# NAPL AREA FOCUSED FEASIBILITY STUDY REPORT ADDENDUM

## CTS OF ASHEVILLE, INC. SUPERFUND SITE

**235 Mills Gap Road**
**Asheville, Buncombe County, North Carolina**
**EPA ID: NCD003149556**
**CERCLA Docket No. CERCLA-04-2012-3762**

**Prepared for:**

**CTS Corporation**
**2375 Cabot Drive**
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**Prepared by:**

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**Amec Foster Wheeler Project 6252-12-0006**

**November 25, 2015**

November 25, 2015

amec foster wheeler

Mr. Craig Zeller
Superfund Remedial and Site Evaluation Branch
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Subject: **NAPL Area Focused Feasibility Study Report Addendum**
**CTS of Asheville, Inc. Superfund Site**
**235 Mills Gap Road, Asheville, Buncombe County, North Carolina**
**EPA ID: NCD003149556**
**CERCLA Docket No. CERCLA-04-2012-3762**
**Amec Foster Wheeler Project 6252-12-0006**

Dear Mr. Zeller:

Please find attached the Non-aqueous Phase Liquid (NAPL) Area Focused Feasibility Study Report Addendum (FFS Addendum) for the above-referenced Site. Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) prepared this FFS Addendum on behalf of CTS Corporation in accordance with the Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study between the United States Environmental Protection Agency (USEPA) Region 4 and CTS Corporation (effective date of January 26, 2012), and as a comment to the USEPA's Proposed Plan for Interim Remedial Action dated September 30, 2015. CTS Corporation notified USEPA of the intent to submit this FFS Addendum, and requested an extension to the public comment period, in a letter dated October 28, 2015.

This FFS Addendum addresses remediating the groundwater in the overburden in the area to the north of the source NAPL Area, which was the subject of the focused feasibility study.

If you have questions regarding this FFS Addendum, please contact us at (828) 252-8130.

Sincerely,
**Amec Foster Wheeler Environment & Infrastructure, Inc.**

M R Gryder

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for Susan E. Kelly
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## ACRONYMS

| | |
|---|---|
| ARAR | Applicable or Relevant and Appropriate Requirement |
| bgs | below ground surface |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | Code of Federal Regulations |
| cis-1,2-DCE | cis-1,2-dichloroethene |
| ECD | electron capture detector |
| ERH | electrical resistance heating |
| FFS | Focused Feasibility Study |
| ISCO | in-situ chemical oxidation |
| µg/L | micrograms per liter |
| NAPL | non-aqueous phase liquid |
| NCP | National Contingency Plan |
| ORP | oxidation reduction potential |
| PVC | polyvinyl chloride |
| PWR | partially weathered rock |
| RAO | Remedial Action Objective |
| RI/FS | Remedial Investigation/Feasibility Study |
| TCE | trichloroethene |
| USEPA | United States Environmental Protection Agency |
| VOC | volatile organic compound |

# 1.0 INTRODUCTION

This document presents the Non-Aqueous Phase Liquid (NAPL) Area Focused Feasibility Study Addendum (FFS Addendum) for the CTS of Asheville, Inc. Superfund Site (Site) located at 235 Mills Gap Road in Asheville, Buncombe County, North Carolina (Figure 1). This FFS Addendum was prepared by Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler), on behalf of CTS Corporation, pursuant to the 2012 Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (RI/FS) between the United States Environmental Protection Agency (USEPA) Region 4 and CTS Corporation (Settlement Agreement).

The draft NAPL Area FFS Report was submitted to USEPA on July 31, 2015. In response to USEPA's comments dated August 26, 2015, a Final NAPL Area FFS Report was submitted to USEPA on September 10, 2015. USEPA distributed the "Proposed Plan for Interim Remedial Action" regarding the proposed interim remedial plan for the NAPL area to the public on September 30, 2015, indicating that the public comment period was from October 1 through October 30, 2015, with a possible extension upon request. A public meeting presenting the Proposed Plan, which included a public comment period, was held on October 13, 2015.

USEPA indicated that comments received during the initial public comment period were regarding the contaminated groundwater plume in the northern area of the Site (i.e., in the vicinity of monitoring well pairs MW-6/6A and MW-7/7A). On October 28, 2015, Amec Foster Wheeler, on behalf of CTS Corporation, requested a 30-day extension to the public comment period. Amec Foster Wheeler indicated that comments would be provided by CTS Corporation in the form of an FFS Addendum, which would provide information on expanding the interim remedial action area beyond the approximate one-acre NAPL source area. Amec Foster Wheeler indicated the FFS Addendum would present an evaluation for using electrical resistive heating (ERH) and in-situ chemical oxidation (ISCO) as an interim remedial measure in the expanded/northern area.

## 1.1 SCOPE

The purpose of this FFS Addendum is to evaluate remedial alternatives for contaminated groundwater in the overburden of the "Northern Area" of the Site (i.e., in the area extending north from the NAPL Area to the vicinity of monitoring well pairs MW-6/6A and MW-7/7A), as depicted in Figure 2, and to present the recommended remedial alternative.

In accordance with the National Contingency Plan (NCP), under the Code of Federal Regulations (CFR) 40 CFR 300.430(e), “the primary objective of the feasibility study (FS) is to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action options can be presented to a decision-maker and an appropriate remedy selected. The lead agency may develop a feasibility study to address a specific site problem or the entire site.” The NAPL Area FFS evaluated interim remedial alternatives for the approximate one-acre NAPL source area containing elevated concentrations of trichloroethene (TCE) in the saturated soil, groundwater, and NAPL. This FFS Addendum focuses on a second defined area of the Site (i.e., the Northern Area of the Site, as depicted in Figure 2) that is to be included in the interim remedy. The Site-wide RI/FS will be presented in the future under separate cover and will focus on the remainder of the Site.

## 1.2 REPORT ORGANIZATION

This FFS Addendum contains seven sections, as follows:

*Section 1, Introduction* describes the scope and organization of the report.

*Section 2, Northern Area Conceptual Site Model* provides a description of the Northern Area’s physical characteristics and the nature and extent of contamination in the defined area of the Site.

*Section 3, Development of Remedial Alternatives* presents the remedial action objective, describes Applicable or Relevant and Appropriate standards (ARARs), and describes the media and area to be addressed.

*Section 4, Detailed Evaluation of Remedial Alternatives* contains an evaluation of the remedial alternatives with respect to USEPA criteria.

*Section 5, Recommended Remedial Alternative* presents the recommended remedial alternative.

*Section 6, Additional Cost of NAPL Area Remediation* presents cost information for remediation related to the expanded NAPL Area.

*Section 7, Additional Data Requirements* describes additional information that is necessary to refine the remedial area and collect data for full implementation of the recommended interim remedy.

# 2.0 NORTHERN AREA CONCEPTUAL SITE MODEL

The following Conceptual Site Model is based on data collected to date related to the overburden formation in the Northern Area of the Site.

## 2.1 SITE 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.

## 2.2 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) (monitoring well MW-5 and soil boring SB-01) 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 has been observed to a depth of approximately 81 feet bgs (monitoring well MW-6A) in the Northern Area of the Site, where the apparent top of bedrock is encountered. 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 structure) to strongly foliated. Foliated zones were observed to be approximately horizontal to steeply dipping (i.e., greater than 50 degrees). 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 samples as 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 (MACTEC, 2009).

The depth to bedrock in the Northern Area ranges from approximately 50 feet bgs to approximately 81 feet bgs, based on the depth to drilling refusal using rotary/roller cone drilling equipment (MACTEC, 2009) and direct-sensing equipment (Amec, 2014).

## 2.3 HYDROGEOLOGY

A groundwater divide is present in the overburden in the north-central portion of the Site. As previously discussed, 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 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 January 2015, the depth to groundwater in the Northern Area of the Site, ranged from approximately 17 to 33 feet bgs in monitoring wells MW-7 and MW-6, respectively. The horizontal hydraulic gradient in the shallow overburden in the central portion of the Site is approximately 0.031. 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 and the horizontal gradient from Northern Area of the Site toward the discharge zone west of the Site is approximately 0.015 (Amec Foster Wheeler, 2015a).

The horizontal hydraulic gradient in the PWR in the source area at the Site is approximately 0.018. 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 and the horizontal gradient from the Site toward the spring west of the Site is approximately 0.014 (Amec Foster Wheeler, 2015a).

Upward and downward vertical hydraulic gradients were measured between proximal overburden shallow and PWR monitoring wells, based on the January 2015 monitoring event. An upward gradient (-0.12) was measured at the MW-6/6A well pair and a relatively small downward vertical gradient (0.0009) was measured at the MW-7/7A well pair. The presence of essentially such a slight vertical gradient at the MW-7/7A well pair is indicative of a groundwater divide at, or in the vicinity of, the well pair.

Groundwater elevations have fluctuated since monitoring wells were installed in 2009. From 2009 to 2013, groundwater elevations in the Northern Area of the Site increased 10.8 feet and 12.5 feet at monitoring wells MW-7A and MW-6A, respectively. 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 2015, groundwater elevations decreased approximately 3 to 5 feet in the Northern Area of the Site.

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 x $10^{-4}$ cm/sec determined by slug testing conducted for the NAPL Area FFS Report (Amec Foster Wheeler, 2015) and an assumed effective porosity of 0.25, the groundwater seepage velocity from the Northern Area (monitoring well pairs MW-6/6A and 7/7A) ranges from 13 feet per year to the western discharge zone to 63 feet per year to the eastern discharge zone.

## 2.4 NATURE AND EXTENT OF CONTAMINATION

As determined from previous investigations, and confirmed during the 2013/2014 NAPL Investigation, the contamination source area is located below the south-central portion of the former building and extends 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 observed at the Site is also unknown.

The petroleum contamination identified in the source area at the Site consists 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.

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

### 2.4.1 Unsaturated Soil

Unsaturated soil samples collected from the overburden in the Northern Area of the Site to date do not indicate a source of soil contamination that contributes to the contaminated groundwater plume in the Northern Area of the Site. For instance, four unsaturated soil samples collected by USEPA subcontractors in late 2007/early 2008 did not indicate the presence of Site-related VOCs in the Northern Area of the Site (TNA, 2008). Also, an unsaturated soil sample collected from the MW-6 soil boring in September 2008 did not indicate Site-related VOCs (MACTEC, 2009).

In 2010, the facility's sanitary sewer line was located and unsaturated soil samples were collected within approximately two feet below the identified sewer line, which extends from the eastern portion of the former building to Mills Gap Road. Five unsaturated soil samples (SS-126 through SS-130) were collected below the sewer line in the Northern Area of the Site and minor concentrations of TCE were reported in two of the samples (e.g., 5.4 and 8.1 micrograms per kilogram in SS-127 and SS-128, respectively; MACTEC, 2010).

During the 2013/2014 NAPL Investigation, an electron capture device (ECD) was used to qualitatively measure the concentration/amount of chlorinated VOCs, such as TCE, adjacent to the ECD probe as it was advanced down through the overburden. The ECD probe was advanced at 14 locations in the Northern Area of the Site. Elevated ECD responses indicating the presence of chlorinated VOCs were not measured in the unsaturated soil, and in many cases, the estimated depth of the water table was consistent with the beginning of positive ECD responses indicating the presence of the dissolved-phase chlorinated VOC plume in groundwater (Amec, 2014).

### 2.4.2 Groundwater

The dissolved-phase chlorinated VOC plume in overburden, primarily consisting of TCE, 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 (Amec, 2014) and the Western Area Remedial Investigation (Amec Foster Wheeler, 2015b), the Northern Area dissolved-phase groundwater plume likely does not extend north of Mills Gap Road. The core of the Northern Area groundwater plume (i.e., TCE groundwater concentrations greater than 5,000 micrograms per liter, µg/L, based on TCE concentrations in groundwater samples and elevated ECD responses observed during the NAPL Investigation) is depicted in Figure 2 and is the focus of this FFS Addendum.

As previously described, the petroleum NAPL (primarily residual NAPL that is not migrating) acts as the primary source to the dissolved-phase groundwater plume. Over time, constituents in the NAPL dissolve into groundwater migrating through the NAPL Area, creating the dissolved-phase plume.

Concentrations of TCE in the dissolved-phase plume core downgradient of the NAPL are elevated (in the tens of thousands µg/L). As noted by Bernard Kueper, PhD, one of the preeminent scientists studying NAPLs, concentrations of constituents exceeding the one percent solubility of the constituent (one percent of the solubility of TCE is 11,000 µg/L) does not necessary indicate that NAPL is present at that location. Dr. Kueper indicates “There never was a technical basis for the exact 1% value. It is a very rough guide to simply alert investigators that if 1% solubility is exceeded, it is possible that the groundwater flow path leading to the monitoring well in question may have contacted

[NAPL] at some point in time, and at some location up-gradient or side-gradient of the monitoring point in question" (Kueper, 2013). Evidence of NAPL (light or dense) has not been identified in the overburden in the Northern Area of the Site.

TCE is the primary chlorinated VOC present in groundwater in the Northern Area of the Site. 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 does not appear to be occurring in the Northern Area.

Based on the January 2015 sampling event, the pH of shallow groundwater in the Northern Area of the Site (MW-6 and MW-7) was approximately 5, which could be one of the factors limiting the ability of microbes to anaerobically biodegrade TCE to cis-1,2-DCE (Amec Foster Wheeler, 2015). The pH of the deeper groundwater in the Northern Area of the Site is approximately 7 and 9 in monitoring wells MW-6A and MW-7A, respectively. It should be noted that the initial pH in groundwater purged from the deeper monitoring wells after installation in 2009 ranged from 11 to 12, indicating likely grout/concrete "contamination" from the alkaline grout/cement emplaced in the annulus of the monitoring wells (Nielsen, 2006). The "elevated" pH readings in the January 2015 measurements in the PWR wells could be a result of the continuing effect of the alkaline grout/cement.

Concentrations of TCE vary horizontally and vertically in the Northern Area. Based on TCE concentrations in collected groundwater samples and ECD responses, chlorinated VOC concentrations generally increase 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 50 feet bgs). The relatively significant upward vertical hydraulic gradient (i.e., -0.015 in 2009 and -0.12 in 2015) at the MW-6/6A monitoring well pair is likely the reason TCE concentrations in shallow groundwater at MW-6 are higher compared to TCE concentrations in shallow groundwater at MW-7, where the vertical hydraulic gradient is very low (i.e., 0.004 upward in 2009 and 0.0009 downward in 2015).

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 groundwater samples collected in January 2015 from monitoring wells MW-6 and MW-7, as well as in groundwater samples collected from SB-05 and SB-10 during the NAPL Investigation. These minor concentrations indicate that the groundwater plume in the Northern Area of the Site does contain a relatively small proportion of petroleum constituents. In general, the petroleum constituents that have been detected are short-chain hydrocarbons (e.g., benzene, toluene, and xylenes) which more readily dissolve into groundwater from a petroleum fuel source, such as the petroleum NAPL in the source area. Petroleum constituents in groundwater in the Northern Area are not considered to contribute significant mass to the overall contaminated groundwater plume.

## 2.5 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.

### 2.5.1 Contaminants of Concern

For the purposes of this FFS Addendum, the primary constituent of concern for the Northern Area is TCE.

### 2.5.2 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. Some component of groundwater from the overburden likely also migrates into the underlying bedrock.

### 2.5.3 Mass Distribution

The NAPL source area at the Site contains the largest mass of contaminants. The downgradient dissolved-phase plume contains chlorinated VOC degradation compounds and minor concentrations of 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.

# 3.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121 (d)(4)(A) states that a remedial alternative can be selected that does not attain a level or standard of control at least equivalent to a legally applicable or relevant and appropriate requirement, criteria, or limitation if the remedial action selected is part of a total remedial action that will attain such level or standard of control when completed. The remedial alternatives developed for this FFS Addendum are focused on remediating TCE in groundwater in the Northern Area of the Site as depicted in Figure 2 to a degree that the TCE concentrations in the downgradient dissolved-phase plume (i.e., in the area of the downgradient discharge zones) will begin to decrease.

## 3.1 IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are medium-specific or operable-specific goals for protecting human health and the environment and specify contaminants of concern, media of concern, potential exposure pathways, and remedial goals (USEPA, 1988). USEPA guidance states that RAOs should specify:

- The contaminant(s) of concern
- Exposure route(s) and receptor(s)
- An acceptable contaminant level or range of levels for each exposure route (i.e., a preliminary remediation goal)

The objective of the Northern Area interim remedy is to reduce the mass of TCE in the identified area. Over time, and while the Site-wide RI/FS is being conducted, the dissolved-phase plume is expected to decrease in size and concentration. The specific RAO of the remedial action is to reduce TCE concentrations in the Northern Area of the Site by 95 percent based on groundwater concentrations. Because this will be an interim action that is part of a larger remedial action that will eventually attain legally applicable or relevant and appropriate requirements (such as Maximum Contaminant Levels or state cleanup levels), it is not necessary to determine cleanup levels at this stage or to define the objectives of this interim action with reference to those levels.

## 3.2 IDENTIFICATION OF POTENTIAL ARARS

Section 121 of CERCLA specifies that Superfund remedial actions must meet the more stringent of federal or state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate. In accordance with the NCP at 40 CFR 300.430(e)(9)(iii)(B), ARARs are identified to ensure that the proposed remedial alternative(s) can be implemented.

For the purposes of the Northern Area interim remedy, ARARs are expected to be the same as those identified in the Final NAPL Area FFS Report.

## 3.3 AREA/VOLUME AND MEDIA TO BE ADDRESSED

### 3.3.1 Northern Area

The Northern Area of the Site to be addressed has an aerial extent of approximately 82,000 square feet (or approximately 1.9 acres). Groundwater in the overburden (i.e., above bedrock) below the water table is targeted for remediation. The depth to groundwater in the Northern Area in January 2015 ranged from approximately 17 to 33 feet bgs, but has been shallower in the past. The depth to bedrock in the Northern Area ranges from approximately 60 to 80 feet bgs. Based on an average depth to groundwater of 22 feet bgs and a conservative average depth to bedrock of 75 feet bgs, the volume to be treated is approximately 161,000 cubic yards. For comparison, the Northern Area treatment volume is approximately four times greater than the NAPL area treatment volume presented in the Final NAPL Area FFS Report due to the larger areal extent of the plume and the thicker treatment zone.

### 3.3.2 Addition to NAPL Area Volume

Because of remediation timing and inclusion of the Northern Area to the interim remedial action, a relatively small ‘crescent-shaped’ area of dissolved-phase TCE south of the NAPL plume will be included in the ERH treatment of the NAPL Area. This crescent-shaped area is approximately 9,100 square feet (or approximately 0.21 acres) in size. The thickness of the groundwater treatment zone is approximately 20 feet (groundwater approximately 10 feet bgs and top of bedrock approximately 30 feet bgs). Based on these dimensions, the additional volume to be treated is approximately 6,750 cubic yards. The treatment of this crescent-shaped area brings the total volume of material to be treated in the NAPL Area to 47,250 cubic yards.

# 4.0 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

The purpose of the interim remedial action is to reduce TCE concentrations at and below the water table in the overburden in the Northern Area of the Site. The following interim remedy approaches have been identified for evaluation as the Northern Area interim remedy:

- No action
- In-situ treatment/reduction of contaminants

As required by the NCP, remedial technologies are evaluated based on their effectiveness, implementability, and cost.

Effectiveness is evaluated based on how well a technology satisfies the RAOs for a specific medium; protects human health and the environment in the short and long term; attains federal and state ARARs; and permanently reduces the toxicity, mobility, or volume of hazardous constituents through treatment.

Implementability is evaluated based on the technical feasibility of implementation, and the availability of the technology. Implementability also considers the technical and institutional ability to monitor, maintain, and replace a technology, and the administrative feasibility of implementing the technology.

During the technology screening process, cost is evaluated on a relative basis. A high level of accuracy in estimating costs is not required, although the relative costs of competing technologies should be reasonably well defined. Cost estimates for technologies that are retained and incorporated into remedial alternative(s) are more accurately estimated during the detailed alternative analysis.

Effectiveness, implementability, and cost were generally evaluated for the Northern Area to reduce TCE concentrations in the Northern Area. Three proposed potential remedial alternatives have been determined to meet the three criteria and have been screened in the detailed analysis of alternatives described below.

## 4.1 ASSESSMENT CRITERIA

The USEPA has outlined nine criteria to be used in evaluating remedial alternatives (40 CFR 300.430(e)(9)(iii)). The detailed analysis presents facts/data which are assembled and evaluated to develop the rationale for remedy selection (USEPA, 1988). The nine criteria are further divided into three categories (threshold criteria, balancing criteria, and modifying criteria), as summarized in the following table and described in the following sections.

| Threshold Criteria | Balancing Criteria | Modifying Criteria |
|---|---|---|
| - Overall protection of human health and the environment<br>- Compliance with ARARs | - Long-term effectiveness and permanence<br>- Reduction of mobility, toxicity, and volume through treatment<br>- Short-term effectiveness<br>- Implementability<br>- Cost | - State acceptance<br>- Community acceptance |

### 4.1.1 Threshold Criteria

Overall protection of human health and the environment and compliance with ARARs (unless an ARAR(s) is waived) are statutory criteria that must be met in order to be eligible for selection.

#### 4.1.1.1 <u>Overall Protection of Human Health and the Environment</u>

The assessment of overall protection draws on other evaluations, such as long term-effectiveness and permanence, short-term effectiveness, and compliance with ARARs. This evaluation focuses on how the alternatives achieve adequate protection and how risks are eliminated, reduced, or controlled.

#### 4.1.1.2 <u>Compliance with ARARs</u>

Compliance with identified ARARs is required for an alternative to be eligible for selection. If an ARAR(s) cannot be met, the basis for justifying one of the six waivers is discussed. The determination of which requirements are applicable or relevant and appropriate is made by the USEPA.

### 4.1.2 Balancing Criteria

Balancing criteria are the technical criteria upon which the detailed analysis is primarily based.

#### 4.1.2.1 Long-term Effectiveness and Permanence

Long-term effectiveness addresses the protection of human health and the environment after the RAOs have been met. In evaluating alternatives for their long-term effectiveness, the analysis considers: the ability to perform intended functions such as containment or removal; the adequacy and reliability of long-term engineering or institutional controls; and long-term performance, operation, and maintenance requirements.

#### 4.1.2.2 Reduction of Mobility, Toxicity, and Mobility through Treatment

This criterion evaluates ability of the alternatives to meet the statutory preference for treatment as a principal element of remediation. For each alternative, reduction of the toxicity, mobility, and volume of impacted material achieved through treatment are discussed. This criterion includes the permanence of the remedy and the nature of residuals remaining after treatment.

#### 4.1.2.3 Short-term Effectiveness

Short-term effectiveness evaluates the alternative during construction and implementation until RAOs are achieved. Specific considerations include potential exposures to the community, environment, and on-site workers during construction and the relative duration of the alternative to achieve RAOs.

#### 4.1.2.4 Implementability

Implementability addresses the ability to implement an alternative, as well as technical factors involved in implementation and administrative issues. Considerations include the relative ease of installation (constructability) and technical feasibility of implementing the selected technologies at the site (including compatibility with site features, site constraints and limitations, and accessibility of the area), administrative feasibility of coordinating implementation of the alternative among various state and federal agencies, acquiring required permits and approvals, and the availability of the technologies services, equipment, and materials necessary for implementation.

#### 4.1.2.5 Cost

This criterion considers the costs associated with implementing an alternative, and includes a breakdown of capital costs and annual operations, maintenance, and monitoring costs. Cost estimates are based on conceptual designs of the remedial alternatives. Labor and material costs are estimated from published unit costs and experience on similar projects, as contractor and vendor bids generally are not obtained. Actual project costs may vary depending on the final design of the remedial system, site conditions, additional evaluations, regulatory and community requirements, and availability of labor and materials at the time of implementation.

### 4.1.3 Modifying Criteria

Modifying criteria, including state and community acceptance, will be addressed in the Interim Record of Decision after comments on the FFS and proposed remedy have been received.

## 4.2 ALTERNATIVE 1: NO ACTION

No action is retained as an alternative because it provides the baseline for comparing alternatives. Its inclusion among the alternatives is mandated by USEPA guidance. The No Action alternative was evaluated in the Final NAPL Area FFS Report. The No Action alternative was rejected due to the inability to achieve the RAO. The RAO for the NAPL Area includes reduction of TCE in groundwater by 95 percent, which is the same RAO for the Northern Area. Therefore, the No Action alternative is rejected for the Northern Area without further evaluation, as it will not meet the proposed RAO.

## 4.3 ALTERNATIVE 2: ELECTRICAL RESISTIVITY HEATING

ERH involves heating of the subsurface using electrodes installed in the zone of contamination. An alternating current voltage is applied to the electrodes, which generates an electric current. The electric current causes heating of the subsurface and contaminants that are volatile, such as TCE, volatize and are recovered from vent wells that are located adjacent to the electrodes. The vapors are then treated aboveground and discharged to the atmosphere. Condensate from the vapors also is collected and treated.

The treated condensate is used to provide “drip water” to the electrodes or discharged to the sanitary sewer system.

Heating occurs in the saturated zone where there is sufficient moisture to conduct electricity. Temperature monitoring points are installed at multiple depths to monitor the temperature of the subsurface. Borings for the electrodes would be installed using hollow-stem augers. Borings would be advanced to auger refusal and the electrode and vent well installed.

The ERH bench test conducted during implementation of the NAPL Area FFS indicated that ERH could reduce TCE concentrations to greater than 95 percent (Amec Foster Wheeler, 2015). ERH bench tests are typically representative of what removal levels can be achieved in the field. Pilot testing is typically not conducted, as the cost to benefit ratio is small. A bench test was not conducted using subsurface materials from the Northern Area; however assumptions related to groundwater concentrations and subsurface characteristics were used to develop costs for implementation of ERH in the Northern Area.

ERH is safe to site workers and the community, as ERH work is performed with numerous safeguards. Isolation transformers only allow electricity to flow between electrodes within the work area. Thus, electricity cannot travel beyond the ERH treatment area.

Because of the power required for treatment of the estimated material volumes in the NAPL and Northern Areas, implementation of ERH for the two areas at the same time would be practically infeasible. Implementation of ERH for the NAPL Area and the Northern Area at the same time would require power service upgrades from the power utility, such as new power lines, equipment, transformers, switches, etc. Upgrading the power grid in the area of the Site to provide the required power service would incur significant time and significant costs. In addition, there would likely be equipment availability limitations as ERH vendors have a limited number of power control units available for use. Investment in, and construction of, additional power units and ancillary devices by vendors would not be economically feasible for the vendor to address the needs of one project (typical power unit cost is greater than $1,000,000) and would add additional time to the schedule.

#### 4.3.1 Overall Protection of Human Health and the Environment

Implementation of ERH is protective of human health and the environment, as TCE in the Northern Area can be reduced by up to 95 percent. Concentrations of TCE in the downgradient dissolved-phase plume (i.e., between the Northern Area and the discharge zones east and west of the Site) would be expected to decline after implementation of ERH in the Northern Area.

#### 4.3.2 Compliance with ARARs

ERH would meet the proposed ARARs. Applicable ARARs are generally associated with waste collection, handling, and disposal or discharge.

#### 4.3.3 Long-term Effectiveness and Permanence

ERH is effective for the long term. Contamination does not rebound after treatment, making ERH a permanent remedial alternative for groundwater in the Northern Area of the Site.

#### 4.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

ERH reduces the volume of contaminants from the subsurface via transfer of the contaminants from the solid/sorbed or dissolved phase into the vapor phase for subsequent extraction and treatment/destruction. The toxicity of the contaminants, primarily TCE, will not increase, as the contaminants are directly removed (i.e., not chemically degraded) and will not form more toxic compounds.

#### 4.3.5 Short-term Effectiveness

ERH is considered to be effective in the short-term, as the timeframe required for remediation is typically less than one year after heating begins. Monitoring and engineering controls are implemented to protect workers and the community. Engineering controls would be used to prevent contaminated materials from migrating with surface runoff water or becoming airborne during construction. Air monitoring would be implemented during construction activities that come into contact with contaminated media to ensure workers don the proper protective equipment for the level of contamination present. Air and wastewater discharge monitoring would also be implemented to ensure that contaminants being discharged do not exceed applicable standards, which are protective of the surrounding environment.

#### 4.3.6 Implementability

ERH is technically and administratively implementable. ERH is somewhat innovative, but experienced contractors are available to design, construct, and operate an ERH system.

#### 4.3.7 Cost

The estimated cost for implementation of ERH in the Northern Area is $8,700,000 (Table 1). This estimated cost includes implementation of ERH in sequence with the source NAPL Area interim remedy, as implementation at the same time would require power upgrades from the power utility (which would incur significant extra time and significant costs) and there would likely be equipment availability limitations (i.e., ERH vendors have a limited number of power units available for use). Note that this estimated cost does not include the estimated cost associated with implementation of ERH in the NAPL Area, but would be in addition to the estimated cost for implementation of ERH in the NAPL Area.

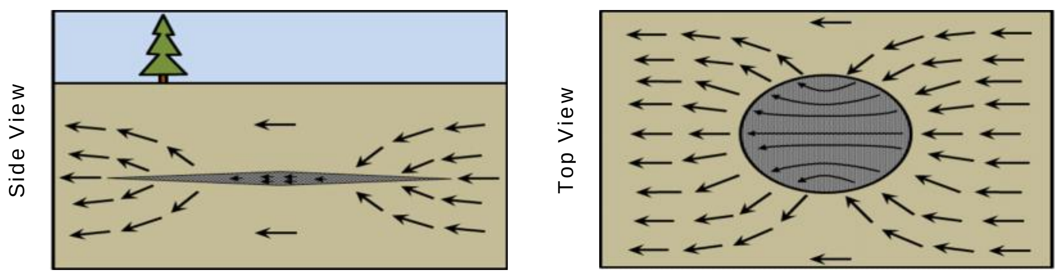
Materials for implementation of ERH in the NAPL and Northern Areas would be mobilized at the same time. Installation of the ERH system and heating of the NAPL Area would occur first. While heating is occurring in the NAPL Area, electrodes would be installed in the Northern Area. Once heating is completed in the NAPL Area, as determined by confirmation sampling, the surface installation and heating would begin in the Northern Area. Implementation of ERH in the NAPL and Northern Areas is estimated to take 2.5 years from the notice to proceed. This estimated cost does not include long-term monitoring following implementation of ERH in the Northern Area.

### 4.4 ALTERNATIVE 3: IN-SITU CHEMICAL OXIDATION

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.

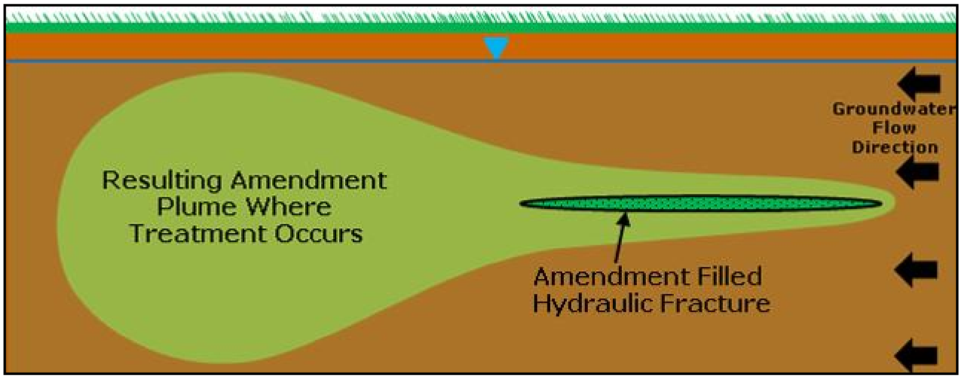
Potassium permanganate was chosen for ISCO evaluation in the Northern Area. Permanganate (as potassium or sodium) is a powerful oxidant that is commonly used to oxidize/destroy dissolved-phase chlorinated VOCs. Permanganate can be injected as a liquid solution via injection points or emplaced as a solid via hydraulic delivery methods. Solid potassium permanganate, which has a greater oxidation capacity than liquid permanganate, was selected for evaluation, as described below.

Solid potassium permanganate is mixed with silica sand and emplaced as a slurry via hydraulic delivery methods. Depending on the soil characteristics and the amount of oxidant required, the emplaced slurry is typically less than an inch thick and has a radius ranging from 15 to 25 feet from the emplacement point. The sand/permanganate slurry has a much higher hydraulic conductivity than the surrounding soil matrix (i.e., the permeability of the emplaced slurry is orders of magnitude greater than the surrounding formation). This zone of high conductivity “draws” groundwater preferentially toward emplaced permanganate/sand structure, as depicted below.




Profile examples of groundwater flow lines converging on a high permeability emplaced structure. (From Hall, et. al., 2013).

Contaminants in groundwater that migrate through the zone of solid potassium permanganate are quickly oxidized/destroyed. Also, the potassium permanganate dissolves into the groundwater in the surrounding formation and, via advection and dispersion, creates an “oxidative plume” that oxides contaminants in this zone (see depiction below). The permanganate will continue to oxidize chemicals until the oxidative capacity is exhausted.



Provided by FRx, Inc.

Solid polyvinyl chloride (PVC) casings would be installed to the depth of refusal using sonic drilling techniques. An eight-inch diameter borehole would be created, a four-inch casing installed, and the annulus of the boring backfilled with cement grout. Once the cement grout has fully cured, the PVC casing would be cut using a high-pressure jetting tool at specified intervals. The solid potassium permanganate would be mixed with sand and a small amount of bentonite would be added to keep the solids in suspension during emplacement. The permanganate/sand slurry would be emplaced via hydraulic delivery methods. A packer system would be used to isolate the emplacement interval. The permanent casings allow for subsequent reagent emplacements or injection of water or other amendments to the existing emplacements, if necessary.

Pilot testing would be conducted to design the full-scale system. Pilot testing would be conducted to determine the radius of the emplaced slurry, evaluate the amount of oxidant required, and evaluate contaminant reductions in nearby monitoring wells.

#### 4.4.1 Overall Protection of Human Health and the Environment

Implementation of ISCO is protective of human health and the environment, as TCE in the Northern Area will be reduced. Implementation of this ISCO approach has resulted in TCE reductions greater than 95 percent at other sites (Maalouf, 2015). Concentrations of TCE in the downgradient dissolved-phase plume (i.e., between the Northern Area and the discharge zones east and west of the Site) would be expected to decline after implementation of ISCO.

### 4.4.2 Compliance with ARARs

ISCO would meet the proposed ARARs. Applicable ARARs are generally associated with waste collection, handling, and disposal or discharge.

Because the permanganate migrates beyond the emplacement location, and in consideration of the downgradient discharge zones, a contingency plan would be implemented to ensure the permanganate does not discharge to the surface water features. Contingency monitoring wells would be installed between the Northern Area and the discharge zones and the oxidation reduction potential (ORP) of the groundwater would be monitored. Significant increases in ORP are indicative that permanganate is migrating upgradient the monitoring well and will likely reach the monitoring well in a short time period. If such indications were identified (i.e., significant ORP increases or visual presence of permanganate in the well), control measures are readily-available to remove the permanganate prior to reaching the discharge zone. For instance, ascorbic acid could be injected upgradient of the surface water features to neutralize the permanganate. Ascorbic acid is used for collection of groundwater samples containing permanganate where permanganate is desired to be neutralized (USEPA, 2012).

### 4.4.3 Long-term Effectiveness and Permanence

This ISCO approach is effective for the long-term, as contaminants are destroyed in-situ. The solid potassium permanganate remains in the subsurface and continues to oxidize contaminants until the oxidative capacity is spent, which can take several years. As with any injection/emplacement project, it is expected that some areas in the Northern Area will require additional treatment; however, the bulk of the treatment will occur with the initial emplacement of the potassium permanganate.

After ERH treatment of the NAPL Area, lower concentrations of dissolved-phase chlorinated VOCs will migrate with groundwater passing through the treated NAPL Area to the Northern Area. The potassium permanganate present in the Northern Area will be available to provide additional, ongoing, treatment for this migrating groundwater.

### 4.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

ISCO would reduce the mass of TCE in the Northern Area. Given the relatively low pH of the subsurface materials in the source area, as well as the lowering of the pH during oxidation, creation of daughter product cis-1,2-DCE is not expected to be significant. Therefore, formation of vinyl chloride, a daughter product of cis-1,2-DCE, is not expected to be significant. Overall, the toxicity of contamination will be reduced. The mobility of the contaminant plume in the Northern Area is not expected to change.

The emplaced materials are typically less than an inch thick. Displacement of soil and groundwater surrounding the structure is only vertically up or down a fraction of an inch. Therefore, “pushing” contaminated groundwater away from the structures does not occur, as can happen when injecting large volumes of a liquid reagent into the subsurface.

#### 4.4.5 Short-term Effectiveness

ISCO via emplaced solid potassium permanganate is considered to be effective in the short-term, as the timeframe required for remediation is expected to be less than two to three years. A pilot study would be required to design the full-scale injection system and would take approximately four months to complete. Monitoring and engineering controls are implemented to protect workers and the community. Engineering controls would be used to prevent contaminated materials from migrating with surface runoff water or becoming airborne during construction. Air monitoring would be implemented during construction activities that come into contact with contaminated media to ensure workers don the proper protective equipment for the level of contamination present.

#### 4.4.6 Implementability

ISCO is technically and administratively implementable. A pilot study would be conducted prior to design and implementation of the full-scale system. Experienced contractors are available to design and construct an emplaced ISCO system, as described.

#### 4.4.7 Cost

The estimated cost for implementation of ISCO is $4,300,000 (Table 2). This estimated cost includes pre-remediation sampling, performance of a pilot test, installation of permanent casings, emplacement of solid potassium permanganate, one “polishing” emplacement event, and confirmation sampling. Implementation of ISCO via emplacement of solid permanganate is estimated to take eight to ten months to complete from the notice to proceed. The time for remediation is estimated to take two to three years after emplacement of the solid potassium permanganate.

## 4.5 COMPARATIVE ANALYSIS OF ALTERNATIVES

The following sections include a comparison of the remedial alternatives with respect to the criteria required by USEPA.

### 4.5.1 Overall Protection of Human Health and the Environment

ERH and ISCO both provide the high levels of protection of human health and the environment. Both remedial alternatives can achieve the RAO.

### 4.5.2 Compliance with ARARs

The evaluated alternatives will be compliant with ARARs. Applicable ARARs are generally associated with waste collection, handling, and disposal or discharge.

### 4.5.3 Long-term Effectiveness and Permanence

ERH and ISCO both have long-term effectiveness and permanence, as the significant portion of the mass of TCE can be removed.

### 4.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

ERH has a higher probability of reducing the toxicity and volume of contaminants in the Northern Area by the specific amount, as the electrical current creating the heat is not affected by hydrogeological features, such as low permeability zones, and thus the majority of the treatment zone is heated non-preferentially. However, if a portion of the treatment zone was not adequately treated as determined by long-term monitoring, it would likely be cost prohibitive to use ERH again for a smaller area.

With ISCO, the oxidant must directly contact the contaminant for the contaminant to be destroyed. However, the oxidative plumes that would be created via the emplaced potassium permanganate are created primarily by advection and dispersion, and are expected to contact the large majority of the treatment zone. Where monitoring might indicate a particular area is not receiving adequate treatment, additional emplacements could easily be installed.

### 4.5.5 Short-term Effectiveness

Both remedial options are effective in the short-term, as presented. Implementation of ERH in the Northern Area after remediation in the NAPL Area would extend the ERH program by approximately eleven months for a total of 30 months (2.5 years). Implementation of ISCO would take an estimated eight to ten months, and treatment following emplacement of the sodium permanganate is estimated to take two to three years.

### 4.5.6 Implementability

The remedial alternatives evaluated are technically and administratively implementable. An ISCO pilot test would be necessary to design the full-scale system. Vendors are available for implementation of both remediation alternatives.

### 4.5.7 Cost

The estimated cost of ERH is $8,700,000 and the estimated cost of ISCO is $4,300,000. The significant difference in cost is primarily due to spacing of the subsurface equipment/features and operational costs. For cost estimating purposes, the ERH electrodes were assumed to be spaced approximately 19 feet apart (requiring 262 electrodes), whereas the ISCO emplaced structures were assumed to be spaced 30 to 40 feet apart (59 cased borings with 4 to 6 emplacements at each location). The ISCO alternative is a passive remedial approach, so there are no operation and maintenance costs. While ERH does not require long-term operation and maintenance costs, the installation and operation of the system is expensive, especially for such a relatively large treatment volume.

# 5.0 RECOMMENDED REMEDIAL ALTERNATIVE

The recommended Northern Area remedial alternative is ISCO via emplaced potassium permanganate. Both potential alternatives will meet USEPA's evaluation criteria; however the cost of ERH is more than double the cost of ISCO, indicating the cost to benefit ratio of remediation via ISCO is considerably greater than with ERH. In addition, ISCO affords an additional benefit by providing ongoing additional treatment of lower concentration VOCs that migrate through the Northern Area treatment zone.

ISCO can be readily implemented after implementation of ERH in the source NAPL Area. The ISCO pilot test would be conducted during installation activities of the ERH system in the NAPL Area. Once the ERH interim remedy is completed in the NAPL Area, implementation of the ISCO interim remedy in the Northern Area of the Site would begin.

# 6.0 COST OF EXPANDED NAPL AREA REMEDIATION

The cost of remediation by ERH for the additional crescent-shaped area south of the NAPL plume is estimated to be $585,000, which brings the estimated total cost of ERH remediation for the NAPL Area to $4,585,000.

# 7.0 ADDITIONAL DATA REQUIREMENTS

In order to implement either remedial alternative in the Northern Area of the Site, collection of additional data is required, primarily to enhance the characterization of the contaminant distribution in the area. Direct-sensing equipment equipped with an ECD probe would be used to characterize the horizontal and vertical extent of contamination in the overburden. This data will aid in identifying potential ‘hot spots’ and refine the area and volume of the treatment zone for full-scale system design. Saturated soil and groundwater samples would be collected to compare with the direct-sensing results and determine the natural oxidant demand and contaminant concentrations. This information is important in designing the full-scale system.

# 8.0 REFERENCES

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# TABLES

**TABLE 1**
**Estimate of Costs for Electrical Resistivity Heating for the Northern Area**
**CTS of Asheville, Inc. Superfund Site**
**Asheville, North Carolina**
**Amec Foster Wheeler Project 6252-12-0006**

| Item | Estimated Cost | Comment/Assumtion |
|---|---|---|
| Design, work plan | $280,000 | |
| Monitoring well installation | $80,000 | 10 monitoring well pairs (stainless steel) |
| Pre-remediation sampling/analysis | $10,000 | sample groundwater |
| Mobilization of electrode materials | $1,900,000 | |
| Drilling | $1,630,000 | 262 co-located electrodes and vent wells; 27 temperature monitoring points; includes waste disposal (soil cuttings from below the water table are considered hazardous) |
| Subsurface installation/oversight | $600,000 | |
| Surface installation and start-up | $650,000 | |
| System operation | $3,400,000 | |
| Confirmation sampling | $20,000 | includes groundwater sampling during remediation |
| Demobilization and well abandonment | $130,000 | does not include abandonment of monitoring wells to be used in future monitoring |
| **Total estimated cost** | **$8,700,000** | |

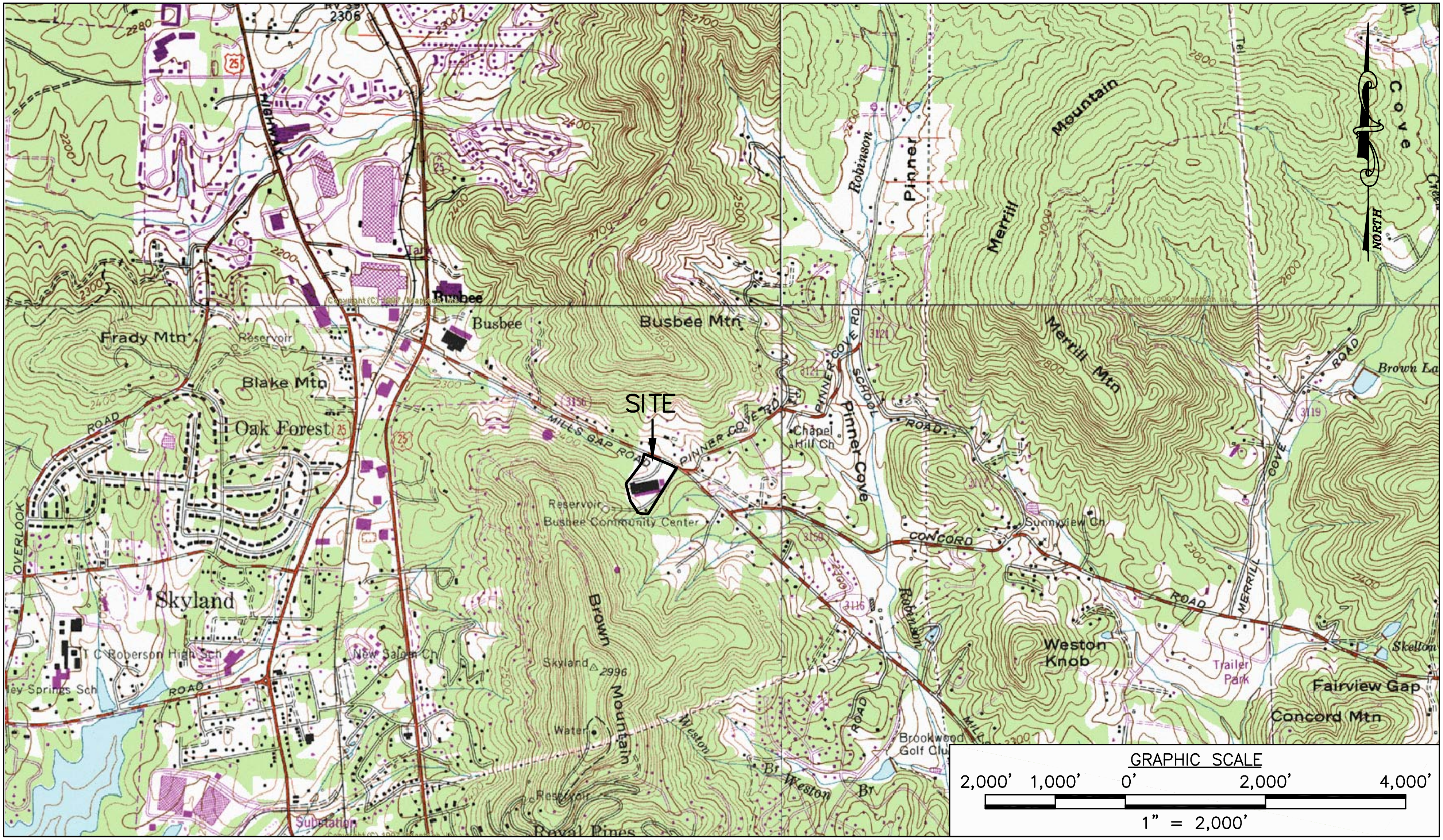
Prepared By: SEK 11/20/15
Checked By: MEW 11/23/15

**TABLE 2**
**Estimate of Costs for In-situ Chemical Oxidation for the Northern Area**
**CTS of Asheville, Inc. Superfund Site**
**Asheville, North Carolina**
**Amec Foster Wheeler Project 6252-12-0006**

| Item | Estimated Cost | Comment/Assumtion |
|---|---|---|
| Monitoring well installation | $60,000 | 10 monitoring well pairs (PVC) |
| Pre-remediation sampling/analysis | $10,000 | sample groundwater from monitoring wells |
| Pilot test | $160,000 | |
| Full-scale design | $20,000 | |
| Casing installation | $400,000 | 59 cased borings; includes waste disposal (cuttings from below the water table are considered hazardous) |
| Reagent (solid potassium permanganate) | $1,330,000 | |
| Reagent emplacement | $1,850,000 | 286 emplacements, oversight, equipment |
| Contingency monitoring | $20,000 | monitor oxidation reduction potential between remediation area and discharge zones |
| Confirmation sampling | $20,000 | includes sampling during remediation |
| Additional reagent emplacement | $400,000 | one additional treatment, as needed based on monitoring. |
| Casing abandonment and documentation | $30,000 | does not include abandonment of monitoring wells to be used in future monitoring |
| **Total estimated cost** | **$4,300,000** | |

Prepared By: SEK 11/20/15
Checked By: MEW 11/23/15

# FIGURES

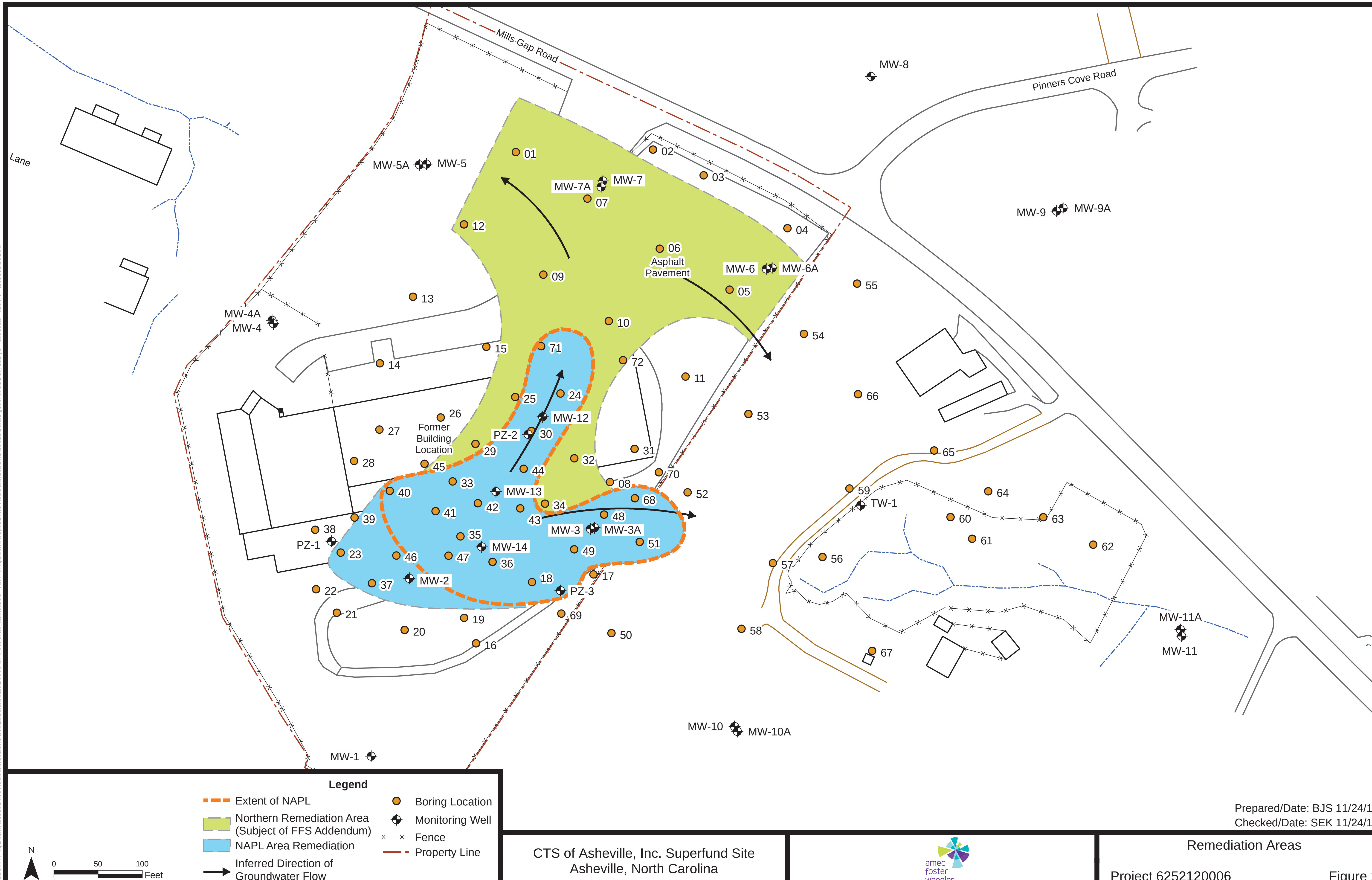



TOPOGRAPHIC SITE LOCATION MAP
CTS OF ASHEVILLE, INC. SUPERFUND SITE
ASHEVILLE, NORTH CAROLINA

amec foster wheeler

| | | | |
|---|---|---|---|
| DRAWN: SEK | ENG CHECK: -- | DATE: JULY 2015 | PROJECT: 6252120006 |
| DFT CHECK: MEW | APPROVAL: MEW | SCALE: 1" = 2,000' | FIGURE: 1 |

REFERENCE: USGS QUADRANGLES: ASHEVILLE (1961), OTEEN (1962), FRUITLAND (1978) AND SKYLAND (1978)




Prepared/Date: BJS 11/24/15
Checked/Date: SEK 11/24/15

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

amec foster wheeler

Remediation Areas

Project 6252120006

Figure 2