IN-SITU CHEMICAL OXIDATION PRELIMINARY REMEDIAL DESIGN

CTS OF ASHEVILLE, INC. SUPERFUND SITE

235 Mills Gap Road
Asheville, Buncombe County, North Carolina
EPA ID: NCD003149556
Consent Decree – Civil Action No. 1:16-cv-380

Prepared for:

CTS Corporation
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Wood Project 6252-16-2012

June 6, 2019

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June 6, 2019

Mr. Craig Zeller, P.E.
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Remedial Project Manager
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Atlanta, Georgia 30303
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RE: In-situ Chemical Oxidation Preliminary Remedial Design
CTS of Asheville, Inc. Superfund Site
235 Mills Gap Road, Asheville, Buncombe County, North Carolina
EPA ID: NCD003149556
Consent Decree – Civil Action No. 1:16-cv-380
Wood Project 6252-16-2012

Dear Mr. Zeller:

Please find attached the In-situ Chemical Oxidation (ISCO) Preliminary Remedial Design for the above-referenced Site. Wood Environment & Infrastructure Solutions, Inc. prepared this ISCO Preliminary Remedial Design on behalf of CTS Corporation to comply with the Consent Decree for Interim Remedial Design/Remedial Action at the CTS of Asheville, Inc. Superfund Site between the United States of America and CTS Corporation, Mills Gap Road Associates, and Northrop Grumman Systems Corporation (entered on March 7, 2017).

If you have questions regarding this ISCO Preliminary Remedial Design, please contact us at (828) 252-8130.

Sincerely,

Wood Environment & Infrastructure Solutions, Inc.

Susan E. Avritt, P.E., L.G.
Senior Engineer

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Principal Engineer

SEA/MEW:sea

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Scott Lutz, Northrop Grumman Systems Corporation
William Clarke, Roberts & Stevens, P.A.

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bgs	below ground surface
BMP	best management practice
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFATS	Chemical Facility Anti-Terrorism Standards
cis-1,2-DCE	cis-1,2-dichloroethene
DHS	Department of Homeland Security
ECD	electron capture device
ERH	electrical resistance heating
FSAP	Field Sampling and Analysis Plan
ft/ft	feet per foot
g/kg	gram per kilogram
ISCO	in-situ chemical oxidation
LNAPL	light non-aqueous phase liquid
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
NAPL	non-aqueous phase liquid
NCDEQ	North Carolina Department of Environmental Quality
OSHA	Occupational Safety and Health Administration
PDI	Pre-design Investigation
PNOD	permanganate natural oxidant demand
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RD	Remedial Design
SOW	Statement of Work
SWMP	Site Wide Monitoring Plan
TCE	trichloroethene (also, trichloroethylene)
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1.0 INTRODUCTION

This document presents the Preliminary Remedial Design (RD) for implementation of the in-situ chemical oxidation (ISCO) interim remedial action at the CTS of Asheville, Inc. Superfund Site (Site) located at 235 Mills Gap Road in Asheville, Buncombe County, North Carolina (Figure 1). This ISCO Preliminary RD has been prepared to comply with Paragraph 3.5 of the Statement of Work (SOW) of the Consent Decree for Interim Remedial Design/Remedial Action (CD) at the Site between the United States of America and CTS Corporation, Mills Gap Road Associates, and Northrop Grumman Systems Corporation.

1.1 SITE DESCRIPTION

The approximate center of the Site is located at north latitude 35°29’36” and west longitude 82°30’25”. The Site formerly contained an approximate 95,000-square foot, single-story brick and metal structure on the southern portion of the Site. The building was demolished in December 2011 and the concrete building pad remains intact. The northeastern portion of the Site contains an asphalt-paved parking area, and asphalt-paved driveways are located parallel to the north (front) of the building pad and southeast (rear) of the building pad. A six-foot high chain-link fence surrounds the Site and a locked gate at the north end of the Site controls access to the Site from Mills Gap Road. The Site is unoccupied. The Site and surrounding area are illustrated on Figure 2.

1.2 BACKGROUND

A non-aqueous phase liquid (NAPL) investigation was conducted at the Site in 2013 and 2014. An approximate one-acre area containing light NAPL (LNAPL) with comingled trichloroethene (TCE) was identified (Wood, 2014). A Focused Feasibility Study (FFS) was conducted to evaluate potential remedial alternatives for the one-acre NAPL area. Electrical resistance heating (ERH) was chosen as the recommended alternative (Wood, 2015a). An additional approximate 0.2-acre area located adjacent and upgradient of the NAPL area where elevated TCE concentrations were detected was added to the proposed treatment area (Wood, 2015b). This 1.2-acre area is considered the TCE source area.

A NAPL FFS Addendum was prepared to evaluate potential remedial alternatives for the dissolved-phase TCE groundwater plume downgradient from the TCE source area (the Northern Area). ISCO via emplaced potassium permanganate was the recommended alternative for the 1.9-acre Northern Area depicted in Figure 3 (Wood, 2015b).

The United States Environmental Protection Agency (USEPA) approved ERH as the recommended interim remedial alternative for the source area and ISCO for the downgradient plume and memorialized the decision in the Interim Record of Decision in February 2016. The CD was entered by the United States District Court for the Western District of North Carolina on March 7, 2017. A Remedial Design Work Plan was submitted to USEPA on April 19, 2017 and approved by USEPA on May 1, 2017.

ERH was implemented in 2018 to remediate saturated soil, groundwater, and LNAPL in the TCE source area. TCE concentrations were reduced by greater than 95 percent in the three media based on baseline and confirmation sampling activities.

An ISCO Treatability Study was conducted in 2018 and 2019 to collect information to determine if the proposed remedial action is effective to meet the RAO and, if so, to develop the full-scale ISCO remedial design. The results of the ISCO Treatability Study are described in the ISCO Treatability Study Evaluation Report (Wood, 2019).

This ISCO Preliminary RD presents the following:

- The remedial design criteria;
- The remedial approach;
- ISCO layout and specifications;
- An evaluation of 'green' processes that can potentially be implemented throughout the project;
- A description of monitoring and control measures to protect human health and the environment;
- A revised Remedial Action (RA) schedule;
- Site-wide monitoring information;
- Construction quality assurance/quality control information;

- Performance monitoring objectives and procedures; and,
- A description for photographic documentation of the RA.

1.3 REMEDIAL ACTION OBJECTIVE

ISCO will be implemented in the approximate 1.9-acre Northern Area of the Site. TCE is the primary contaminant of concern and is dissolved in groundwater. A remedial action objective (RAO) of a 95 percent reduction of TCE concentrations will be applied to groundwater samples collected in the ISCO treatment area.

A Technical Memorandum concerning the RAO (RAO Tech Memo) was submitted to USEPA on September 13, 2017. The RAO Tech Memo presented the methodology for determining successful achievement of the RAO. Using a 'population of data approach', the arithmetic average TCE concentration in the treatment area will be determined from baseline samples collected, and 5 percent of the arithmetic average TCE concentration will be calculated (i.e., 95 percent TCE removal). These concentrations will become the target concentration for groundwater in the Northern Area. As described herein, groundwater samples will be collected on a semi-annual basis until the RAO has been achieved. If a 95 percent TCE reduction is not achieved in a particular area in a reasonable timeframe, additional ISCO treatment might be necessary. Additional information on the ISCO performance monitoring is described in Section 5.0.

1.4 REMEDIAL DESIGN/REMEDIAL ACTION SCHEDULE

An updated interim Remedial Design/Remedial Action schedule is included in Appendix A.

1.5 SITE WIDE MONITORING PLAN

A Site Wide Monitoring Plan (SWMP) was prepared for monitoring various media throughout implementation of the ERH and ISCO interim remedial actions. The SWMP was included in Appendix B of the ERH Final Remedial Design (Wood, 2017b).

2.0 ISCO TREATMENT AREA

The remedial design is based on subsurface data collected from within the ISCO treatment area and general Site geologic and hydrogeologic information, as described in the following sections. The remedial design is also based on the results of the ISCO Pre-design Investigation (Wood, 2017a) and the ISCO Treatability Study (Wood, 2019).

2.1 DESCRIPTION OF THE ISCO TREATMENT AREA

The ISCO treatment area is approximately 1.9 acres in size and is located primarily in the northern portion of the property located at 235 Mills Gap Road (Figure 4). Based on data collected during the ISCO Pre-design Investigation, the area east of the former NAPL/TCE source area will also be included in the ISCO treatment.

2.1.1 Physical Setting

The area surrounding the Site is considered rural and contains residential and light commercial properties. The Site is situated on a topographic "saddle" between two prominent mountains - Busbee Mountain to the north and Brown Mountain to the south and southwest. Properties northwest and southeast are topographically downgradient of the Site. The majority of the Site is relatively flat and natural surface drainage at the Site is to the northwest. The surrounding area contains mountains and rolling hills, typical of the eastern flank of the Appalachian Mountain range.

2.1.2 Geology

Fill material and residual soil (overburden) have been identified in the Northern Area of the Site. Fill material, consisting of loose silty sand with gravel, has been observed to a depth of approximately 20 feet below ground surface (bgs) in the northwestern portion of the Site where two apparent natural intermittent surface water drainage channels were historically backfilled for development/grading. Overburden is located below the fill material, where present, and extends to bedrock which is generally 65 to 80 feet bgs.

The uppermost zone of overburden generally consists of fine to medium sand with 10 to 15 percent silt. The overburden "fabric" ranges from massive (i.e., no apparent geologic structure) to strongly foliated. Foliated zones were observed to be approximately horizontal to steeply dipping. Quartz veins ranging in thickness from less than 0.5 inches to approximately 12 inches, and consisting of sand to gravel-sized fragments, have been observed in the overburden. The partially weathered rock (PWR), which is a zone of less weathered rock than the shallower overburden, has been observed to be approximately 15 feet thick in the Northern Area and typically consists of fine to coarse sand with minor amounts of silt and gravel-sized rock fragments. The fabric of the PWR is similar to the overburden fabric (Wood, 2009).

2.1.3 Hydrogeology

A generally north to south trending groundwater divide is present in the overburden in the north-central portion of the Site. The Site is located on a topographic saddle between mountains to the north and south. A portion of groundwater that is flowing from each mountain (i.e., from a higher elevation) is presumed to be toward the saddle. Therefore, a groundwater divide has developed where groundwater in the overburden flows from the mountains and turns east or west to respective discharge zones. The position and shape of the groundwater divide likely changes in response to seasonal precipitation/infiltration.

The direction of shallow groundwater flow (water table) and groundwater flow in the PWR zone are similar. Groundwater flow in the southern portion of the Site appears to flow radially, to the north and east. From the north/central portion of the Site, groundwater flows northwest and east/southeast toward the respective groundwater discharge zones.

In November/December 2018, the depth to the water table in the Northern Area ranged from approximately 17 to 33 feet bgs in monitoring wells MW-7 and MW-6, respectively. Considering the depth to the water table and the depth to bedrock, the aquifer thickness ranges from approximately 30 to 50 feet.

Based on depth to water measurements collected in 2015, the horizontal hydraulic gradient in the shallow overburden from the source area to the Northern Area is approximately 0.031 feet per foot (ft/ft). The horizontal hydraulic gradient in the shallow overburden in the Northern Area of the Site toward the discharge zone east of the Site is approximately 0.066 ft/ft and the horizontal gradient from Northern Area of the Site toward the discharge zone west of the Site is approximately 0.015 ft/ft (Wood, 2015a).

The horizontal hydraulic gradient in the PWR from the source area to the Northern Area is approximately 0.018 ft/ft. The horizontal hydraulic gradient in the PWR from the Northern Area of the Site toward the discharge zone east of the Site is approximately 0.063 ft/ft and the horizontal gradient from the Site toward the spring west of the Site is approximately 0.014 ft/ft (Wood, 2015a).

Upward vertical hydraulic gradients were observed in the Northern Area between proximal overburden shallow and PWR monitoring wells, based on the November/December 2017 monitoring events. An upward gradient (-0.055 ft/ft) was measured at the MW-6/6A well pair and a relatively small upward vertical gradient (-0.001 ft/ft) was measured at the MW-7/7A well pair, which is located at/near the groundwater divide.

Groundwater elevations have fluctuated since monitoring wells were installed in 2009. From 2009 to 2013, groundwater elevations in the Northern Area increased 10.8 feet and 12.5 feet at monitoring wells MW-7A and MW-6A, respectively. This period represents a transition from generally drought conditions to above-average rainfall conditions. Groundwater elevation increases in the shallow (water table) monitoring wells were similar during this period (i.e., 11.1 feet at MW-7 and 11.2 feet at MW-6). From 2013 to 2017, groundwater elevations decreased approximately 7 to 8 feet and increased approximately 6 feet in the first half of 2018.

The groundwater seepage velocity (v) is calculated as:

$v = ki/n_e$, where
k = hydraulic conductivity
i= hydraulic gradient
n_e = effective porosity

Based on the average hydraulic conductivity of 2.3×10^{-4} cm/sec determined by slug testing conducted for the NAPL Area FFS Report (Wood, 2015a) and an assumed effective porosity of 0.25, the groundwater seepage velocity from the Northern Area ranges from 13 feet per year to the western discharge zone to 63 feet per year to the eastern discharge zone.

2.1.4 Nature and Extent of Contamination

As determined from previous investigations, and confirmed during the 2013/2014 NAPL Investigation, the contamination source area was located below the south-central portion of the former building and extended to the immediate south. The nature of the chlorinated volatile organic compound (VOC) contamination, whether from pure product or from a mixed material/liquid containing a portion of chlorinated VOCs, is unknown. The primary release mechanism(s) associated with the chlorinated VOC contamination at the Site is also unknown. The primary chlorinated VOC present in groundwater in the Northern Area is TCE.

The petroleum contamination identified in the source area at the Site consisted primarily of fuel oil. The primary release mechanism(s) associated with the petroleum contamination observed at the Site is unknown; however, the petroleum is suspected of originating from an aboveground fuel oil storage tank formerly used to store and supply fuel oil to the facility’s boiler.

In 2018, electrical resistance heating was implemented to remediate the TCE source area. Concentrations of TCE in saturated soil, groundwater, and LNAPL were reduced greater than 95 percent, indicating that the source area has largely been removed.

Based on results from the NAPL Investigation, a significant portion of TCE partitioned into (i.e., dissolved into) the petroleum light NAPL (LNAPL). Based on geochemical parameters, primarily the octanol-water coefficient, TCE more readily partitions into LNAPL than it dissolves into groundwater; however, via equilibrium conditions, the TCE will dissolve into groundwater over time (Wood, 2014). Therefore, TCE in the LNAPL acted as the primary source to the dissolved-phase groundwater plume, which extends generally north to east from the LNAPL zone. From the Northern Area of the Site, the dissolved-phase groundwater plume extends east and west to discharge zones. Based on previous investigations, there is no evidence of NAPL (either light or dense) in the overburden in the Northern Area of the Site.

2.1.5 Unsaturated Soil

Unsaturated soil samples collected to date from the overburden in the Northern Area do not indicate a source of soil contamination that contributes to the contaminated groundwater plume in the Northern Area.

2.1.6 Saturated Soil

Saturated soil samples were collected during the NAPL Investigation and PDI. TCE concentration in saturated soil samples collected from the Northern Area are relatively low (up to 5,000 micrograms per kilogram, mg/kg) compared to TCE concentrations in saturated soil samples collected in the LNAPL source area prior to remediation (up to 1,120,000 mg/kg), which is indicative of the majority of the TCE mass in the Northern Area being dissolved in groundwater and not sorbed to soil.

2.1.7 Groundwater

The dissolved-phase chlorinated VOC plume in overburden extends from the source NAPL Area to the Northern Area and then east and west toward groundwater discharge zones. Based on data collected during the NAPL Investigation (Wood, 2014) and the Western Area Remedial Investigation (Wood, 2015b), the Northern Area dissolved-phase chlorinated VOC groundwater plume likely does not extend north of Mills Gap Road.

TCE is the primary chlorinated VOC present in groundwater in the Northern Area. Minor concentrations of chlorinated VOC degradation products, such as 1,2-cis-dichloroethene (cis-1,2-DCE), have been detected in groundwater samples collected from the Northern Area. The lack of elevated concentrations of degradation products indicates that natural biodegradation is not readily occurring in the Northern Area. The pH of groundwater in the Northern Area is generally between 5 and 6. Furthermore, the aquifer is mildly aerobic (i.e., dissolved oxygen generally between 1 and 4 milligrams per liter) and reducing conditions are not present (i.e., oxidation reduction potential generally in the 100 to 300 millivolt range). These aquifer conditions could be factors limiting the ability of microbes to anaerobically biodegrade TCE to cis-1,2-DCE.

Concentrations of TCE vary horizontally and vertically in the Northern Area (from tens of micrograms per liter [µg/L] to tens of thousands µg/L). Based on TCE concentrations in collected groundwater samples and electron capture device (ECD) responses measured during the NAPL Investigation and the ISCO PDI, chlorinated VOC concentrations generally increased with depth (Note: the ECD probe did not advance to the depth of bedrock due to limitations of the drilling equipment; the ECD probe generally advanced to a depth of approximately 40 to 50 feet bgs). Nearest the source area, VOC concentrations increased rapidly at the water table based on ECD response data. However, farther away from the source area, VOC concentrations began to increase 5 to 20 feet below the water table. For example, at MIP-80 near the source/LNAPL area, the water table is estimated to be at 19 feet bgs, and the ECD response immediately increased to a maximum reading just below this depth. Conversely, at MIP-100 in the downgradient plume area, the water table is at approximately 20 feet bgs, but the ECD responses began to increase at approximately 35 feet bgs and maximum readings were not obtained until a depth of approximately 42 feet bgs. Figure 3 of the ISCO PDI Evaluation Report depicts the soil boring locations referenced in this section (Wood, 2017).

In the west-central area of the Site, VOC concentrations began to decrease after a zone of elevated readings. For example, at MIP-105, ECD responses increased at approximately 30 feet bgs, but began to decline at approximately 45 feet bgs. Two drainage swales formed by intermittent streams were formerly located in this area of the Site, indicating that there was at one time an upward gradient and discharge zone. This ‘upwelling’ could be inhibiting the downward migration of groundwater containing VOCs in this area.

Based on the results of the NAPL Investigation, an area generally to the east and northeast of the former building was identified where groundwater was not highly contaminated (i.e., outside of the dissolved-phase TCE plume core). However, data collected for the ISCO PDI identified elevated TCE concentrations in this area deeper than was observed during the NAPL Investigation. For example, MHP-11 was advanced in this area during the NAPL Investigation to a refusal depth of approximately 42 feet bgs, and a groundwater sample collected at 42 feet bgs indicated a TCE concentration of 419 µg/L. During advancement of MIP-102 and MIP-103 in this area for the ISCO PDI, ECD responses began to increase at 40 feet bgs and maximum responses were measured at 45 to 48 feet bgs. A groundwater sample collected at 52 feet bgs at MIP-102 indicated a TCE concentration of 17,800 µg/L.

Petroleum constituents have not been detected at elevated concentrations in groundwater samples collected in the Northern Area of the Site. Relatively minor concentrations of petroleum constituents (i.e., compared to reported TCE concentrations) were detected in soil and groundwater samples collected nearest the NAPL source area. In general, the petroleum constituents that have been detected/estimated are ring-structured hydrocarbons (e.g., benzene, toluene, and xylenes) which more readily dissolve into groundwater from a petroleum fuel source. Petroleum constituents in groundwater in the Northern Area are not considered to contribute significant mass to the overall contaminated groundwater plume.

2.2 PERMANGANATE NATURAL OXIDANT DEMAND

In addition to the contaminants present in the area to be treated, the subsurface formation contains organic and inorganic materials that will be oxidized by the chemical oxidant (potassium permanganate). This natural oxidant demand will consume some portion of the injected oxidant. Therefore, the permanganate natural oxidant demand (PNOD) was measured during the ISCO PDI to determine the magnitude of the PNOD that will potentially be consumed by the potassium permanganate, in conjunction with the contaminants present in the groundwater.

PNOD samples were collected from the saturated zone in the ISCO treatment area. Each soil sample was analyzed in triplicate. The average PNOD results for each sample ranged from 0.9 grams per kilogram (g/kg) to 2.2 g/kg (Wood, 2017). The results indicate that the PNOD does not vary greatly in the Northern Area and is relatively low; therefore, PNOD would not be expected to consume a significant portion of the potassium permanganate.

2.3 FATE AND TRANSPORT

The fate and transport of contaminants in soil and groundwater is influenced by numerous factors, including the primary and secondary release mechanisms; the physical and chemical properties of the constituents that were released; and the characteristics of the subsurface medium through which the contaminants migrate.

2.3.1 Contaminant of Concern

The primary contaminant of concern for the Northern Area is TCE.

2.3.2 Contaminant Transport Pathways

The primary transport pathway for contamination in the overburden in the Northern Area is via groundwater. The unsaturated soil pathway, where contaminants leach from the soil to the underlying groundwater, is not considered a transport pathway, as evidence of contamination in the unsaturated soil has not been identified in the Northern Area. The dissolved-phase groundwater plume in the Northern Area discharges at surface water features east and west of the Site resulting in an airborne contaminant pathway via volatilization of VOCs, as well as a surface water contaminant transport pathway.

2.3.3 Mass Distribution

The downgradient dissolved-phase plume contains minor concentrations of chlorinated VOC degradation compounds and petroleum constituents. Groundwater in the Northern Area contains concentrations of TCE ranging from hundreds μg/L to tens of thousands μg/L. As previously described, concentrations of TCE vary horizontally and vertically in groundwater in the Northern Area.

2.4 EXISTING FEATURES

The Site is unoccupied, and the only operable utilities are electricity and potable water. A terra cotta sewer line that is no longer used is located in the central portion of the Northern Area. A steel natural gas line that is no longer used is located near the eastern property boundary. Overhead electrical service to the Site remains in place and is located in the central portion of the Northern Area. The water service connection is located between the fence and Mills Gap Road (east of the entrance gate), and a spigot is located inside the fence. The concrete pad of the former building is located in the southern portion of the Site and the northeastern portion of the Site contains asphalt pavement.

3.0 ISCO REMEDIAL DESIGN

3.1 ISCO DESCRIPTION

ISCO involves injection or emplacement of oxidant chemical substances into the contaminated zone. The chemicals oxidize the contaminants to form non-hazardous substances such as carbon dioxide and water. The oxidant potassium permanganate was chosen for groundwater treatment in the Northern Area. Potassium permanganate is a powerful oxidant that is commonly used to oxidize/destroy dissolved-phase chlorinated VOCs, such as TCE. Potassium permanganate can be injected as a liquid solution via injection points or emplaced as a solid via hydraulic delivery methods. Solid potassium permanganate, which has a greater oxidation capacity than liquid permanganate, was selected for groundwater treatment in the Northern Area.

Potassium permanganate will be hydraulically emplaced in the subsurface as a slurry of granular potassium permanganate, water, and a thickener (such as bentonite) creating a sheet-like sub-horizontal disc in the subsurface. Due to the concentration gradient between the potassium permanganate and surrounding groundwater, the potassium permanganate will diffuse over time into the soil/groundwater surrounding the emplacement. In addition, the potassium permanganate emplacement will generally be more permeable than the surrounding formation, so groundwater will preferentially flow through the emplacement. Contaminants in groundwater that migrate through the zone of solid potassium permanganate are then oxidized (i.e. destroyed). Also, the potassium permanganate dissolves into the groundwater in the surrounding formation and, via advection and dispersion, creates an "oxidative zone" that oxidizes contaminants in this zone. The potassium permanganate will continue to oxidize VOCs until the oxidative capacity is exhausted.

3.2 ISCO TREATABILITY STUDY

An ISCO Treatability Study (TS) was implemented in the Northern area from November 2017 to March 2019. Three emplacement wells were installed to depths of 75 feet at the locations depicted in Figure 3. Emplacement wells EPW-1 and EPW-2 were located 30 feet apart and emplacement wells EPW-2 and EPW-3 were located 35 feet apart. Baseline groundwater sampling was conducted in December 2017 and quarterly groundwater sampling was conducted in May, August, and November 2018. A potassium permanganate soil evaluation was conducted in December 2018 and additional groundwater sampling was conducted in March 2019. The results of the TS are described in the ISCO Treatability Study Evaluation Report (Wood, 2019).

The results of the ISCO TS indicate that, where potassium permanganate was identified in groundwater, TCE concentrations were reduced an estimated 87 to 100 percent in approximately one year. Potassium permanganate emplacements, where visually identified, ranged in thickness from 0.01 feet to 0.13 feet. Potassium permanganate diffusion zones ranged in thickness from 0.1 feet to 12.8 feet. Based on visual identification of the potassium permanganate in six of the soil cores, the radius of the emplacements is approximately ten feet. Potassium permanganate was identified in groundwater in one well pair (one shallow and one deep) located 20 feet from the nearest emplacement wells.

3.3 ISCO REMEDIAL DESIGN

A groundwater treatment remedy employing ISCO via emplaced potassium permanganate has been developed. The objective of the remedial design is to place sufficient reactive material to achieve a 95 percent reduction of TCE in groundwater within three to five years.

A 30-foot by 40-foot spacing between emplacement locations/wells is proposed (Figure 4). The 40-spacing is generally parallel to groundwater flow, and the 30-foot spacing is generally perpendicular to groundwater flow. This layout takes advantage of natural groundwater flow to distribute the potassium permanganate that becomes dissolved in groundwater.

As described in Section 2.1.6, TCE concentrations vary with depth in the Northern Area. In some areas (i.e., further away from the former source area), TCE concentrations do not begin to increase until 10 or more feet below the water table. Potassium permanganate will be emplaced from the top of the 'highly' contaminated zone to bedrock. Emplacements will be vertically spaced 6 feet apart beginning 3 to 6 feet above the top of bedrock to within 3 to 6 feet of the top of the contaminated zone. The top of the contaminated zone will be based on previously collected data in the treatment area. The emplacement depths will be staggered between locations, as is possible based on the thickness of the contaminated zone and the depth to bedrock.

The amount of potassium permanganate used in each emplacement will depend upon the approximate TCE concentration in the vicinity of the emplacements. TCE concentrations in the baseline groundwater samples and previously collected data from the Northern area will be evaluated to determine the amount of potassium permanganate to be emplaced at each location. Where TCE concentrations are greater than 10,000 µg/L, approximately 1,000 pounds of potassium permanganate will be used at each emplacement. Where TCE concentrations are less than 10,000 µg/L, at least 500 pounds of potassium permanganate will be emplaced. Where a lesser amount of permanganate is to be emplaced, a bulking agent such as sand and/or additional bentonite will be added to the potassium permanganate slurry. The bulking agent will create emplacements of similar size to the 1,000-pound potassium permanganate emplacements, but of a lesser concentration since the TCE concentrations are lower and less oxidant is required.

3.4 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL

A Construction Quality Assurance/Quality Control Plan was also developed to evaluate and confirm that overall project management is maintained, production and quality are in compliance with project requirements, and construction deficiencies are identified and corrected in a timely manner. The ISCO Remedial Action Construction Quality Assurance/Quality Control Plan is included in Appendix B.

3.5 INFRASTRUCTURE REQUIREMENTS

Duke Energy maintains overhead electrical power along Mills Gap Road and through the central portion of the Site. A temporary power pole is located near the entrance gate and will be used to provide service for a temporary construction trailer.

The City of Asheville maintains a water supply main along Mills Gap Road and a connection to the main was made during the ERH activities. A spigot is located inside of the Site fence and will be used to supply water for the drilling and emplacement activities.

3.6 PERMIT REQUIREMENTS

Under CERCLA Section 121(e)(1), federal, state, or local permits are not required for the portion of any removal or remedial action conducted entirely on site as defined in 40 CFR 300.5 (see also 40 CFR 300.400(e)(1) and (2)). In addition, CERCLA actions must only comply with the "substantive requirements," not the administrative requirements of regulations. Administrative requirements include permit applications, reporting, record keeping, and consultation with administrative bodies.

The following agency regulations requiring a permit/adherence have been identified for implementation of ISCO at the Site:

- North Carolina Department of Environmental Quality (NCDEQ) well construction and abandonment standards
- NCDEQ Underground Injection Control Program rules for subsurface injection
- State and federal hazardous and non-hazardous waste characterization, storage, and disposal requirements
- Department of Homeland Security (DHS) Chemical Facility Anti-Terrorism Standards (CFATS)

An "Application for Permit to Construct and/or Use a Well(s) for Injection" will be prepared and submitted to USEPA and NCDEQ prior to initiation of emplacement activities. A DHS CFATS Top-Screen Survey will also be completed prior to initiation of emplacement activities. As potassium permanganate is received at the Site, and as it is emplaced in the subsurface (i.e., no longer being stored at the Site), DHS will be notified via the DHS on-line reporting portal.

Actions to comply with the substantive requirements of the aforementioned regulations are described in Sections 4.0 and 7.0.

3.7 ISCO IMPLEMENTATION

Prior to subsurface drilling activities, it is anticipated that the following Site preparation activities will be conducted:

- Clearing of vegetation around the Site entrance to provide improved ingress/egress visibility from/to Mills Gap Road.
- Installation of signage along Mills Gap Road notifying traffic of the Site entrance.

- Clearing of vegetation in the treatment area.
- Installation of a Site office trailer.

The locations of the emplacement wells and monitoring wells will be marked at the Site using surveying equipment.

3.7.1 Emplacement Well Installation

The emplacement well borings will be advanced using a sonic drill rig and an 8-inch nominal diameter casing bit. The boreholes will be extended three feet into apparent bedrock. A solid (un-screened) 4-inch diameter, schedule 40, PVC flush-threaded casing will be installed in the boring. Centralizers will be installed at an approximate 15-foot spacing in the annulus of the borehole. The surrounding approximate 2-inch annular space between the casing and soil will be pressure grouted from the bottom of the borehole to ground surface using a tremie pipe and grout pump. The grout development will be completed using Type I Portland cement with less than three percent powdered bentonite. The emplacement wells will be completed flush with ground surface and equipped with an expandable locking cap. The grout will cure for at least 72 hours prior to installation of the emplacements.

The subsurface equipment (e.g., augers, cables, tremie pipe) used in drilling activities will not be decontaminated between emplacement well locations, as the area where the borings are advanced will subsequently be treated by ISCO. Drilling equipment will be decontaminated between borings for installation of monitoring wells.

3.7.2 Emplacement Installation

The emplacement process will occur in the following steps:

1. Two inflatable packers attached to steel piping will be lowered into the emplacement casing to the target depth via a pump hoist truck.
2. The packers will be inflated to seal off the emplacement interval.
3. A high velocity water jet set at the target depth will be used to cut the PVC casing/grout and create a kerf, or notch, in the surrounding formation.
4. The potassium permanganate will be transferred to a shrouded hopper via an all-terrain fork lift where it will be weighed.

5. Water will be pumped into a polyethylene tank from the on-Site spigot.
6. Powdered bentonite will be added to the water stream using an in-line mixing device.
7. The potassium permanganate will be mixed with the water/bentonite slurry in the hopper. Sand will be added if determined to be necessary.
8. The slurry will be injected into the formation using a positive displacement pump until the proposed amount has been emplaced. The anticipated injection pressure will be between approximately 100 and 200 pounds per square inch.
9. The packers will be deflated, moved to the next interval, and steps 1 through 7 will be repeated. The process will proceed from the deepest emplacement depth to the shallowest emplacement depth.

The equipment and materials for ISCO implementation will be stored in a secure manner at the Site to protect the materials, property and the public. Granular, research-grade potassium permanganate, which is marketed as RemOx® S by Carus Corporation, will be delivered in 2,000-pound weather-proof 'super sacks' and stored on wooden pallets. Weekly deliveries of potassium permanganate are anticipated, so that significant quantities of potassium permanganate are not stored at the Site at one time. Bentonite will be delivered in 50-pound bags and will be stored in an enclosed trailer.

In the event of a release of potassium permanganate to the ground surface, the material will be promptly swept, vacuumed or shoveled up and placed back in a super sack. Remnants will be neutralized in place with either sodium thiosulfate pentahydrate, or a mixture of equal parts of vinegar, peroxide, and water. The resulting manganese dioxide is a common, non-hazardous material which can be disposed in a municipal landfill.

3.7.3 Additional Emplacements

Based on the results of performance monitoring (Section 5.0), additional emplacements might be required for additional groundwater treatment. Existing emplacement well casings can be used for the additional emplacements. The emplacement process would be as described in Section 3.7.2.

3.7.4 Emplacement Well Abandonment

Upon achieving the RAO, the emplacement well casings will be properly abandoned in accordance with North Carolina Well Construction Standards. Groundwater that is in the well casings will be removed and placed in 55-gallon drums or other approved containers (e.g., polyethylene tanks) for subsequent disposal as described in Section 4.0.

3.8 OPERATION AND MAINTENANCE

The proposed remedial action relies on natural groundwater flow for the potassium permanganate from the emplacements to contact and oxidize TCE in the dissolved-phase groundwater plume; therefore, operation and maintenance of remediation equipment is not required. After installation of the emplacements, monthly site visits will be conducted to check on Site conditions and to confirm that the emplacement and monitoring well caps are secure.

3.9 PHOTOGRAPHIC DOCUMENTATION OF REMEDIAL ACTIONS

Photographs of the ISCO system installation activities will be taken periodically during the remedial action construction. Photographs will also be taken when there are work stoppages for material reasons (i.e., not administrative) and when material or equipment defects are identified. Photograph files will indicate briefly what the photograph is documenting, initials of the photographer, and the date of the photograph.

4.0 WASTE MANAGEMENT

Multiple waste streams will be generated during implementation of ISCO remedial action activities. This section describes how waste will be characterized, stored, and disposed.

4.1 WASTE STREAMS

The following waste streams are expected to be generated:

- General solid waste
- Soil from drill cuttings
- Water from drilling activities
- Water from monitoring well development and groundwater purging
- Water from decontamination activities

Wastes will be managed in accordance with Paragraph 4.4 of the CD SOW and applicable regulations, as described below.

4.2 SOLID WASTE

Non-regulated solid waste will include used disposable items, such as personal protective equipment, disposable sampling equipment, empty and neutralized potassium permanganate super-sacks, and general refuse. The items will be placed in plastic bags and deposited in a bulk solid water collection container for transport and disposal at the permitted Buncombe County municipal solid waste landfill.

4.3 SOIL

Soil will be generated during the installation of monitoring wells and emplacement wells. Based on the analytical results of soil samples collected from the vadose zone in the Northern Area (Wood, 2017), unsaturated soil can be managed as non-hazardous waste. Similarly, it is anticipated that saturated soil will be managed as hazardous waste based on TCE concentrations (characteristic waste by toxicity). During drilling operations, soil cuttings will be transferred to roll-off containers staged at the Site. The roll-off containers will be lined with plastic sheeting and will have covers that can be placed over the soil when not being filled. The containers will be visually inspected daily to identify potential leaks. If leaks are identified, temporary containment facilities will be constructed.

Unsaturated and saturated soil samples will be collected during drilling for determination of the contaminant concentrations and characterization for waste disposal. The quantity of soil samples to be collected will ultimately be determined by the disposal contractor and/or the disposal facility. The samples will either be analyzed for total VOCs according to USEPA Method 8260 and/or VOCs according to the toxicity characteristic leaching potential test, as directed by the disposal contractor and/or the disposal facility.

Soil generated from installation of the off-Site monitoring wells (see Section 5.2) will be placed in 55-gallon drums and stored in the fenced easement area on the property. Unsaturated and saturated soil samples will be collected during drilling for determination of the contaminant concentrations and characterization for waste disposal, as described above.

Based on the analytical results of the soil samples, the soil will be manifested as either a non-hazardous waste and disposed of at a Subtitle D landfill, or as a hazardous waste and disposed of at a Subtitle C landfill or other appropriate disposal facility.

In accordance with Section 4.4 of the CD SOW, for out-of-state shipments, the USEPA Project Coordinator and the receiving facility state's environmental official will be notified prior to shipment of the waste.

4.4 WATER

Water generally includes groundwater generated during monitoring well installation/development, groundwater generated during purging/sampling monitoring wells, and water generated during decontamination activities. Water will also be used during drilling to assist in the advancement of the sonic drill casings. Water will be accumulated in a double-walled storage tank ('frac' tank). A sample of the water will be collected for determination of the contaminant concentrations and characterization for waste disposal. The quantity of water samples to be collected will ultimately be determined by the disposal contractor and/or the disposal facility. The samples will be analyzed for total VOCs according to USEPA Method 8260 or as directed by the disposal contractor and/or the disposal facility.

Groundwater purged during performance monitoring (Section 5.0) will be placed in 55-gallon drums staged at the Site. The analytical results of the collected groundwater samples will be used to determine if the water can be disposed of as a hazardous or non-hazardous waste.

Groundwater purged during monitoring well development of the off-Site monitoring wells will be placed in 55-gallon drums and stored in the fenced easement area on the property. A sample of the water will be collected for determination of the contaminant concentrations and characterization for waste disposal, as described above.

5.0 PERFORMANCE MONITORING

Groundwater will be monitored in the ISCO treatment area to determine if/when the groundwater RAO has been met. Groundwater monitoring will also be conducted downgradient of the ISCO treatment area to monitor for the potential presence of potassium permanganate upgradient of the eastern springs area.

5.1 PERFORMANCE MONITORING

Existing monitoring wells MW-6, MW-6A, MW-7, MW-7A, MW-19, and MW-19A, which are located in the ISCO treatment area, will be used for groundwater monitoring during the ISCO remedial actions. Seven additional monitoring well pairs (seven shallow and seven deep overburden at each location) will be installed and used for additional groundwater monitoring. The proposed locations of the new monitoring wells are depicted in Figure 4. The new monitoring wells will be positioned in the approximate center of adjacent emplacement wells. Monitoring well installation procedures will be described in the forthcoming ISCO Remedial Action Work Plan (RAWP) Field Sampling and Analysis Plan (FSAP).

The proposed monitoring well screened intervals are intended to be distributed throughout the treatment volume in the 1.9-acre Northern Area. The monitoring well screened intervals might be adjusted based on the depth to bedrock (i.e., if drilling refusal is encountered above the proposed screened interval depth). The following table contains screened intervals of the proposed and existing monitoring wells.

Shallow Monitoring Well	Screened Interval (feet bgs)	Deep Monitoring Well	Screened Interval (feet bgs)
MW-6[1]	37.2 – 46.8	MW-6A[1]	75.6 – 80.4
-	-	MW-7A[1]	66.8 – 71.3
MW-19[1]	40.0 – 44.8	MW-19A[1]	59.7 – 64.5
MW-33	50 - 55	MW-33A	65 - 70
MW-34	45 - 50	MW-34A	65 - 70
MW-35	40 - 45	MW-35A	55 - 60
MW-36	50 - 55	MW-36A	70 - 75

Shallow Monitoring Well	Screened Interval (feet bgs)	Deep Monitoring Well	Screened Interval (feet bgs)
MW-37	45 - 50	MW-37A	65 - 70
MW-38	45 - 50	MW-38A	65 - 70
MW-39	35 - 40	MW-39A	50 - 55
Notes: [1] – existing monitoring well bgs - below ground surface			

Baseline groundwater samples will be collected prior to initiating ISCO emplacement activities. Groundwater samples will be collected using low-flow purging/sampling. Water quality parameters (pH, temperature, conductivity, dissolved oxygen and oxidation reduction potential) will be monitored during purging. The groundwater samples will be submitted for analysis of TCE, cis-1,2-dichloroethene, trans-1,2-dichlororethene, and vinyl chloride according to USEPA Method 8260. Groundwater sampling procedures will be described in the RAWP FSAP and QA/QC procedures and documentation will be described in the RAWP Quality Assurance Project Plan (QAPP).

Groundwater samples will be collected from the 19 monitoring wells on a semi-annual basis until the RAO is achieved. Groundwater samples will be collected as described above and the concentration of potential potassium permanganate will be attempted to be measured with a colorimeter.

5.2 DETECTION MONITORING

Two additional monitoring wells will be installed downgradient of the ISCO treatment area on the property to the east of the Site to monitor for potential potassium permanganate presence (Figure 5). The monitoring wells will be screened across the water table which will be determined during drilling. Groundwater samples will be collected from these two monitoring wells, as well as from one temporary monitoring well (TW-1), on a monthly basis beginning approximately four months after the emplacements along the Site’s eastern property boundary have been installed. The groundwater samples will be visually evaluated for the presence of potassium permanganate. Monitoring well installation and groundwater sampling procedures will be described in the forthcoming ISCO RAWP and FSAP.

The proposed detection monitoring wells will be located on private property to the east of the Site. USEPA will obtain an access agreement for CTS and USEPA representatives to access this property to install the wells, stage investigation derived waste, and perform the ISCO monitoring activities.

If potassium permanganate is observed in the off-Site detection monitoring wells, efforts to determine if the potassium permanganate is discharging to surface water will be undertaken. If potassium permanganate is determined to be discharging to surface water, mitigation efforts, such as neutralization of the potassium permanganate upgradient of the discharge zone, will be contemplated.

6.0 GREEN ELEMENTS OF REMEDIATION

USEPA's *Principles for Greener Cleanups* (USEPA, 2009) establishes a policy goal for evaluating ways to reduce the environmental footprint of cleanup/remediation actions to the extent possible, while still protecting human health and the environment. Environmental remediation is intrinsically a green process, as the environment is improved and risk to the community and human health is reduced or diminished. However, the various processes that are required to implement remediation each have environmental 'footprints' associated with them. USEPA advocates a green cleanup assessment using the following five elements:

- Total energy use and renewable energy use;
- Air pollutants and greenhouse gas emissions;
- Water use and impacts to water resources;
- Materials management and waste reduction; and
- Land management and ecosystems protection.

USEPA encourages the use of ASTM International's *Standard Guide for Greener Cleanups* E2893 (ASTM, 2016) which describes a process for evaluating, implementing, documenting, and reporting activities that reduce the environmental footprint of a cleanup project (USEPA, 2013). The *Standard Guide* identifies best management practices (BMPs) that can be evaluated for use during implementation of remedial activities. The BMPs are grouped into categories (e.g., materials and power/fuel), with 58 BMPs identified as being applicable to ISCO. BMPs identified in the *Standard Guide,* or identified independently, which have been incorporated into the design include the following:

- Implementing a more passive remediation approach which does not require installation, operation and maintenance of active equipment.
- Using sonic drilling which generates less soil than other drilling methods.
- Segregating drilling waste, so that not all of the waste is disposed of as hazardous, which has higher energy requirements.
- Using existing monitoring wells for performance monitoring.
- Cleaning sampling equipment using a biodegradable cleaning solution.
- Providing reports/drawings electronically to reduce paper usage.
- Recycling consumables at the Site (e.g., drink bottles, cardboard).

- Carpooling to the Site, as is possible, to minimize travel impacts.
- Utilizing local staff and subcontractors to minimize travel impacts.

7.0 PROTECTING HUMAN HEALTH AND THE ENVIRONMENT

The ISCO remedial activities will be implemented in a manner that is protective of human health and the environment. Protection of human health includes Site workers, persons on neighboring properties, and the community at large. A Health and Safety Plan (HASP) has been developed for workers conducting Site activities. The HASP conforms to applicable Occupational Safety and Health Administration (OSHA) regulations. The Site HASP will be updated to include health and safety information related to the ISCO remedial action activities.

Environmental protection is the prevention and control of environmental pollution and the reduction of habitat disruption that may occur to soil, groundwater, biological systems, surface water and air. To the extent possible, Site personnel will manage or reduce the impact to visual aesthetics, noise, and generation of waste streams (solid, liquid, and gas). Environmental resources within and adjacent to the project boundaries that may potentially be affected by the remedial activities will be identified and protected to the extent possible.

7.1 TRAINING

Site personnel will be trained in 40-hour Hazardous Waste Operations and Emergency Response in accordance with OSHA 29 Code of Federal Regulations, with current annual refresher training.

Site personnel will also be trained in environmental protection and pollution control. An awareness briefing discussing environmental protection and pollution control as they relate to the ISCO remedial action activities will be conducted prior to initiating work at the Site. Additional meetings will be conducted for new personnel and when Site conditions change.

7.2 SITE ACCESS

The project will require various personnel to enter the Site and project area. Only those persons who are properly trained or otherwise require access will be allowed to enter. A six-foot high chain-link fence surrounds the Site and a locked gate at the north end of the Site controls access to the Site from Mills Gap Road. The gate to the Site will remain locked to restrict entry to the Site by non-authorized persons.

7.3 WORK HOURS

Site activities will be conducted during daylight hours (generally 7:00 a.m. to 7:00 p.m.). It is not anticipated to have personnel on Site over the weekends or holidays, but personnel will be available if a response at the Site is required.

7.4 LAND RESOURCES

Activities will primarily be limited to the fenced Site property boundaries. Significant grading is not anticipated. Clearing of trees and shrubs in the ISCO treatment area is anticipated to provide clearances for drill rigs and emplacement equipment.

7.5 EROSION AND SEDIMENTATION CONTROL

An erosion and sedimentation control plan will be prepared prior to conducting intrusive activities that will require the removal of soil, if necessary, which may have the potential to create or promote soil erosion at/off the Site. Best management practices (BMPs) will be implemented to reduce or eliminate erosion and promote sediment control. BMPs may include vegetation cover, soil stabilization, or silt fencing. Structural systems will be installed, if necessary, to divert water flows from exposed soils, temporarily store flows, or otherwise limit runoff and the potential discharges of pollutants from exposed areas of the Site. Where drilling activities disturb vegetated surfaces, erosion and sedimentation control activities such as applying seed and straw to the ground surface will be implemented.

Site runoff with visible and significant amounts of sediment will be diverted from entering surface waters. Site runoff is expected from the asphalt parking area in the northern portion of the Site. Runoff will be dispersed to the extent possible to reduce erosion.

7.6 WATER RESOURCES

Best work practices will be implemented to prevent additional contamination from impacting groundwater. There is no surface water at the Site; however, groundwater discharges areas are located east and west of the Site and develop into tributaries. Application of pesticides, insecticides or other hazardous chemicals to the soil or vegetation is not anticipated.

A Spill Prevention, Control, and Countermeasures Plan is not applicable as oil products will not be stored or handled on Site above a quantity of 1,320 U.S. gallons (40 C.F.R. Part 112). Surface waters are not located proximal to the areas of proposed ISCO activities, such that releases of oil or other chemical products would be expected to impact the closest surface waters.

Potassium permanganate is a strong oxidizer that can pose a hazard to ecological receptors if released into the environment. The potassium permanganate will be stored in weatherproof/sealed containers until use. The stored potassium permanganate will be inspected to determine if there are punctures to the containers or they are otherwise compromised. A shroud will be placed over the hopper of the emplacement equipment to minimize fine particles of potassium permanganate from becoming airborne.

In the event of a release of potassium permanganate to the ground surface, the material will be promptly swept, vacuumed or shoveled up and placed back in a super sack. Remnants will be neutralized in place with either sodium thiosulfate pentahydrate, or a mixture of equal parts of vinegar, peroxide, and water. The resulting manganese dioxide is a common, non-hazardous material which can be disposed in a municipal landfill.

When spills or releases of hazardous materials or material that is suspected to be hazardous occurs, the following procedures will be implemented immediately:

- Work will be suspended in the area.
- The spill or leak source will be identified and controlled with the appropriate protective gear.
- Containment actions such as earthen beams, use of sorbet booms and/or pads, or excavating a shallow ditch to capture the release.
- Additional measures will be taken to minimize further movement and effect of the spill or leak on the surrounding area.

Actions or procedures addressing spills and leaks will be conducted in accordance with the Site Emergency Management Plan.

7.7 AIR RESOURCES

Remediation activities will be performed in a manner that minimizes the quantity of dust and gaseous vapors that may be released. Dust emissions and particulate will be controlled to the extent possible by implementing dust control measures, spraying water to minimize dust, and limiting the movement of vehicles and other dust suppression techniques, as necessary. Loads on trucks that could emit dust or falling debris will be covered. Containerized drill cuttings will be covered at the end of each day during drilling activities.

7.7.1 Particulates

Driving areas at the Site will be maintained so they are free from particulates which would cause applicable standards to be exceeded or which would cause a hazard or a nuisance. Spraying driving areas with water can be used control particulates from becoming airborne. Minimizing vehicle speeds, wetting dry soils, covering loads, and similar measures will control particulates along Site driving areas. Particulate control will be performed as the work proceeds and whenever a particulate nuisance or hazard is identified. The majority of the surface in the area of the Site that will receive vehicle use is either paved with asphalt or concrete which will minimize particulate generation.

7.7.2 Odor and Vapors

Vapors or odors are not expected to travel off-Site during implementation of the ISCO remedial action activities. If vapors or odors are identified off-Site, action similar to the spill notification will apply.

7.7.3 Noise

The drilling and emplacement activities will produce noise typical of a construction site. Drilling and emplacement activities will be performed during daylight hours when ambient noise is typically present in the Site area.

8.0 REFERENCES

ASTM International, 2016. Standard Guide for Greener Cleanups, E2893-16.

USEPA, 2009. EPA's Principles for Greener Cleanups website (August 27, 2009) https://www.epa.gov/greenercleanups/epa-principles-greener-cleanups accessed on August 24, 2017.

USEPA, 2013. Memorandum: Encouraging Greener Cleanup Practices through Use of ASTM Internationals Standard Guide for Greener Cleanups. December 23, 2013.

Wood Environment & Infrastructure Solutions, Inc. (Wood), 2014. NAPL Investigation Report, CTS of Asheville, Inc. Superfund Site (May 5, 2014).

Wood, 2015a. Final NAPL Area Focused Feasibility Study Report, CTS of Asheville, Inc. Superfund Site, September 10, 2015.

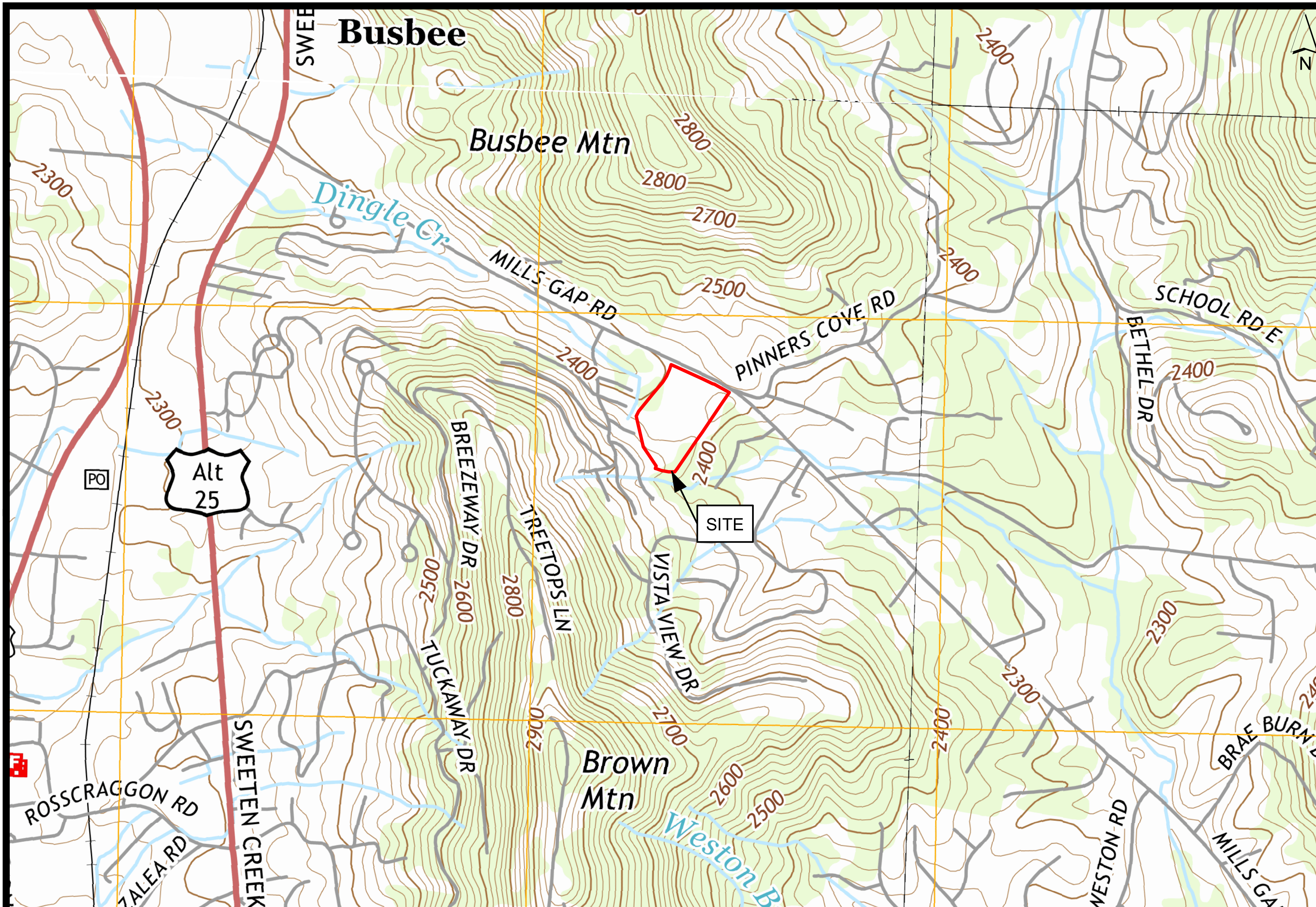
Wood, 2015b. NAPL Area Focused Feasibility Study Report Addendum, CTS of Asheville, Inc. Superfund Site, November 25, 2015.

Wood, 2017a. ISCO Pre-design Investigation Report, CTS of Asheville, Inc. Superfund Site, September 11, 2017.

Wood, 2017b. Electrical Resistance Heating Final Remedial Design, CTS of Asheville, Inc. Superfund Site, November 27, 2017.

Wood, 2019. ISCO Treatability Study Evaluation Report, CTS of Asheville, Inc. Superfund Site, May 3, 2019.

FIGURES



wood.

Topographic Site Map
CTS of Asheville, Inc. Superfund Site
Asheville, North Carolina

Project 6252162012
Figure 1
Drawn By: GLH 02/25/19
Approved By: SEA 02/25/19

1:12,000
0 1,000 2,000 Feet

Sources: USGS Topographic Quadrangles Skyland, NC, Asheville, NC, Fruitland, NC, and Oteen, NC.

Wood Environment & Infrastructure Solutions, Inc.

1308 Patton Ave Suite C
Asheville, NC 28806
(828)252-8130

Site Map
CTS of Asheville, Inc. Superfund Site
Asheville, North Carolina

wood.

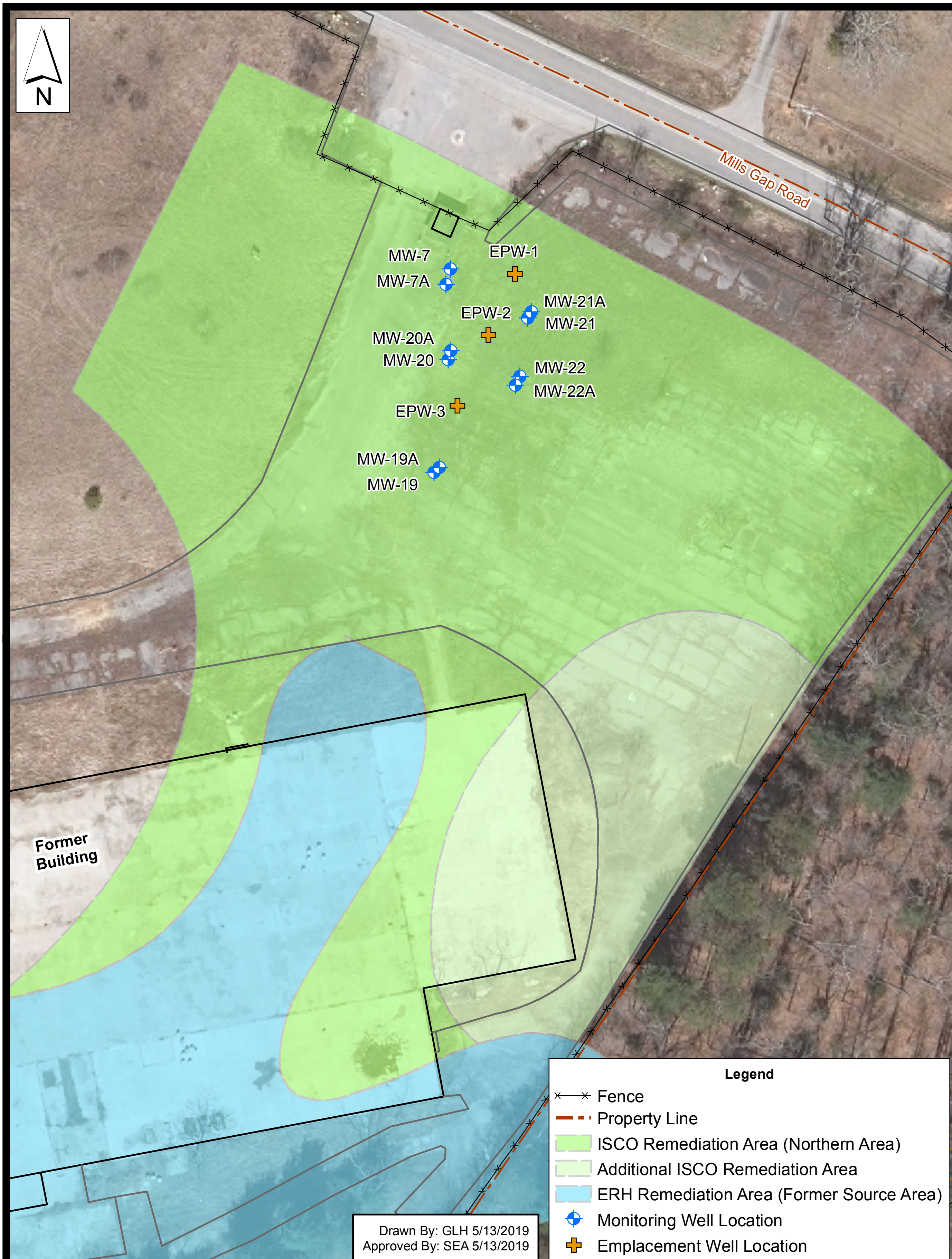
1 inch = 100 feet

0 100 200 Feet

Figure 2

PROJ.: 6252162012

LOCATION: P:\CTS - Mills Gap\GIS\ISCO



wood.

Northern Area and Treatability Study Location
CTS of Asheville, Inc. Superfund Site
Asheville, North Carolina

1 inch = 60 feet

0 30 60 Feet

Project 6252162012

Figure 3

Wood Environment & Infrastructure Solutions, Inc.
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Preliminary ISCO Emplacement
and Monitoring Well Layout
CTS of Asheville, Inc. Superfund Site
Asheville, North Carolina

wood.

1 inch = 50 feet
0 50 100 Feet

PROJ.: 6252162012

LOCATION: P:\CTS - Mills Gap\GIS\ISCO

Figure
4

wood.

Proposed Off-site Monitoring Well Locations
CTS of Asheville, Inc. Superfund Site
Asheville, North Carolina

1 inch = 100 feet

0 50 100 Feet

Project 6252162012

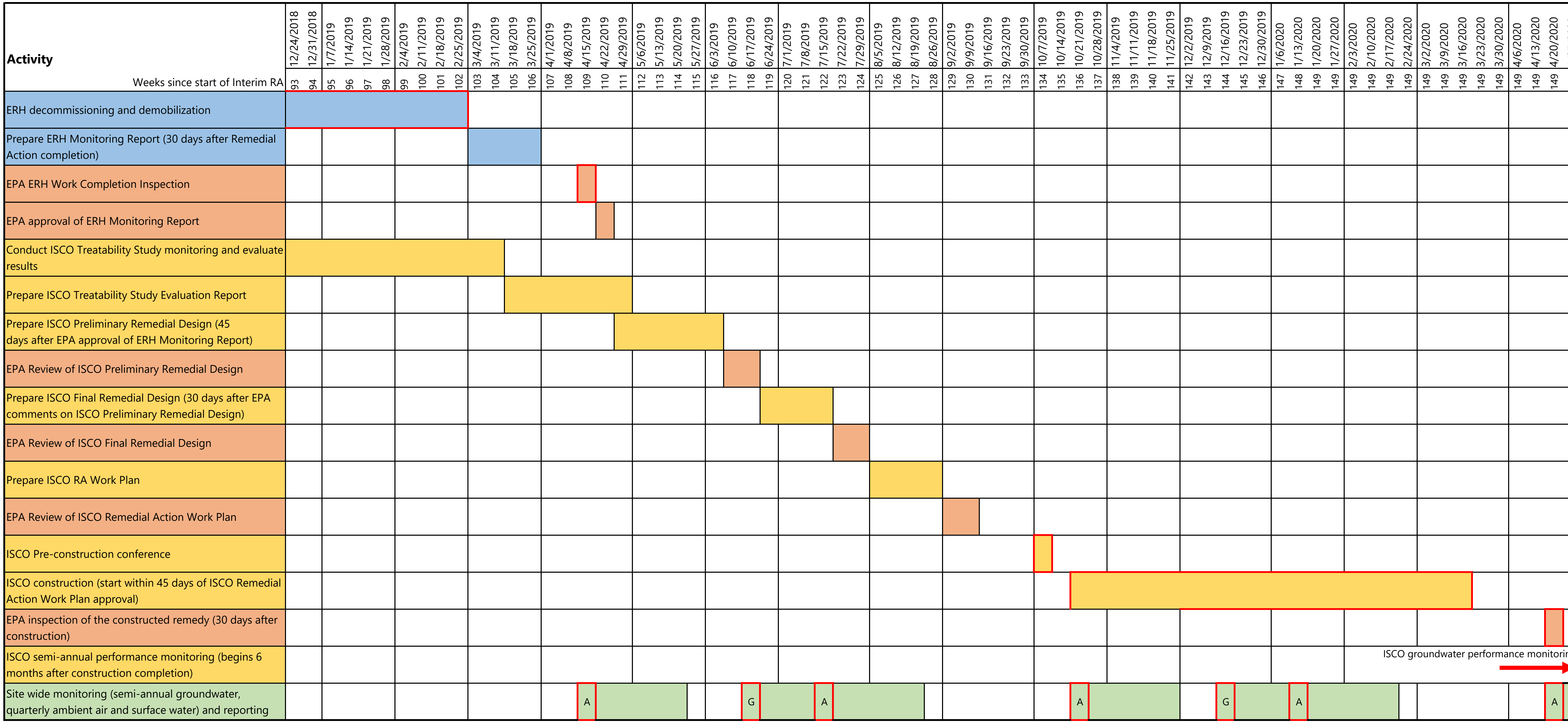
Figure 5

APPENDIX A

INTERIM REMEDIAL DESIGN/REMEDIAL ACTION SCHEDULE

CTS OF ASHEVILLE, INC. SUPERFUND SITE

SCHEDULE FOR INTERIM REMEDIAL DESIGN/REMEDIAL ACTION (Including ISCO Remedial Action Construction)



Notes:

The schedule is based on indicated period for EPA approval or conditional approval of submittals without significant revisions, and is dependant on weather conditions and equipment availability, as applicable.

The project deliverable submittal dates shown above meet the stipulated schedules listed in the Consent Decree.

Date indicates the beginning of the week (period of work).

ERH - Electrical Resistance Heating

ISCO - In-situ Chemical Oxidation

EPA document review and finalization period

Sire wide monitoring and reporting

Field activities/site visits are in red outline

APPENDIX B

ISCO CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

ISCO REMEDIAL ACTION
CONSTRUCTION QUALITY ASSURANCE/
QUALITY CONTROL PLAN

CTS OF ASHEVILLE, INC. SUPERFUND SITE

235 Mills Gap Road
Asheville, Buncombe County, North Carolina
EPA ID: NCD003149556
Consent Decree – Civil Action No. 1:16-cv-380

Prepared for:

CTS Corporation
4925 Indiana Avenue
Lisle, Illinois 60532

Prepared by:

Wood Environment & Infrastructure Solutions, Inc.
1308 Patton Avenue
Asheville, North Carolina 28806

Wood Project 6252-16-2012

June 6, 2019

TABLE OF CONTENTS

LIST OF ACRONYMS

CD	Consent Decree
CQA/QCP	Construction Quality Assurance/Quality Control Plan
ERH	electric resistivity heating
FI	Field Inspector
HASP	Health and Safety Plan
ISCO	in-situ chemical oxidation
NCDEQ	North Carolina Department of Environmental Quality
PC	Project Coordinator
PM	Project Manager
QA	Quality Assurance
QC	Quality Control
RA	Remedial Action
RAO	remedial action objective
SM	Site Manager
SOW	Statement of Work
TCE	trichloroethene
USEPA	United States Environmental Protection Agency

DOCUMENT REVISION LOG

Revision	Date	Description
0	6/06/2019	Initial Issuance (with ISCO Preliminary Remedial Design)

1.0 INTRODUCTION

This ISCO Remedial Action Construction Quality Assurance/Quality Control Plan (CQA/QCP) describes the construction quality program for the proposed Interim Remedial Action (RA) at the CTS of Asheville, Inc. Superfund Site (Site) located at 235 Mills Gap Road in Asheville, Buncombe County, North Carolina. The construction quality assurance (QA) and quality control (QC) activities described herein will be performed to comply with Paragraphs 3.5(h) and 6.7(f) of the Statement of Work (SOW) of the Consent Decree for Interim Remedial Design/Remedial Action (CD) at the Site between the United States of America and CTS Corporation, Mills Gap Road Associates, and Northrop Grumman Systems Corporation.

This CQA/QCP pertains to construction activities performed at the Site related to the in-situ chemical oxidation (ISCO) portion of the Interim RA as described in the Preliminary Remedial Design, dated June 6, 2019.

1.1 OBJECTIVE

The objective of the CQA/QCP is to identify procedures that ensure overall project management is maintained, production and quality are in compliance with project requirements, and construction deficiencies are identified and corrected in a timely manner.

The CQA/QCP describes planned and systematic activities that provide confidence that the remedial action construction will satisfy plans, specifications, and related requirements.

1.2 IMPLEMENTATION

Implementation of the CQA/QCP requires an appropriate organizational structure and a feedback system accomplishing the following key processes:

- Describes procedures that ensure site tasks/construction will be in accordance with project plans and specifications.
- Establishes personnel responsibility for tasks and communication procedures for successful completion of the project.
- Identifies and tracks construction deficiencies through corrective action.

- Provides technical review, follow-up, and correction.
- Documents quality activities and retaining quality documents.

2.0 PROJECT ORGANIZATION

An organizational structure has been developed to provide overall technical and administrative management control to accomplish the project task and quality objectives. This organizational structure assures that project objectives are defined and that competent team members have been assigned responsibility for performing the work. The project organizational chart is included in Appendix A.

2.1 REGULATORY AGENCIES

The United States Environmental Protection Agency (USEPA) is the lead agency overseeing design and implementation of the Interim RA. The USEPA will review/approve plans and reports related to design and implementation of the Interim RA. The USEPA Remedial Project Manager is Mr. Craig Zeller, P.E.

The North Carolina Department of Environmental Quality (NCDEQ) will consult with USEPA during design and implementation of the Interim RA. NCDEQ will review submittals and provide comments to USEPA. The NCDEQ Project Manager is Ms. Beth Hartzell.

2.2 SETTLING DEFENDANTS

The Settling Defendants are designated in the CD as CTS Corporation, Mills Gap Road Associates, and Northrop Grumman Systems Corporation. Mr. Andrew Warren is the Responsible Official of CTS Corporation and will provide overall responsibility for procuring contractors/consultants, budgeting, and assuring the requirements of the Interim RA are achieved. Mills Gap Road Associates is the owner of the property located at 235 Mills Gap Road and will provide access to the Site. Northrop Grumman Systems Corporation will provide additional review of project documents.

2.3 SUPERVISING CONTRACTOR

Wood Environment & Infrastructure Solutions, Inc. (Wood) is the Supervising Contractor procured by CTS Corporation to direct and supervise the technical aspects of designing and implementing the Interim RA.

The Wood Project Manager (PM) is Mr. Matthew Wallace, P.E. The Project Manager's primary responsibility is executing the project and achieving quality in the delivery of services for the project.

The Wood Site Manager (SM) and CQA Manager is Ms. Susan Avritt, P.E., L.G. As the SM, Ms. Avritt will monitor and approve each contractor's quality and progress submittals to ensure construction activities are in accordance with project plans and specifications. As the CQA Manager, Ms. Avritt will perform actions necessary for the completion of the QA and QC program in accordance with project plans and specifications. The CQA Manager or designee is assigned to the project full time and has the authority to stop work when quality objectives are not met.

Wood Field Inspectors (FIs) will monitor day-to-day activities of the contractor to ensure compliance with project plans and specifications, good workmanship and the QC requirements. The FIs will maintain accurate records of the contractor's work and will complete inspection and testing/inspection documentation.

Wood activities will be performed in accordance with the firm's Quality Management Plan (revision number 3, dated June 10, 2016), which was prepared in accordance with the USEPA's QA/R-2 requirements for Quality Management Plans.

2.4 DRILLING CONTRACTOR

The drilling contractor has yet to be designated but will be contracted by Wood. Wood will perform oversight of the drilling activities for installation of emplacement well casings and monitoring wells.

2.5 EMPLACEMENT CONTRACTOR

The drilling emplacement will be contracted by Wood or CTS, with technical support and oversight by Wood. The proposed Interim RA requires a specialty contractor for installation of the emplacements. FRx, Inc. (FRx) is proposed to install the emplacements, with oversight by Wood.

2.6 OXIDANT SUPPLIER

Granular, research-grade potassium permanganate, which is marketed as RemOx® S by Carus Corporation, will be the oxidant used for the proposed Interim RA. Wood will coordinate deliveries of the oxidant with Carus Corporation.

2.7 WASTE MANAGEMENT CONTRACTOR

The waste management contractor has yet to be designated but will be contracted by Wood. Wood will coordinate the delivery and pick-up of waste containers and review waste manifests for completeness and correctness.

2.8 ANALYTICAL LABORATORY

Pace Analytical Services, LLC will be contracted by Wood to perform laboratory analyses of groundwater samples and waste characterization samples. The Pace Analytical Services Quality Assurance Manual was included in the *Remedial Design Work Plan: Quality Assurance Project Plan* dated April 19, 2017. Current/updated versions of these laboratory Quality Assurance Manuals, if applicable, will be obtained and submitted to USEPA in the ISCO Remedial Action Work Plan prior to implementation of the Interim RA.

3.0 MAJOR SITE TASKS

The overall remedial action objective (RAO) of the ISCO Interim RA is a 95 percent reduction of trichloroethene (TCE) concentrations in groundwater in the approximate 1.9-acre portion of the Site (Northern Area). The major tasks associated with the Interim RA in the Northern Area are described in the following sections.

3.1 INSTALLATION OF EMPLACEMENT CASINGS AND MONITORING WELLS

Prior to ground disturbance activities, a North Carolina-licensed surveyor will mark the designated emplacement and monitoring well locations within the treatment area.

A North Carolina-licensed well contractor will advance borings to prescribed depths and install the emplacement well casings and the monitoring wells. Wood personnel will observe and document the details of the constructed emplacement well casings and monitoring wells. Drilling and installation information will be recorded and compared to design plans and specifications.

3.2 WASTE MANAGEMENT

The waste streams generated from site activities (drill cuttings/water, groundwater purge water) will be managed by Wood as described in the Preliminary Remedial Design. Waste transport and disposal activities will be performed by trained and licensed personnel, and waste disposal will occur at permitted facilities appropriate for the type of waste.

3.3 EMPLACEMENT INSTALLATION

FRx will install potassium permanganate emplacements as described in the RD. FRx will document the quantities of materials used and injection pressure for each emplacement. FRx will provide this information to Wood on a weekly basis. Wood personnel will observe installation of the emplacements and will document the details of each emplacement for comparison to design plans and specifications.

4.0 VERIFICATION AND INSPECTION ACTIVITIES

4.1 GENERAL CONSTRUCTION INSPECTION AND VERIFICATION REQUIREMENTS

QA inspection/testing will be used to evaluate the sufficiency and effectiveness of the contractor QC program. To confirm construction quality and maintain compliance with design drawings and specifications, inspections of work will include the following phases:

- Surveying of emplacement casing and monitoring well locations
- Monitoring well installation
- Emplacement casing installation
- Installation of emplacements
- Accumulation of waste

The CQA Manager or a designee will perform the inspections for each major construction task at a minimum. Inspections will be documented. Construction quality inspection of each major construction task, as described in Section 3.0, is listed below.

4.1.1 Initial Inspections

An initial inspection will be performed before the beginning of a major construction task focusing on the work area, materials and equipment. The delineated work area will be inspected to confirm it is free of obstructions that could impact the construction tasks. Materials and equipment will be inspected for defects and compliance with project plans and specifications prior to use. In addition, the CQA Manager and the drilling and emplacement contractors will confirm field personnel have clear understandings of tasks to be completed and the CQA and Health and Safety Plan (HASP) requirements.

4.1.2 Progress Inspections

Daily construction progress inspections will be conducted by the CQA Manager or designee. These inspections will focus on the quality of construction and compliance with CQA, HASP and project plans and specifications. Inspection information and photographs will be recorded. Defects or non-compliance with project plans and specifications will be communicated to the contractors and Supervising Contractor PM for timely resolution.

4.1.3 Final Inspections

A final inspection will be performed by the CQA Manager at the completion of each major site task for quality, completeness, and compliance with project plans and specifications. Final inspections will be documented and reported by the Supervising Contractor PM. If defects are identified during final inspections, they will be corrected and re-inspected before the task is considered complete.

4.2 QC DOCUMENTATION

The surveyor, drilling contractor, FRx, and the waste contractor will be responsible for establishing individual programs to identify, perform and document required QC documentation. The QC programs will be comprised of a system of daily reports that will record QC documentation. Weekly reports will be submitted to the CQA Manager. The CQA Manager will review QC documentation for non-conformance and hold discussions with the contractor for potential corrective action, if necessary.

4.3 QA DOCUMENTATION

The CQA Manager will be responsible for the QA testing and inspection program which will verify the sufficiency and effectiveness of the contractor’s QC documentation. QA documentation will be performed independent of and in addition to QC documentation at the discretion of the CQA Manager.

4.4 CONSTRUCTION AUDITS

FRx will establish and document a system to verify conformance to the emplacement QC procedures defined in this plan. Audits shall be performed by properly trained personnel who are familiar with the QC program. Non-conformance conditions identified will be re-audited to evaluate the effectiveness of the corrective action.

5.0 CONSTRUCTION DEFICIENCIES

Construction deficiencies (non-conformance with project plans or specifications) will be tracked from identification through corrective action.

5.1 IDENTIFICATION OF CONSTRUCTION DEFICIENCIES

Construction deficiencies will be identified when a performed work, material, or installation does not meet project plans or specifications.

5.2 CONTROL OF CONSTRUCTION DEFICIENCIES

When a construction deficiency is identified, the CQA Manager (or designee) will ensure the deficiency is controlled to prevent unintended use or further deficient action. The CQA Manager will notify the appropriate contractor of the deficiency and applicable foregoing requirements. The contractor will take corrective action after notification. The CQA Manager will verify that corrective actions have been completed.

Minor deficiencies include items that will not result in significant deviations from the project plan or specification if corrected immediately. Since minor deficiencies do not require significant repair work to correct, they will be noted in the Daily Construction Report and verbally communicated to the contractor by the CQA Manager (or designee). These deficiencies should be corrected quickly and by agreement with the contractor and should not require further action.

Major deficiencies include major deviations or non-conformance with project plans or specifications or quality standards and must be formally documented for corrective action by the PM in non-conformance reports. A log of non-conformances will be tracked through verification that the non-conformance has been corrected. Minor deficiencies not corrected by the contractor within five days of notification will also result in a major deficiency.

5.3 CORRECTION OF CONSTRUCTION DEFICIENCIES

After notification of the construction deficiency, the contractor will implement correction actions to remedy the work, material, or installation which does not meet project plans or specifications. The corrective actions will remove and replace deficient work in accordance to procedures set forth by the Supervising Contractor PM. Replacement of work will be completed under the QC/QA inspection and testing requirements.

6.0 DOCUMENTATION

6.1 RECORD KEEPING

Daily inspection and documentation will be prepared by personnel performing the corresponding inspection or test. The documentation will vary depending on the inspection or test but at a minimum will include: location of inspection activity or location sample was collected, observation, test data, results of inspection/test, and personnel involved.

Daily construction reports will be prepared and at a minimum will include a summary of the contractor's daily activities, descriptions of problems or delays, and progress photos. Daily inspection and test documentation will be attached to the daily construction reports.

Daily construction reports will be submitted to the project QC/QA file and maintained as part of the project permanent record. The reports will be reviewed by the Supervising Contractor PM and CQA Manager.

6.2 RECORD/AS-BUILT DRAWINGS

The Supervising Contractor, Wood, will survey as-built features.

6.3 RETENTION AND CONTROL OF QUALITY RECORDS

The CQA Manager maintains copies of quality records including construction reports, inspection checklists, and non-conformance reports. Documentation will be stored in files maintained by Wood. Quality records will be available for inspection and audit.

APPENDIX A

PROJECT ORGANIZATION CHART

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