene	X	--	--
sec-butylbenzene	X	--	--
Soil			
1,2,4-trimethylbenzene	X	X	--
1,2-dichlorobenzene	X	--	--
1,3,5-trimethylbenzene	X	X	--
benzene	X	X	--
ethylbenzene	X	X	--
methyl ethyl ketone	X	--	--
methylene chloride	X	X	--
n-butylbenzene	X	--	--
n-propylbenzene	X	X	--
naphthalene	X	--	--
sec-butylbenzene	X	--	--
toluene	X	--	--
1,3-xylene & 1,4-xylene	X	X	--

3 FEASIBILITY EVALUATION

3.1 Selection of Remedial Technologies

The following soil and groundwater remedial technologies were considered during the feasibility evaluation:

- No Action
- Institutional Controls (ICs) – Proprietary Controls, Enforcement Tools, Government Controls, Information Devices
- MNA
- Removal – Soil Excavation
- Containment – Vertical Subsurface Barrier (Slurry Wall, Grout Curtain, Sheet Piling), Hydraulic Control (Groundwater Extraction, Phytotechnology)
- In Situ Treatment – Chemical Treatment (Chemical Oxidation, Chemical Reduction), Biological Treatment (Anaerobic and Aerobic Bioremediation), Physical Treatment (Thermal Treatment, Air Sparging/Soil Vapor Extraction)
- Discharge/Disposal – Disposal (Off-Site Landfill), Discharge (Publicly-Owned Treatment Works [POTW], and Surface Water Discharge)

The No Action option is retained only as a baseline for comparison.

For the ICs, proprietary land use controls, groundwater use control, information devices, and access restrictions provide on-site protectiveness and ensure that groundwater is not used as potable water. ICs are in themselves not effective in providing protectiveness because the remedial goal for the sites is to reduce the contamination to below unrestricted use clean up goals, not simply to prevent contact with the contaminated media. They are implementable at the sites and have relatively low cost. ICs were not retained since the remedial goal is to achieve unrestricted use.

MNA is easily implementable, has low cost and is moderately effective compared to active in-situ technologies. Since the COC concentrations in groundwater at site UST-3580 are relatively low or decreasing and the groundwater is not migrating off-site, MNA was retained for groundwater remediation at site UST-3580.

Soil excavation is a proven technology of contaminant removal and is highly effective; however, it has moderate implementability due to the contamination depth and disruptions of current operations at the former Plattsburgh AFB. It would also have high cost associated with excavation and disposal of the excavated soil. Therefore, soil excavation was not retained as a remedial technology.

Groundwater extraction is generally effective in controlling contaminant migration and is technically feasible; however, VOCs remain localized demonstrating limited potential for migration. Additionally, the operating timeframe of a groundwater extraction and treatment system would be lengthy, resulting in relatively high operation and maintenance costs; and equivalent results are achievable in a shorter timeframe using other remedial technologies. Therefore, groundwater extraction was not retained as a remedial option for groundwater treatment.

In-situ treatment, specifically ISCO, was retained considering its proven technical capabilities to treat COCs such as benzene and its derivatives. Between ISCO and aerobic bioremediation, ISCO treatment is more effective at treating contamination in a shorter time frame compared to aerobic bioremediation. ISCO would be moderately implementable and would have moderate cost. ISCO technology was thus retained for soil and groundwater remediation.

Physical in situ treatment technologies such as air sparging/soil vapor extraction, surfactant flushing, and in-well stripping were not retained since these technologies require exchange of contaminant mass and also typically require a significant amount of infrastructure and capital cost. As such, they are cost-prohibitive considering the limited extent of low dissolved concentrations in the saturated zone (i.e., price per unit mass removed). Thermal treatment was not retained since it is a costly aggressive source area treatment technology and would not be appropriate for the relatively low concentration and distribution of the COCs. Ex situ groundwater treatments were not retained since these technologies are coupled with groundwater extraction, which was not retained as a process option.

Disposal of excavated soil to an off-site landfill was not relevant since the removal option was not retained. Discharge of extracted groundwater under applicable permits to a POTW, groundwater (reinjection), and surface water was not retained as a process option since groundwater extraction and ex-situ treatments were not retained.

3.2 Overview of Retained Technologies

ISCO technology was retained for treatment of the soil and groundwater contamination at site UST-2009 and for the soil contamination at site UST-2704. MNA was retained to address the groundwater contamination at site UST-3508. The following sub-sections provide an overview of the selected technologies:

3.2.1 In-Situ Chemical Oxidation

ISCO is an effective and proven technology for the remediation of soil and groundwater impacted with organic constituents. ISCO involves injection of oxidizing reagents such as sodium persulfate (proposed for this injection), permanganates, hydrogen peroxide, or ozone into an aquifer. Persulfate has considerable longevity in the subsurface, ranging from weeks to months. This stability is due to slower reaction kinetics. When compared to the more rapid kinetics of other oxidizing reagents, the use of persulfate allows for a comparatively greater radius of influence when deployed via injections.

Persulfate requires activation in order for sulfate and hydroxyl radicals to be produced and improve kinetics. Activators include chelated iron, a base compound such as sodium hydroxide (proposed for this injection), hydrogen peroxide, or heat. Persulfate ISCO is achieved by delivering oxidant (i.e., sodium persulfate) and activator (i.e., sodium hydroxide) to contaminated media, such that the target constituents are chemically transformed to less toxic compounds and ultimately into carbon dioxide, water, sulfate, and chloride. Following persulfate depletion, transient sulfate continues to provide additional remedial benefits by supporting the anaerobic biological oxidation of hydrocarbons as an electron acceptor. ISCO injections may generate transient byproducts through radical chain reactions and may alter the biogeochemistry of the injection area temporarily; however, the natural biogeochemical conditions reestablish once the ISCO reagents are utilized.

ISCO injections are typically conducted by slightly pressurized injection or by gravity feeding the persulfate solution and activator into the subsurface. Groundwater quality parameters (i.e., specific conductance, pH), depth to water, and injected oxidant are normally monitored during injection for real-time determination of injection breakthrough in the field. Groundwater COCs and presence of oxidant are also monitored following the ISCO injections to evaluate the effectiveness of the ISCO technology and to obtain site-specific design parameters for potential modifications to the injection system during successive injections (if warranted).

3.2.2 Monitored Natural Attenuation

Natural attenuation mechanisms include the natural, physical, chemical, and/or biological processes (such as biodegradation, dispersion, dilution, sorption, volatilization and chemical or biological stabilization, transformation, or destruction of constituents) that reduce COC concentrations in groundwater without active remediation. MNA is used to collectively describe these processes and the monitoring of the effect of the processes on COC concentrations over time as a way to achieve site-specific remedial objectives. Groundwater is monitored in a systematic approach until the remedial goals for the groundwater are met at the site. Accordingly, existing monitoring locations with VOC/SVOC exceedances are used as primary monitoring wells and downgradient locations showing no exceedances of COCs are utilized as the sentinel wells.

The decreasing trend in COC concentrations in groundwater over time is used to provide a primary line of evidence that one or more of the natural attenuation mechanisms are taking place and the net result is overall COC mass reduction. Geochemical indicator parameters (e.g., pH, dissolved oxygen, and oxidation-reduction potential) are monitored to provide supplemental lines of evidence to document that groundwater conditions are conducive to natural attenuation and that one or more of the natural attenuation processes is occurring.

4 REMEDIAL ACTION WORK PLAN

This section presents the methodology, implementation, and performance monitoring of the ISCO injection/MNA to be conducted at each of the three sites and the health and safety requirements related to the ISCO implementation.

4.1 ISCO Implementation

To remediate the remaining soil/groundwater contamination, an ISCO injection approach utilizing alkaline activated sodium persulfate as the oxidant will be implemented for sites UST-2009 and UST-2704. Alkaline activated sodium persulfate will be injected into injection wells. **Figures 5** and **6** show the approximate number and location of injection wells along with the presumed radii of influence for sites UST-2009 and UST-2704, respectively. The location of these points may be modified in the field based on observed conditions. The injection will be conducted through gravity feeding or under slight pressures if practical injection flow rates cannot be achieved through gravity feeding. Additional injection details are provided in section 4.1.2. Dose-response monitoring will be conducted during injection to monitor oxidant solution distribution. Post-injection monitoring will be conducted to confirm successful treatment. The following subsections provide details related to the implementation of the ISCO strategy.

4.1.1 Well Installation

The following sections provide details related to the installation of injection wells. **Figures 5** and **6** show the location of the proposed injection wells.

4.1.1.1 Utility Clearance

Prior to mobilization to the site, a utility clearance ticket will be placed with Dig Safely of New York a minimum of three business days prior to beginning intrusive work. Arcadis will review any available utility maps for the property to identify potential conflicts prior to selecting the final locations for each boring location. Site access will be coordinated with the former Plattsburgh AFB BRAC Environmental Coordinator.

A private utility clearance company may be used, if warranted, to identify and mark all subsurface utilities and abnormal features within the proposed work area. The Arcadis field supervisor and the private utility company will discuss known utilities onsite and complete a walkthrough of the work area to identify any obvious signs of utility corridors or subsurface disturbances. The presence of utilities and/or metallic, energized, or non-metallic objects may be obtained by the use of an electromagnetic metal detector, ground-penetrating radar, and/or various other utility-locating instruments.

Final locations for the temporary wells will be selected following the identification of any utility lines or other subsurface anomalies. Any temporary well placed within five feet of an identified utility or anomaly will be hand cleared with a hand auger, air knife, or similar appropriate method to a depth of at least five feet prior to drilling.

4.1.1.2 Injection Well Installation

A New York State licensed driller will be subcontracted to install the six injection wells at site UST-2009 and two injection wells at site UST-2704. **Table 1** and **Table 2** present the well installation details for site UST-2009 and UST-2704, respectively. Borings will be advanced to 11 and 9 feet bgs, consistent with groundwater and/or soil impacts, using rotary drilling techniques for sites UST-2009 and UST-2704, respectively. After the boring has been advanced to its total depth, drilling tools will be removed to allow the installation of the injection well. Single cased injection wells will be constructed using 2-inch diameter stainless steel wire V-wrap screens and 2-inch diameter poly vinyl chloride (PVC) casing with an overall length of five feet, i.e., from 6 to 11 feet bgs for site UST-2009 and from 4 to 9 feet bgs for site UST-2704. The annular space around the location will be backfilled with a sand pack to a depth of two feet above the top of the well screen, followed by one foot of choker sand and then neat cement to the surface. Top of the casing will be finished with two-inch diameter male cam lock and secured with dust cap. The well casing will be centered in a 12-inch diameter manhole. The well seal will be allowed to set for at least 24 hours prior to injection.

An Arcadis staff member will be onsite during the drilling process to record total depths for each location, ensure proper installation techniques are used, and provide general oversight. The air in the breathing zone and general work area will be monitored for VOCs continuously by Arcadis personnel using a photo-ionization detector (PID). Air monitoring and associated action levels will be performed in accordance with the Site Safety and Health Plan (SSHP).

Injections may be conducted simultaneously via manifolds, if possible. The number of locations injected into simultaneously may be changed in the field based on observed injection conditions. The observed injection conditions at the first injection point will be used to determine if any modifications to the installation procedure are required to improve the performance of the injection points.

It is anticipated that at least two injection events will need to be performed for site UST-2009 and at least three injection events for site UST-2704 over two years. The determination for additional injection events will be made after review of the post-injection data. Once the contamination is reduced to below NYSDEC standards and no more ISCO implementation is needed, the injection wells will be abandoned.

4.1.1.3 Monitoring Well Installation

Two monitoring wells (UST-2009-MW04 and UST-2009-MW05) will be installed within the source area at Site UST-2009 to monitor the performance of the remedial action. **Figure 5** shows the location of the proposed monitoring wells. **Table 3** presents the monitoring well installation details for site UST-2009. Monitoring wells are to be screened immediately below the first water-bearing unit at a depth of approximately 6 feet bgs.

Boreholes will be advanced through the overburden material utilizing a truck-mounted drill rig and the hollow-stem auger drilling technique. While advancing the borehole, continuous soil samples will be collected using 2-inch diameter, 2-foot long split-spoon soil samplers. Descriptions of the overburden materials, including physical characteristics, PID readings, visual evidence of staining, and odors, will be made by the on-site geologist and logged in the field book.

The monitoring wells will be constructed of 2-inch diameter flush-joint threaded PVC risers with a 5-foot-length of 0.01-inch PVC well screen. A washed silica sand pack will be placed between the well screen and the formation to approximately 2 feet above the top of the well screen followed by a 2-foot layer of fine sand (#00) as a seal. A cement-bentonite grout will be installed in the remaining annular space to lock the well in place. Each monitoring well will be completed as a flush-mounted well with a protective steel casing and locking well cap.

Upon completion, each monitoring well will be properly developed to remove fine-grained materials that may have settled in and around the monitoring well during installation, and to ensure that the monitoring well is hydraulically connected to the formation. The monitoring wells will be developed via the block and surge and overpumping method. Well development will continue until the discharge is free of turbidity, or for one hour. Groundwater sampling will not be conducted for two weeks after installation of the new monitoring wells to ensure the wells have equilibrated.

4.1.1.4 Surveying

The injection wells will be field measured and field located via a handheld Global Positioning System (GPS) unit. Field measurements will include distances measured from locations UST-2009-3, UST-2009-10, and UST-2009-12 to each injection well in order to confirm radius of influence calculations.

All monitoring wells will be surveyed by a New York licensed surveyor. Top of casing elevation will be established to within 0.01-foot relative to the 1988 North American Vertical Datum (NAVD 88). The location of each monitoring well will be established to within 0.1-foot relative to the 1983 North American Horizontal Datum (NAD 83).

4.1.2 ISCO Injection Implementation

The following sections describe the details of the injection program, including components of the injection system, injection solution composition, injection procedures, and injection monitoring procedures.

4.1.2.1 Injection System

Injection system operation and system monitoring will be performed by Arcadis staff after the injection wells have been installed by the subcontractor. At a minimum, 40-hr Hazardous Waste Operations and Emergency Response (HAZWOPER) and 8-hr HAZWOPER refresher training is required for all personnel involved in the injection system operations and monitoring related activities.

The injection system may consist of solution mixing tanks, a water source, generator or other power source, pumps for solution mixing/injection and water transfer, manifolds with flow totalizers and flow control valves for solution distribution, well head fittings with pressure gauges and pressure relief valves, and flexible solution distribution hoses. Injection solution will be distributed via aboveground hose to the injection wellhead of each of the injection points. The parts and components of equipment and supplies that will be in contact with injection solution will be made of materials chemically compatible with sodium persulfate and sodium hydroxide. **Table 4** provides additional information regarding injection influence. It is anticipated that the initial injection volume will be approximately 7,200 gallons and 2,400 gallons for Sites UST-2009 and UST-2704, respectively, although this will be confirmed based on real-time data collection during the injection process. Injection volumes for a conceptualized cylinder centered at each injection well are estimated based on the following equation:

$$V_{inj} = \pi * h * r_{ROI}{}^{2} * \eta_m$$

Where: V_{inj} = injection volume
h = vertical delivery extent
r_{ROI}= Estimated radius of influences
η_m = mobile porosity (i.e., the fraction of the aquifer actively contributing to groundwater flow)

Well screens are designed to be 5 feet long and the estimated radius of influence (ROI) is 10 feet and assumed mobile porosity is 0.10. However, typically the assumed mobile porosity can vary with an expected maximum of 0.30. Based on the mobile porosity observed during injection, the total injection volume may vary.

Secondary containment will be used to prevent potential minor leaks and spills of the injection solution from the mixing tank and the manifold from getting to the ground surface. The solution mixing tanks, mixing and injection pumps, and solution distribution manifolds will be placed inside the secondary containment units. If pre-mixed liquid sodium hydroxide solution is used, the sodium hydroxide tanks will also be placed inside secondary containment units. Unused chemicals will be stored securely near the injection area.

4.1.2.2 Injection Reagent and Solution

Injection solution will be prepared using water from a fire hydrant or nearby water source located on the former Plattsburgh AFB. If it is determined during injection that use of the on-site water source is not practical, clean water from a local water vendor may be used. The injection solution will be prepared in portable aboveground storage tanks that are, in turn, in the secondary containment.

Sodium persulfate and sodium hydroxide solutions will be mixed to a target injection solution concentration of 50 grams per liter (g/L) sodium persulfate, and sodium hydroxide and sodium persulfate molar ratio of 3 to 1. It is anticipated that the target sodium persulfate concentration will be sufficient to meet the total oxidant demand (both soil and COC) of the impacted matrix. However, if data collected during and following an injection event show a significantly different oxidant demand, reagents concentrations will adjusted in the subsequent event. **Table 4** provides additional information regarding oxidant demand.

The solution will be prepared in batches on an as-needed basis to eliminate or reduce the need to store unused injection solution at the end of each injection day. To mix the solution, the following procedure will be used:

- The mixing tank will be partially filled with water;
- The required amount of sodium persulfate for the volume to be mixed will be added to the mixing tank and agitated until it is completely mixed into solution;
- The required amount of sodium hydroxide solution for the volume to be mixed will be added to the mixing tank and agitated until it is completely mixed into solution; and
- Sufficient water to finish filling the tank to the specified volume will be added.

During mixing, the solution and tanks will be monitored for evidence of excessive heat generation due to dilution of the sodium hydroxide. If excessive heat generation is observed, the mixing method may be modified to reduce heat generation. Arcadis staff will measure the pH, conductivity, and persulfate concentration of the mixed injection solution at least once per day to verify that the injection solution is being prepared to the target oxidant concentration.

4.1.2.3 Field implementation

Following installation of the injection wells as described in section 4.1.1, hoses will be run from the mixing tank(s) through a chemically compatible injection pump to a distribution manifold outfitted with enough flow totalizers and flow control valves to allow simultaneous injection into the injection points. From the manifold, a hose will be connected to a wellhead fitting attached to each injection well. The wellhead fittings will include pressure gauges and pressure relief valves. An additional hose will be run from the manifold back to the mixing tank as a recirculation line to allow additional control of flow rates and pressures at the injection wells.

Prior to the injection of mixed solution, a clean (potable) water injection will be conducted to test the injection system for any potential leaks in the piping configuration. In the event that leaking occurs, the leaks will be fixed prior to the start of reagent injection.

Following the clean water test, the injection solution will be mixed. The mixed solution will be injected into the injection wells either under gravity feed or at low pressures of up to 5 pounds per square inch (psi). Based on Arcadis' experience with injections into similar formations, an injection flow rate of approximately 1 gallon per minute (gpm) is anticipated. If the injection capacity is limited by the aquifer (limiting flow rate to less than 1 gpm), a pressure step test may be conducted. The pressure step test will include incremental pressure increases of 0.5 to 1 psi with evaluation of the improvement in injection flow rate. This will be continued up to 3 psi if the injection flow rate correspondingly improves and if it can be done safely without observation of surfacing of the injectant, with the intent to achieve a practicable flow rate. If injections cannot be conducted under low pressure, site conditions will be evaluated and the allowable injection pressure may be altered. During injection, Arcadis personnel will monitor injection flow rates, injected volumes, and pressures to monitor the progress of the injection and ensure that safe injection pressures are not exceeded. Arcadis personnel will also monitor for signs of injection solution "daylighting" to the surface.

Injection will continue until the target injection volume for each injection point is attained. Target injection volumes for each well may be adjusted based on field observations. If surfacing of injection solution is observed before the target volume is achieved, the flow rate for the nearest wells will be slowed; if the surfacing does not stop, injection at that location will be suspended. A neutralization solution will be applied to neutralize any surfaced injection solution.

Following the completion of injections at the end of each day and at the end of the injection event, a small volume of clean water will be run through the pumps and hoses to reduce the potential for accidental exposure to injection solution and prevent potential equipment damage from injection solution remaining in place overnight. The valves at the manifold and the shut-off valves at well heads will be closed completely to prevent accidental releases of residual solution remaining in the hoses.

The injection event will be conducted approximately eight to 12 hours per day and is anticipated to be completed in two weeks. The exact duration of the injection event will be directly related to the injection flow rate, which may be limited by the geology at each of the sites. ISCO injections will be performed over a two-year period. Site UST-2009 is scheduled to receive at least one injection and as many as two injections, and site UST-2704 is scheduled to receive at least two injections and as many as three injections. As discussed, the injection is anticipated to be performed under gravity or minimal injection pressure; however, changes to the injection strategy, including installing supplemental direct push technology (DPT) injection points or using monitoring wells for injection, may be made during field implementation to enhance remedy effectiveness.

4.1.2.4 Injection Monitoring

The injection solution flow rates, cumulative injected volumes, and injection pressures will be monitored and recorded in an injection log. When injection is conducted under a pumping scenario, injection pressures will be monitored and adjusted as necessary during injection. Injection flow rates and total injected volume will be recorded and calculated based on the changes of volumes in solution tanks. In addition, mixed reagent quantities will be recorded for every batch. Persulfate concentration, pH, and conductivity of the mixed solution will be analyzed at least once per day.

4.1.2.5 Dose Response

Dose response monitoring will be performed at Site UST-2009. Proposed monitoring wells UST-2009-MW04 and UST-2009-MW05 will be used to confirm solution arrival. Dose response monitoring will be conducted at least twice per day for field parameters (specific conductivity, pH, temperature, and redox potential) using a field water quality meter, and at least once per day for sodium persulfate (using a field test kit). If an increase in conductivity or pH is observed the frequency of monitoring for both field parameters and sodium persulfate may be increased. These data will be utilized to evaluate the arrival of injection solution in the source zone.

4.1.2.6 Hydraulic Responses

In conjunction with the dose response monitoring, hydraulic response monitoring will be conducted at Site UST-2009. Groundwater elevation measurements will be manually measured at least twice per day at proposed monitoring wells UST-2009-MW04 and UST-2009-MW05.

4.1.3 Groundwater Sampling

Monitoring well purging will be conducted using 2-inch-diameter submersible pumps with dedicated polyethylene tubing. Field parameters (pH, specific conductivity, turbidity, dissolved oxygen content, and temperature) will be measured and recorded before, during, and after well purging, and after sampling. These measurements will be collected to ensure that the samples are representative of groundwater quality within the surrounding overburden formation. Approximately three well volumes of water will purged from each well prior to the collection of groundwater samples.

Groundwater samples will be collected using dedicated disposable Teflon® bailers, and the samples will be transferred directly from the bailers to decontaminated sample bottles supplied by the laboratory. After sampling, the submersible pump will be decontaminated conforming to the decontamination procedures outlined in ASTM D5088-15a (Standard Practice for Decontamination of Field Equipment Used at Waste Sites).

Quality Assurance/Quality Control (QA/QC) samples will be collected along with the groundwater samples. Blind duplicate and Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected on a 20 percent frequency. Field blanks will be collected from all nondedicated field sampling equipment on a daily basis for the duration of the sampling event. Trip blanks will accompany all VOC sample shipments to and from the laboratory.

4.1.4 Soil Sampling

Soil borings will be advanced utilizing the direct push soil sampling techniques, including hand or pneumatic driven. Direct-push sampling tools will be used to advance a Macrocore soil sampling device below the ground surface. The Macrocore soil sampling device consists of a 2-inch-diameter tube fitted with a dedicated acetate liner.

Once the Macrocore sample device is advanced to the desired depth the device will be retrieved to the surface and immediately screened with a PID equipped with a 10.6 electronvolt bulb. The on-site geologist will then log the soil core, noting any visual evidence of impact, PID results, and observations of the soil's physical characteristics. When sampling is completed, the resulting boreholes will be backfilled with cuttings.

QA/QC samples will be submitted to the laboratory for analysis along with the samples collected in the field. QA/QC samples will include blind duplicates and MS/MSD samples collected at a frequency of one per 20 samples. Field blanks will be collected from all nondedicated field sampling equipment on a daily basis for the duration of the sampling event. Trip blanks will accompany all VOC sample shipments to and from the laboratory.

4.1.5 Performance Monitoring

Performance monitoring associated with the injection events for Site UST-2009 and Site UST-2704 will consist of baseline and post-injection monitoring, and confirmation sampling.

4.1.5.1 Site UST-2009

For site UST-2009, a groundwater sampling event will occur immediately prior to the initial injection event to establish baseline groundwater quality conditions in the source area at proposed monitoring wells UST-2009-MW04 and UST-2009-MW05. Groundwater samples will be collected and analyzed for select VOCs in accordance with **Table 3**. Additionally, during the baseline event persulfate concentrations will be measured in the injection wells and monitoring wells UST-2009-MW04 and UST-2009-MW05 using a field test kit (CHEMetrics' persulfate test kit, PeroxyChem's Kit "K", or similar).

Post-injection monitoring will be conducted to measure the rate at which the persulfate persists at concentrations above baseline. Based on experience at similar project sites, persulfate concentrations are expected to return to baseline conditions in approximately three to six months. Using field test kits, persulfate concentrations will be measured in the injection wells and monitoring wells UST-2009-MW04 and UST-2009-MW05 approximately 2 weeks post-injection, 4 weeks post-injection, and then monthly until persulfate concentrations have approached baseline conditions. Post-injection monitoring frequency may be adjusted based on professional judgement.

Confirmation groundwater sampling will be conducted once persulfate concentrations in the injection wells and monitoring wells UST-2009-MW04 and UST-2009-MW05 have approached baseline conditions. Groundwater samples will be collected and analyzed for select VOCs in accordance with **Table 3**. If COC concentrations remain at levels greater than the NYSDEC groundwater quality standards, a second injection event may be performed. Confirmation samples will be collected every six months to evaluate remedy effectiveness. Once COC concentrations have decreased below applicable NYSDEC groundwater quality standards, groundwater monitoring frequency will increase to quarterly. Following four consecutive quarters of compliance monitoring with concentrations less than applicable NYSDEC groundwater quality standards, the monitoring program will cease and the site closure process will commence. Following NYSDEC approval of the no further action request, the monitoring and injection wells will be decommissioned.

Following the initial occurrence when COC concentrations have decreased below applicable NYSDEC groundwater quality standards, compliance soil sampling will be conducted. The soil sampling program will consist of collecting soil samples adjacent (within one foot) to three previous boring locations (UST-2009-03, UST-2009-09, and UST-2009-12) with constituent concentrations exceeding NYSDEC SCOs. Three soil samples will be collected for select VOC analysis from intervals corresponding to previous samples with exceedances of the NYSDEC SCOs in accordance with **Table 5**. Additional injection events will be scheduled based on the soil analytical results and screening to the SCOs.

4.1.5.2 Site UST-2704

For site UST-2704, baseline persulfate concentrations will be measured immediately prior to the initial injection event in the injection wells using a field test kit (CHEMetrics' persulfate test kit, PeroxyChem's Kit "K", or similar).

Post-injection monitoring will be conducted to measure the rate at which the persulfate persists at concentrations above baseline in the injection wells. Using field test kits, persulfate concentrations will be measured in the injection wells approximately 2 weeks post-injection, 4 weeks post-injection, and then monthly until persulfate concentrations have approached baseline conditions. Post-injection monitoring frequency may be adjusted based on professional judgement.

Following a return to near baseline conditions after the second injection event, compliance soil sampling will be conducted. The soil sampling program will consist of collecting soil samples adjacent (within one foot) to three previous boring locations (UST-2704-5, UST-2704-6, and UST-2704-7) with constituent concentrations exceeding NYSDEC SCOs. Three soil samples will be collected for select VOC analysis from intervals corresponding to previous samples with exceedances of the NYSDEC SCOs in accordance with Table 6. If the remedy has reduced soil concentrations below SCOs, the third injection event may be canceled. If a third injection event is performed, an additional round of compliance soil sampling will be performed. Additional injection events will be scheduled based on a comparison of the analytical results to the SCOs. Following confirmation that soil concentrations have been remediated below SCOs, the site closure process will commence. Following NYSDEC approval of the no further action request, the injection wells will be decommissioned.

4.2 MNA Implementation (Site UST-3580)

To address the remaining naphthalene concentrations, a MNA approach will be used for site UST-3580. Groundwater will be monitored on a quarterly basis until the remedial goals for the groundwater are met at UST-3580-MW-01 and UST-3590-MW-03 (**Figure 7**). Groundwater sampling will be performed as described above in section 4.1.3.1.2 and presented in **Table 7**. Monitoring well UST-3580-MW-01 will be used as the primary compliance point and will be sampled quarterly to monitor residual concentration of naphthalene. Consistent with the June 2015 sampling event, downgradient well UST-3580-MW-03, will also be sampled on a quarterly basis. Naphthalene concentration trends over time will be used to demonstrate mass reduction over time.

Once naphthalene concentrations have attenuated to below groundwater quality standards and remained below for four quarters, the monitoring program will cease and the site closure process will commence. Following NYSDEC approval of the no further action request, the monitoring wells will be decommissioned.

4.3 Health and Safety

This section summarizes health and safety issues that may be encountered during ISCO activities. The SSHP contains additional information relating to site health and safety precautions. The Safety Data Sheets (SDS) for sodium persulfate and sodium hydroxide and the ISCO Injection Activity Hazard Analysis (AHA) forms for injection of activated sodium persulfate via injection wells have been added to the SSHP. The SDSs and AHAs have been included in this Work Plan as **Appendices A** and **B**, respectively. The SSHP will be kept readily available during all on-site activities. During field activities, each day will begin with a health and safety tailgate briefing including all field staff and subcontractors.

The proposed ISCO activities will involve preparation and injection of sodium hydroxide activated persulfate solution. Sodium persulfate is an oxidizer and is purchased as a powdered solid. Sodium hydroxide is a strong corrosive agent and is purchased as either a powdered solid or pre-mixed as a liquid solution. To prevent injury and exposure when handling these compounds, field staff will wear chemical resistant coveralls, chemical resistant boots or boot covers, and chemical resistant gloves when mixing solution, and a full-face respirator when mixing powdered chemicals. Respirator cartridges are to be changed out every six to eight hours of use. In situations other than mixing where exposure to the chemical solution is possible, staff will wear chemical resistant splash aprons and face shields.

Safety precautions to be followed during this event include, but are not limited to:

ISCO Hazard Prevention:

- Inhalation: wear full-face respirator while handling sodium persulfate and/or sodium hydroxide powder during mixing;
- Sodium persulfate and sodium hydroxide solution exposure:

  - wear proper personal protective equipment (PPE) as described above,
  - ensure that all materials/piping/manifolds are chemically compatible with the corrosivity of persulfate (preferably poly vinyl chloride [PVC], polypropylene, and stainless steel but never use carbon steel, brass or other incompatible materials);
- Chemical Test Kit or laboratory bottleware reagent exposure: wear proper PPE as described in the SSHP;
- Excessive heat generated during sodium hydroxide solution mixing: mix solution slowly, add concentrated sodium hydroxide solution or sodium hydroxide into water and avoid adding water into concentrated sodium hydroxide solution, use pre-mixed sodium hydroxide solution instead of powdered sodium hydroxide at high ambient temperatures;
- Spills: utilize secondary containment (spill containment berms), absorbent socks, dilution, neutralization;
- Leaks: conduct clean (potable) water injection to test piping and connections for leaks prior to ISCO injection;
- Fires: store chemicals away from heat, moisture, and combustible materials, keep a fire extinguisher near the work and chemical storage areas;
- Trip hazards: keep work area clear within tank batch mixing area, near wells/hoses, etc. (watch footing), lay out hoses on paths outside of main walking paths where possible;
- Pinch points and sharp edges: mark pinch points, tape off sharp edges;
- Back strain: use proper lifting techniques;
- Noise around drill rigs: use ear plugs;
- Pressure: use proper tools, fittings, and pressure gauges, wear proper PPE, depressurize lines prior to working on or disconnecting them; and
- Splash: shower/eye wash station for personal decontamination, wear proper PPE as described above.

4.4 Investigative-Derived Waste

Investigative-derived waste (IDW) generated during injection and monitoring well installation will be containerized in 55-gallon Department of Transportation (DOT) approved drums pending characterization and removal for transport to an approved off-site disposal facility. Waste disposal will be performed in collaboration with the former Plattsburgh AFB BRAC Environmental Coordinator.

Groundwater generated during performance monitoring will be passed through granulated active charcoal filter buckets and allowed to recharge through the ground surface within the treatment area. Soil generated during performance monitoring will be used to backfill the borehole.

5 REPORTING

Data collected during the implementation of the CAP will be evaluated against the performance objectives and the results will be summarized in an Annual Remedial Action Progress Report. Following the completion of remediation action activities, a Remedial Action Report will be prepared. The report will present groundwater performance monitoring results that demonstrate the effectiveness of the ISCO treatment/MNA and will also describe the plan for decommissioning the injection wells and monitoring wells at the associated sites. Reports will be submitted to the NYSDEC for review.

6 PROJECT SCHEDULE

Arcadis plans to implement the scope of work detailed in this CAP during the spring 2017. Figure 7 shows the proposed project schedule. Injection work of this manner is not practical during the winters in northern New York due to freezing temperatures and, therefore, will be conducted when an assurance of above freezing temperatures is expected. Drilling subcontractors will be evaluated and coordinated in a timely manner prior to commencement of the injection. ISCO injection will begin immediately following the installation of the injection wells. It is anticipated that injection activities will take five to eight business days to complete. Performance monitoring will be implemented as described in section 4.1.5 and 4.2. Additional injection activities, if warranted, will be based on the effectiveness of the prior events to successfully reduce COCs to concentrations less than the SCOs and applicable groundwater quality standards.

For site UST-3580, semi-annual MNA groundwater sampling will begin in spring 2017 and continue until naphthalene attenuates to concentrations less than the groundwater quality standard. Compliance monitoring will subsequently be performed for four consecutive quarters.

7 REFERENCES

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Tetra Tech, Inc., 2015f. Remedial Investigation Summary Report for UST-3580, Plattsburgh AFB, New York. September 2015.

TABLES

Table 1. Site UST-2009 Injection Well Details
Site UST-2009, Former Plattsburgh AFB, Plattsburgh, New York

Injection Well ID	Target Locations	Assumed Radius of Influence (feet)	Total Depth (feet bgs)	Screen Intervel (feet bgs)	Well Diameter (inches)	Screen Construction Details	Casing Construction Details
UST-2009-IW-1	03-05-A UST 2009	10	11	6 - 11	2	SS Wire V-wrap	Sch-40 PVC
UST-2009-IW-2	UST-2009-09	10	11	6 - 11	2	SS Wire V-wrap	Sch-40 PVC
UST-2009-IW-3	UST-2009-12	10	11	6 - 11	2	SS Wire V-wrap	Sch-40 PVC
UST-2009-IW-4	UST-2009-03	10	11	6 - 11	2	SS Wire V-wrap	Sch-40 PVC
UST-2009-IW-5	02-05-A UST 2009; UST-2009-03; UST-2009-05	10	11	6 - 11	2	SS Wire V-wrap	Sch-40 PVC
UST-2009-IW-6	UST-2009-10	10	11	6 - 11	2	SS Wire V-wrap	Sch-40 PVC

Notes:
bgs - below ground surface
PVC - poly vinyl chloride
SS - stainless steel

Table 2. Site UST-2704 Injection Well Details
Site UST-2704, Former Plattsburgh AFB, Plattsburgh, New York

Injection Well ID	Target Locations	Assumed Radius of Influence (feet)	Total Depth (feet bgs)	Screen Intervel (feet bgs)	Well Diameter (inches)	Screen Construction Details	Casing Construction Details
UST-2704-IW-1	UST-2704-05; UST-2704-06	10	9	4 - 9	2	SS Wire V-wrap	Sch-40 PVC
UST-2704-IW-2	UST-2704-06; UST-2704-07	10	9	4 - 9	2	SS Wire V-wrap	Sch-40 PVC

Notes:
bgs - below ground surface
PVC - poly vinyl chloride
SS - stainless steel

Table 3. Site UST-2009 Monitoring Well Construction Details and Groundwater Performance Monitoring Details
Site UST-2009, Former Plattsburgh AFB, Plattsburgh, New York

Proposed Monitoring Well ID	Sampling Frequency	Sampling Parameters	Total Depth (feet bgs)	Screen Intervel (feet bgs)	Well Diameter (inches)	Screen Construction Details	Casing Construction Details
UST-2009-MW04	Baseline, Post-Injection, and Confirmation	VOCs[1]	11	6 - 11	2	0.01-Slot Sch-40 PVC	Sch-40 PVC
UST-2009-MW05	Baseline, Post-Injection, and Confirmation	VOCs[1]	11	6 - 11	2	0.01-Slot Sch-40 PVC	Sch-40 PVC

Notes:

* This location will only be sampled if upgradient location shows a groundwater exceedance.

NA - not applicable

[1] Groundwater VOC samples will be analyzed using USEPA Method 8260B for 1,2,4-trimethylbenzene, 1,2-xylene, 1,3,5-trimethylbenzene, 1,3-xylene & 1,4-xylene, 4-isopropyltoluene, ethylbenzene, isopropylbenzene, naphthalene, n-butylbenzene, n-propylbenzene, and sec-butylbenzene

bgs - below ground surface

PVC - poly vinyl chloride

VOCs - volatile organic compounds

Table 4. Sites UST-2009 and UST-2704 Injection Details
Sites UST-2009 and UST-2704, Former Plattsburgh AFB, Plattsburgh, New York

Injection Information and Assumptions	Unit	Site UST-2009	Site UST-2704
Number of injection wells	well	6	2
Target treatment area	square feet	1884	628
Total target depth	feet	11	9
Treatment interval	feet	5	5
Mobile porosity	percent	10	10
Injection volume per well	gallons	1200	1200
Total injection volume	gallons	7200	2400
Sodium persulfate injection strength	grams/liter	50	50
Sodium persulfate demand	pounds	3000	1000
Activator dosing (molar ratio $NaOH:Na_2S_2O_4$)	ratio	3	3
Target activator (NaOH) strength	grams/liter	25	25
Activator (NaOH, powder) demand for activation	pounds	1500	500

Notes:

Assumed Radius of influence (ROI) = 10 feet

Target treatment area = Number of wells x [pi $(ROI)^2$]

Total Injection Volume = Number of wells x [pi (ROI)2] x treatment interval x mobile porosity

Reagent demand = Reagent injection strength x injection volume

Table 5. Sites UST-2009 Soil Performance Monitoring Details
Site UST-2009, Former Plattsburgh AFB, Plattsburgh, New York

Proposed Soil Boring ID	Adjacent Previous Soil Boring ID	Sampling Program	Sampling Parameters	Sample Depth (feet bgs)
UST-2009-24	UST-2009-03	Following initial compliance with GWQS	VOCs[1]	9.5 to 10.0
UST-2009-25	UST-2009-09	Following initial compliance with GWQS	VOCs[1]	9.5 to 10.0
UST-2009-26	UST-2009-12	Following initial compliance with GWQS	VOCs[1]	12.0 to 12.5

Notes:

[1] Soil VOC samples will be analyzed using USEPA Method 8260 for 1,2,4-trimethylbenzene, 1,2-dichlorobenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, methyl ethyl ketone, methylene chloride, n-butylbenzene, n-propylbenzene, naphthalene, sec-butylbenzene, toluene, and xylenes (mixed)

GWQS - NYSDEC Groundwater Quality Standards

bgs - below ground surface

VOCs - volatile organic compounds

Table 6. Site UST-2704 Soil Performance Monitoring Details
Site UST-2704, Former Plattsburgh AFB, Plattsburgh, New York

Proposed Soil Boring Location	Adjacent Previous Soil Boring Location	Sampling Program (Following Reagent Delpleation)	Sampling Parameters	Sample Depth (feet bgs)
UST-2704-16	UST-2704-5	After second and third* injection events	VOCs[1]	5.5 to 6.0
UST-2704-17	UST-2704-6	After second and third* injection events	VOCs[1]	4.5 to 5.0
UST-2704-18	UST-2704-7	After second and third* injection events	VOCs[1]	7.0 to 7.5

Notes:

[1] Soil VOC samples will be analyzed using USEPA Method 8260 for 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, methylene chloride, n-propylbenzene, and xylenes (mixed)

bgs - below ground surface

VOCs - volatile organic compounds

* - The third injection event may be cancelled if soil concentrations are less than clean up objectives after the second injection.

Table 7. Site UST-3580 Groundwater Performance Monitoring Details
Site UST-3580, Former Plattsburgh AFB, Plattsburgh, New York

Well ID	Sampling Frequency	Sampling Parameters	Total Depth (feet bgs)	Screen Intervel (feet bgs)	Well Diameter (inches)
UST-3580-MW01	Quarterly	Naphthalene	15	5 - 15	2
UST-3580-MW03	Quarterly	Naphthalene	15	5 - 15	2

Notes:

Naphtalene will be analyzed using USEPA Method 8260B

bgs - below ground surface

FIGURES

Citrix DIV/GROUP: ENV/IMDV DB: LD: PIC: PM: TM:
PROJECT: PATH: \\corpstorage\Data\ArcGisData\GISPROJECTS_ENV\AFCEC_Plattsburgh\GIS\ArcMap_MXD\USTs\Fig1_SiteLocations.mxd DATE: 9/23/2016 1:59:16 PM Saved By: sbell

LEGEND:

▭ Site Locations

0 2,650 5,300
SCALE IN FEET

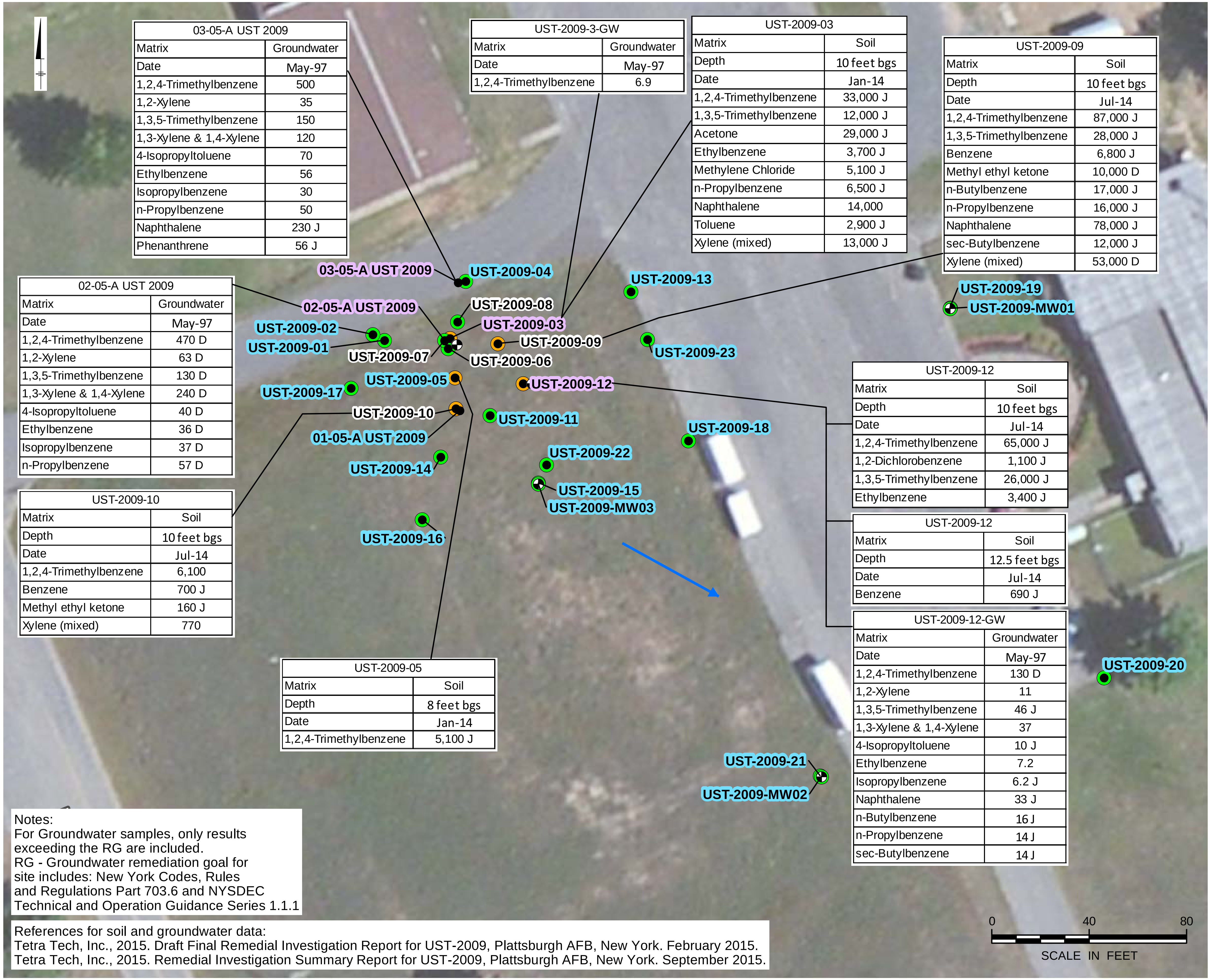
FORMER PLATTSBURGH AFB,
PLATTSBURGH, NEW YORK

CORRECTIVE ACTION PLAN

SITE LOCATIONS

ARCADIS

FIGURE
1



03-05-A UST 2009	
Matrix	Groundwater
Date	May-97
1,2,4-Trimethylbenzene	500
1,2-Xylene	35
1,3,5-Trimethylbenzene	150
1,3-Xylene & 1,4-Xylene	120
4-Isopropyltoluene	70
Ethylbenzene	56
Isopropylbenzene	30
n-Propylbenzene	50
Naphthalene	230 J
Phenanthrene	56 J

UST-2009-3-GW	
Matrix	Groundwater
Date	May-97
1,2,4-Trimethylbenzene	6.9

UST-2009-03	
Matrix	Soil
Depth	10 feet bgs
Date	Jan-14
1,2,4-Trimethylbenzene	33,000 J
1,3,5-Trimethylbenzene	12,000 J
Acetone	29,000 J
Ethylbenzene	3,700 J
Methylene Chloride	5,100 J
n-Propylbenzene	6,500 J
Naphthalene	14,000
Toluene	2,900 J
Xylene (mixed)	13,000 J

UST-2009-09	
Matrix	Soil
Depth	10 feet bgs
Date	Jul-14
1,2,4-Trimethylbenzene	87,000 J
1,3,5-Trimethylbenzene	28,000 J
Benzene	6,800 J
Methyl ethyl ketone	10,000 D
n-Butylbenzene	17,000 J
n-Propylbenzene	16,000 J
Naphthalene	78,000 J
sec-Butylbenzene	12,000 J
Xylene (mixed)	53,000 D

02-05-A UST 2009	
Matrix	Groundwater
Date	May-97
1,2,4-Trimethylbenzene	470 D
1,2-Xylene	63 D
1,3,5-Trimethylbenzene	130 D
1,3-Xylene & 1,4-Xylene	240 D
4-Isopropyltoluene	40 D
Ethylbenzene	36 D
Isopropylbenzene	37 D
n-Propylbenzene	57 D

UST-2009-10	
Matrix	Soil
Depth	10 feet bgs
Date	Jul-14
1,2,4-Trimethylbenzene	6,100
Benzene	700 J
Methyl ethyl ketone	160 J
Xylene (mixed)	770

UST-2009-12	
Matrix	Soil
Depth	10 feet bgs
Date	Jul-14
1,2,4-Trimethylbenzene	65,000 J
1,2-Dichlorobenzene	1,100 J
1,3,5-Trimethylbenzene	26,000 J
Ethylbenzene	3,400 J

UST-2009-12	
Matrix	Soil
Depth	12.5 feet bgs
Date	Jul-14
Benzene	690 J

UST-2009-12-GW	
Matrix	Groundwater
Date	May-97
1,2,4-Trimethylbenzene	130 D
1,2-Xylene	11
1,3,5-Trimethylbenzene	46 J
1,3-Xylene & 1,4-Xylene	37
4-Isopropyltoluene	10 J
Ethylbenzene	7.2
Isopropylbenzene	6.2 J
Naphthalene	33 J
n-Butylbenzene	16 J
n-Propylbenzene	14 J
sec-Butylbenzene	14 J

UST-2009-05	
Matrix	Soil
Depth	8 feet bgs
Date	Jan-14
1,2,4-Trimethylbenzene	5,100 J

Notes:
For Groundwater samples, only results exceeding the RG are included.
RG - Groundwater remediation goal for site includes: New York Codes, Rules and Regulations Part 703.6 and NYSDEC Technical and Operation Guidance Series 1.1.1

References for soil and groundwater data:
Tetra Tech, Inc., 2015. Draft Final Remedial Investigation Report for UST-2009, Plattsburgh AFB, New York. February 2015.
Tetra Tech, Inc., 2015. Remedial Investigation Summary Report for UST-2009, Plattsburgh AFB, New York. September 2015.

LEGEND:

◐	Monitoring Well
●	Soil Boring
🟢	Soil Sample Result Below Soil Cleanup Objective
🟠	Soil Sample Result Above Soil Cleanup Objective
UST-2009-04	Groundwater Sample Result Below RG
UST-2009-03	Groundwater Sample Result Above RG
→	Groundwater Flow Direction

Constituent of Concern Groundwater	RG (ug/L)
1,2,4-Trimethylbenzene	5
1,2-Xylene	5
1,3,5-Trimethylbenzene	5
1,3-Xylene & 1,4-Xylene	5
4-Isopropyltoluene	5
Ethylbenzene	5
Isopropylbenzene	5
Naphthalene	10
n-Butylbenzene	5
n-Propylbenzene	5
Phenanthrene	50
sec-Butylbenzene	5

Constituent of Concern Soil	Soil Cleanup Objective (ug/kg)
1,2,4-Trimethylbenzene	3,600
1,2-Dichlorobenzene	1,100
1,3,5-Trimethylbenzene	8,400
Acetone	50
Benzene	60
Ethylbenzene	1,000
Methyl ethyl ketone	120
Methylene chloride	50
Naphthalene	12,000
n-Butylbenzene	12,000
n-Propylbenzene	3,900
sec-Butylbenzene	11,000
Toluene	700
Xylene (mixed)	260

Notes:
D - Reported value is from a diluted sample
J - Value is estimated
bgs - below ground surface
ug/L - Groundwater matrix sampling results reported in micrograms per liter (ug/L)
ug/kg - Soil matrix sampling results reported in micrograms per kilogram (ug/kg)

FORMER PLATTSBURGH AIR FORCE BASE
PLATTSBURGH, NEW YORK

CORRECTIVE ACTION PLAN

SITE UST-2009 MAP AND PREVIOUS SAMPLE RESULTS

ARCADIS

FIGURE
2

Citrix DIV/GROUP: ENV/IMDV DB: LD: PIC: PM: TM:
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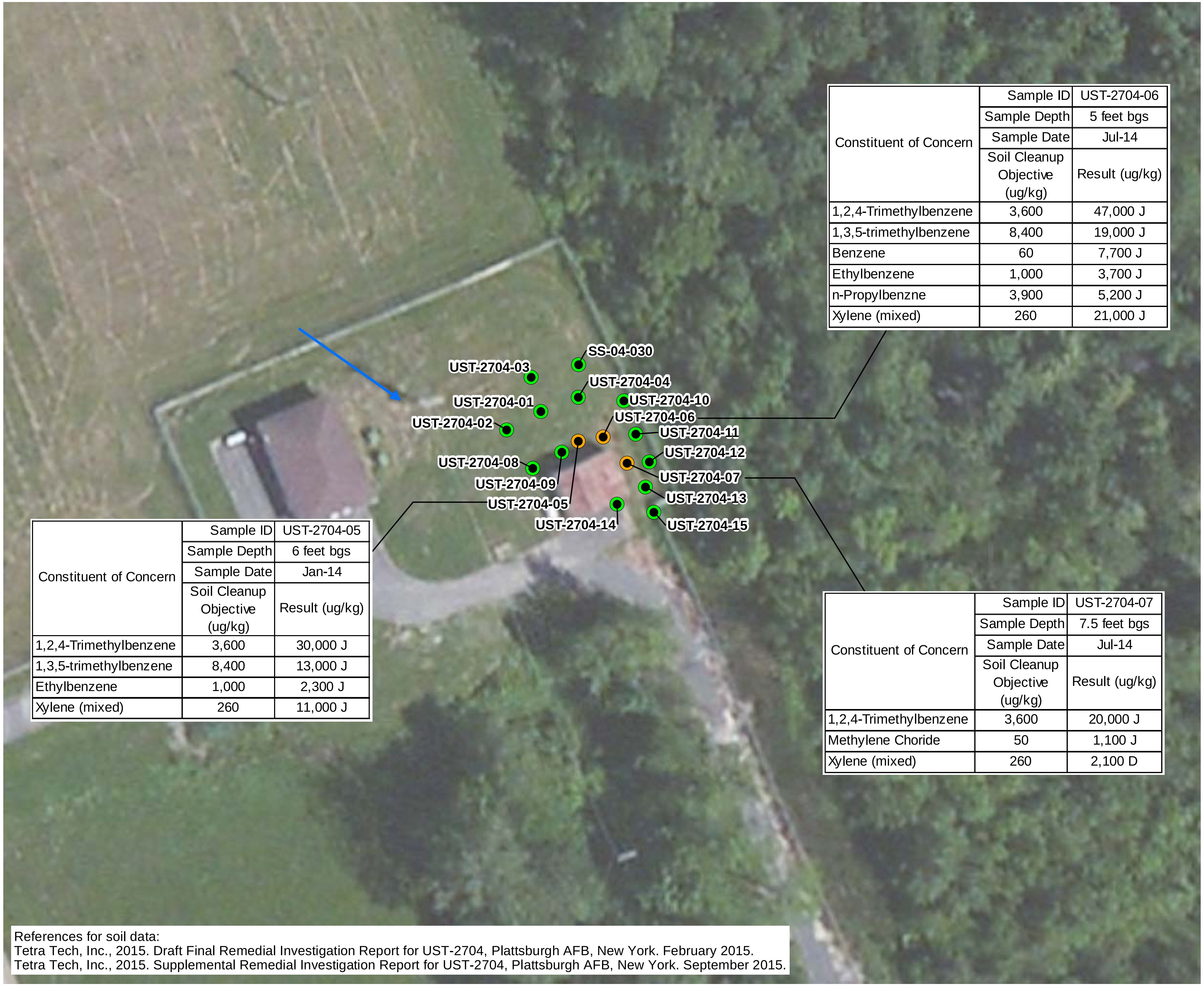
Citrix DIV/GROUP: ENV/IMDV DB: LD: PIC: PM: TM:
PROJECT: PATH: \\corpstorage\Data\ArcGisData\GISPROJECTS_ENV\AFCEC_Plattsburgh\GIS\ArcMap_MXD\USTs\Fig3_UST2704_Analytical.mxd DATE: 11/17/2016 3:12:16 PM Saved By: kgpeters



Constituent of Concern	Sample ID	UST-2704-06
	Sample Depth	5 feet bgs
	Sample Date	Jul-14
	Soil Cleanup Objective (ug/kg)	Result (ug/kg)
1,2,4-Trimethylbenzene	3,600	47,000 J
1,3,5-trimethylbenzene	8,400	19,000 J
Benzene	60	7,700 J
Ethylbenzene	1,000	3,700 J
n-Propylbenzne	3,900	5,200 J
Xylene (mixed)	260	21,000 J

Constituent of Concern	Sample ID	UST-2704-05
	Sample Depth	6 feet bgs
	Sample Date	Jan-14
	Soil Cleanup Objective (ug/kg)	Result (ug/kg)
1,2,4-Trimethylbenzene	3,600	30,000 J
1,3,5-trimethylbenzene	8,400	13,000 J
Ethylbenzene	1,000	2,300 J
Xylene (mixed)	260	11,000 J

Constituent of Concern	Sample ID	UST-2704-07
	Sample Depth	7.5 feet bgs
	Sample Date	Jul-14
	Soil Cleanup Objective (ug/kg)	Result (ug/kg)
1,2,4-Trimethylbenzene	3,600	20,000 J
Methylene Choride	50	1,100 J
Xylene (mixed)	260	2,100 D

References for soil data:
Tetra Tech, Inc., 2015. Draft Final Remedial Investigation Report for UST-2704, Plattsburgh AFB, New York. February 2015.
Tetra Tech, Inc., 2015. Supplemental Remedial Investigation Report for UST-2704, Plattsburgh AFB, New York. September 2015.

LEGEND:

● Soil Boring

🟢 Soil Sample Result Below Soil Cleanup Objective

🟠 Soil Sample Result Above Soil Cleanup Objective

→ Groundwater Flow Direction

Notes:
D - Reported value is from a diluted sample.
J - Value is estimated
bgs - below ground surface
ug/kg - Soil matrix sampling results reported in micrograms per kilogram (ug/kg)

0 40 80
SCALE IN FEET

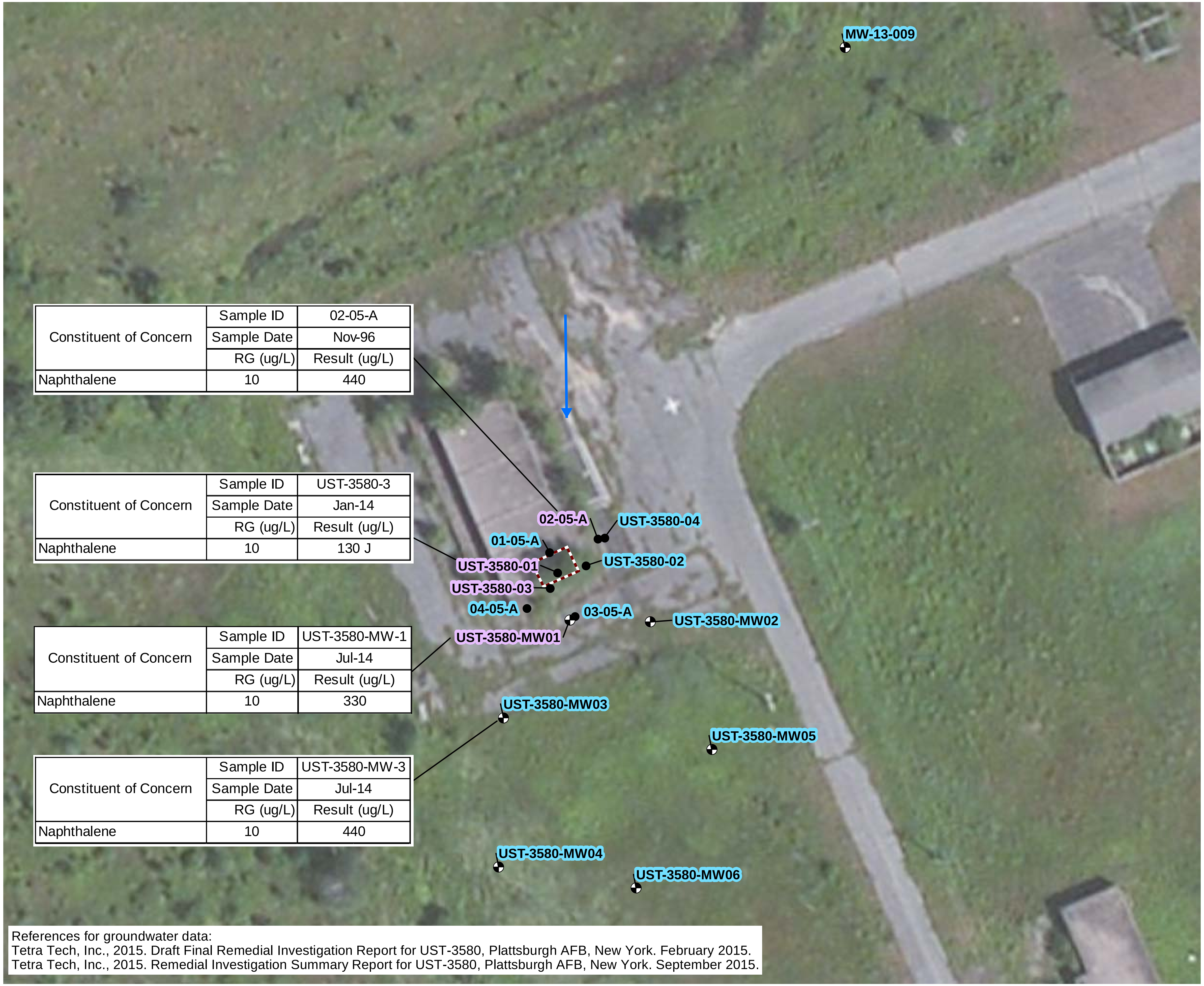
FORMER PLATTSBURGH AIR FORCE BASE
PLATTSBURGH, NEW YORK

CORRECTIVE ACTION PLAN

SITE UST-2704 MAP AND PREVIOUS SAMPLE RESULTS

ARCADIS

FIGURE
3



Constituent of Concern	Sample ID	02-05-A
	Sample Date	Nov-96
	RG (ug/L)	Result (ug/L)
Naphthalene	10	440

Constituent of Concern	Sample ID	UST-3580-3
	Sample Date	Jan-14
	RG (ug/L)	Result (ug/L)
Naphthalene	10	130 J

Constituent of Concern	Sample ID	UST-3580-MW-1
	Sample Date	Jul-14
	RG (ug/L)	Result (ug/L)
Naphthalene	10	330

Constituent of Concern	Sample ID	UST-3580-MW-3
	Sample Date	Jul-14
	RG (ug/L)	Result (ug/L)
Naphthalene	10	440

References for groundwater data:
Tetra Tech, Inc., 2015. Draft Final Remedial Investigation Report for UST-3580, Plattsburgh AFB, New York. February 2015.
Tetra Tech, Inc., 2015. Remedial Investigation Summary Report for UST-3580, Plattsburgh AFB, New York. September 2015.

LEGEND:

⊕	Monitoring Well
●	Soil Boring
UST-3580-MW03	Most Recent Groundwater Sample Result Below RG for Naphthalene
UST-3580-MW01	Most Recent Groundwater Sample Result Above RG for Naphthalene
- - - -	Former UST Excavation
→	Groundwater Flow Direction

Notes:
J - Value is estimated
bgs - below ground surface
ug/L - Groundwater matrix sampling results reported in micrograms per liter (ug/L)

RG - Groundwater remediation goal for site includes: New York Codes, Rules and Regulations Part 703.6 and NYSDEC Technical and Operation Guidance Series 1.1.1

The databoxes present the highest Naphthalene detection exceeding the RG.

0 40 80
SCALE IN FEET

FORMER PLATTSBURGH AIR FORCE BASE
PLATTSBURGH, NEW YORK

CORRECTIVE ACTION PLAN

SITE UST-3580 MAP AND PREVIOUS SAMPLE RESULTS

ARCADIS

FIGURE
4

Citrix DIV/GROUP: ENV/IMDV DB: LD: PIC: PM: TM:
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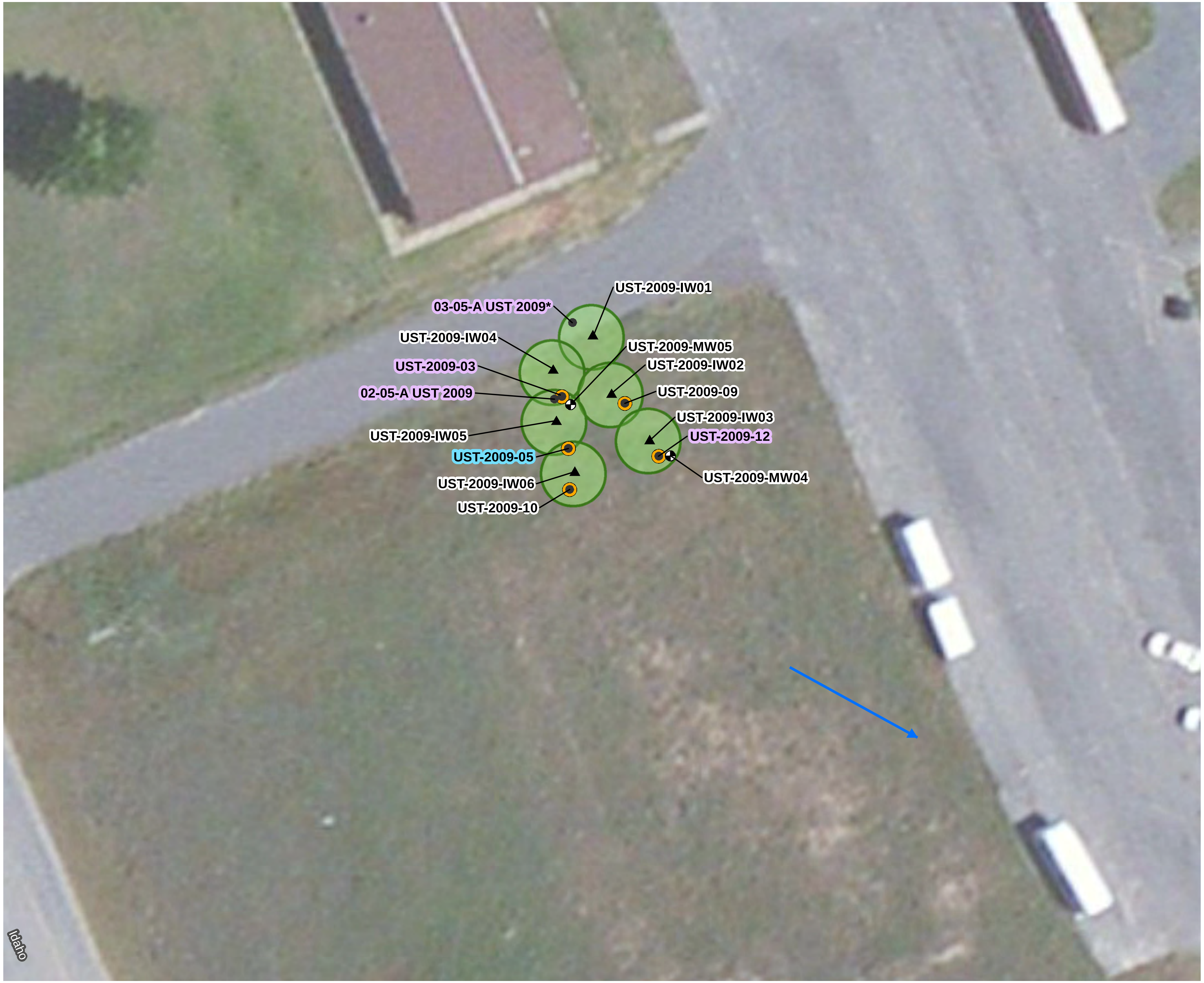

LEGEND:

◒	Proposed Monitoring Well
●	Soil Boring
▲	Injection Wells
●	Soil Sample Result Above Soil Cleanup Objective
UST-2009-01	Groundwater Sample Result Below RG
UST-2009-03	Groundwater Sample Result Above RG
→	Groundwater Flow Direction
●	10 Feet Radius of Influence

Notes:
RG - Groundwater remediation goal for site includes: New York Codes, Rules and Regulations Part 703.6 and NYSDEC Technical and Operation Guidance Series 1.1.1

* - Groundwater VOC concentrations at this location were above RG in 1997 (03-05-A UST 2009) but below RG in the 2014 confirmation sample (UST-2009-04).

0 30 60
SCALE IN FEET

FORMER PLATTSBURGH AIR FORCE BASE
PLATTSBURGH, NEW YORK

CORRECTIVE ACTION PLAN

SITE UST-2009 PROPOSED ISCO INJECTION LAYOUT

ARCADIS

FIGURE
5

Citrix DIV/GROUP: ENV/IMDV DB: LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENVAFCEC_Plattsburgh\GIS\ArcMap_MXD\USTs\Fig5_UST2009_ISCO.mxd DATE: 10/12/2016 2:23:49 PM Saved By: kgpeters

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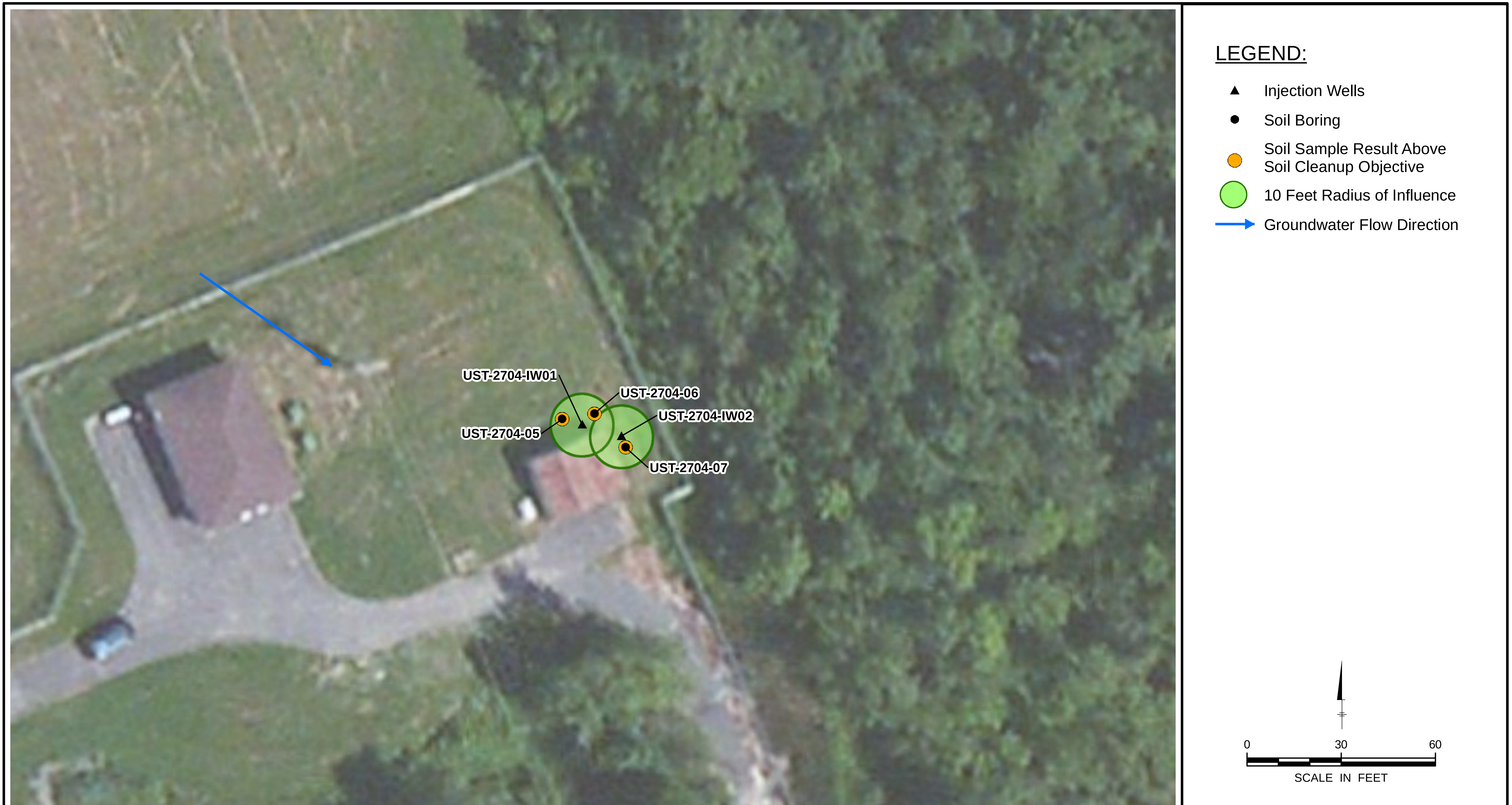


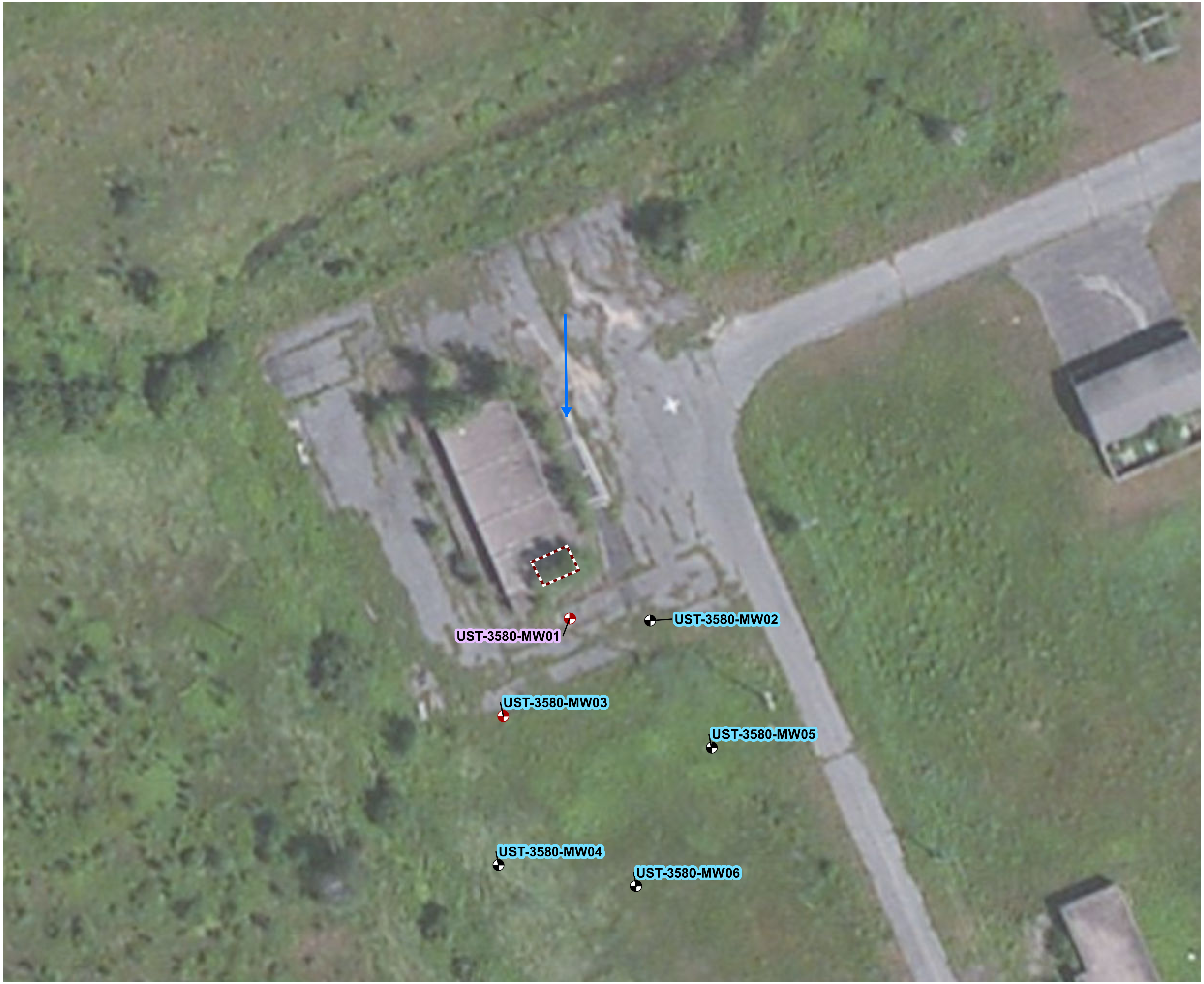
FORMER PLATTSBURGH AIR FORCE BASE
PLATTSBURGH, NEW YORK

CORRECTIVE ACTION PLAN

SITE UST-2704 PROPOSED ISCO INJECTION LAYOUT

ARCADIS

FIGURE
6



LEGEND:

- Monitoring Well
- Monitored Natural Attenuation Performance Monitoring Well
- UST-3580-MW01 Groundwater Sample Result Below RG
- UST-3580-MW03 Groundwater Sample Result Above RG
- Former UST Excavation
- Groundwater Flow Direction

Notes:
RG - Groundwater remediation goal for site includes: New York Codes, Rules and Regulations Part 703.6 and NYSDEC Technical and Operation Guidance Series 1.1.1

FORMER PLATTSBURGH AIR FORCE BASE
PLATTSBURGH, NEW YORK

CORRECTIVE ACTION PLAN

SITE UST-3580
PROPOSED MNA LAYOUT

ARCADIS

FIGURE
7

Citrix DIV/GROUP: ENV/IMDV DB: LD: PIC: PM: TM:
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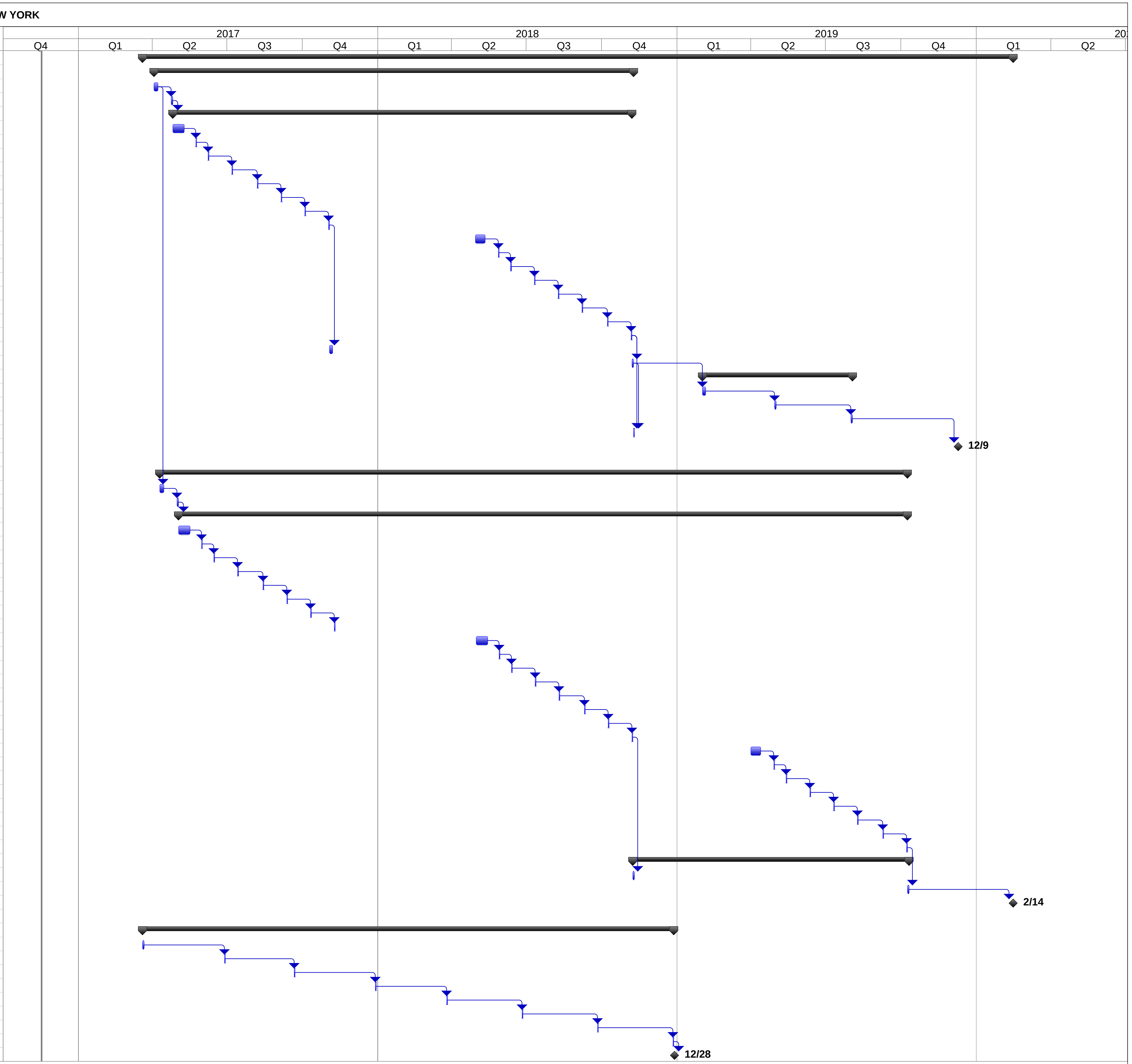
Figure 8. PROJECT SCHEDULE - CORRECTIVE ACTION PLAN UST-2009, UST-2704, AND UST-3580, FORMER PLATTSBURGH AIR FORCE BASE, PLATTSBURGH, NEW YORK

ID	ℹ	Task Name	Duration	Start	Finish	Predecessors
1		**CORRECTIVE ACTION PLAN: UST-2009, UST-2704, AND UST-3580**	**760 days**	**Mon 3/20/17**	**Fri 2/14/20**	
2		**Site UST-2009**	**419 days**	**Mon 4/3/17**	**Thu 11/8/18**	
3	▦	Well Installation	5 days	Mon 4/3/17	Fri 4/7/17	
4		Baseline Groundwater Monitoring Event	2 days	Mon 4/24/17	Tue 4/25/17	3FS+10 days
5		**Remedy Implementation**	**400 days**	**Wed 4/26/17**	**Tue 11/6/18**	**4**
6		Injection Event - 1	10 days	Wed 4/26/17	Tue 5/9/17	
7		Post-injection monitoring	1 day	Wed 5/24/17	Wed 5/24/17	6FS+10 days
8		Post-injection monitoring	1 day	Thu 6/8/17	Thu 6/8/17	7FS+10 days
9		Post-injection monitoring	1 day	Fri 7/7/17	Fri 7/7/17	8FS+20 days
10		Post-injection monitoring	1 day	Mon 8/7/17	Mon 8/7/17	9FS+20 days
11		Post-injection monitoring	1 day	Tue 9/5/17	Tue 9/5/17	10FS+20 days
12		Post-injection monitoring	1 day	Wed 10/4/17	Wed 10/4/17	11FS+20 days
13		Post-injection monitoring	1 day	Thu 11/2/17	Thu 11/2/17	12FS+20 days
14	▦	Injection Event - 2	10 days	Mon 4/30/18	Fri 5/11/18	
15		Post-injection monitoring	1 day	Mon 5/28/18	Mon 5/28/18	14FS+10 days
16		Post-injection monitoring	1 day	Tue 6/12/18	Tue 6/12/18	15FS+10 days
17		Post-injection monitoring	1 day	Wed 7/11/18	Wed 7/11/18	16FS+20 days
18		Post-injection monitoring	1 day	Thu 8/9/18	Thu 8/9/18	17FS+20 days
19		Post-injection monitoring	1 day	Fri 9/7/18	Fri 9/7/18	18FS+20 days
20		Post-injection monitoring	1 day	Mon 10/8/18	Mon 10/8/18	19FS+20 days
21		Post-injection monitoring	1 day	Tue 11/6/18	Tue 11/6/18	20FS+20 days
22		Confirmation Groundwater Monitoring Event	2 days	Fri 11/3/17	Mon 11/6/17	13
23		Confirmation Groundwater Monitoring Event	2 days	Wed 11/7/18	Thu 11/8/18	21
24		**Compliance Groundwater Monitoring**	**131 days**	**Fri 2/1/19**	**Fri 8/2/19**	
25		Compliance Monitoring	2 days	Fri 2/1/19	Mon 2/4/19	23FS+60 days
26		Compliance Monitoring	2 days	Tue 4/30/19	Wed 5/1/19	25FS+60 days
27		Compliance Monitoring	2 days	Thu 8/1/19	Fri 8/2/19	26FS+65 days
28		**Compliance Soil Sampling**	1 day	Fri 11/9/18	Fri 11/9/18	23,21
29		Submit the Final Site Closeout and Well Decommissioning Report to USAF	1 day	Mon 12/9/19	Mon 12/9/19	27FS+90 days
30						
31		**Site UST-2704**	**652 days**	**Mon 4/10/17**	**Tue 10/8/19**	
32		Well Installation	5 days	Mon 4/10/17	Fri 4/14/17	3
33		Baseline Groundwater Monitoring Event	2 days	Mon 5/1/17	Tue 5/2/17	32FS+10 days
34		**Remedy Implementation**	**635 days**	**Wed 5/3/17**	**Tue 10/8/19**	**33**
35		Injection Event - 1	10 days	Wed 5/3/17	Tue 5/16/17	
36		Post-injection monitoring	1 day	Wed 5/31/17	Wed 5/31/17	35FS+10 days
37		Post-injection monitoring	1 day	Thu 6/15/17	Thu 6/15/17	36FS+10 days
38		Post-injection monitoring	1 day	Fri 7/14/17	Fri 7/14/17	37FS+20 days
39		Post-injection monitoring	1 day	Mon 8/14/17	Mon 8/14/17	38FS+20 days
40		Post-injection monitoring	1 day	Tue 9/12/17	Tue 9/12/17	39FS+20 days
41		Post-injection monitoring	1 day	Wed 10/11/17	Wed 10/11/17	40FS+20 days
42		Post-injection monitoring	1 day	Thu 11/9/17	Thu 11/9/17	41FS+20 days
43	▦	Injection Event - 2	10 days	Tue 5/1/18	Mon 5/14/18	
44		Post-injection monitoring	1 day	Tue 5/29/18	Tue 5/29/18	43FS+10 days
45		Post-injection monitoring	1 day	Wed 6/13/18	Wed 6/13/18	44FS+10 days
46		Post-injection monitoring	1 day	Thu 7/12/18	Thu 7/12/18	45FS+20 days
47		Post-injection monitoring	1 day	Fri 8/10/18	Fri 8/10/18	46FS+20 days
48		Post-injection monitoring	1 day	Mon 9/10/18	Mon 9/10/18	47FS+20 days
49		Post-injection monitoring	1 day	Tue 10/9/18	Tue 10/9/18	48FS+20 days
50		Post-injection monitoring	1 day	Wed 11/7/18	Wed 11/7/18	49FS+20 days
51	▦	Injection Event - 3	10 days	Mon 4/1/19	Fri 4/12/19	
52		Post-injection monitoring	1 day	Mon 4/29/19	Mon 4/29/19	51FS+10 days
53		Post-injection monitoring	1 day	Tue 5/14/19	Tue 5/14/19	52FS+10 days
54		Post-injection monitoring	1 day	Wed 6/12/19	Wed 6/12/19	53FS+20 days
55		Post-injection monitoring	1 day	Thu 7/11/19	Thu 7/11/19	54FS+20 days
56		Post-injection monitoring	1 day	Fri 8/9/19	Fri 8/9/19	55FS+20 days
57		Post-injection monitoring	1 day	Mon 9/9/19	Mon 9/9/19	56FS+20 days
58		Post-injection monitoring	1 day	Tue 10/8/19	Tue 10/8/19	57FS+20 days
59		**Compliance Soil Sampling**	**241 days**	**Thu 11/8/18**	**Thu 10/10/19**	
60		Compliance Soil Sampling	2 days	Thu 11/8/18	Fri 11/9/18	50
61		Compliance Soil Sampling	2 days	Wed 10/9/19	Thu 10/10/19	58
62		Submit the Final Site Closeout and Well Decommissioning Report to USAF	1 day	Fri 2/14/20	Fri 2/14/20	61FS+90 days
63						
64		**Site UST-3580**	**464 days**	**Mon 3/20/17**	**Thu 12/27/18**	
65	▦	Baseline Groundwater Monitoring Event	2 days	Mon 3/20/17	Tue 3/21/17	
66	▦	Compliance Monitoring	1 day	Wed 6/28/17	Wed 6/28/17	65FS+70 days
67		Compliance Monitoring	1 day	Thu 9/21/17	Thu 9/21/17	66FS+60 days
68		Compliance Monitoring	1 day	Fri 12/29/17	Fri 12/29/17	67FS+70 days
69		Compliance Monitoring	1 day	Mon 3/26/18	Mon 3/26/18	68FS+60 days
70		Compliance Monitoring	1 day	Tue 6/26/18	Tue 6/26/18	69FS+65 days
71		Compliance Monitoring	1 day	Wed 9/26/18	Wed 9/26/18	70FS+65 days
72		Compliance Monitoring	1 day	Thu 12/27/18	Thu 12/27/18	71FS+65 days
73		Submit the Final Site Closeout and Well Decommissioning Report to USAF	1 day	Fri 12/28/18	Fri 12/28/18	72



Project: Figure 7 Project Schedule
Date: Thu 11/17/16

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

APPENDIX A

Safety Data Sheets

MATERIAL SAFETY DATA SHEET

Klozur®

MSDS Ref. No.: 7775-27-1-12
Date Approved: 05/13/2009
Revision No.: 5

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200 and Canada's Workplace Hazardous Materials Information System (WHMIS) requirements.

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1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	Klozur®
SYNONYMS:	Sodium Persulfate, Sodium Peroxydisulfate; Disodium Peroxydisulfate
GENERAL USE:	In situ and ex situ chemical oxidation of contaminants and compounds of concern for environmental remediation applications.

MANUFACTURER

FMC CORPORATION
FMC Peroxygens
1735 Market Street
Philadelphia, PA 19103
(215) 299-6000 (General Information)
msdsinfo@fmc.com (Email - General Information)

EMERGENCY TELEPHONE NUMBERS

(303) 595-9048 (Medical - U.S. - Call Collect)

For leak, fire, spill, or accident emergencies, call:
(800) 424-9300 (CHEMTREC - U.S.A. & Canada)

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2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

- White, odorless, crystals
- Oxidizer.
- Decomposes in storage under conditions of moisture (water/water vapor) and/or excessive heat causing release of oxides of sulfur and oxygen that supports combustion. Decomposition could form a high temperature melt. See Section 10 ("Stability and Reactivity").

POTENTIAL HEALTH EFFECTS: Airborne persulfate dust may be irritating to eyes, nose, lungs, throat and skin upon contact. Exposure to high levels of persulfate dust may cause difficulty in breathing in sensitive persons.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt.%	EC No.	EC Class
Sodium Persulfate	7775-27-1	>99	231-892-1	Xn-O; R8-R22-R36/37/38-R42/43

4. FIRST AID MEASURES

EYES: Flush with plenty of water. Get medical attention if irritation occurs and persists.

SKIN: Wash with plenty of soap and water. Get medical attention if irritation occurs and persists.

INGESTION: Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

INHALATION: Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

NOTES TO MEDICAL DOCTOR: This product has low oral toxicity and is not irritating to the eyes and skin. Flooding of exposed areas with water is suggested. For gastric lavage or emesis induction, consider the possible aggravation of esophageal injury, and the expected absence of system effects. Treatment is controlled removal of exposure followed by symptomatic and supportive care.

5. FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: Deluge with water.

FIRE / EXPLOSION HAZARDS: Product is non-combustible. On decomposition releases oxygen which may intensify fire. Presence of water accelerates decomposition.

FIRE FIGHTING PROCEDURES: Do not use carbon dioxide or other gas filled fire extinguishers; they will have no effect on decomposing persulfates. Wear full protective clothing and self-contained breathing apparatus.

FLAMMABLE LIMITS: Non-combustible

SENSITIVITY TO IMPACT: No data available

SENSITIVITY TO STATIC DISCHARGE: Not available

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6. ACCIDENTAL RELEASE MEASURES

RELEASE NOTES: Spilled material should be collected and put in approved DOT container and isolated for disposal. Isolated material should be monitored for signs of decomposition (fuming/smoking). If spilled material is wet, dissolve with large quantity of water and dispose as a hazardous waste. All disposals should be carried out according to regulatory agencies procedures.

---

7. HANDLING AND STORAGE

HANDLING: Use adequate ventilation when transferring product from bags or drums. Wear respiratory protection if ventilation is inadequate or not available. Use eye and skin protection. Use clean plastic or stainless steel scoops only.

STORAGE: Store (unopened) in a cool, clean, dry place away from point sources of heat, e.g. radiant heaters or steam pipes. Use first in, first out storage system. Avoid contamination of opened product. In case of fire or decomposition (fuming/smoking) deluge with plenty of water to control decomposition. For storage, refer to NFPA Bulletin 430 on storage of liquid and solid oxidizing materials.

COMMENTS: VENTILATION: Provide mechanical general and/or local exhaust ventilation to prevent release of dust into work environment. Spills should be collected into suitable containers to prevent dispersion into the air.

---

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS

Chemical Name	ACGIH	OSHA	Supplier
Sodium Persulfate	0.1 mg/m^3 (TWA)		

ENGINEERING CONTROLS: Provide mechanical local general room ventilation to prevent release of dust into the work environment. Remove contaminated clothing immediately and wash before reuse.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Use cup type chemical goggles. Full face shield may be used.

RESPIRATORY: Use approved dust respirator when airborne dust is expected.

PROTECTIVE CLOTHING: Normal work clothes. Rubber or neoprene footwear.

GLOVES: Rubber or neoprene gloves. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

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9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR:	None
APPEARANCE:	White crystals
AUTOIGNITION TEMPERATURE:	Not applicable. No evidence of combustion up to 800°C. Decomposition will occur upon heating.
BOILING POINT:	Not applicable
COEFFICIENT OF OIL / WATER:	Not applicable
DENSITY / WEIGHT PER VOLUME:	Not available
EVAPORATION RATE:	Not applicable (Butyl Acetate = 1)
FLASH POINT:	Non-combustible
MELTING POINT:	Decomposes
ODOR THRESHOLD:	Not applicable
OXIDIZING PROPERTIES:	Oxidizer
PERCENT VOLATILE:	Not applicable
pH:	typically 5.0 - 7.0 @ 25 °C (1% solution)
SOLUBILITY IN WATER:	73 % @ 25 °C (by wt.)
SPECIFIC GRAVITY:	2.6 (H_2O=1)
VAPOR DENSITY:	Not applicable (Air = 1)
VAPOR PRESSURE:	Not applicable

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10. STABILITY AND REACTIVITY

CONDITIONS TO AVOID:	Heat, moisture and contamination.
STABILITY:	Stable (becomes unstable in presence of heat, moisture and/or contamination).
POLYMERIZATION:	Will not occur
INCOMPATIBLE MATERIALS:	Acids, alkalis, halides (fluorides, chlorides, bromides and iodides), combustible materials, most metals and heavy metals, oxidizable materials, other oxidizers, reducing agents, cleaners, and organic or carbon containing compounds. Contact

	with incompatible materials can result in a material decomposition or other uncontrolled reactions.
HAZARDOUS DECOMPOSITION PRODUCTS:	Oxygen that supports combustion and oxides of sulfur.

COMMENTS: PRECAUTIONARY STATEMENT: Pumping and transport of Klozur persulfate requires appropriate precautions and design considerations for pressure and thermal relief.

Decomposing persulfates will evolve large volumes of gas and/or vapor, can accelerate exponentially with heat generation, and create significant and hazardous pressures if contained and not properly controlled or mitigated.

Use with alcohols in the presence of water has been demonstrated to generate conditions that require rigorous adherence to process safety methods and standards to prevent escalation to an uncontrolled reaction.

11. TOXICOLOGICAL INFORMATION

EYE EFFECTS: Non-irritating (rabbit) [FMC Ref. ICG/T-79.029]

SKIN EFFECTS: Non-irritating (rabbit) [FMC Ref. ICG/T-79.029]

DERMAL LD_{50}: > 10 g/kg [FMC Ref. ICG/T-79.029]

ORAL LD_{50}: 895 mg/kg (rat) [FMC Ref. ICG/T-79.029]

INHALATION LC_{50}: 5.1 mg/l (rat) [FMC Ref. I95-2017]

SENSITIZATION: May be sensitizing to allergic persons. [FMC Ref. ICG/T-79.029]

TARGET ORGANS: Eyes, skin, respiratory passages

ACUTE EFFECTS FROM OVEREXPOSURE: Dust may be harmful and irritating. May be harmful if swallowed.

CHRONIC EFFECTS FROM OVEREXPOSURE: Sensitive persons may develop dermatitis and asthma [Respiration 38:144, 1979]. Groups of male and female rats were fed 0, 300 or 3000 ppm sodium persulfate in the diet for 13 weeks, followed by 5000 ppm for 5 weeks. Microscopic examination of tissues revealed some injury to the gastrointestinal tract at the high dose (3000 ppm) only. This effect is not unexpected for an oxidizer at high concentrations. [Ref. FMC I90-1151, Toxicologist 1:149, 1981].

CARCINOGENICITY:

NTP:	Not listed
IARC:	Not listed
OSHA:	Not listed
OTHER:	ACGIH: Not listed

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12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION:

Bluegill sunfish, 96-hour LC_{50} = 771 mg/L [FMC Study I92-1250]
Rainbow trout, 96-hour LC_{50} = 163 mg/L [FMC Study I92-1251]
Daphnia, 48-hour LC_{50} = 133 mg/L [FMC Study I92-1252]
Grass shrimp, 96-hour LC_{50} = 519 mg/L [FMC Study I92-1253]

CHEMICAL FATE INFORMATION: Biodegradability does not apply to inorganic substances.

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13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Dispose as a hazardous waste in accordance with local, state and federal regulatory agencies.

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14. TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

PROPER SHIPPING NAME:	Sodium Persulfate
PRIMARY HAZARD CLASS / DIVISION:	5.1 (Oxidizer)
UN/NA NUMBER:	UN 1505
PACKING GROUP:	III
LABEL(S):	5.1 (Oxidizer)
PLACARD(S):	5.1 (Oxidizer)
MARKING(S):	Sodium Persulfate, UN 1505
ADDITIONAL INFORMATION:	Hazardous Substance/RQ: Not applicable

49 STCC Number: 4918733

This material is shipped in 225 lb. fiber drums, 55 lb. poly bags and 1000 - 2200 lb. IBC's (supersacks).

INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

PROPER SHIPPING NAME: Sodium Persulfate

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

PROPER SHIPPING NAME: Sodium Persulfate

OTHER INFORMATION:

Protect from physical damage. Do not store near acids, moisture or heat.

15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):
Not applicable

SECTION 311 HAZARD CATEGORIES (40 CFR 370):
Fire Hazard, Immediate (Acute) Health Hazard

SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):
The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None

SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):
There are no ingredients in this product, which are subject to Section 313 reporting requirements.

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):
Unlisted, RQ = 100 lbs., Ignitability

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA INVENTORY STATUS (40 CFR 710):

All components are listed or exempt.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261):

Waste Number: D001

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Hazard Classification / Division:	C D2A D2B
Domestic Substance List:	All components are listed or exempt.

INTERNATIONAL LISTINGS

Australia (AICS): Listed
China: Listed
Japan (ENCS): (1)-1131
Korea: KE-12369
Philippines (PICCS): Listed

HAZARD AND RISK PHRASE DESCRIPTIONS:

EC Symbols:	Xn	(Harmful)
	O	(Oxidizer)
EC Risk Phrases:	R8	(Contact with combustible material may cause fire)
	R22	(Harmful if swallowed.)
	R36/37/38	(Irritating to eyes, respiratory system and skin.)
	R42/43	(May cause sensitization by inhalation or by skin contact.)

16. OTHER INFORMATION

HMIS

Health	1
Flammability	0
Physical Hazard	1
Personal Protection (PPE)	J

Protection = J (Safety goggles, gloves, apron & combination dust & vapor respirator)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

NFPA

Health	1
Flammability	0
Reactivity	1
Special	OX

SPECIAL = OX (Oxidizer)

NFPA (National Fire Protection Association)

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

REVISION SUMMARY:
This MSDS replaces Revision #4, dated September 18, 2006.
Changes in information are as follows:
Section 1 (Product and Company Identification)
Section 3 (Composition / Information on Ingredients)
Section 15 (Regulatory Information)
Section 16 (Other Information)

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Safety Data Sheet

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: **PEARL CAUSTIC SODA**

Other name(s): Sodium hydroxide; Soda lye; Sodium hydrate; White caustic; Caustic soda solid; Caustic soda pearl; Solid caustic soda.

Recommended Use: General chemical.

Supplier: Orica Australia Pty Ltd
ABN: 99 004 117 828
Street Address: 1 Nicholson Street,
Melbourne 3000
Australia
Telephone Number: +61 3 9665 7111
Facsimile: +61 3 9665 7937
Emergency Telephone: **1 800 033 111 (ALL HOURS)**

2. HAZARDS IDENTIFICATION

This material is hazardous according to criteria of Safe Work Australia; HAZARDOUS SUBSTANCE.

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

Risk Phrases: Causes severe burns. Risk of serious damage to eyes.

Safety Phrases: Do not breathe dust. Avoid contact with skin and eyes. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible).

Poisons Schedule: S6 Poison.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Risk Phrases
Sodium hydroxide	1310-73-2	100%	R35, R41

4. FIRST AID MEASURES

For advice, contact a Poisons Information Centre (e.g. phone Australia 131 126; New Zealand 0800 764 766) or a doctor.

Inhalation:
Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. If patient finds breathing difficult and develops a bluish discolouration of the skin (which suggests a lack of oxygen in the blood - cyanosis), ensure airways are clear of any obstruction and have a qualified person give oxygen through a face mask. Apply artificial respiration if patient is not breathing. Seek immediate medical advice.

Skin Contact:
If spilt on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin and hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor. For skin burns, cover with a clean, dry dressing until medical help is available.

Eye Contact:
If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre or a doctor, or for at least 15 minutes.

Ingestion:
Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.

Medical attention and special treatment:
Treat symptomatically. Can cause corneal burns.

5. FIRE FIGHTING MEASURES

Hazards from combustion products:
Non-combustible material.

Precautions for fire fighters and special protective equipment:
Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

Suitable Extinguishing Media:
Not combustible, however, if material is involved in a fire use: Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder).

Hazchem Code: 2W

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures:
Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Methods and materials for containment and clean up:
Wear protective equipment to prevent skin and eye contact and breathing in dust. Work up wind or increase ventilation. Cover with damp absorbent (inert material, sand or soil). Sweep or vacuum up, but avoid generating dust. Collect and seal in properly labelled containers or drums for disposal. Caution - heat may be evolved on contact with water.

7. HANDLING AND STORAGE

This material is a Scheduled Poison S6 and must be stored, maintained and used in accordance with the relevant regulations.

Conditions for safe storage:
Store in a cool, dry, well ventilated place and out of direct sunlight. Store away from foodstuffs. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for spills.

Precautions for safe handling:
Avoid skin and eye contact and breathing in dust. Keep out of reach of children. There is a risk of splash-back causing injury if Pearl Caustic Soda is added to HOT water.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Sodium hydroxide: Peak Limitation = 2 mg/m^3

As published by the National Occupational Health and Safety Commission.

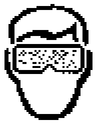
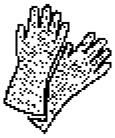
Peak Limitation - a ceiling concentration which should not be exceeded over a measurement period which should be as short as possible but not exceeding 15 minutes.

These Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Engineering controls:
Ensure ventilation is adequate to maintain air concentrations below Exposure Standards. Avoid generating and breathing in dusts. Use with local exhaust ventilation or while wearing dust mask. Keep containers closed when not in use.

Personal Protective Equipment:
The selection of PPE is dependant on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

Orica Personal Protection Guide No. 1, 1998: F - OVERALLS, SAFETY SHOES, CHEMICAL GOGGLES, GLOVES, DUST MASK.


Wear overalls, chemical goggles and impervious gloves. Avoid generating and inhaling dusts. If dust exists, wear dust mask/respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state:	Solid
Colour:	White
Molecular Formula:	$NaOH$
Solubility:	Soluble in water.
Specific Gravity:	2.13 @20°C
Relative Vapour Density (air=1):	Not available
Vapour Pressure (20 °C):	Not available
Flash Point (°C):	Not applicable
Flammability Limits (%):	Not available
Autoignition Temperature (°C):	Not available
Melting Point/Range (°C):	318
Boiling Point/Range (°C):	1390
pH:	12.7 (1% aqueous solution)

10. STABILITY AND REACTIVITY

10. STABILITY AND REACTIVITY

Chemical stability:	Stable. Hygroscopic: absorbs moisture or water from surrounding air.
Conditions to avoid:	Avoid dust generation. Avoid exposure to moisture. Avoid contact with foodstuffs.
Incompatible materials:	Incompatible with ammonium salts , acids , chlorinated hydrocarbons , aluminium , zinc , lead , tin , and their alloys .
Hazardous decomposition products:	None known.
Hazardous reactions:	Reacts with ammonium salts, evolving ammonia gas. In the presence of moisture, the material is corrosive to aluminium, zinc and tin producing highly flammable hydrogen gas. May react violently with acids and chlorinated hydrocarbons . Can react vigorously with water .

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion:	Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.
Eye contact:	A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.
Skin contact:	Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.
Inhalation:	Breathing in dust may result in respiratory irritation.

Long Term Effects:
No information available for the product.

Toxicological Data: No LD50 data available for the product.

12. ECOLOGICAL INFORMATION

Ecotoxicity	Avoid contaminating waterways.

13. DISPOSAL CONSIDERATIONS

Disposal methods:
Refer to local government authority for disposal recommendations. Dispose of material through a licensed waste contractor. Decontamination and destruction of containers should be considered.

14. TRANSPORT INFORMATION

Road and Rail Transport
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

UN No: 1823
Class-primary 8 Corrosive
Packing Group: II
Proper Shipping Name: SODIUM HYDROXIDE, SOLID
Hazchem Code: 2W

Marine Transport

Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

UN No: 1823
Class-primary: 8 Corrosive
Packing Group: II
Proper Shipping Name: SODIUM HYDROXIDE, SOLID

IMDG EMS Fire: F-A
IMDG EMS Spill: S-B

Air Transport

Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; DANGEROUS GOODS.

UN No: 1823
Class-primary: 8 Corrosive
Packing Group: II
Proper Shipping Name: SODIUM HYDROXIDE, SOLID

15. REGULATORY INFORMATION

Classification: This material is hazardous according to criteria of Safe Work Australia; HAZARDOUS SUBSTANCE.

Hazard Category: C: Corrosive

Risk Phrase(s):
R35: Causes severe burns.
R41: Risk of serious damage to eyes.

Safety Phrase(s):
S22: Do not breathe dust.
S24/25: Avoid contact with skin and eyes.
S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36/37/39: Wear suitable protective clothing, gloves and eye/face protection.
S45: In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible).

Poisons Schedule: S6 Poison.

This material is listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

This safety data sheet has been prepared by Orica SDS Services.

Reason(s) for Issue:
5 Yearly Revised Primary SDS

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Orica Limited cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Orica representative or Orica Limited at the contact details on page 1.

Orica Limited's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

APPENDIX B

ISCO Task Hazard Analysis

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): L

Date: 22 August 2016

Project: Plattsburgh Air Force Base- Wa ⊞

Activity: Sodium Persulfate and Sodium Hydroxide Injection, Handling, and Treatment ⊞

Activity Location: Plattsburgh, NY

Prepared By: M. Lennertz

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

Add Identified Hazards

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Site reconnaissance and walk-around	Slips/trips/falls can occur from uneven ground surface, slippery walkways or from tripping over equipment	Survey the site upon arrival. Note any site conditions that may pose a potential hazard, and make note of any changes since the last injection event.	L
X		Personnel could be struck by vehicle	• Secure work area with cones. • Position vehicle to serve as a barrier between personnel and site traffic. • Unload equipment as close to the work area as possible. • Plan the location where the injection equipment will be set up making sure to not block any ingress/egress to the work area • Choose vehicle staging/parking areas that minimize vehicle movement in and around the work area	L
X	Setting up of the trailer with injection equipment or unloading the trailer into an injection compound	Pinch points on the trailer or equipment can cause hand injury	• Look for pinch points and sharp edges/burrs that can be present on the metal portions of the trailer or injection equipment before handling. • Wear work leather gloves.	L
X		Heavy equipment can fall and strike personnel	• Make sure jack stands, if present, are secured on the equipment trailer. • Make sure that the wheels of the trailer have been chocked prior to trailer operation or unloading. • Level the trailer utilizing jack stands if necessary.	L
X		Truck and/or trailer becomes stuck on soft or uneven ground causing potential property damage and impact injury to workers during extraction	• Plan trailer setup and factor weight of full tanks when accessing and egressing from injection areas and selecting a staging area for the tanks. • Ensure adequate hose lengths are available to pump solutions to wells in soft ground areas from stable road surface or another firm surface.	L

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Receiving chemical deliveries	Chemical releases during delivery and storage	• Have a secondary containment set up and place the chemicals directly into the containment to minimize the potential for releases to the ground surface • Ensure proper equipment is available to move pallets/totes of chemical without requiring intermediate staging or repackaging • Ensure neutralization solution is available.	M
X	Load, unload and set up of required PPE, equipment including waterline hoses, injection hoses, flow meters and supplies in/out of vehicle or storage area	Ergonomic strain from improper lifting techniques or awkward body positions/twisting	• Follow proper lifting technique, bending with the knees and not with the back. Avoid twisting at the waist when lifting. • Ask a buddy for help when lifting objects weighing over 50 lbs. (as a general guide; may vary on specific circumstances)	L
X		Slips/trips/falls can occur from walking over dragging and unsecured hoses	• Keep coiled hose ends secured to coil when loading and unloading, stop and pick up dangling hoses that could be a trip hazard when carrying.	L
X	Connecting the water supply to the injection trailer or compound	Lifting hoses resulting in a back injury	• Do not lift more than your personal limits. • Use a second person if needed or when lifting hoses >50 lbs. • Lift with your knees and not your back.	L
X		Possible pressure build up can result in equipment failure or flying objects that can cause personal injury	• Check equipment and valves before making connections. • Check the water valves are in the off position. • Make the hose connections and secure the cam locks . • Open supply valves slowly to avoid damage to hoses or personnel. • Check supply lines and valves for leaking .	L
X	Connect the power supply	Electrocution or power surge resulting in equipment damage, injury or loss of life	• Inspect power cords for evidence of damage to the wire or connector. If damage is present, do not use power cord. • Inspect connection of power supply for evidence of damage. • Use GFCI 'pigtail'.	L
X		Misuse of generators or electrical equipment can cause electrocution, fire or equipment failure	• If using generator inspect components for damage before use. • Check oil/fuel levels and fill if necessary. • Inspect electrical equipment for evidence of damage to switches, circuits or breakers before connecting power. • Connect power cord then power supply. Watch for wet or other conductive surfaces.	L
X	Connecting the injection hoses and well heads to the injection wells	Pressure build up in wells can cause well caps to fly off causing head or bodily injury	• When opening injection wells, be sure your body is not over the well when opening. • If wells were constructed with a pressure relief valve (or retrofitted) open the pressure relief valve to release build-up of pressure within the well and listen for pressure escaping from the well. • Be sure that safety glasses are worn and your head is facing away from the well when opening.	L
X	Mixing of chemicals and water	Breathing or contact with sodium persulfate or sodium hydroxide can irritate nose, throat and lungs causing coughing, wheezing and/or shortness or breath. Contact may cause skin allergy resulting in itching and skin rash	• Use full-face respirator with P100 cartridges as needed. • Wear chemical protective clothing; splash shield (as needed) and gloves to minimize contact with skin/eyes/face when handling solid or solution.	M
X		Lifting/handling bags of sodium persulfate or sodium hydroxide can result in muscle strain	• Do not lift more than your personal limits. • Use a second person if needed or when lifting heavy items. • Lift with your knees and not your back. • Use a step stool and/or have a second person lift chemical bags to you if mixing in taller tanks.	M

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Pump solution into wells and read pressure and flow gauges	Pressure can build up resulting in hose or flow meter failure leading to possible injury	• Start injections at low flow rate and pressure and adjust as needed. • Secure cam locks to hoses and flow meters. • Never place any body part directly over well heads or in front of fittings that may fly off. • Monitor pressures and stress points of the system during injection (connections, valves, threaded fitting, etc.) • When injection is complete, ensure there is no pressure prior to disassembly. • Shut down injection and let formation de-pressurize itself before disconnecting hoses.	L
X		Cold/wet conditions can cause improper well-head adapted connections, i.e. PVC glue/ cement may not cure properly	• Connect during a warmer day and for a cold weather injection event do any PVC glue related work a few days ahead of the injection event.	L
X		Slips/trips/falls can occur due to hoses laying on the ground resulting in injury	• Practice good housekeeping techniques. • For hoses used during introductions, avoid walking over hoses as much as practicable. • Use high visibility marking and warning devices and secure hose if traveling across a designated facility walking area.	L
X	Clean Equipment	Slips/trips/falls can occur from water and soap causing slippery surfaces. Tripping can occur from equipment being laid out for cleaning	• Be aware of surroundings when cleaning equipment. • Maintain good footing and walk slowly on wet/slippery surfaces. • Keep equipment in a designated cleaning area outside of main walkways	L
X		Heavy lifting of equipment can cause muscle strain	• Use proper lifting techniques. Request assistance when lifting heavy equipment.	L
X		Exposure to chemical solution	• Pump clean water through pumps and hoses before disconnecting for cleaning to remove chemical solution. • Wear PPE including splash aprons or chemical protective suits, chemical resistant gloves, safety glasses/face shield to prevent splashes with residual chemical solution. • Ensure hoses are drained and depressurized before disconnecting. • Ensure eye wash and neutralization solution are available	L
X	Site restoration/loading of equipment	Tripping on equipment laying on the ground	• Secure all equipment after use. • Leave the site clean and free from any trash or debris. • Secure all wells, gates and entrances to the site.	L
X		Heavy lifting can cause muscle strain	• Use proper lifting techniques when loading equipment.	L
X	Inspect injection/equipment trailer and demobilize from site	Improperly loading the trailer can cause flying debris on the roadway. Improper trailer connections can cause the trailer to detach during demobilization.	• Be sure all line items on the check list are satisfactory before departing from the site.	L
X	DPT drilling	Utility Strike	• A minimum of three lines of evidence are required prior to intrusive work • Boreholes cannot be located within 4 ft of a suspected utility. • The first 5 feet will be hand cleared • Properly trained and experienced personnel to be onsite	L

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X		Pinch Points or intanglement	• Leather gloves are to be worn at all times while working near the drill rig • No loose fitting clothes or jewelry is allowed • Tear away high visibility vests are required\	L

Add Items

	EQUIPMENT	TRAINING	INSPECTION
X	Vehicles/Trailer		Perform inspection of vehicle at the start and end of each day and prior to each use.
X	PPE	Respirator training	Before each use.
X	Pumps, hoses, injection fittings		Inspect before use. Inspect for leaks during injection.
X	Secondary containment		Inspect on delivery and before placing equipment in containment. Inspect at least daily for holes/leaks.

Involved Personnel:

All site workers participating in injection, mixing, or monitoring activities while injections are occurring

Acceptance Authority (digital signature): ______________________________

Arcadis U.S., Inc.

10 Friends Lane

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Newtown, Pennsylvania 18940

Tel 267 685 1800

Fax 267 685 1801

www.arcadis.com