FOURTH FIVE-YEAR REVIEW REPORT
SANGAMO WESTON/TWELVEMILE CREEK/LAKE HARTWELL PCB
CONTAMINATION SUPERFUND SITE
PICKENS COUNTY, SOUTH CAROLINA

Prepared by

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List of Acronyms and Abbreviations

µg/L	microgram per liter
AEI	Additional Environmental Investigation
AOC	Administrative Order on Consent
AS	air sparging
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH2M	CH2M HILL, Inc.
COC	chemical of concern
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FDA	U.S. Food and Drug Administration
FMB	Former Manufacturing Building
FS	Feasibility Study
FYR	Five-Year Review
GWTS	groundwater recovery and treatment system
IC	institutional control
ISCO	in situ chemical oxidation
KMnO4	potassium permanganate
LTM	long-term monitoring
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
NaMnO4	sodium permanganate
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
O&M	operations and maintenance
OU	Operable Unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
Plant Site	220-acre capacitor manufacturing plant in Pickens County, South Carolina
ppm	part per million
RAO	remedial action objective

RI	Remedial Investigation
RMT	RMT, Inc.
ROD	Record of Decision
RPM	Remedial Project Manager
the Site	Sangamo Weston Inc./Twelvemile Creek/Lake Hartwell Polychlorinated Biphenyl Contamination Superfund Site
Sangamo Weston	Sangamon Weston Inc.
SBGR	subgrade biogeochemical reactor
SCDHEC	South Carolina Department of Health and Environmental Control
SMU	Sediment Management Unit
STC	Schlumberger Technology Corporation
TCE	trichloroethene
USACE	United States Army Corps of Engineers
VOC	volatile organic compound

Executive Summary

The Sangamo Weston Inc./Twelvemile Creek/Lake Hartwell Polychlorinated Biphenyl (PCB) Contamination Superfund Site (the Site) is located in Pickens County, South Carolina. There are two Operable Units (OUs) associated with this site. OU1 addresses the land-based source areas (including the 220-acre capacitor manufacturing plant in Pickens County, South Carolina [Plant Site] and six satellite disposal areas) and contaminated groundwater associated with the land-based source areas. Three satellite disposal sites (Nix, Welborn, and Trotter) were delisted from National Priorities List in September 1998 and the fourth satellite site (Dodgens) was delisted in January 2002. Only the Plant Site, Breazeale, and Cross Roads Sites remain to be addressed. OU2 addresses the surface water, sediment, and biological migration pathways downstream of OU1 as well as the Sediment Management Unit associated with the Twelvemile Creek remediation.

The U.S. Environmental Protection Agency Region 4 is the lead agency and South Carolina Department of Health and Environmental Control is the support agency for the investigations and remediation of this site. The Record of Decision (ROD) for OU1 was issued in December 1990 and the ROD for OU2 was issued in June 1994. Table ES-1 lists the Remedial Action Objectives identified and selected remedy described in the RODs, provides a summary of remediation activities conducted to date and a protective statement, and summarizes issues identified during this Five-Year Review (FYR) and recommendations made for each OU. Further details can be found in the remaining sections of this report.

The first FYR Reports for OU1 and OU2 were issued in September 2005 and September 2004, respectively (EPA 2004 and 2005). The second FYR Reports for OU1 and OU2 were issued in February 2010 (EPA 2010). The third FYR Reports for OU1 and OU2 were issued in March 2015 (EPA 2015). This is the fourth FYR Report for the Site which addresses both OUs separately, but under the same cover.

Table ES-1. Summary of Remedial Action Objectives, Selected Remedy, Remediation Activities, and Status

OU #	RAOs	Selected Remedy	Summary of Remediation Activities	Status	Issues and Recommendations
1	• Excavate, treat, and dispose of PCB-contaminated materials at the Plant Site and six satellite disposal sites • Restore groundwater to its beneficial use, which is a current or potential drinking water source • Protect surface water and ecological receptors	• Extraction and treatment by air stripping and/or carbon adsorption of contaminated groundwater at the Dodgens, Breazeale, Cross Roads, and Plant sites • Discharge of treated water to the nearest viable surface water body in accordance with applicable regulations • Excavation of materials contaminated with greater than 1 ppm of PCBs at the Nix and Welborn properties and transport of the materials to the Plant Site for staging and appropriate treatment • Excavation of materials contaminated with greater than 10 ppm PCBs on the remaining four private properties (Trotter, Dodgens, Breazeale and Cross Roads) and transport to the Plant site for staging and appropriate treatment • Backfilling two feet of clean fill at each of the private properties where contaminated materials of greater than 1 ppm remain (Trotter, Dodgens, Breazeale and Cross Roads) • Excavation of material containing greater than 25 ppm concentration of PCBs on the Plant Site • Treatment of all excavated materials to 2 ppm PCBs	<u>Groundwater Remediation at Plant Site</u> • In 1998, a groundwater recovery and treatment system was installed to treat VOCs and PCBs in groundwater at seven specific areas (Areas 2 through 7 and Area D). The extracted groundwater is treated with air stripping, filtration, and carbon absorption before discharge to Town Creek. Groundwater recovery at Area 3 and Area 6 was discontinued due to ineffectiveness associated with extremely low yield. Groundwater seep collection systems were installed at Areas 2 and 3 in late 2010 and began operation in 2011. The groundwater recovery well at Area D was shut down in 2012 due to low yield. The recovery well at Area 2 was suspended in 2017 to facilitate a groundwater study and AS pilot studies. From system startup in November 1998 to March 2018, approximately 412.3 million gallons of groundwater have been extracted and treated, removing approximately 2,180 pounds of VOCs and 34.1 pounds of PCBs from the environment. • To achieve the MCLs within a reasonable timeframe, pilot studies of more sustainable remedial technologies have been implemented in respective areas of the Plant Site, including 1) ISCO injections at Area D in August 2015, between April 2016 and July 2017, and in April/May 2018; 2) ISCO injections at Area H between September 2015 and June 2017, and in April/May 2018; 3) limited AS treatment at Area 2 since November 2016 and expanded AS treatment since March 2018; and 4) SBGR treatment at Area 3 since September 2018. Ongoing evaluation shows that the pilot study systems are achieving their desired goal of reducing VOC concentrations in groundwater. Groundwater Remediation at Breazeale Site • In 1997, a groundwater recovery and treatment system was installed to treat VOCs in groundwater. The extracted groundwater was treated with air stripping before discharge to Wolf Creek. The system was shut down in 2009 indefinitely because the remedy was modified to use ISCO treatment to accelerate groundwater remediation. During the operation, approximately 116 million gallons of groundwater were extracted, and an estimated 84.4 pounds of chlorinated VOCs were removed. • Full-scale ISCO injections were completed in September 2009, December 2012, and December 2014. <u>Soil Remediation</u> • Between 1993 and 1997, initial excavation of PCB-contaminated materials occurred at the satellite disposal sites and the Plant Site. Approximately 60,000 tons of soil were consolidated at the Plant Site and treated by low-temperature thermal desorption to meet the established performance standard of 2 mg/kg. The treated soil was backfilled at the Plant Site.	Protectiveness Determination: <u>Protective</u> The remedy at OU1 is protective of human health and the environment in the short-term because known contaminated soil sources above the acceptable level defined in the ROD have been removed from OU1. Institutional controls have been implemented to restrict land and groundwater uses at OU1. The ongoing groundwater remediation activities are expected to mitigate contaminant releases to onsite and downgradient surface water and sediment and to reduce VOC and PCB concentrations in groundwater.	Plant Site The contaminant concentrations in groundwater are not expected to achieve the MCLs within a reasonable timeframe. Therefore, more sustainable remedial technologies in respective areas continue to be evaluated and implemented as pilot studies. The ROD for OU1 will be amended to document the changes to the selected remedy for the Plant Site once these alternative technologies have been demonstrated to be effective. Specific recommendations are as follows: • Continue to operate and maintain the existing groundwater extraction and treatment system, as necessary and in accordance with the National Pollutant Discharge Elimination System permit to protect surface water and receptors. • Continue to conduct long-term groundwater monitoring and inspect conditions of existing monitoring wells biennially, with the next event planned for 2020. • Continue operation of the AS system at Area 2 and continue shutdown of the Area 2 groundwater recovery wells and seep recovery system during the expanded pilot studies. Continue to conduct performance monitoring. • Continue Area 3 pilot studies, including the SBGR pilot study and surface water study to evaluate baseline and performance monitoring. • Continue the elective surface water sampling in Area 2, Area 3, and Area 5 as needed to understand how the current remedy and pilot study activities affect VOC and PCB concentrations in surface water. • Implement a pilot study of an injectable form of activated carbon near well SWMW-15 to evaluate its effectiveness in reducing PCB concentrations in groundwater. Conduct

Table ES-1. Summary of Remedial Action Objectives, Selected Remedy, Remediation Activities, and Status

OU #	RAOs	Selected Remedy	Summary of Remediation Activities	Status	Issues and Recommendations
		using thermal separation technology on the Plant site. During Remedial Design, a treatability study will be conducted to determine if any of the contaminated materials will require additional treatment beyond thermal separation in order to meet the 2-ppm criterion. If necessary, a ROD amendment will be completed to account for this required treatment • Replacing remediated soil on the Plant site.	• In 2012, approximately 560 tons of soil contaminated with VOCs were excavated and removed from the Breazeale Site. • Between 2013 and 2014, approximately 28,000 tons of soil contaminated with PCBs and VOCs were removed from two previously unknown source areas (Areas B and H) at the Plant Site. • In 2017, approximately 16,700 tons of soil containing PCBs at concentrations above 25 mg/kg were removed from a previously unknown source area in Area D at the Plant Site.		performance monitoring and document findings in the Annual Reports. Breazeale Site • Conduct long-term groundwater monitoring and inspect conditions of existing monitoring wells biennially, with the next event planned for 2020. Cross Roads Site • Conduct long-term groundwater monitoring and inspect conditions of existing monitoring wells biennially, with the next event planned for 2020.
2	• Mitigate continued migration of PCB-contaminated sediments into Lake Hartwell by eliminating releases of PCBs into Twelvemile Creek • Control or eliminate the downstream migration of PCB-contaminated sediment within the Twelvemile Creek Arm of Lake Hartwell • Limit the transfer of PCBs from sediment to biota to the extent feasible • Prevent or minimize exposure to fish with PCB contamination above target risk or Food and Drug Administration levels	• Continue to implement the existing fish consumption advisory on Lake Hartwell • Continue to monitor aquatic biota and sediment to support continuation or justify modifications to the existing advisory • Regularly flush sediments that are trapped behind the three impoundments on Twelvemile Creek to facilitate burial of contaminated sediment further downstream while mitigating adverse impacts to Lake Hartwell water quality • Implement a public education program to increase awareness about the advisory and methods to prepare/cook fish to reduce the quantity of contaminants consumed	• Active remediation at OU2 was completed in 2011. Over 400,000 cubic yards of sediment was dredged from the middle and lowermost impoundments on Twelvemile Creek. The dredged sediment was dewatered and contained in a dedicated SMU. The two dams were subsequently removed, which allowed approximately 7,600 feet of the creek to return to its natural free-flowing state. Stream restoration began in April 2012.	Protectiveness Determination: <u>Protective</u> The remedy at OU2 is protective of human health and the environment in the short-term because the existing fish consumption advisory on Lake Hartwell continues to be implemented to warn the public of contaminated fish and recommended maximum quantity of consumption. The fish advisory signs for human health and public education have been routinely inspected and properly	Based on the most recent 2018 monitoring results, PCB concentrations in sediment and aquatic biota have decreased to very low and stable concentrations. It is recommended that biennial monitoring of sediments and aquatic biota be continued to ensure that sufficient information is collected to update the fish consumption advisory. The next sediment and aquatic biota monitoring event is planned for 2020. Existing fish advisory signs will continue to be inspected and maintained annually to mitigate human health risks associated with the consumption of PCB-contaminated fish.

Table ES-1. Summary of Remedial Action Objectives, Selected Remedy, Remediation Activities, and Status

OU #	RAOs	Selected Remedy	Summary of Remediation Activities	Status	Issues and Recommendations
				maintained. The ongoing groundwater remediation activities, recent removal actions and improved stormwater controls at the source areas of OU1 and completed sediment remediation on Twelvemile Creek have and are expected to continue to reduce the PCB concentrations in downgradient sediment and aquatic biota to acceptable levels.	

AS = air sparging
ISCO = in situ chemical oxidation
MCL = Maximum Contaminant Level
mg/kg = milligram per kilogram
OU = Operable Unit
PCB = polychlorinated biphenyl
ppm = part per million
ROD = Record of Decision
SBGR = subgrade biogeochemical reactor
SMU = Sediment Management Unit
VOC = volatile organic compound

1 Introduction

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR report pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (40 Code of Federal Regulations Section 300.430(f)(4)(ii)) and considering EPA policy.

This is the fourth FYR for the Sangamo Weston Inc. (Sangamo Weston)/Twelvemile Creek/Lake Hartwell Polychlorinated Biphenyl (PCB) Contamination Superfund Site (the Site) in Pickens County, South Carolina. The triggering action for this statutory review is the completion date of the previous FYR (EPA 2015) . The FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure.

The Site includes a former capacitor manufacturing plant owned and used by Sangamo Weston, six satellite disposal areas used for waste disposal, and surface water, sediment, and fish tissue downstream from the plant (including a portion of Twelvemile Creek and Lake Hartwell). The EPA placed the Site on the National Priorities List (NPL) in 1990 because of the presence of contaminated debris, soil, groundwater, sludge, sediment, and fish tissue resulting from historical facility operations.

To expedite the investigation and response activities, the overall site was divided into two separate Operable Units (OUs). OU1 addresses the land-based source areas (including the 220-acre capacitor manufacturing plant in Pickens County, South Carolina [Plant Site] and six satellite disposal areas) and associated contaminated groundwater while OU2 addresses the surface water, sediment, and biological migration pathways downstream of OU1 as well as the Sediment Management Unit (SMU) associated with the Twelvemile Creek remediation. Both OUs were reviewed and addressed in this FYR.

The FYR for the Site was led by EPA Region 4 and supported by South Carolina Department of Health and Environmental Control (SCDHEC). This review was primarily conducted from February 2019 to August 2019.

The FYR Summary Form below contains general information about the review. Sections 2 and 3 provide details on OU1 and OU2, separately. References for this FYR are provided in Appendix A and figures are provided in Appendix B.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Sangamo Weston/Twelvemile Creek/Lake Hartwell PCB Contamination Superfund Site		
EPA ID: SCD003354412		
Region: 4	**State:** South Carolina	**City/County:** Pickens/Pickens

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA
Author name : Craig Zeller
Author affiliation: EPA
Review period: 2/11/2019 - 8/31/2019
Date of site inspection: 9/20/2018
Type of review: Statutory
Review number: 4
Triggering action date: 3/25/2015
Due date *(5 years after triggering action date)*: 3/25/2020

2 Operable Unit 1

2.1 Site Background

Sangamo Weston owned and operated the 220-acre capacitor manufacturing plant (Plant Site) in Pickens County, South Carolina from 1955 to 1987. A variety of dielectric fluids containing PCBs were used for manufacturing of some capacitors until 1977. Chlorinated solvents, primarily tetrachloroethene (PCE) and trichloroethene (TCE), were used as degreasing agents during the operation. Off-specification capacitors and wastewater treatment sludge were disposed of at several locations of the Plant Site and at six remote sites located off the property (Nix, Dodgens, Welborn, Cross Roads, Trotter, and Breazeale Sites).

Four of the six satellite disposal areas were delisted from the NPL before the first FYR. The Nix, Welborn, and Trotter Sites were delisted from NPL in September 1998 and the Dodgens Site was delisted in January 2002. Only the Plant Site, Breazeale, and Cross Roads Sites remain to be addressed (**Figure 1**). Most of the manufacturing infrastructure at the Plant Site has been demolished. The Breazeale Site is approximately 7 acres and is about 1 mile south-southwest of Pickens, with south and southwest portion of the Breazeale Site located on the flood plain of Wolf Creek. The Cross Roads Site is approximately 5 acres and is about 3 miles southwest of Pickens, with an unnamed tributary to Twelvemile Creek present along the southern boundary. Layouts of the Plant Site, Breazeale Site, and Cross Roads Site are shown in **Figures 2 through 4**. OU1 is currently vacant and the land use at OU1 is designated to be industrial.

Groundwater beneath the Plant Site occurs mainly under unconfined conditions. The east-west trending ridge bisecting the Plant Site acts as a divide for surface water runoff and groundwater. Surface water runoff and groundwater on the north side of the ridge drain northward and discharge into unnamed tributaries to Twelvemile Creek. Surface water runoff and groundwater on the south side of the ridge flow southward and discharge into Town Creek, which flows into Twelvemile Creek. These creeks and tributaries that drain the Plant Site eventually discharge into Lake Hartwell approximately 17 miles from the Plant Site.

The chronology of site events for OU1 is listed in Appendix C, Table C-1.

2.2 Response Action Summary

2.2.1 Basis for Taking Action

A baseline risk assessment was conducted for the Plant Site and each of the six satellite disposal areas (EPA 1990). The media of concern at OU1 are surface soil, subsurface soil, groundwater, sediment, and solid waste/sludge. PCBs are the primary chemical of concern (COC). The human health risk driving the need for a response action was direct contact and incidental ingestion of PCBs in surface soil. The potential carcinogenic risks posed by PCBs in surface soil ranged from 1.2×10^{-5} at the Breazeale Site to 1.3×10^{-3} at the Plant Site.

While potential human health risks associated with future consumption of groundwater were not quantified, PCBs and chlorinated volatile organic compounds (VOCs) were detected in groundwater at concentrations above the Maximum Contaminant Levels (MCLs) and/or risk-based criteria. Because of the elevated concentrations of VOCs in groundwater, a vapor intrusion screening was performed for the Plant, Breazeale, and Cross Road Sites in March 2014 and it was concluded that there were no complete exposure pathways at these sites (EPA 2015).

Table 2-1 summarizes the medium-specific COCs at OU1. Refer to the 1990 ROD for further details.

Table 2-1. Chemicals of Concern at OU1

Site Area	Media		
	Soil	Groundwater	Solid Waste
Plant	• PCBs • TCE • PCE • 1,2-dichlorobenzene • 1,2-dichloroethene • 1,1,1-trichloroethane • acetone • bis(2-ethylhexyl) phthalate • bromodichloromethane • chloroform • di-n-butylphthalate • ethylbenzene • xylenes • silver	• PCBs • TCE • PCE • 1,1-dichloroethane • 1,1-dichloroethene • 1,2-dichloroethene • 1,1,1-trichloroethane • benzene • chloroform	• PCBs* • TCE* • PCE* • 1,2-dichlorobenzene • 2-hexanone • toluene • ethylbenzene • xylenes • phenol • isophorone • benzoic acid • bis(2-ethylhexyl) phthalate • butylbenzylphthalate • di-n-butylphthalate • aluminum* • arsenic* • cadmium • calcium • copper • cyanide • silver* • zinc
Breazeale	• PCBs	• TCE • PCE • 1,1,1-trichloroethane • 1,1,2,2-tetrachloroethane • 1,2-dichloroethene	

Table 2-1. Chemicals of Concern at OU1

Site Area	Media		
	Soil	Groundwater	Solid Waste
		• benzene • toluene	
Nix	• PCBs		• PCBs
Dodgens	• PCBs • silver	• TCE • PCE • bis(2-ethylhexyl) phthalate	• PCBs • cadmium • copper • lead • silver
Cross Roads	• PCBs • silver	• TCE • PCE • 1,2-dichloroethene	• PCBs • TCE • 1,2-dichloroethene • cadmium • silver • cyanide
Trotter	• PCBs		• PCBs • TCE • PCE • antimony • cadmium • copper • lead • silver
Welborn	• PCBs		• PCBs • lead

Note: * These chemicals were also identified as COCs for sludge at the Plant Site.

PCB = polychlorinated biphenyl
PCE = tetrachloroethene
TCE = trichloroethene

2.2.2 Response Actions

The Site was proposed to the NPL in January 1987. On June 18, 1987, Sangamo Weston and EPA Region 4 signed an Administrative Order on Consent (AOC) that specified actions to characterize the nature and extent of contaminants in soil and groundwater at the Plant Site and six satellite disposal sites. A Remedial Investigation (RI)/Feasibility Study (FS) work plan was subsequently developed and approved by the EPA in January 1988. The Site became final on the NPL in February 1990. Upon completion of the RI/FS, the EPA issued the ROD for OU1 in December 1990 (EPA 1990).

Because of a merger with Sangamo Weston, Schlumberger Technology Corporation (STC) became the Potentially Responsible Party for the Site. STC conducted the RI/FS at OU1 pursuant to the terms of the June 1987 AOC and the Remedial Design/Remedial Action pursuant to the terms of an April 1992 Consent Decree with the EPA. Remediation construction objectives outlined in the 1990 ROD for OU1 were achieved in August 1999. In September 2009, an amended ROD for OU1 was finalized to 1) include institutional controls (ICs) to restrict land and groundwater uses at the Breazeale Site, and 2) to incorporate remedy modifications for the Breazeale Site, replacing existing groundwater recovery and treatment system with *in situ* chemical oxidation (ISCO) injections to further reduce VOC concentrations in groundwater (EPA 2009a).

2.2.2.1 Remedial Action Objectives

The remedial action objectives (RAOs) for OU1 were not explicitly identified in the 1990 ROD; however, the general goals were to:

- Excavate, treat, and dispose of PCB-contaminated materials at the Plant Site and six satellite disposal sites
- Restore groundwater to its beneficial use, which is a current or potential drinking water source
- Protect surface water and ecological receptors

2.2.2.2 Remedy Components

The selected remedy for OU1 in the 1990 ROD consisted of the following main components:

- Extraction and treatment by air stripping and/or carbon adsorption of contaminated groundwater at the Dodgens, Breazeale, Cross Roads, and Plant sites
- Discharge of treated water to the nearest viable surface water body in accordance with applicable regulations
- Excavation of materials contaminated with greater than 1 part per million (ppm) of PCBs at the Nix and Welborn properties and transport of the materials to the Plant Site for staging and appropriate treatment
- Excavation of materials contaminated with greater than 10 ppm PCBs on the remaining four private properties (Trotter, Dodgens, Breazeale and Cross Roads) and transport to the Plant site for staging and appropriate treatment
- Backfilling two feet of clean fill at each of the private properties where contaminated materials of greater than 1 ppm remain (Trotter, Dodgens, Breazeale and Cross Roads)
- Excavation of material containing greater than 25 ppm concentration of PCBs on the Plant Site
- Treatment of all excavated materials to 2 ppm PCBs using thermal separation technology on the Plant site. During Remedial Design, a treatability study will be conducted to determine if any of the contaminated materials will require additional treatment beyond thermal separation in order to meet

the 2-ppm criterion. If necessary, a ROD amendment will be completed to account for this required treatment

- Replacing remediated soil on the Plant site.

Three Explanation of Significant Differences (ESD) documents have been issued by the EPA to document changes to the ROD for OU1 and they are summarized as follows:

- In September 1991, the first ESD was issued because the metal concentrations in soil and groundwater may exceed acceptable health-based levels (EPA 1991). As a result, cleanup criteria for metals in groundwater were added and additional data collection for metals was required.
- In June 1993, the second ESD was issued to eliminate metals as potential COCs based on an evaluation of metal data (EPA 1993). Other ROD modifications included updating groundwater cleanup criteria and waiving certain requirements that may be applicable for storage of PCB wastes.
- In August 2014, a third ESD was issued to document the final decision to implement ICs as part of the remedy for the Plant Site and Breazeale Site (EPA 2014). The ICs prohibit residential land development and groundwater use at these two sites.

2.2.3 Status of Implementation

This section provides a summary of the remedial actions performed for soil and groundwater at OU1.

2.2.3.1 Soil

Initial excavation of PCB-contaminated materials occurred at the satellite sites between November 1993 and July 1994, and at the Plant Site between July 1995 and May 1997 (Fluor Daniel Environmental Services 1998). Materials removed from the satellite sites were consolidated at the Plant Site. Approximately 60,000 tons of PCB-contaminated soil were treated by low temperature thermal desorption to meet the established performance standard of 2 milligrams per kilogram (mg/kg). The treated soil was backfilled at the Plant Site and capped with top soil.

In November 2012, 561 tons of VOC-impacted soil were excavated and removed from a 700-square-foot and 13-foot deep source area at the Breazeale Site (CH2M 2013).

Between September 2013 and February 2014, approximately 28,000 tons of PCB- and VOC-impacted soil were removed from two previously unknown source areas in Areas B and H at the Plant Site (CH2M 2014a). It is estimated that 6,284 pounds of PCBs and 715 pounds of PCE and TCE were removed with the excavated soil.

In January 2017, approximately 16,700 tons of soil with PCB concentrations above 25 mg/kg were removed from a previously unknown source area in Area D at the Plant Site. It is estimated that 6,541 pounds of PCBs were removed with the excavated soil (CH2M 2017a).

2.2.3.2 Groundwater

Active groundwater recovery and treatment has been conducted at the Plant and Breazeale Sites, consistent with the 1990 ROD for OU1.

Plant Site

In November 1998, a groundwater recovery and treatment system at the Plant Site began operation to treat VOCs and PCBs in groundwater at seven specific areas (Areas 2 through 7 and Area D). The extracted groundwater is treated with air stripping, filtration, and activated carbon adsorption before it is discharged to Town Creek. Groundwater recovery at Area 3 was discontinued in late 2010 due to ineffectiveness associated with extremely low yield (0.06 gallon per minute), with EPA approval. Groundwater seep collection systems were installed at Areas 2 and 3 in late 2010 and the systems began

operation in 2011 (RMT 2011). With EPA approval, the recovery well at Area D was shut down in 2012 because of extremely low yield. The groundwater recovery wells and seep recovery system at Area 2 was shut down in July 2017 to facilitate the air sparging (AS) pilot studies as discussed further below.

Since November 1998, approximately 412.3 million gallons of groundwater have been extracted from the Plant Site and 2,180 pounds of VOCs (PCE, TCE, and dichloroethene [DCE] isomers) and 34.1 pounds of PCBs (CH2M 2018a) have been removed by the treatment system. The cumulative masses removed by the groundwater treatment system are shown in **Figure 5** for VOCs and **Figure 6** for PCBs.

Multiple pilot studies have been implemented at several Plant Site areas to evaluate their effectiveness in reducing VOC concentrations in groundwater (CH2M 2016a, 2017b, 2018a). The pilot studies are summarized by area below.

- Area D. Approximately 3,400 gallons of a sodium permanganate ($NaMnO_4$) solution were injected in August 2015 and approximately 86,800 gallons of a potassium permanganate ($KMnO_4$) solution were injected between April 2016 and July 2017. The latest injection event occurred in April and May 2018 when approximately 111,600 gallons of a $KMnO_4$ solution were injected. 2019 injection activities began in March 2019 (CH2M 2019). ISCO injections pilot study activities in Area D have significantly reduced VOC concentrations in groundwater.
- Area H. Approximately 140,500 gallons of a $KMnO_4$ solution were injected between September 2015 and June 2017. The latest injection event occurred in April and May 2018 when approximately 54,400 gallons of a $KMnO_4$ solution were injected. 2019 injection activities began in March 2019 (CH2M 2019). ISCO injections pilot study activities in Area H have significantly reduced VOC concentrations in groundwater.
- Area 2. In 2016, Phase I of a pilot study was completed to evaluate if AS could effectively reduce VOC concentrations in groundwater and ultimately replace the existing groundwater extraction system in this area. Four transition-zone AS wells and two saprolite AS wells were installed in October 2016 as the mid-plume transect, which is approximately 300 feet hydrologically upgradient from the property boundary. The Phase I AS system began operation in November 2016. An additional 14 transition-zone AS wells and 16 saprolite AS wells were installed between August and December 2017 as part of Phase II of the pilot study. The objective was to expand the Phase I AS system to span the plume and evaluate AS effectiveness along the property boundary where the groundwater table was closer to the ground surface. After the expansion, the property boundary transect consists of nine paired AS wells and the mid-plume transect consists of six paired AS wells. Three AS locations along the property boundary began operation in November 2017, and the complete Phase II AS system has been operating since March 2018. Since pilot start up, the system appears to be significantly reducing VOC concentrations in groundwater.
- Area 3. In June 2018, a pilot study was initiated to evaluate the feasibility of replacing the existing groundwater recovery system with a subgrade biogeochemical reactor (SBGR) (CH2M 2018c). The SBGR technology promotes abiotic degradation of VOCs using zero-valent iron, which can completely break down PCE and TCE based on bench-scale testing results. The SBGR was installed in June 2018 and went through optimization testing until September 2018 when the pilot study began (CH2M 2018c). Since pilot study start up, the system has continued to reduce VOC concentration in groundwater, the SBGR is functioning as intended in parallel with upgradient source treatment at Areas D and H, and the solar system that powers the SBGR is operating as designed (CH2M 2019).

Breazeale Site

In June 1997, a groundwater recovery and treatment system, consisting of nine recovery wells divided in two well fields, was installed at the Breazeale Site to treat VOCs in groundwater. The extracted

groundwater was treated with an air stripper and then discharged to Wolf Creek. In September 2009, the system was shut down indefinitely because the remedy for the Breazeale Site was modified to use ISCO injections to accelerate groundwater remediation (EPA 2009a). Before its shutdown, approximately 116 million gallons of groundwater were extracted and approximately 84.4 pounds of chlorinated VOCs were removed by the air stripper.

In September 2009, approximately 54,600 gallons of a $KMnO_4$ solution were injected in the central part of the Breazeale Site (RMT 2009). In December 2012, approximately 9,000 gallons of a $NaMnO_4$ solution were injected into an infiltration gallery installed at the soil hotspot (CH2M 2013). In December 2014, approximately 26,200 gallons of a $NaMnO_4$ solution were injected into two target treatment areas where VOC concentrations remained above remediation goals (CH2M 2015).

2.2.4 Institutional Controls Summary Table

Table 2-2 provides a summary of the ICs used at OU1.

Table 2-2. Summary of Planned and Implemented Institutional Controls at OU1

Required ICs	Implementation of ICs
The property will not be used for residential purposes.	The property is designated for industrial use and is currently vacant.
Groundwater beneath the property will not be used until drinking water standards are met.	Groundwater is not currently used as a drinking water source. Most residences and industrial or commercial enterprises in and near Pickens County obtain drinking water from surface water sources supplied by the City of Pickens.
No activities will be conducted on the property that interfere with actions related to the remedial action.	The property is vacant. No activities other than remedial actions have been undertaken on the property.
The EPA, the SCDHEC, and all other parties performing response actions will be provided unrestricted access to the site.	The regulatory agencies and all other parties performing response actions have unrestricted access to the Site.
An annual statement will be submitted to the EPA and SCDHEC regarding the maintenance of the covenants and restrictions.	Annual reports have been prepared and submitted to the agencies.
The covenants and restrictions shall run with the title to the property and shall remain in place until SCDHEC has determined that the covenants and restrictions are no longer necessary.	The covenants and restrictions are attached to the title of the property and remain in place.

EPA = U.S. Environmental Protection Agency
IC = Institutional Control
SCDHEC = South Carolina Department of Health and Environmental Control

2.2.5 Systems Operations and Operations and Maintenance

During this reporting period, the primary operations and maintenance (O&M) activities performed at OU1 were associated with the groundwater recovery and treatment system at the Plant Site.
A 600,000-gallon concrete equalization basin is used to receive the extracted groundwater from recovery wells and seep collection systems located in Areas 2, 3, 4, 5, and 7. Before the recovered groundwater water is treated, it is recycled through a sprayer back into the basin to aerate the water and reduce concentrations of dissolved iron and manganese by precipitating the compounds. When the water depth in the basin exceeds 6 feet (equivalent to 210,000 gallons), water is pumped from the basin through an air stripper and activated carbon vessels. The vapor effluent from the air stripper is discharged to the atmosphere. The treated effluent is discharged under the National Pollutant Discharge Elimination System (NPDES) Permit number SC0046612 to a creek bed, which ultimately discharges to Town Creek.

Repairs and maintenance activities conducted during this reporting period included the following:

- Cleaned air stripper
- Performed two hydrogen peroxide system flushes to eliminate biological buildup
- Performed peroxide injections on water treatment system to eliminate algae bloom
- Removed sediment from pond
- Installed aerator to aerate the pond as needed to maintain dissolved oxygen levels to control algae growth, and replaced pump in the pond
- Performed three activated carbon changeouts
- Replaced modem and performed maintenance on human-machine interface computer system
- Repaired water line from pump SPRW-205
- Installed sampler at storm water pond outfall structure
- Installed new supervisory control and data acquisition system firewall
- Replaced malfunctioning check valves
- Replaced the starter on discharge pump P-52
- Installed new rupture disc in backwash line
- Added Area 3 to the cellular remote monitoring and upgraded control system; all pumps are now on Mission cellular monitoring system
- Replaced the wiring harness, transducer, and variable frequency drive on SPRW-702
- Repaired the emergency generator and pressure relief valves on pumps within the pump house, repaired/replaced pumps, and performed maintenance of the french drain collection and transfer system due to algae buildup at Area 3
- Installed new flow meter at Area 4
- Replaced dated sump pumps at Area 5

Overall, the Plant Site groundwater recovery and treatment system (GWTS) operated as planned, with occasional downtime due to system repairs, maintenance, and optimization. Because of the increased storage capacity available in the concrete stabilization basin, the recovery wells and pumps were not shut down during the plant downtimes. Monthly effluent samples were collected to verify compliance

with the NPDES permit. A dashboard system was developed to provide near-real-time operations data to assist in making timely decisions regarding system performance and optimization.

In addition to the routine O&M activities for the groundwater recovery and treatment system, the conditions of the existing monitoring well at the Plant, Breazeale, and Cross Roads Sites were inspected as part of the long-term monitoring (LTM) program. Periodic mowing was also performed at these sites.

2.3 Progress since the Last Review

During the last (third) FYR, it was determined that the remedy for OU1 was protective of human health and the environment. Several recommendations were made for the Plant, Breazeale, and Cross Roads Sites. The implementation status for these recommendations are summarized in **Table 2-3**.

In the Third FYR Report (EPA 2015), a recommendation was made for the Plant Site to evaluate and implement more sustainable remedial alternatives to reduce the dependence on the current pump and treat remedy, while continuing to protect surface waters and receptors. In 2015 and 2016, Additional Environmental Investigation (AEI) and Predesign Investigation were conducted to identify residual source zones that are sustaining VOC and PCB groundwater plumes and groundwater migration pathways from source zones (for example, Area D, Area H, and the Former Manufacturing Building [FMB] area) to discharge areas (for example, Areas 2, 3, and 5). Data gathered during these investigations served to refine the conceptual site model which was presented in the 2016 Annual Report and evaluate alternative treatment systems for the Plant Site that could be a viable replacement for the existing pump and treat system (CH2M 2016a). The total VOC and PCB plume extents as defined by the AEI and Predesign investigations completed in 2015 and 2016 are shown on **Figure 7** and **Figure 8**, respectively.

Following the Predesign Investigation, multiple remedial technologies were vetted, and multiple factors including ease of implementation, effectiveness, cost, and uncertainty were used to evaluate each remedial technology. Ultimately the decision was made to target residual source material in hydrologically upgradient Areas D and H with ISCO injections and source zone removal via soil excavation while AS and SBGR were implemented in Areas 2 and 3, respectively. The selected remedial technologies were implemented as pilot studies and performance groundwater and surface water data were collected to gauge the effectiveness of each pilot study. **Figure 9** and **Figure 10** show the VOC and PCB plume extent respectively as of March 2018. Data from the ongoing pilot studies are provided in Section 2.4.2, in the Annual Reports (CH2M 2016a, 2017b, 2018a), and meeting summaries (CH2M 2018c, CH2M 2019). The remedial technologies implemented in the pilot studies are viable alternatives to the current pump-and-treat remedy for those areas where implemented.

Table 2-3. Status of Recommendations from the 2015 FYR for OU1

Site	Issues	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
Plant	Although the current groundwater extraction system is protective of human health and environment, it is not going to achieve MCLs within a reasonable timeframe.	More sustainable alternative remedial technologies will be evaluated and the ROD will be amended.	Ongoing	• Additional soil and groundwater data were collected during the 2015 AEI and the 2015-2016 Predesign Investigation (CH2M 2016b). These data along with the LTM data collected from the Site were used to update the conceptual site model for the Plant Site. • The groundwater recovery wells and seep collection system at Areas 2, 3, 4, 5, and 7 continued to operate during this reporting period until July 2017. The groundwater recovery wells at Area 2 were shut down in July 2017 to facilitate the AS pilot studies. The seep recovery system in Area 3 was shut down in April 2019 following the EPA's approval on April 8, 2019 to continue the Area 3 surface water performance monitoring study. • Groundwater monitoring was conducted annually in 2015, 2016, and 2017, and then changed to biennially with the first event in 2018. The next event is planned for 2020. • Ongoing pilot-scale implementation of alternative remedial strategies includes the following: - ISCO injections at Areas D and H source areas - AS system at Area 2	Not Applicable - The process of amending the OU1 ROD to document the addition of alternative treatment strategies to the selected remedy for the Plant Site will begin following this FYR.

Table 2-3. Status of Recommendations from the 2015 FYR for OU1

Site	Issues	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
				- SBGR treatment at Area 3 - Area 5 injectable activated carbon pilot to evaluate its effectiveness in reducing PCB concentrations in groundwater. - Elective surface water sampling in Area 2, Area 3, and Area 5 as needed to understand how the current remedy and pilot study activities affect VOC and PCB. - The elective surface water sampling also includes the Area 3 surface water study which will evaluate VOC concentrations in surface water with the seep recovery system on (baseline conditions) and when the system is shut down and only the pilot study remedies are functioning.	
Breazeale	None	VOC concentrations in groundwater exceed Interim Protective Levels at three wells (EPA 2009a). Continue annual groundwater monitoring and conduct additional ISCO injections, as needed.	Ongoing	• Groundwater monitoring was conducted annually in 2015 and 2016 and then changed to biennially with the first event in 2018 and the next event planned for 2020. • Additional ISCO injections were completed in December 2014.	Not Applicable (i.e., not yet completed)
Cross Roads	None	VOC concentrations in groundwater	Ongoing	• Groundwater monitoring was conducted annually in 2015 and 2016 and then	Not applicable (i.e., not yet completed)

Table 2-3. Status of Recommendations from the 2015 FYR for OU1

Site	Issues	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
		exceed Interim Protective Levels at two wells. Modify groundwater monitoring frequency from annual to biennial, with annual well inspections. No active remediation is recommended at this time.		changed to biennially with the first event in 2018 and the next event planned for 2020.	

AEI = Additional Environmental Investigation
AS = air sparging
EPA = U.S. Environmental Protection Agency
FYR = Five-Year Review
ISCO = in situ chemical oxidation
LTM = long-term monitoring
MCL= Maximum Contaminant Level
PCB = polychlorinated biphenyl
ROD = Record of Decision
SBGR = subgrade biogeochemical reactor
VOC = volatile organic compound

2.4 Five-Year Review Process

2.4.1 Community Notification, Involvement, and Site Interviews

A public notice (**Appendix D**) was published in the *Sentinel-Progress* newspaper on May 15, 2019, stating that there was a FYR and inviting the public to contact the EPA or SCDHEC if they have questions about the Site or the FYR process, or would like to participate in a community interview. The report was made available at the information repositories at the Robert Muldrow Cooper Library of Clemson University on 116 Sigma Drive in Clemson, South Carolina 29631 and at the Pickens County Public Library on 304 Biltmore Road in Easley, South Carolina 29640.

Formal interviews were not conducted during the FYR process; however, a site status meeting was held on September 20, 2018 in Greenville, South Carolina to discuss activities completed and issues identified at OU1 since the last FYR along with the planned activities in 2019. The meeting was led by Mr. Craig Zeller of EPA Region 4, the Remedial Project Manager (RPM) for the Site. The attendees included staff from the support agency, SCDHEC (Mr. Joel Padgett – Project Manager, Ms. Susan Fulmer – Federal Remediation Section Manager, and Ms. Sara MacDonald – Site Hydrologist), STC (Mr. Virgilio Cocianni), and CH2M HILL, Inc. (CH2M; Consultant to STC, Mr. Dave Urann, Ms. Monica Schneider, Mr. Dean Williamson, Mr. Mike Perlmutter, Mr. Matt Davenport, and Mr. Gary Foster).

2.4.2 Data Review

Data presented in the 2015 through 2018 Annual Monitoring Reports for OU1 (CH2M 2015, 2016a, 2017b, and 2018a) were reviewed as part of the FYR. The following sections summarize the long-term and performance monitoring groundwater and surface water data collected during this reporting period. This section focuses primarily on a comparison of the most recent 2018 analytical data to the 2014 data presented in the last FYR.

2.4.2.1 Long-term Groundwater Monitoring

Plant Site

During this reporting period, annual groundwater monitoring was performed at the Plant Site in 2015, 2016, 2017, and 2018. As of March 2018, the LTM program includes 50 monitoring wells screened within the saprolite, transition zone, bedrock units, or some combination of these.

During the March 2018 sampling event, 50 wells were sampled for VOCs and 13 wells were sampled for PCBs. The groundwater results for PCE, TCE, and total VOCs as well as the estimated extent of VOC plume are shown in **Figure 9**. The groundwater results for total PCB and the estimated extent of PCB plume are shown in **Figure 10**.

Total VOC concentrations (the sum of PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride, and 1,1-DCE) greater than 1,000 micrograms per liter (µg/L) were observed at the following four wells: SDMW-4 in Area D, SBMW-5 and SBMW-6 in Area B, and SPMW-29 in the FMB area. As shown in **Figure 9**, total VOC concentration at well SDMW-15 in Area D, which is not part of the LTM program, also exceeded 1,000 µg/L during a separate groundwater sampling event in March 2018. In March 2014, in addition to the wells listed above, total VOC concentrations greater than 1,000 µg/L were also observed at two wells (SPRW-201 and SPRW-204) in Area 2, one well in Area D which was abandoned in preparation for the 2017 soil removal (SDMW-8), one well in the FMB (SPMW-20), and two wells (SHMW-3 and SPMW-12) in Area H.

Overall, the extent and the magnitude of VOC contamination have been significantly reduced compared to those noted in March 2014. Two plumes with total VOC concentrations greater than 1,000 µg/L (with a combined approximate area of 1.5 acres) that were previously observed in Area 2 and Area H in March 2014 were no longer present in March 2018. Changes in the VOC plume extents are a result of the continued groundwater pump and treat as well as several contaminated soil excavations (Areas B, D and H) and recent ISCO and AS pilot studies. Concentration trend graphs of PCE, TCE, and DCE isomers for wells with three or more data points are provided in the 2018 Annual Report (CH2M 2018a). The extent of PCB contamination at Area D is smaller than that noted in March 2016, while the extent of PCB contamination at other areas remains stable.

VOCs. As detailed below, five VOCs were detected at concentrations above their respective MCLs. Exceedances of one or more VOCs were found in 40 of the 50 sampled wells.

- PCE concentrations exceeded its MCL of 5 µg/L in 39 of the 50 sampled wells; concentrations ranged from 9.8 to 5,000 µg/L. PCE concentrations were above 1,000 µg/L at SBMW-5 (2,400 µg/L) and SBMW-6 (5,000 µg/L) in Area B, and SPMW-29 (1,600 µg/L) in the FMB area. All three wells are screened within the transition zone.
- TCE concentrations exceeded its MCL of 5 µg/L in 37 of the 50 sampled wells; concentrations ranged from 6.9 to 700 µg/L. The maximum TCE concentration was at SDMW-4 in Area D, which is screened in the transition zone and bedrock.
- Cis-1,2-DCE concentrations exceeded its MCL of 70 µg/L in 7 of the 50 sampled wells; concentrations ranged from 84 to 700 µg/L. The maximum cis-1,2-DCE concentration was at SPMW-4A, which is a perimeter well that is screened in the bedrock.
- Vinyl chloride concentrations exceeded its MCL of 2 µg/L in 1 of the 50 sampled wells sampled. The exceedance was at SWMW-15 (7.5 µg/L) in Area 5, which is screened in the transition zone.
- 1,1-DCE concentrations exceeded its MCL of 7 µg/L in 1 of the 50 sampled wells. The exceedance was at SDMW-4 (10 µg/L) in Area D, which is screened in the transition zone and bedrock.

PCBs. Total PCB concentrations exceeded its MCL of 0.5 µg/L in 12 of the 13 sampled wells; concentrations ranged from 1.1 to 130 µg/L. The maximum concentration was at SWMW-15 in Area 5, which is screened in the transition zone.

Breazeale Site

During this reporting period, groundwater monitoring was performed annually in 2015 and 2016. The monitoring frequency was then modified to biennial, as approved by the EPA and SCDHEC (CH2M 2016c). The first biennial monitoring event took place in March 2018.

In March 2018, groundwater samples were collected from 16 wells and analyzed for VOCs. PCE and TCE were the only VOCs with concentrations that exceeded their respective MCLs. **Figure 11** shows the 2018 groundwater PCE and TCE concentrations. PCE concentrations exceeded its MCL of 5 µg/L at BRMW-04A (5.8 µg/L), BRMW-11 (380 µg/L), and BRMW-14A (6.5 µg/L). TCE concentrations exceeded its MCL of 5 µg/L at BRMW-02 (5.5 µg/L) and BRMW-11 (560 µg/L). No VOCs were detected at BRMW-01, BRMW-05, BRMW-05A, BRMW-08, BRMW-09, and BRMW-14.

PCE and TCE concentrations at BRMW-02, BRMW-03, BRMW-04, BRMW-04A and BRMW-14A and BRMW-11 have decreased since March 2014. The highest PCE and TCE concentrations continue to be detected at BRMW-11. Concentration trend graphs of PCE, TCE, and DCE isomers for the 16 wells at Breazeale Site are provided in the 2018 Annual Report (CH2M 2018a).

Cross Roads Site

During this reporting period, groundwater monitoring was performed in 2014, 2016 and 2018. The recommendation to change the monitoring frequency was made in the Third FYR Report (EPA 2015).

In March 2018, groundwater samples were collected from six wells and analyzed for VOCs. PCE and TCE were the only VOCs with concentrations that exceeded their respective MCLs. **Figure 12** shows the 2018 groundwater PCE and TCE concentrations. The PCE concentration at CRMW-1 (5.2 µg/L) slightly exceeded its MCL. TCE concentrations at CRMW-1 (5.9 µg/L) and CRMW-3A (6.4 µg/L) slightly exceeded its MCL. In March 2014 PCE and TCE were detected above the MCL at CRMW-1 (6.94 µg/L PCE, 5.39 µg/L TCE) and CRMW-3A (5.86 µg/L PCE, 11.2 µg/L TCE). Long term trend monitoring indicates that the VOC concentrations are generally stable to decreasing. Concentration trend graphs of PCE, TCE, and DCE isomers for the six wells at Cross Roads Site are provided in the 2018 Annual Report (CH2M 2018a).

2.4.2.2 Long-term Surface Water Monitoring

During this reporting period, surface water samples were collected annually at the Plant Site from SW-2 and SW-3 (**Figure 2**) and analyzed for VOCs. The SW-2 sample was collected from north of Area 3, while the SW-3 sample was collected from a small creek downgradient from the Former Secure Landfill. Both samples were collected from creeks upstream of their discharge into Town Creek.

No VOCs were detected at SW-3. PCE and TCE were consistently detected at SW-2, which is upgradient of Area 3. Concentrations exceeded the current surface water standards used for comparison, which are the most stringent SCDHEC surface water standards based on protection of human health (i.e., consumption of water and aquatic organisms). The PCE concentrations at SW-2 ranged from 0.951 to 4.4 µg/L, which exceeded its surface water standard of 0.69 µg/L. The TCE concentrations at SW-2 ranged from 2.83 to 8.2 µg/L, which exceeded its surface water standard of 2.5 µg/L.

2.4.2.3 Performance Groundwater Monitoring

During this reporting period, performance groundwater monitoring was conducted to evaluate the effectiveness of various remediation technologies at the Plant and Breazeale Sites:

- Plant Site: pilot-study ISCO injections at Area D and Area H, pilot-study AS treatment at Area 2, and pilot-study SBGR treatment at Area 3
- Breazeale Site: full-scale ISCO injections

Area D

At Area D, ISCO injections were completed in August 2015, between April 2016 and July 2017, and in April and May 2018. **Figure 13** shows the locations of existing injection wells/galleries and the monitoring network. Post-injection performance monitoring has been conducted at 10 monitoring wells (SDMW-4, SDMW-11 through SDMW-16, SPMW-31, SPMW-32, and SPMW-40). The effectiveness of the injections is evaluated by changes of total and individual VOC concentrations in groundwater over time and post-injection distribution of potassium in groundwater. The findings are summarized as follows:

- Based on the distribution of potassium concentrations, the estimated extent of injection influence is greater than 500 feet to the south of Area D and at least 50 feet to the north of Area D.
- At the northern end of the VOC plume, ISCO appears to be effective. The extent of the plume with total VOC concentrations greater than 1,000 µg/L decreased between 2017 and March 2018. An update on further progress was provided in September 2018 (CH2M 2018b) and the data show there are no longer total VOC concentrations greater than 1,000 µg/L in Area D.

- At the mid plume, post-injection monitoring data show overall positive results. Total VOC concentrations at SDMW-12 decreased from 1,835 to 371 µg/L. Total VOC concentrations at SDMW-13 and SDMW-14, which are downgradient of injection well INJ-D-02, are below 100 µg/L. The total VOC concentrations at SDMW-15 increased from 149 µg/L before the injection to 1,476 µg/L in March 2018, possibly due to a displacement of contaminated groundwater from injection activities at nearby locations. An update on further progress was provided in September 2018 (CH2M 2018b), the data show there are no longer total VOC concentrations greater than 100 µg/L in a significant part of the mid plume and groundwater concentrations are below MCLs in 4 of 6 wells monitored in the mid plume.
- At the distal end of the VOC plume, which extends into Area 3, post-injection monitoring data do not provide significant evidence of injection influence. That said, the VOC concentrations at SPMW-7, downgradient of Area D, decreased from 2016 to 2018, indicating that the cumulative effects of soil removal and ISCO injections at Area D may be beginning to reduce downgradient VOC concentrations in Area 3. The soil source excavation completed at Area D in 2017 and additional permanganate injections conducted in 2017 and 2018 (and planned for 2019 [CH2M 2019]) are expected to continue the downward VOC concentration trends.

Area H

At Area H, ISCO injections were completed between September 2015 and June 2017 and in April and May 2018. **Figure 14** shows the locations of existing injection wells/gallery and the monitoring well network. Post-injection performance monitoring has been conducted at 11 monitoring wells (SHMW-2 though SHMW-4, SHMW-6 through SHMW-8, SH-PZ-01, SPMW-11, SPMW-12, SPMW-28, and SPMW-36). The effectiveness of the injections is evaluated by changes of total and individual VOC concentrations in the groundwater samples and post-injection distribution of $KMnO_4$ in groundwater. The findings are summarized as follows:

- The northern portion of the plume has responded well to the injections that began in late 2014. PCE and TCE concentrations have decreased at SHMW-3, SPMW-11, SPMW-12, and SPMW-28. Notably, total VOC concentration in SHMW-3 decreased from 1,121 to 467 µg/L between the June 2017 baseline sampling and March 2018. The decreasing VOC trends observed in SPMW-11 and SPMW-12 suggest that the northern side Area H injections have positive effects on the northward migration of the VOC plume into Area 2.
- At the mid-plume, total VOC concentrations have decreased significantly from greater than 10,000 µg/L to not detected in areas as a result of continued injections at injection gallery INJ-H-01. VOCs were not detected at SHMW-4, SHMW-6, or SHMW-7 in March 2018. The PCE and TCE concentrations at SHMW-8 and SH-PZ-01 have gradually decreased over time, with SHMW-8 concentrations near the MCLs in March 2018. Historically, this portion of the Area H VOC plume exhibited the highest VOC concentrations, and was thought to be an original source area.
- In the southern portion of Area H, the VOC plume shows a relatively milder response to the injections. PCE and TCE concentrations at SHMW-2, which is screened in the bedrock, have gradually decreased since July 2016. Total VOC concentrations at SPMW-36 have decreased since June 2017; this well is located approximately 600 feet downgradient from the closest injection wells, in the eastern portion of Area 3 and is screened in the transition zone. It appears that SPMW-36 is influenced by the ISCO injections, as indicated by the lower VOC concentrations and increasing potassium concentrations detected at this well following the June 2017 injection.

The updates provided in September 2018 (CH2M 2018b) and March 2019 (CH2M 2019) showed continued progress.

Area 2

Performance groundwater monitoring was conducted at Area 2 in 2017 and 2018. **Figure 15** shows the locations of existing AS wells and monitoring wells. The four transition-zone AS wells (AS-A2-1, AS-A2-2, AS-A2-3, and AS-A2-4) and two saprolite AS wells (AS-A2-2A and AS-A2-3A) installed in the mid-plume began operation in November 2016. The expanded AS pilot system that includes an additional 30 AS wells began operation in March 2018. VOC data were collected from eight observation wells near the mid-plume AS transect between November 2016 and March 2018. The data indicate that the AS system is effective in reducing VOC concentrations in groundwater. VOC concentrations have decreased by 90 percent or more in seven of the eight wells. VOC concentrations at the eighth well (SPMW-26), which is 100 feet downgradient of the AS transect, have decreased by 84 percent since operation began.

The influence of AS on wells SPMW-28 (90+ percent VOC concentration reduction) and SPMW-26, which are located approximately 30 feet and 100 feet downgradient of the AS transect respectively, suggests that VOC concentrations in downgradient groundwater will continue to decrease given that the AS system at Area 2 has been expanded at the mid-plume transect and along the property boundary. As of March 2018, the extent of plumes with total VOC concentrations above 100 µg/L at Area 2 has been significantly reduced since March 2017 (CH2M 2018a). In addition, the small plume with total VOC concentration above 1,000 µg/L (surrounding well SPRW-201 near the property boundary with an approximate area of 0.5 acres) present in March 2017 was no longer present in March 2018 (CH2M 2018b).

The updates provided in September 2018 (CH2M 2018b) and March 2019 (CH2M 2019) showed continued progress.

Area 3

Baseline samples for the SBGR pilot study were collected from SPMW-34 (SBGR influent), SPMW-31, SPMW-40, and SPMW-41 in February 2018 before the SBGR was installed in June 2018 (**Figure 16**). The SBGR underwent optimization testing, June 2018 through September 2018, and the pilot study began in October 2018. During the optimization testing, the SBGR reduced PCE and TCE concentrations by 69 percent and 85 percent respectively (CH2M 2018b). Updates provided in March 2019 show the concentrations of PCE and TCE at the SBGR have decreased by 67 percent and 77 percent respectively compared to the baseline samples collected in February 2018. SBGR influent samples are collected from SPMW-32 which is down gradient of the exfiltration trenches. The decrease in PCE and TCE concentrations is believed to be from a combination of pumping at the well, and dilution due to processed water from the SBGR flowing down gradient (CH2M 2019). Performance groundwater monitoring data will continue to be collected and will be presented in corresponding annual reports.

Breazeale Site

Full-scale permanganate ($KMnO_4$ and $NaMnO_4$) injections were completed in September 2009, December 2012, and December 2014. Performance groundwater monitoring was performed at the Breazeale Site in March 2017 at monitoring wells BRMW-2, BRMW-4A, BRMW-10, and BRMW-11. In March 2018 groundwater samples were collected from the LTM well network which includes the performance monitoring wells listed above.

In March 2018, TCE and/or PCE concentrations exceeded the performance standards (5 µg/L) in four monitoring wells (BRMW-02, BRMW-04A, BRMW-11, and BRMW-14A). TCE and PCE concentrations have declined at BRMW-02 and BRMW-11 since the March 2017 sampling event (CH2M 2018a). No VOCs were detected in groundwater at monitoring wells BRMW-01, BRMW-05, BRMW-05A, BRMW-08, BRMW-09, and BRMW-14 in March 2018. The highest TCE and PCE concentrations continue to be detected in monitoring well BRMW-11;

the concentrations are lower than detected in March 2017 and are less than the March 2015 post-injection VOC concentrations. Permanganate was visually observed at BRMW-02A, BRMW-04, BRMW-05, and BRMW-05A.

2.4.2.4 Elective Performance Surface Water Monitoring

In addition to the compliance long-term surface water monitoring, nine quarterly surface water sampling events were completed at Areas 2, 3, and 5 between January 2016 and March 2018 to evaluate the effectiveness of alternative treatment systems for the Plant Site (i.e., ISCO injections, AS treatment, and SBGR treatment). The samples were collected from waterways that could be subject to groundwater discharge or migration of contaminants via surface flow (**Figure 2**). Surface water samples were collected from one location at each area and analyzed for VOCs. The samples from Area 5 were also analyzed for PCBs.

The surface water results from Areas 2, 3, and 5 were compared against the most stringent SCDHEC surface water standards (SCDHEC 2014) based on protection of human health (i.e., consumption of water and aquatic organisms and a target cancer risk level of 1×10^{-6}).

The surface water sampling results are summarized as follows:

- Area 2. PCE and TCE were detected at concentrations that exceeded the SCDHEC surface water standards (SCDHEC 2014) during all sampling events, with maximum concentrations of 6.8 µg/L and 6.77 µg/L, respectively. Cis-1,2-DCE was also detected during all sampling events with a maximum concentration of 1.96 µg/L, which is well below the SCDHEC surface water standards. While PCE and TCE results exceeded the SCDHEC standards, the stream does not provide sufficient habitat for edible-size fish for human ingestion and is not used as a drinking water source.
- Area 3. VOCs were not detected above the detection limits.
- Area 5. VOCs concentration in March 2016 and January 2017 were below the SCDHEC standards. PCBs were only detected in the July 2016 sampling event, during which Aroclor-1248 and Aroclor-1254 concentrations were slightly above the SCDHEC standards. Despite the two detections, PCB concentrations are typically below detection limits, indicating that the remedial activities and the stormwater management system in Area 5 are effective in mitigating PCB release into Town Creek.

2.4.3 Site Inspection

The inspection for OU1 was conducted on September 20, 2018. In attendance were the representatives from EPA Region 4, SCDHEC, STC, and CH2M listed in Section 2.4.1. The purpose of the inspection was to assess the protectiveness of the remedy. Photographs taken during the inspection and are included in **Appendix E**. No issues were identified during the inspection.

2.5 Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Yes. The remedy continues to function as intended by the decision document. Known contaminated soil sources have been removed from OU1 and ICs have been implemented to restrict land and groundwater uses at OU1. Progress in groundwater remediation is being made toward achievement of the RAOs. Recommendations designed to optimize the existing groundwater recovery and treatment system performance continue to be evaluated and implemented at the Plant Site. Once the alternative technologies have been demonstrated to be effective, a ROD amendment will be prepared to document the changes to the groundwater remedy for the Plant Site. Additionally, the ongoing groundwater remediation activities are expected to continue mitigating contaminant releases to onsite and downgradient surface water and sediment.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

Yes. There have been no changes to exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. The data review in combination with the September 20, 2018 site inspection provided the basis for this technical assessment. Performance groundwater monitoring will continue at this site. Ongoing evaluations for options to optimize the groundwater remedy at the Plant Site will continue along with the long-term groundwater monitoring.

2.6 Issues and Recommendations

Recommendations that were identified during the FYR but do not affect the current and future protectiveness are presented in the following subsections.

2.6.1 Plant Site

Although the existing groundwater recovery and treatment system at the Plant Site is protective of human health and the environment, the contaminant concentrations in groundwater are not expected to achieve the MCLs within a reasonable timeframe. The remedial technologies implemented in the pilot studies are viable alternatives to the current pump-and-treat remedy for those areas where implemented. The process of amending the OU1 ROD to document the addition of alternative treatment strategies to the selected remedy for the Plant Site will begin following this FYR.

Specific recommendations for the Plant Site are as follows:

- Continue to operate and maintain the existing groundwater extraction and treatment system as necessary and in accordance with the NPDES permit to protect surface water and receptors.
- Continue to conduct long-term groundwater monitoring and inspect conditions of existing monitoring wells biennially, with the next event planned for 2020.
- Continue approved pilot studies in Area 2, 3, 5, D, and H to further optimize the groundwater remedy.
- Prepare a ROD Amendment to add the proven alternative treatment strategies from the pilot studies to the selected remedy.

2.6.2 Breazeale Site

Specific recommendations for the Breazeale Site are as follows:

- Continue to conduct long-term groundwater monitoring and inspect conditions of existing monitoring wells biennially, with the next event planned for 2020.

2.6.3 Cross Roads Site

Specific recommendations for the Cross Roads Site are as follows:

- Continue to conduct long-term groundwater monitoring and inspect conditions of existing monitoring wells biennially, with the next event planned for 2020.

2.7 Protectiveness Statement

Protectiveness Statement	
Operable Unit: OU1	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy for OU1 is protective of human health and the environment.	

2.8 Next Review

The next FYR report for the Site is required 5 years from the completion date of this review.

3 Operable Unit 2

3.1 Site Background

OU2 addresses the surface water, sediment, and biological migration pathways downstream of OU1 as well as the SMU associated with the Twelvemile Creek remediation. OU2 includes approximately 40 stream miles of Twelvemile Creek and its tributaries, the Twelvemile Creek Arm of Lake Hartwell, and portions of the Keowee and Seneca River Arms of Lake Hartwell down to the Route 37 bridge just south of Clemson, South Carolina (**Figure 17**).

3.1.1 Twelvemile Creek

The Twelvemile Creek watershed is approximately 140 square miles and includes first-, second-, third- and fourth-order streams. The tributaries to Twelvemile Creek are predominantly first- and second-order streams. Twelvemile Creek is a third-order stream above the mouth of Town Creek and becomes a fourth-order stream below the mouth of Town Creek. Twelvemile Creek is the longest stream segment in the watershed and flows southward for approximately 24 miles until reaching the headwaters of Lake Hartwell. Within this 24-mile reach, approximately 80 tributaries flow into Twelvemile Creek. The bulk of the stream flow is from runoff. Sediment in the creek is composed primarily of sand and has a low total organic carbon content throughout most of the streambed.

According to South Carolina Regulations (Regulation 61-68, Water Classifications and Standards), Twelvemile Creek is considered a Class B stream, which is defined as suitable for secondary-contact recreation (fishing, boating, wading), drinking water supply (assuming conventional treatment methods are used), and agricultural and industrial uses.

There were initially three impoundments of masonry construction on the lower section of Twelvemile Creek. The uppermost impoundment built in 1926 was formerly used as a water supply reservoir for Pickens County by the Easley-Central Water District, who uses the head pool for raw water storage. The middle impoundment (Woodside 1) in the community of Cateechee was rebuilt in 1937 after it failed in 1934. The lowermost impoundment (Woodside 2) was built in 1905. Woodside 1 and Woodside 2 were small hydroelectric impoundments owned and operated by Consolidated Hydro Southeast, generating a combined electrical output of 2.5 million kilowatts per year. Both Woodside 1 and Woodside 2 impoundments were removed in 2011. Only the uppermost impoundment remains in place.

Most of the Twelvemile Creek watershed (and Pickens County in general) is undeveloped, with forest or cleared agricultural land nearby and small towns or rural residential development in the watershed.

3.1.2 Lake Hartwell

Lake Hartwell is located on the state border of Georgia and South Carolina and was constructed by the Savannah District United States Army Corps of Engineers (USACE) between 1955 and 1963 by damming the Savannah, Seneca, and Tugaloo Rivers. Lake Hartwell is an impoundment with a drainage basin of 2,088 square miles. The lake is 56,000 acres in size with a shoreline of 962 miles. It is managed by the USACE for flood control and electric power generation, both of which are affected by the storage capacity of the reservoir (i.e., approximately 830 billion gallons). Lake Hartwell is one of the major recreational lakes in the Southeast. The lake is drawn down in the fall in anticipation of the increased rainfall that the area usually receives during the winter and spring.

According to South Carolina Regulations, Lake Hartwell is considered a Class A surface water, which is defined as suitable for primary-contact recreation (swimming, waterskiing), secondary-contact recreation (fishing, boating, wading), drinking water supply, and agricultural/industrial uses. The lake

receives a significant amount of point and nonpoint source discharges. NPDES permitted discharges include industrial facilities, electric power generating stations, and various sewage treatment plants. The reservoir continues to be a source of potable water for several communities, and these discharges have not had an appreciable impact on water quality in the lake.

Larger towns and more concentrated development are present in the areas surrounding Lake Hartwell. Development along the shoreline of Lake Hartwell is partially controlled through the USACE Lakeshore Management Plan. Surface water supplies the bulk of potable water utilized by the residents of Pickens County and surrounding areas.

The chronology of site events at OU2 is listed in Appendix C, Table C-2.

3.2 Response Action Summary

3.2.1 Basis for Taking Action

Sediment is the medium of concern at OU2 and PCBs are the primary COCs. The need for response actions at OU2 was largely driven by human health risks associated with the consumption of PCB-contaminated fish. PCB contamination was also found in all levels of the aquatic food web. Habitat degradation from development may also result in adverse impacts at the population and community levels. The health of fish in Lake Hartwell did not appear to be affected at the population level for fish that had PCB at concentrations around 5 mg/kg, which was the average PCB concentrations in fish at the time the ROD was issued. However, there was historical evidence indicating that the health of fish could be affected if PCB concentrations in fish tissue exceed 20 mg/kg.

3.2.2 Response Actions

In 1987, an AOC with STC was signed to initiate an RI/FS. In 1992, a Consent Decree with STC was lodged in court. In 1993, South Carolina entered into a Consent Order with the owners of two small hydroelectric impoundments (Woodside 1 and Woodside 2) to develop a more effective sediment management plan. In 2004, negotiations between Natural Resource Trustees and STC took place over a Natural Resource Damage Assessment (NRDA) settlement. The NRDA Settlement Consent Decree for OU2 was issued in May 2006. In September 2009, an ESD to the 1994 ROD was issued to allowed for dam removal and stream restoration at Twelvemile Creek (EPA 2009b).

3.2.2.1 Remedial Action Objectives

The RAOs developed for OU2 (EPA 1994) include the following:

- Mitigate continued migration of PCB-contaminated sediments into Lake Hartwell by eliminating releases of PCBs into Twelvemile Creek
- Control or eliminate the downstream migration of PCB-contaminated sediment within the Twelvemile Creek Arm of Lake Hartwell
- Limit the transfer of PCBs from sediment to biota to the extent feasible
- Prevent or minimize exposure to fish with PCB contamination above target risk or U.S. Food and Drug Administration (FDA) levels

3.2.2.2 Remedy Components

The major components of the selected remedy documented in the 1994 ROD for OU2 (EPA 1994) include the following:

- Continue to implement the existing fish consumption advisory on Lake Hartwell

- Continue to monitor aquatic biota and sediment to support continuation or justify modifications to the existing advisory
- Regularly flush sediments that are trapped behind the three impoundments on Twelvemile Creek to facilitate burial of contaminated sediment further downstream while mitigating adverse impacts to Lake Hartwell water quality
- Implement a public education program to increase awareness about the advisory and methods to prepare/cook fish to reduce the quantity of contaminants consumed

3.2.3 Status of Implementation

This section provides a summary of the activities conducted since the Consent Decree was signed. The summary is presented by each of the major remedy components.

3.2.3.1 Continuation of Fish Consumption Advisory

A fish consumption advisory, warning the public against eating fish from Twelvemile Creek and the Seneca River Arm of Lake Hartwell north of State Highway 24 was originally issued by SCDHEC in 1976. This advisory has been modified many times and remains in effect. Warning signs have been posted at most of the public boat launch and recreation areas in South Carolina since 1987. The current advisory adopts a risk-based approach that issues meal frequency advice to Lake Hartwell anglers based on species harvested and PCB concentration trends in fish tissue. The Lake Hartwell PCB fish advisory for South Carolina and Georgia is posted at:

https://www.scdhec.gov/food-safety/food-monitoring-advisories/fish-consumption-advisories/lake-hartwell-fish-consumption

3.2.3.2 Sediment and Aquatic Biota Monitoring

Annual monitoring of sediments and aquatic biota has been conducted in the spring of each year since 1995. This effort includes: 1) sediment sampling at 21 locations in Twelvemile Creek, the Twelvemile Creek Arm of Lake Hartwell, and portions of Lake Hartwell; 2) fish tissue analyses for largemouth bass, catfish, and hybrid bass at six stations in Lake Hartwell, 3) fish tissue analyses on forage fish species at three locations in Lake Hartwell, and 4) four 28-day caged *Corbicula* analyses at seven stations in Twelvemile Creek.

Between 2001 and 2003, the EPA conducted three-phases investigation on Lake Hartwell to gain a better understanding of natural mechanisms that contribute to the recovery of PCB-contaminated sediments. The goal was to develop and evaluate physical, chemical, and biological tools and approaches for measuring the short- and long-term performance of monitored natural recovery. Sediment age dating results and statistical analysis using the 95 percent confidence interval were used to predict the sedimentation rate and time required to achieve the 1 mg/kg cleanup goal. It is estimated that most of the surficial sediments in the Twelvemile Creek Arm of Lake Hartwell would achieve the 1 mg/kg cleanup goal between 2007 and 2011.

3.2.3.3 Sediment Flushing Behind Twelvemile Creek Impoundments

The primary goal of the OU2 remedy is to use natural sedimentation processes at Twelvemile Creek to deliver sediment to the Twelvemile Creek Arm of Lake Hartwell, thus providing a clean sediment cap on top of PCB-impacted sediments to prevent further re-suspension and transport of sediments throughout the creek and lake ecosystem.

Sediments at the uppermost impoundment are sluiced approximately quarterly, meeting the requirements specified in the ROD. The middle and lowermost impoundments on Twelvemile Creek were removed in 2011. Both dams were equipped with low flow sluice gates. Historically, sediment was flushed

downstream via sluice gates when sediment accumulation began to interfere with power generation. Reportedly, sediment flushing events during low flow periods in 1984 and 1995 had adverse impacts on water quality and stream habitat, and in some instances resulted in fish kills.

Active remediation at OU2 was completed in 2011. Over 400,000 cubic yards of sediment was dredged from the middle and lowermost impoundments on Twelvemile Creek. The dredged sediment was contained in a dedicated SMU constructed in accordance with SCDHEC Regulation 61-107.19 for a Class III Landfill. The two dams were subsequently removed, which allowed approximately 7,600 feet of the creek to return to its natural free-flowing state. Stream restoration began in April 2012 after the creek channel returned to its natural configuration and the creek had significant flows (ARCADIS 2012).

The SMU is located approximately 2 miles northwest of the town of Norris, across Twelvemile Creek from the Cateechee community. The landfill cap was completed in November 2011 and the SMU was officially closed in September 2013. The Closure and Post-Closure Care Plan prepared by Arcadis in January 2010 required quarterly inspections and reporting as well as semiannual post-closure groundwater sampling for PCBs after year one. In January 2016 the recommendation was made to modify the formal inspection and reporting frequency and provide SCDHEC a single annual report composed of an annual inspection report summary for the SMU. In September 2016 SCDHEC agreed to an annual inspection frequency of the SMU, a change in the groundwater monitoring from annually to every five years and submitting annual reports for OU1 and OU2 under one cover. These changes were summarized in the 2017 Annual Report (CH2M 2017b).

3.2.3.4 Public Education Program

The Public Education Program was initiated in 1998 to increase awareness of the fish consumption advisory among users of Lake Hartwell and to assist them in making informed decisions regarding consumption of fish harvested from the lake. Approximately 20,000 copies of a brochure were printed and distributed in July 1998 to an estimated 8,000 dock permit holders on Lake Hartwell, an estimated 1,400 members of the Lake Hartwell Association, approximately 100 retail outlets in six counties that border the lake and sell fishing licenses, the USACE Lake Hartwell Visitor Center, South Carolina and Georgia Welcome Centers on Interstate 1-85, Lake Hartwell campgrounds and day use areas, local Chambers of Commerce, and miscellaneous personnel involved with state regulatory agencies.

The exposure from fish consumption appears to be minimal and health effects are unlikely for people who eat small to moderate amounts of fish. Fish consumption advisory signs were posted along the shores of Lake Hartwell at boat ramps and known fishing areas accessed by the public in 2009. Information regarding PCB-related fish consumption and cleaning can be found at the following link:

https://www.scdhec.gov/food-safety/food-monitoring-advisories/fish-consumption-advisories/lake-hartwell-fish-consumption

3.2.4 Institutional Controls Summary Table

Table 3-1 provides a summary of the ICs used at OU2.

Table 3-1. Summary of Planned and Implemented Institutional Controls at OU2

Required ICs	Implementation of ICs
Continue to implement the existing fish consumption advisory on Lake Hartwell. Implement a public education program to increase awareness	The Lake Hartwell PCB fish advisory for South Carolina and Georgia is posted at:

Required ICs	Implementation of ICs
about the advisory and methods to prepare/cook fish to reduce the quantity of contaminants consumed.	https://www.scdhec.gov/food-safety/food-monitoring-advisories/fish-consumption-advisories/lake-hartwell-fish-consumption The fish consumption advisory signs are posted along the shores of Lake Hartwell and they are inspected and maintained at least annually.

EPA = U.S. Environmental Protection Agency
IC = Institutional Control

3.2.5 System Operations/Operations and Maintenance

The primary O&M activities conducted at OU2 during this reporting period are summarized in the following sections.

Inspections and Maintenance of Fish Advisory Signs

Annual inspections of the health advisory signs at Lake Hartwell were performed in May 2016, May 2017, and April and May 2018 (CH2M 2017b, CH2M 2018c). A total of 12 signs were replaced following the inspections in 2018.

Inspections, Maintenance, and Groundwater Monitoring of Twelvemile Creek SMU

Formal inspections of the SMU were completed quarterly in 2014 and 2015, and then annually since 2016 as approved by SCDHEC. The SMU and support areas were found to be in good condition. The SMU was also inspected weekly to verify the integrity of the fencing and gates and to identify signs of erosion, potential presence of rodents or unwanted trees, and signs of trespassing within the fenced area. Mowing and trimming of the SMU were conducted on an as-needed basis.

Five monitoring wells associated with the SMU (MW-1 through MW-5) were sampled semiannually in 2014 and 2015, and annually in 2016. The recommendation to change the groundwater monitoring frequency at the SMU from annual to every 5 years was approved by SCDHEC during the August 2016 annual site status meeting and documented in the 2017 Annual Report (CH2M 2017b). The monitoring wells were sampled again in October 2018 to align with the FYR process. PCBs were not detected in any of the groundwater samples collected from 2014 to 2018.

Inspections and Maintenance of Twelvemile Creek Water Treatment System

The Twelvemile Creek water treatment system was operated in October 2015, October 2016, and April 2018, treating approximately 229,100, 206,500, and 214,300 gallons of water, respectively. The system operation began when the water level measured at the SMU's leachate recovery system, which was monitored monthly, reached 83.8 inches and continued until the water level was too low to support the operation. To operate the system, new carbon and berm media drums were installed, followed by pump installation and connection of piping hookups. The discharged water samples were collected and analyzed for PCBs, total suspended solids, and toxicity. PCBs and total suspended solids were not detected, and the toxicity test passed. Upon completion of operation, the system was dismantled and winterized. Leachate recovery rates have appeared to be slow, and an increased amount of time between system operations has been observed. Operation of the treatment system is not expected to be required until fall 2019.

3.3 Progress Since Last Five-Year Review

During the last FYR, it was determined that the remedy for OU2 was protective of human health and the environment. No issue was identified. Four recommendations were made during the last FYR and the current implementation status for these recommendations is summarized in **Table 3-2**.

Table 3-2. Status of Recommendations from the 2015 FYR for OU2

Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
None	Continue to administer the existing fish consumption advisory.	Ongoing	The current fish consumption advisory is provided online at: https://www.scdhec.gov/food-safety/food-monitoring-advisories/fish-consumption-advisories/lake-hartwell-fish-consumption	Not Applicable
	Continue to inspect and maintain fish advisory signs.	Ongoing	Fish advisory signs have been inspected and maintained annually (CH2M 2018a, 2017b, TRC 2014, 2015, 2016).	Not Applicable
	Reduce the frequency of sediment and aquatic biota monitoring from annual to biennially.	Completed	Frequency of sediment and aquatic biota monitoring has been modified to biennially since 2014.	2014
	Review and consider further modification of the annual sediment and aquatic biota monitoring program over the next 5-year cycle to include reduction of the total number of stations. Per the ROD, PCB levels have been monitored in sediment and aquatic biota (*Corbicula* and fish) for 20 years.	Under Discussion	A fish and sediment study for Lake Hartwell was completed in 2014, 2016, and 2018. PCB concentrations in sediment and aquatic biota have shown significant decreases over time to very low and stable concentrations and this trend is expected to continue. Although incremental decreases over time may be masked by field and laboratory variability at these low concentrations, it is recommended that sediment and aquatic biota biennial monitoring be continued, and the current sampling plan be optimized to ensure that sufficient information is collected to update the fish consumption advisory.	Not Applicable

PCB = polychlorinated biphenyl
ROD = Record of Decision

3.4 Five-Year Review Process

3.4.1 Community Notification, Involvement, and Site Interviews

A public notice (**Appendix D**) was made available in the *Sentinel-Progress* newspaper on May 15, 2019, stating that there was a FYR and inviting the public to contact the EPA or SCDHEC if they have questions about the Site or the FYR process, or would like to participate in a community interview. The report was made available at the information repositories at the Robert Muldrow Cooper Library of Clemson University on 116 Sigma Drive in Clemson, South Carolina 29631 and at the Pickens County Public Library on 304 Biltmore Road in Easley, South Carolina 29640.

Formal interviews were not conducted during the FYR process; however, a site status meeting was held on September 20, 2018 in Greenville South Carolina to discuss activities completed and issues identified at OU2 since the last FYR along with the planned activities in 2019. The meeting was led by Mr. Craig Zeller of EPA Region 4, the RPM for the Sangamo Superfund Site. The attendees included staff from the support agency, SCDHEC (Mr. Joel Padgett – Project Manager, Ms. Susan Fulmer – Federal Remediation Section Manager, and Ms. Sara MacDonald – Site Hydrologist), STC (Mr. Virgilio Cocianni), and CH2M (Consultant to STC, Mr. Dave Urann, Ms. Monica Schneider, Mr. Dean Williamson, Mr. Mike Perlmutter, Mr. Matt Davenport, and Mr. Gary Foster).

3.4.2 Data Review

Information regarding sediment and aquatic biota sampling data from 2014 through 2018 (CH2M 2014c, 2016d, and 2018c) were reviewed. As indicated in **Table 3-3**, the monitoring frequency of sediment and aquatic biota at OU2 was modified in 2014 from annual to biennial, with the next event planned for 2020. The PCB results from the most recent April 2018 sampling event are depicted in **Figure 18**. The findings of the review are summarized in the following paragraphs.

3.4.2.1 Sediment

Sediment monitoring was conducted at 21 sampling stations (including 3 background stations) in 2014, 2016, and 2018.

In 2018, total PCB concentrations (**Figure 18**) ranged from non-detect to 0.846 mg/kg, below the sediment cleanup level of 1 mg/kg. PCBs were not detected at the three background stations (SD-000, SD-003, and SD-641) and five non-background stations (SD-005, SD-106, SD-532, SD-535, and SD-642). The maximum PCB concentration in 2018 (at SD-009) was lower than that in 2016 (0.911 mg/kg at SD-015). Total PCB concentrations increased at 3 stations (SD-009, SD-010, and SD-014) and decreased at the remaining 12 stations since 2016.

The three sampling stations with higher PCB concentrations in 2018 are in lower Twelvemile Creek; however, no specific activity or event that might have caused such an increase in sediment PCB concentrations was identified. Data variation between 2016 and 2018 at these three stations was similar to the range of variation noted at the stations where PCB concentrations declined between 2016 and 2018, suggesting that the increases may be related to the normal variation among sampling data. Regardless, the PCB concentrations at these three stations remained below the cleanup level of 1 mg/kg.

The average PCB concentrations in sediment at the upper Twelvemile Creek, lower Twelvemile Creek, and Lake Hartwell over each 5-year period since 1995, plus the 2016 and 2018 monitoring data, are depicted in the 2018 Fish and Sediment Study (CH2M 2018c). Overall, the 23 years of monitoring data show a decline in PCB concentrations over time in the study area. The PCB concentrations in sediment have been below the cleanup goal of 1 mg/kg since 2010 in upper Twelvemile Creek, since 2016 in lower Twelvemile Creek, and since 2013 in Lake Hartwell.

3.4.2.2 Corbicula

Corbicula, an Asian clam, is used as a surrogate for fish in portions of the Twelvemile Creek watershed where there are no significant populations of game fish or where fish are difficult to catch. *Corbicula* monitoring was conducted at 12 sampling stations (including 3 background stations) in 2014 and 2016 and at only 11 sampling stations in 2018 because 1 station (C-009) was lost due to vandalism.

In 2018, survival rate of *Corbicula* was generally good, with some observed mortality likely due to suffocation resulting from sedimentation. PCB concentrations in *Corbicula* tissue (**Figure 18**) ranged from non-detect to 0.729 mg/kg, below the 2 mg/kg FDA safe tolerance level for consumption of fish by humans.

Since 2016, PCB concentrations in *Corbicula* tissue increased at seven of the eight non-background stations (C-001, C-003, C-005, C-006, C-007, C-008, and C-011) and decreased at one station (C-010). The largest increase of 0.33 mg/kg was observed at station C-003; however, no specific activity or event that might have caused an increase in *Corbicula* tissue PCB concentrations was identified.

The average PCB concentrations in *Corbicula* tissue over each 5-year period since 1995, plus the 2016 and 2018 monitoring data, are depicted in the 2018 Fish and Sediment Study (CH2M 2018c). Overall, PCB concentrations in *Corbicula* tissue have decreased over time and remained below the FDA safe tolerance level of 2 mg/kg since 2004.

3.4.2.3 Fish

The fish monitoring program includes sampling of game fish from six stations (SV-106, SV-107, SV-532, SV-535, SV-641, and SV-642) and forage fish from three stations (SV-107, SV-532, and SV-641). The average PCB concentrations by sampling station are presented in **Figure 18** and summarized as follows:

Game Fish. In 2018, the PCB concentrations for hybrid bass (0.67 to 1.15 mg/kg) and for channel catfish (0.02 to 0.78 mg/kg) remained below the FDA limit of 2 mg/kg, consistent with the 2014 and 2016 findings. The PCB concentrations for largemouth bass ranged from 0.05 to 2.19 mg/kg. The maximum concentration was found at Station SV-107 in the lower Twelvemile Creek, slightly above the FDA limit of 2 mg/kg. The PCB concentration at this station was 2.08 mg/kg in 2014 and 2.98 mg/kg in 2016.

Forage Fish. In 2018, the PCB concentrations for bluegill (0.02 to 1.07 mg/kg) and for threadfin shad (0.15 to 0.98 mg/kg) remained below the FDA safe tolerance level of 2 mg/kg. The PCB concentrations for gizzard shad ranged from 0.21 to 2.25 mg/kg. The maximum concentration was found at Station SV-107 in the lower Twelvemile Creek, slightly above the FDA safe tolerance level of 2 mg/kg. The PCB concentration for gizzard shad at this station was 3.79 mg/kg in 2014 and 2.20 mg/kg in 2016.

3.4.3 Site Inspection

The OU2 inspection was conducted on September 20, 2018. In attendance were the representatives from EPA Region 4, SCDHEC, STC, and CH2M listed in Section 3.4.1. The purpose of the inspection was to assess the protectiveness of the remedy. Photographs taken during the inspection and are included in **Appendix E**. No issues were identified during the inspection.

3.5 Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy is functioning as intended per the decision document. During this reporting period, additional soil and groundwater remediation activities have been completed at the upgradient source area (OU1), eliminating further releases and transfer of PCBs into Twelvemile Creek and Lake Hartwell. The dam removal and stream corridor restoration continue to allow natural sediment transport processes

to occur in the stream, facilitating burial of contaminated sediments downstream. The existing fish consumption advisory continues to warn the public against eating fish from Twelvemile Creek and the Seneca River Arm of Lake Hartwell. Existing fish advisory signs have been inspected and maintained. A public education program is being implemented to increase awareness about the advisory and methods to prepare and cook fish to reduce the quantity of contaminants consumed. Since 2014, sediment and aquatic biota monitoring has been performed every 2 years to support continuation or justify modifications to the existing advisory.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

Yes. There have been no changes to the exposure assumptions, toxicity data, cleanup levels, or RAOs used at the time of remedy selection.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. The data review in combination with the September 20, 2018 site inspection provided the basis for this technical assessment. Based on available data, PCB concentrations in sediment and aquatic biota have shown significant decreases over time to very low and stable concentrations and this trend is expected to continue.

3.6 Issues and Recommendations

Recommendations that were identified during the FYR but do not affect the current and future protectiveness are presented in the following subsections.

Based on the recent monitoring results, it appears that the PCB concentrations in sediment and aquatic biota have decreased to very low and stable concentrations. It is recommended that the biennial sediments and aquatic biota monitoring be continued, to ensure that sufficient information is collected to update the fish consumption advisory. Existing fish advisory signs will continue to be inspected and maintained annually to mitigate human health risks associated with the consumption of PCB-contaminated fish.

3.7 Protectiveness Statement

Protectiveness Statement	
Operable Unit: OU2	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy for OU2 is protective of human health and the environment. Exposure pathways that could result in unacceptable risks are being controlled. The existing fish consumption advisory on Lake Hartwell continues to be implemented to warn the public of contaminated fish and recommended maximum quantity of consumption. The fish advisory signs for human health and public education have been routinely inspected and properly maintained. The ongoing groundwater remediation activities at the source areas of OU1 and completed sediment remediation on Twelvemile Creek are expected to reduce the PCB concentrations in downgradient sediment and aquatic biota to acceptable levels.	

PCB = polychlorinated biphenyl

Sitewide Protectiveness Statement
Protectiveness Determination: Protective
Protectiveness Statement: The remedies for the Site are protective of human health and the environment. Exposure pathways that could result in unacceptable risks are being controlled.

3.8 Next Review

The next FYR report for the Site is required 5 years from the completion date of this review.

Appendix A - Reference List

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CH2M HILL, Inc. (CH2M). 2018a. *Annual Report, April 2017 to March 2018, Sangamo Weston, Inc./Twelvemile Creek/Lake Hartwell PCB Contamination Superfund Site (Operable Units 1 and 2), Pickens, South Carolina*. August.

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Appendix B - Figures

1 Operable Unit 1 Site Location Map

2 Plant Site Map, March 2018

3 Breazeale Site Map, March 2018

4 Cross Roads Site Map, March 2018

5 GWTS Cumulative Mass Removal - VOCs

6 GWTS Cumulative Mass Removal - PCBs

7 Plant Site VOC Plume Extents, 2016

8 Plant Site PCB Plume Extent, 2016

9 Plant Site VOC Plume Extents, March 2018

10 Plant Site PCB Plume Extent, March 2018

11 Breazeale Site PCE and TCE Concentrations in Groundwater, March 2018

12 Cross Roads Site PCE and TCE Concentrations in Groundwater, March 2018

13 Area D In Situ Chemical Oxidation Pilot Study Network

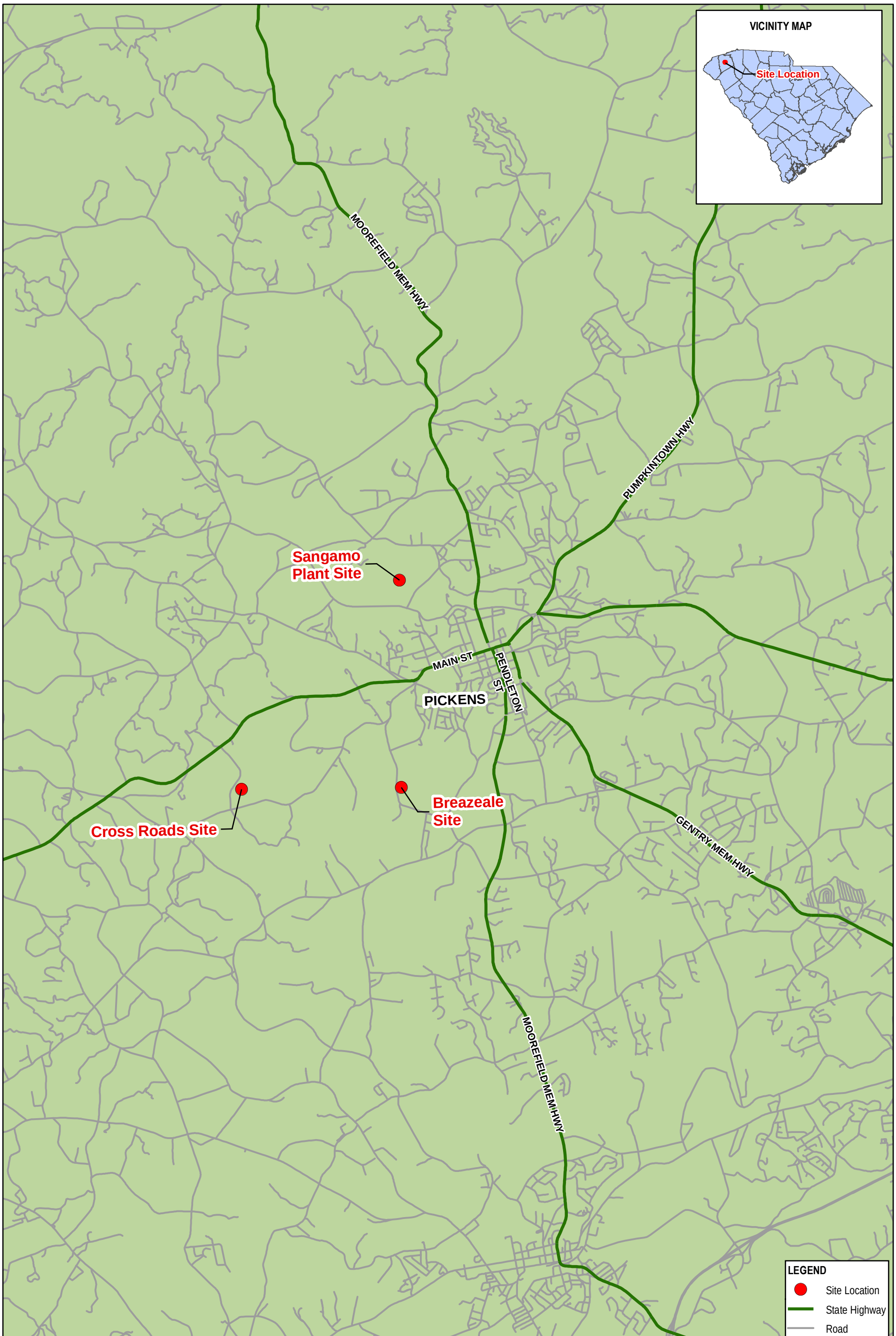
14 Area H In Situ Chemical Oxidation Pilot Study Network

15 Area 2 Air Sparging Pilot Study Layout

16 Area 3 SBGR Pilot Study Layout

17 Operable Unit 2 Site Location Map

18 2018 Results by Sampling Location



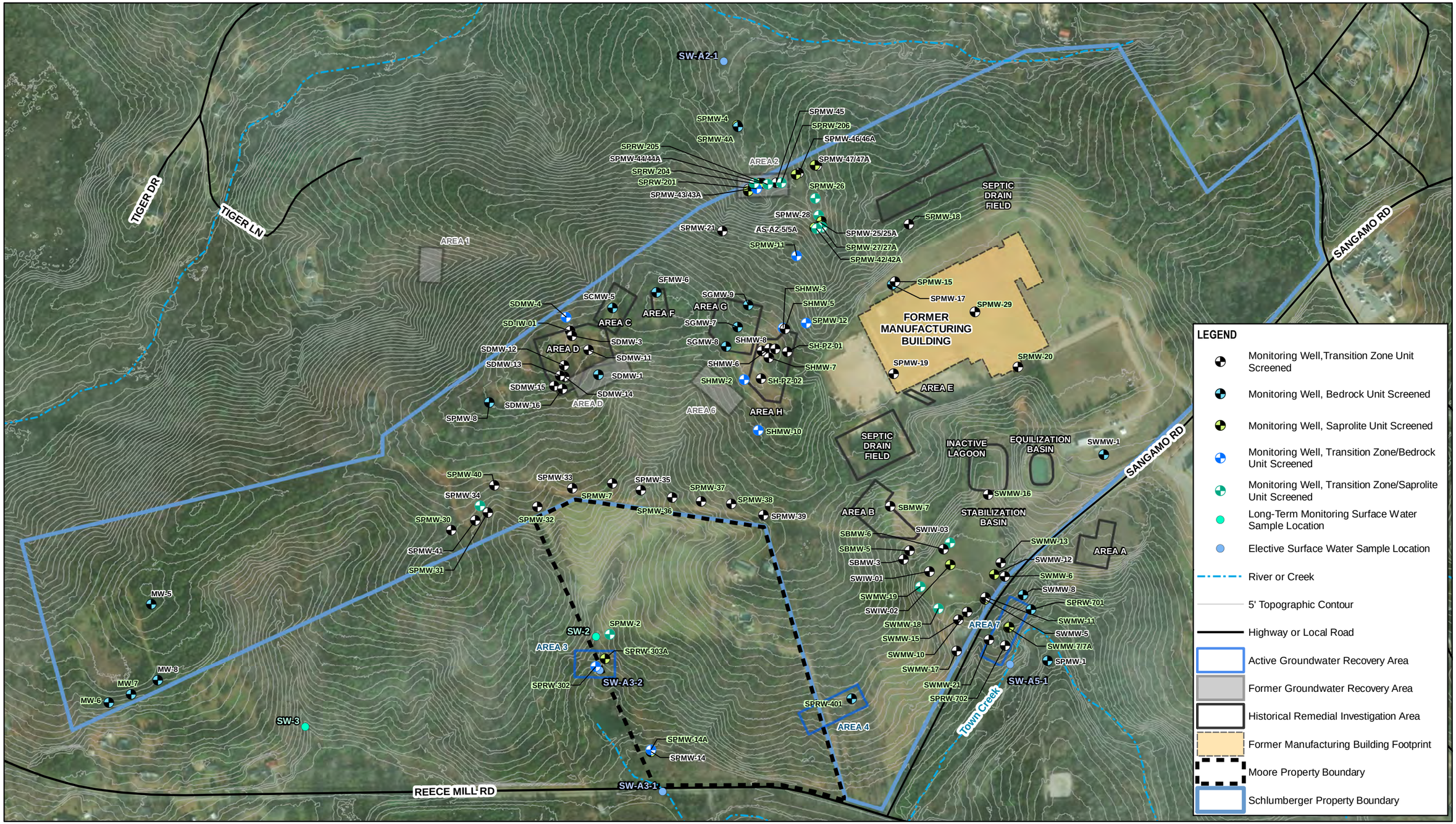
Source:
Environmental Systems Research Institute (ESRI)
North America Streets Layer, 2013

0 0.5 1
Approximate scale in miles

Figure 1
Operable Unit 1 Site Location Map
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG1_OU1_SITE_LOCATION.MXD AUTHOR: AG 3/29/2019



Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011
Streams: USGS, National Hydrography Dataset (NHD),1999

Note:
Green highlighted labels (SPMW-8) indicate Long-Term Monitoring Wells

0 400 800
Approximate scale in feet

Figure 2
Plant Site Map, March 2018
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG2_PLANT_SITE_MAP_2018.MXD AUTHOR: AG 4/1/2019

Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011
Streams: USGS, National Hydrography Dataset (NHD),1999

Note:
Green highlighted labels (BRMW-08) indicate Long-Term Monitoring Wells

N

0 90 180
Approximate scale in feet

Figure 3
Breazeale Site Map, March 2018
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG3_BREAZEALE_SITE_MAP_2018.MXD AUTHOR: AG 4/1/2019

Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011

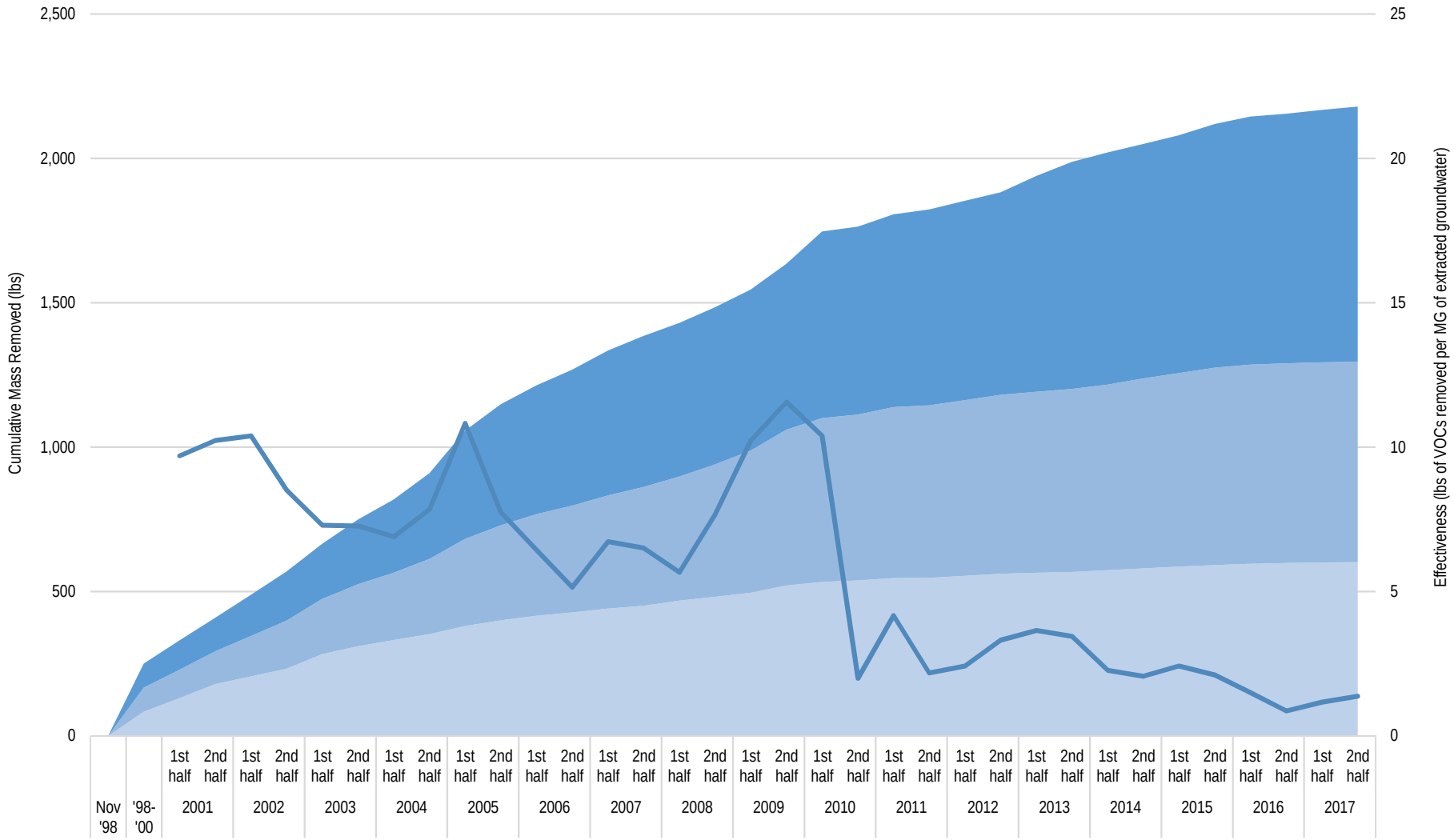
N

0 80 160
Approximate scale in feet

Figure 4
Cross Roads Site Map, March 2018
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

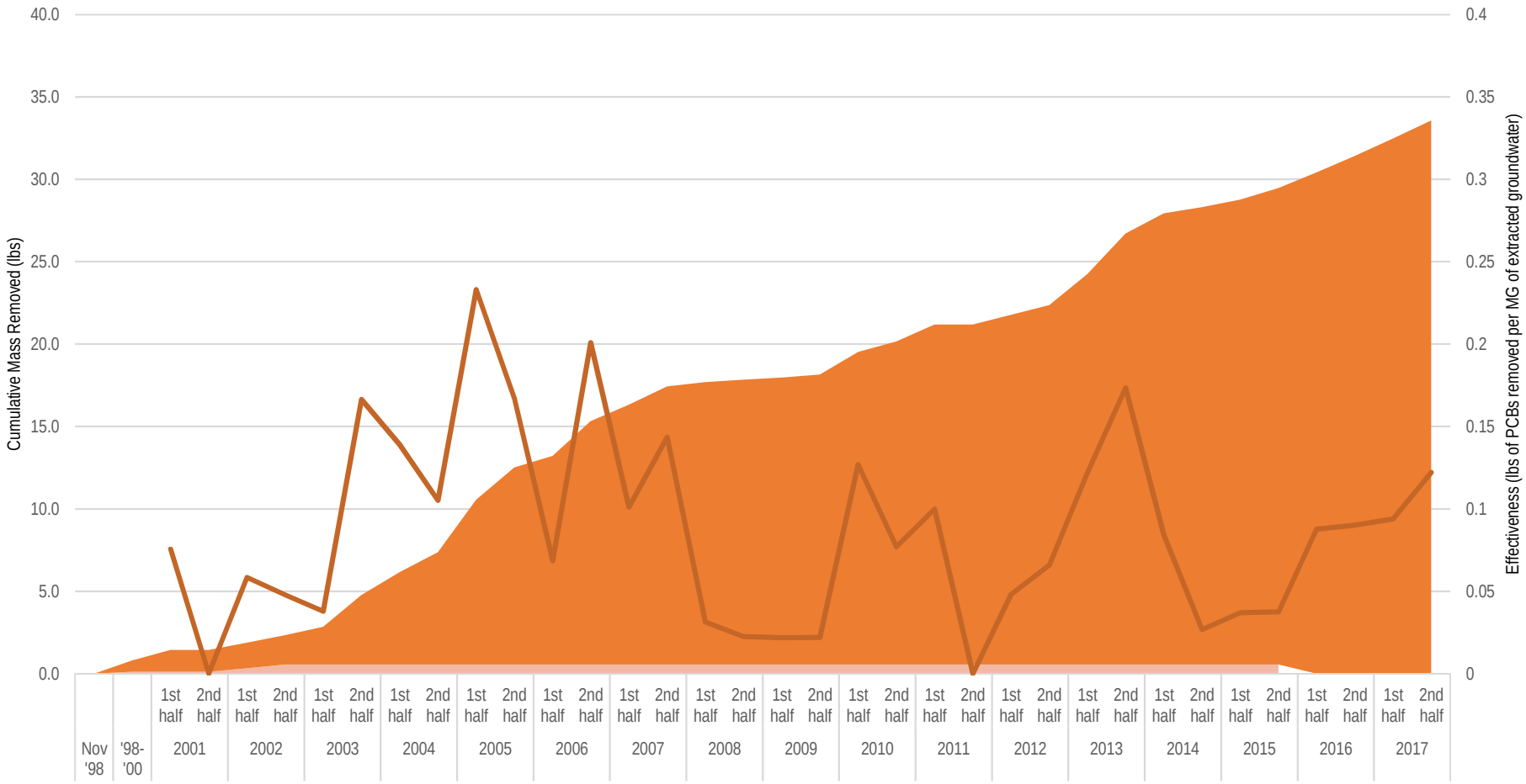
EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG4_CROSSROADS_SITE_MAP.MXD AUTHOR: AG 3/29/2019



Notes:
1,2-DCE = dichloroethene (total of cis-1,2-DCE + trans-1,2-DCE)
GWTS = groundwater treatment system
lbs = pounds
MG = million gallons
PCE = tetrachloroethene
TCE = trichloroethene
VOC = volatile organic compound

PCE
TCE
1,2-DCE, total
VOC Removal Effectiveness (lbs/MG)

FIGURE 5
GWTS Cumulative Mass Removal - VOCs
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina



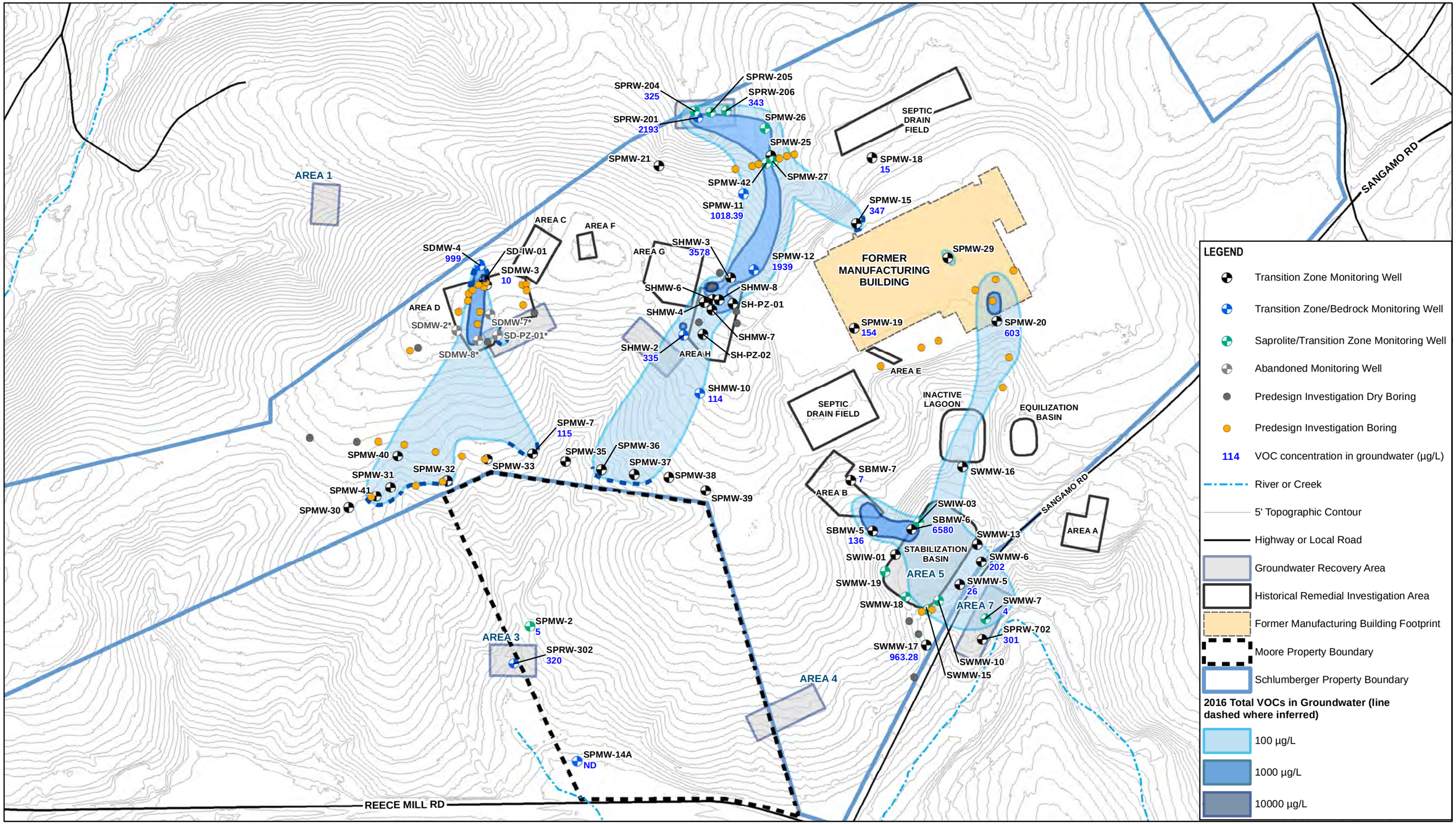
Notes:
GWTS = groundwater treatment system
lbs = pounds
MG = million gallons
PCB = polychlorinated biphenyl (total of Aroclor-1242, -1248, and -1254)
Aroclor-1254 has not been detected.

Aroclor-1248

Aroclor-1242

PCB Removal Effectiveness (lbs/MG)

FIGURE 6
GWTS Cumulative Mass Removal - PCBs
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina



Notes:
1. Wells screened exclusively in bedrock were excluded from the VOC plume contours.
2. * Well abandoned in 2016
3. VOC plume developed using data from the 2016 Long Term Monitioring sampling and the 2016 Predesign Investigation.

Acronyms:
µg/L= micrograms per liter
LTM= long-term monitoring
ND= not detected in sample
VOC= volatile organic compound

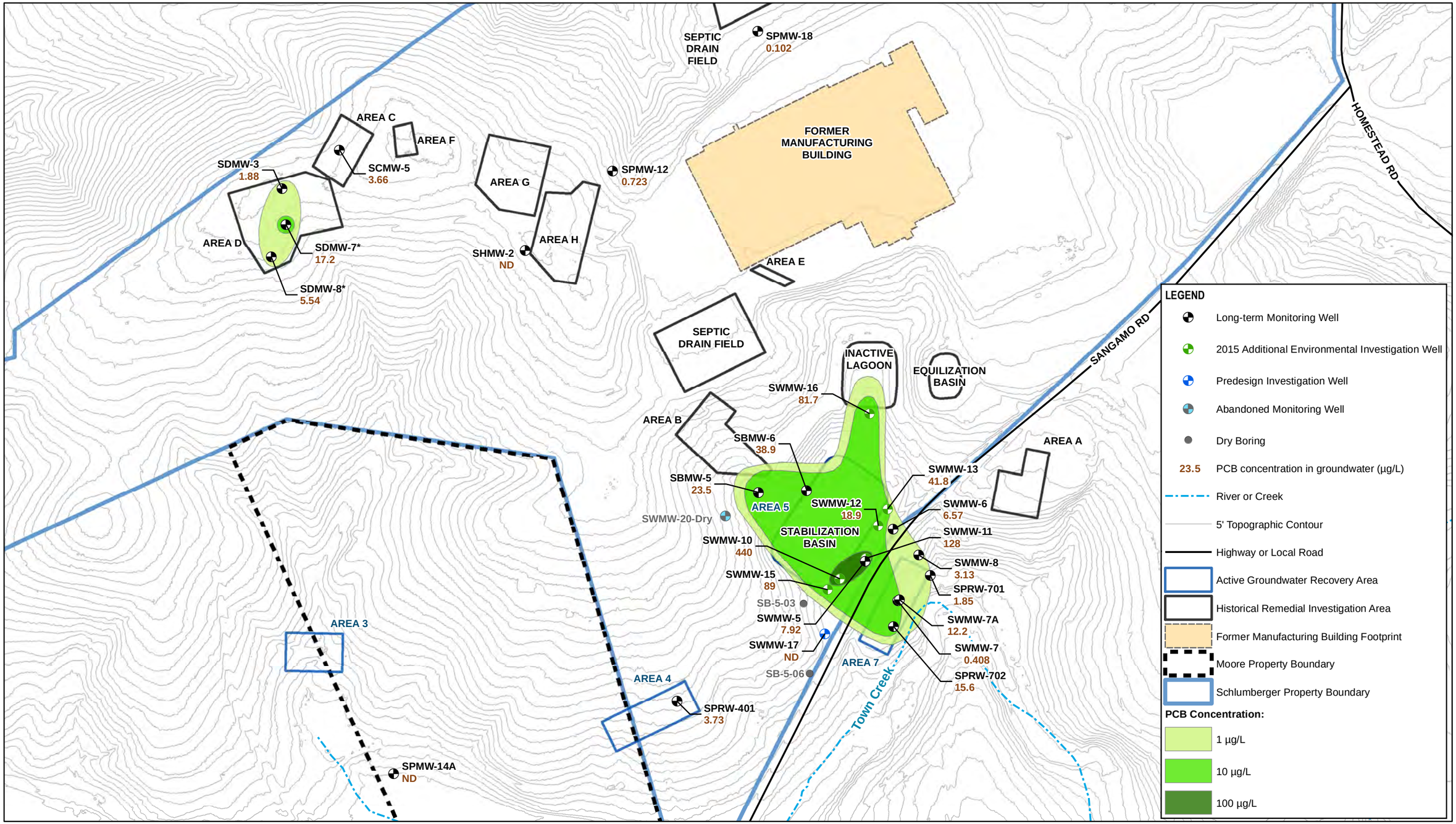
Data Sources:
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011
Streams: USGS, National Hydrography Dataset (NHD),1999

0 350 700
Approximate scale in feet

Figure 7
Plant Site VOC Plume Extents, 2016
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\2016_PLANTSITE_VOC_PLUME_EXTENT_REFORMATTED.MXD AG017958 4/12/2019



Notes:
1. * Well abandoned in 2016 before excavation

Acronyms:
LTM= long-term monitoring
ND= PCBs not detected in groundwater
PCB= polychlorinated biphenyl
µg/L= micrograms per liter

Data Sources:
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011
Streams: USGS, National Hydrography Dataset (NHD),1999

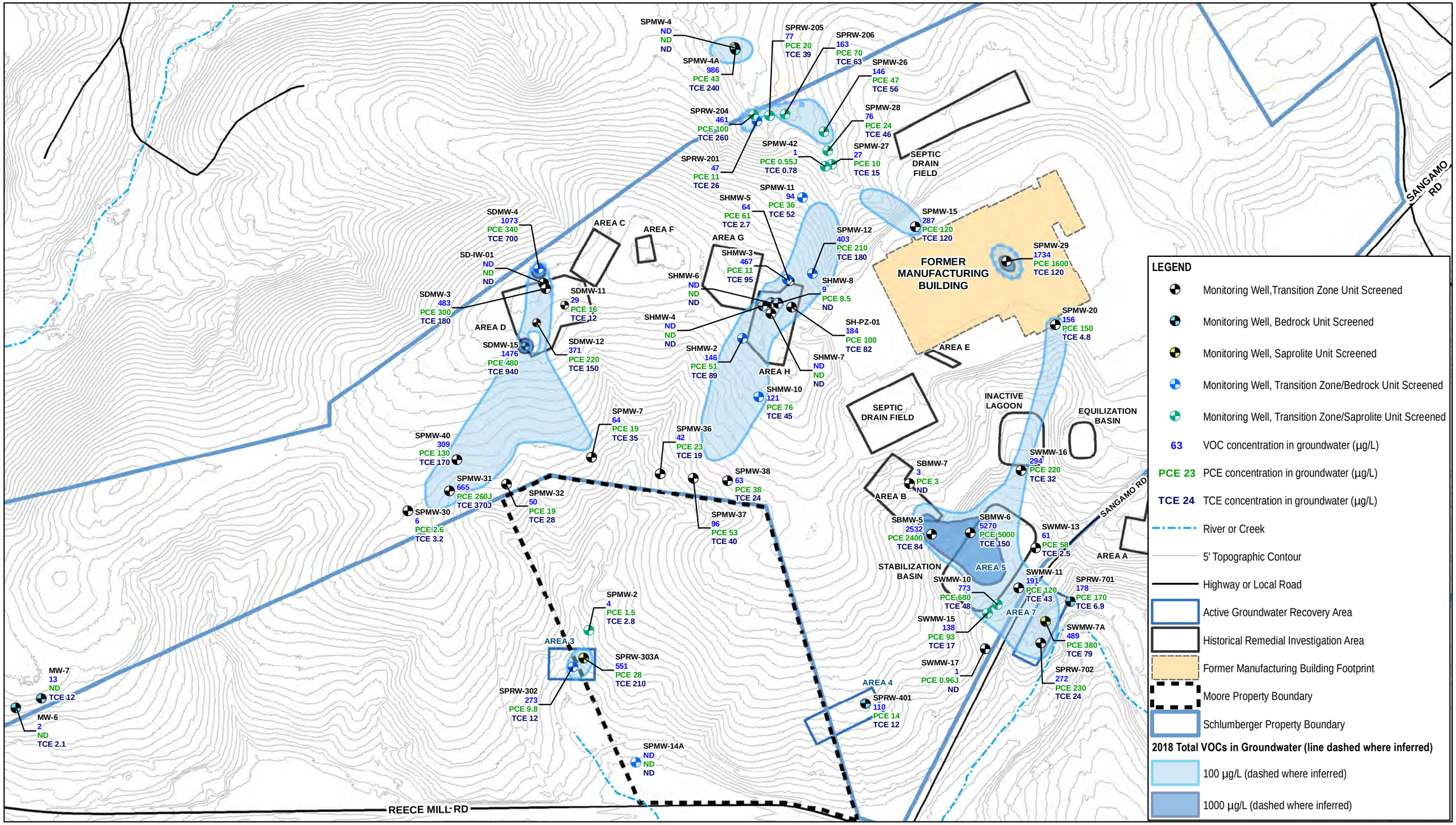
N

0 300 600
Approximate scale in feet

Figure 8
Plant Site PCB Plume Extent, 2016
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\2016_PLANTSITE_PCB_PLUME_EXTENT_REFORMATTED.MXD AUTHOR: AG 4/11/2019



Notes:
1. VOC plume developed using data from the 2018 LTM biennial and the March 2018 UIC groundwater sampling events. Please refer to figures in section 4 through section 6 for more detail about the March 2018 sampling events.
2. Wells screened exclusively in bedrock were excluded from the VOC plume contours.

Acronyms:
LTM= long-term monitoring
µg/L= micrograms per liter
ND= not detected in sample
PCE= tetrachloroethylene
TCE= trichloroethylene
VOC= volatile organic compound
UIC= underground injection control

Data Sources:
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011
Streams: USGS, National Hydrography Dataset (NHD),1999

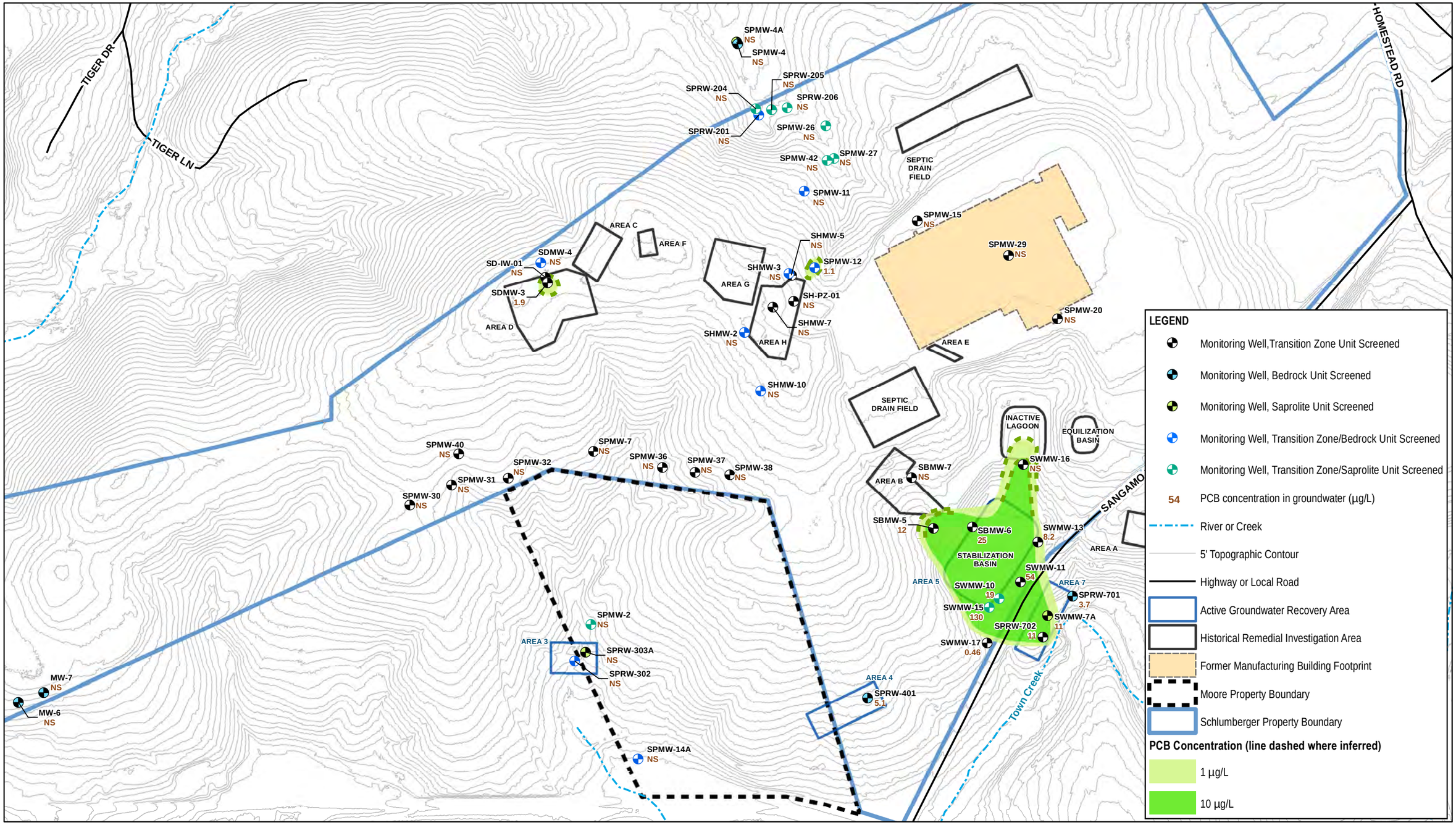
N

0 350 700
Approximate scale in feet

Figure 9
Plant Site VOC Plume Extents, March 2018
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG7_PLANT_SITE_VOC_PLUME_EXTENTS_2018.MXD AUTHOR: AG 4/12/2019



Notes:
1. PCB plume developed using data from the 2018 LTM biennial groundwater sampling event.
2. Wells screened exclusively in bedrock were excluded from the PCB plume contours.

Acronyms:
LTM= long-term monitoring
µg/L= micrograms per liter
NS= PCBs not sampled in groundwater
PCB= polychlorinated biphenyl

Data Sources:
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011
Streams: USGS, National Hydrography Dataset (NHD),1999

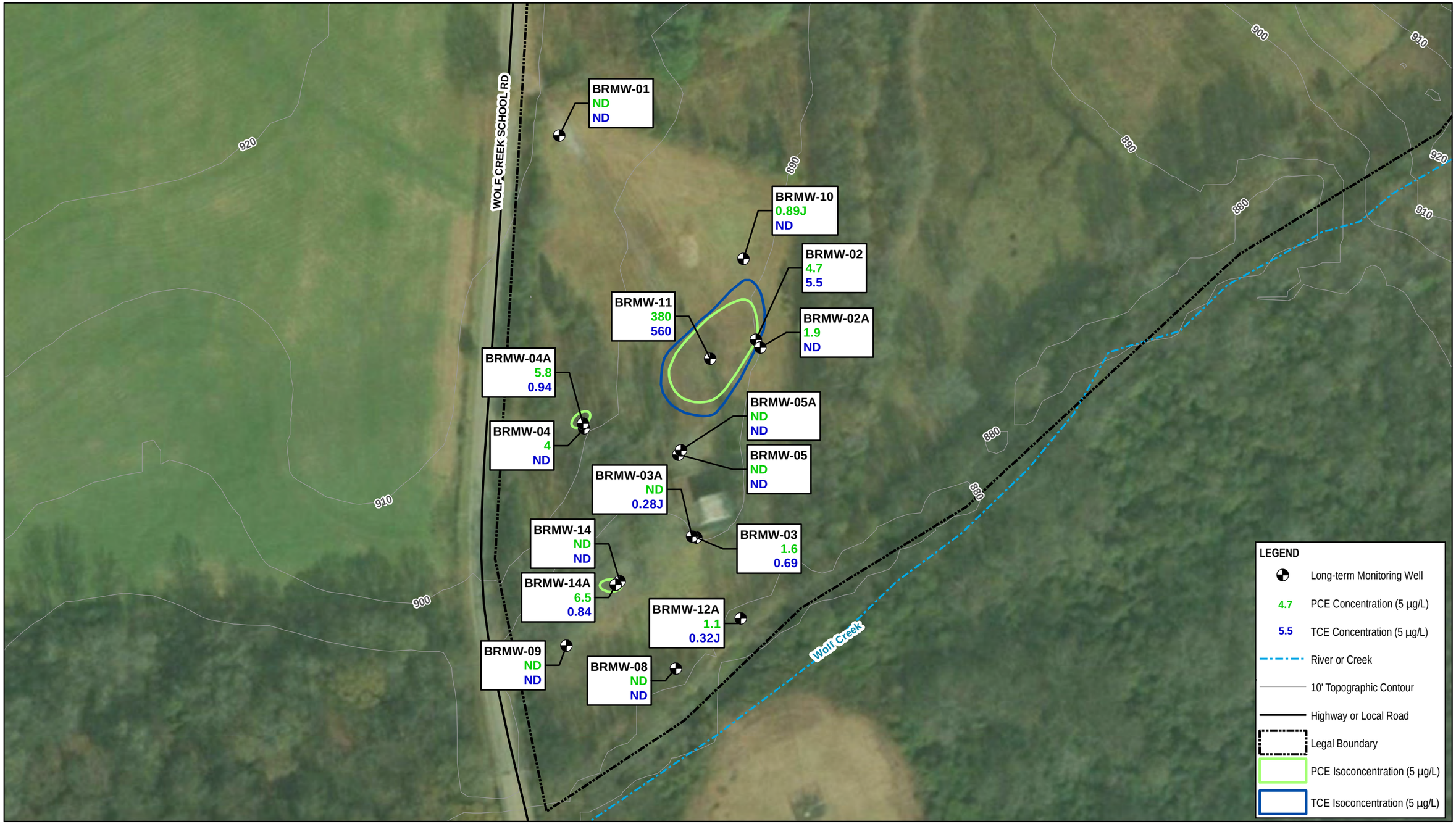
N

0 350 700
Approximate scale in feet

Figure 10
Plant Site PCB Plume Extent, March 2018
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG8_PLANT_SITE_PCB_PLUME_EXTENTS_2018.MXD AUTHOR: AG 4/11/2019



Notes:
PCE and TCE plumes developed using data from the 2018 LTM biennial groundwater sampling event.
Acronyms:
J = estimated concentration
µg/L = micrograms per liter
ND = not detected
PCE = tetrachloroethene
TCE = trichloroethene

Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011
Streams: USGS, National Hydrography Dataset (NHD),1999

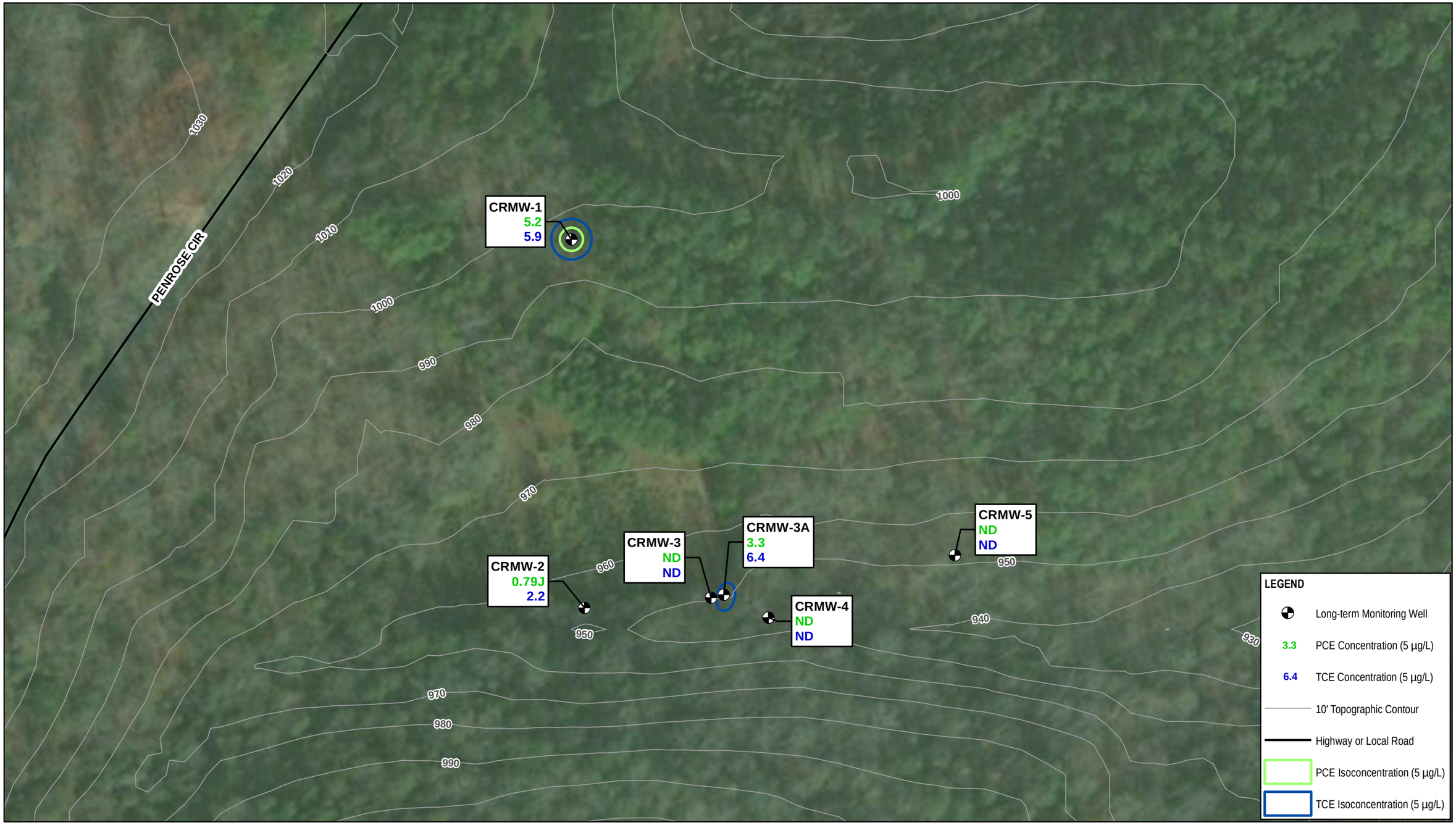
N

0 100 200
Approximate scale in feet

Figure 11
Breazeale Site PCE and TCE Concentrations in Groundwater, March 2018
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG9_BREAZEALE_PCE_TCE_2018.MXD AUTHOR: AG 3/29/2019



Notes:
PCE and TCE plumes developed using data from the 2018 LTM biennial groundwater sampling event.
Acronyms:
J = estimated concentration
µg/L = micrograms per liter
ND = not detected
PCE = tetrachloroethene
TCE = trichloroethene

Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011

N

0 80 160
Approximate scale in feet

Figure 12
Cross Roads Site PCE and TCE Concentrations in Groundwater, March 2018
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG10_CROSSROADS_PCE_TCE_2018.MXD AUTHOR: AG 3/29/2019

Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011

N

0 125 250
Approximate scale in feet

Figure 13
Area D In Situ Chemical Oxiation Pilot Study Network
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

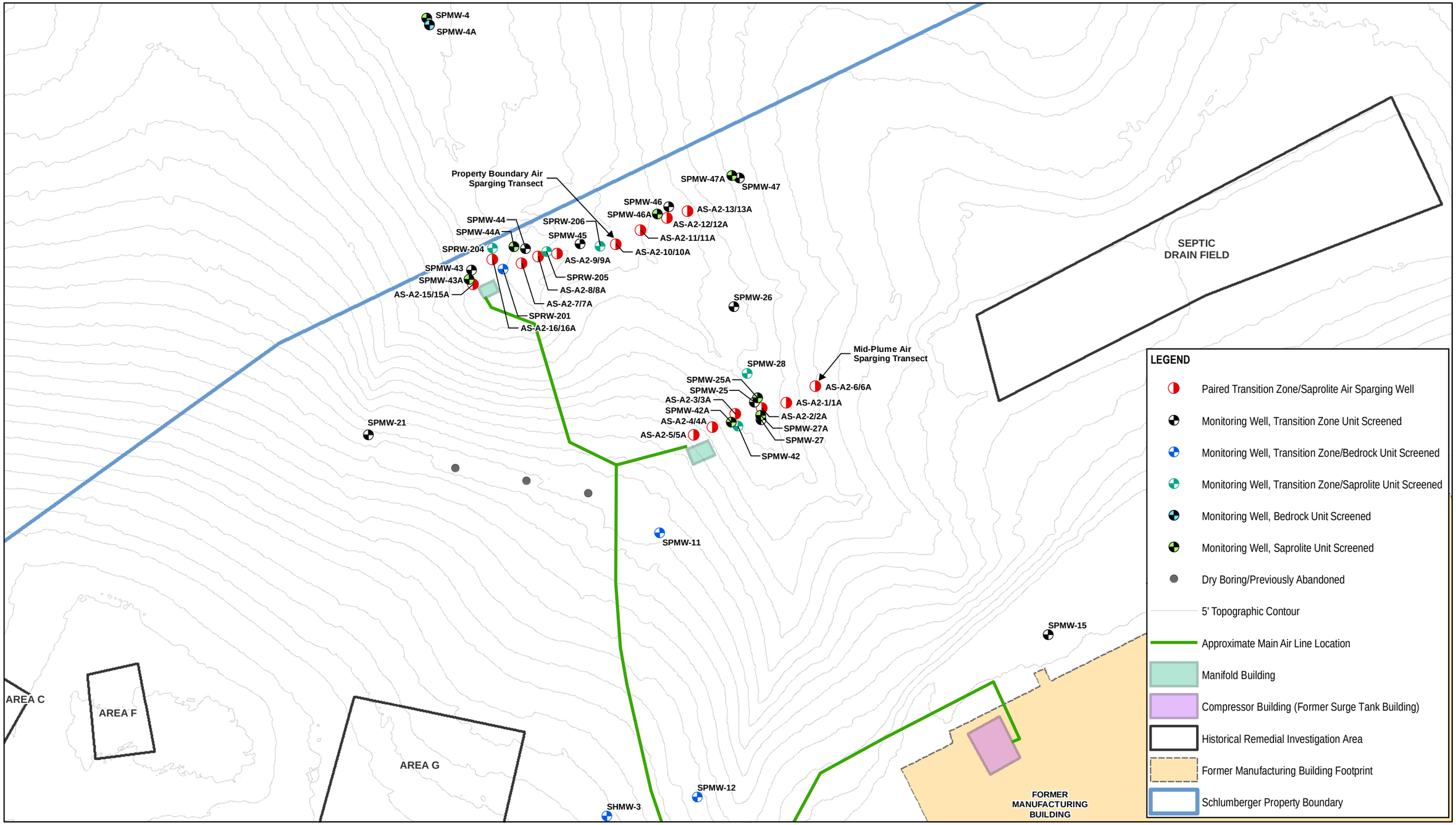
EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG13_AREAD_PILOT_STUDY_NETWORK.MXD

Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011

N

0 150 300
Approximate scale in feet

Figure 14
Area H In Situ Chemical Oxidation Pilot Study Network
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina



Notes:
AS wells AS-A2-1, 2, 3, 4, 2A, and 3A were installed as part of the Area 2 Phase I Air Sparging Pilot Study
Individual air lines are run to each AS well from the manifold building
Data Sources:
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011

N

0 100 200
Approximate scale in feet

Figure 15
Area 2 Air Sparging Pilot Study Layout
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\ANNUAL_REPORT_2018\FIG6-1_AREA2_AS_PILOT_STUDY_NETWORK.MXD

Notes:
SBGR = Subgrade biogeochemical reactor

Data Sources:
Basemap: USDA, Farm Service Agency (FSA), National Agriculture Imagery Program (NAIP), 2015
Contours: South Carolina Department of Natural Resources, Digital Elevation Model (DEM), 2011

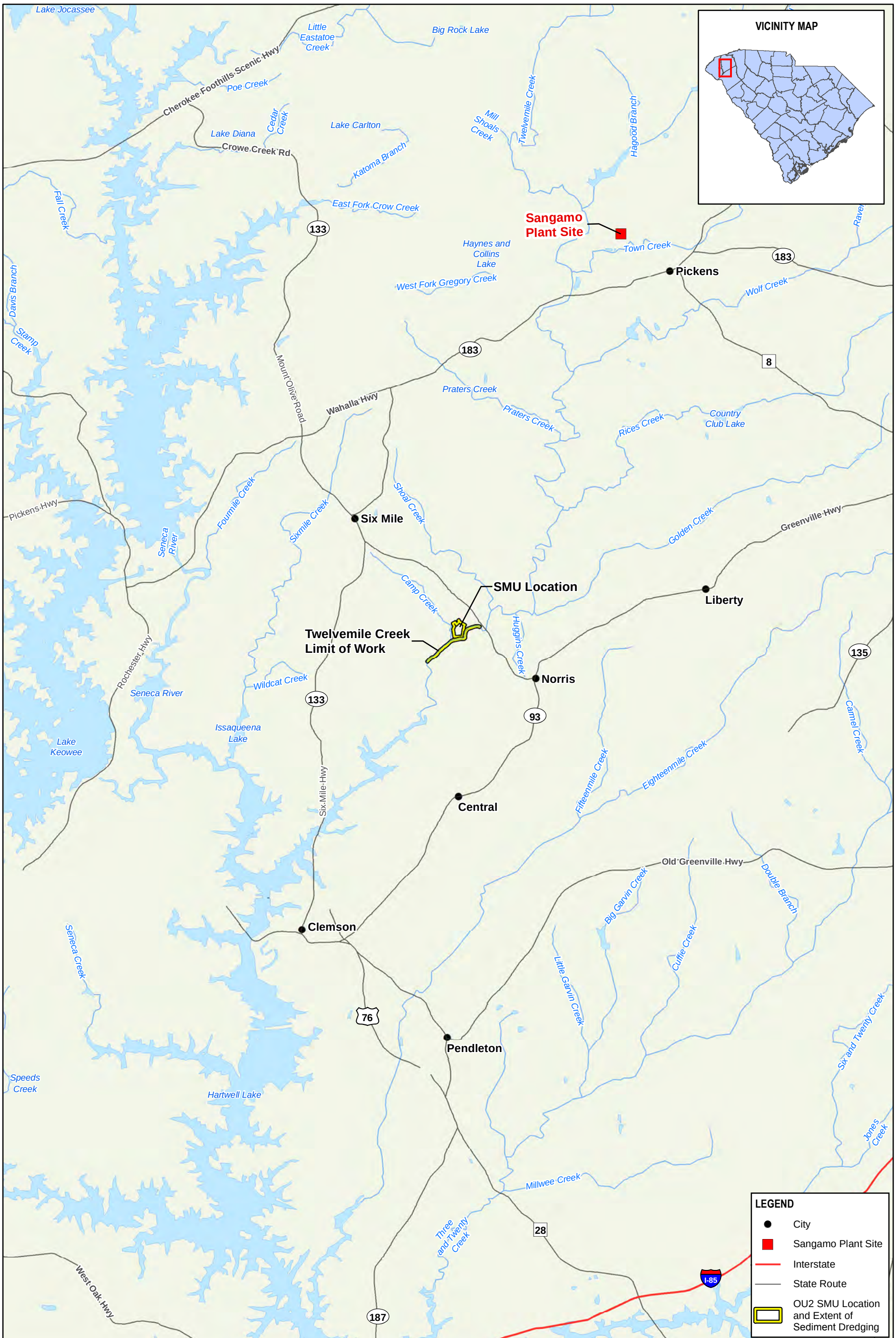
N

0 70 140
Approximate scale in feet

Figure 16
Area 3 SBGR Piolt Study Layout
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

ch2m

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG16_AREA3_SBGR_PILOT_STUDY_LAYOUT.MXD



Notes:
1. OU2 = Operable Unit 2
2. SMU = Sediment Management Unit

Data Sources:
Transportation: Esri World Transportation Reference Layer, 2019
Streams: USGS, National Hydrography Dataset (NHD),1999

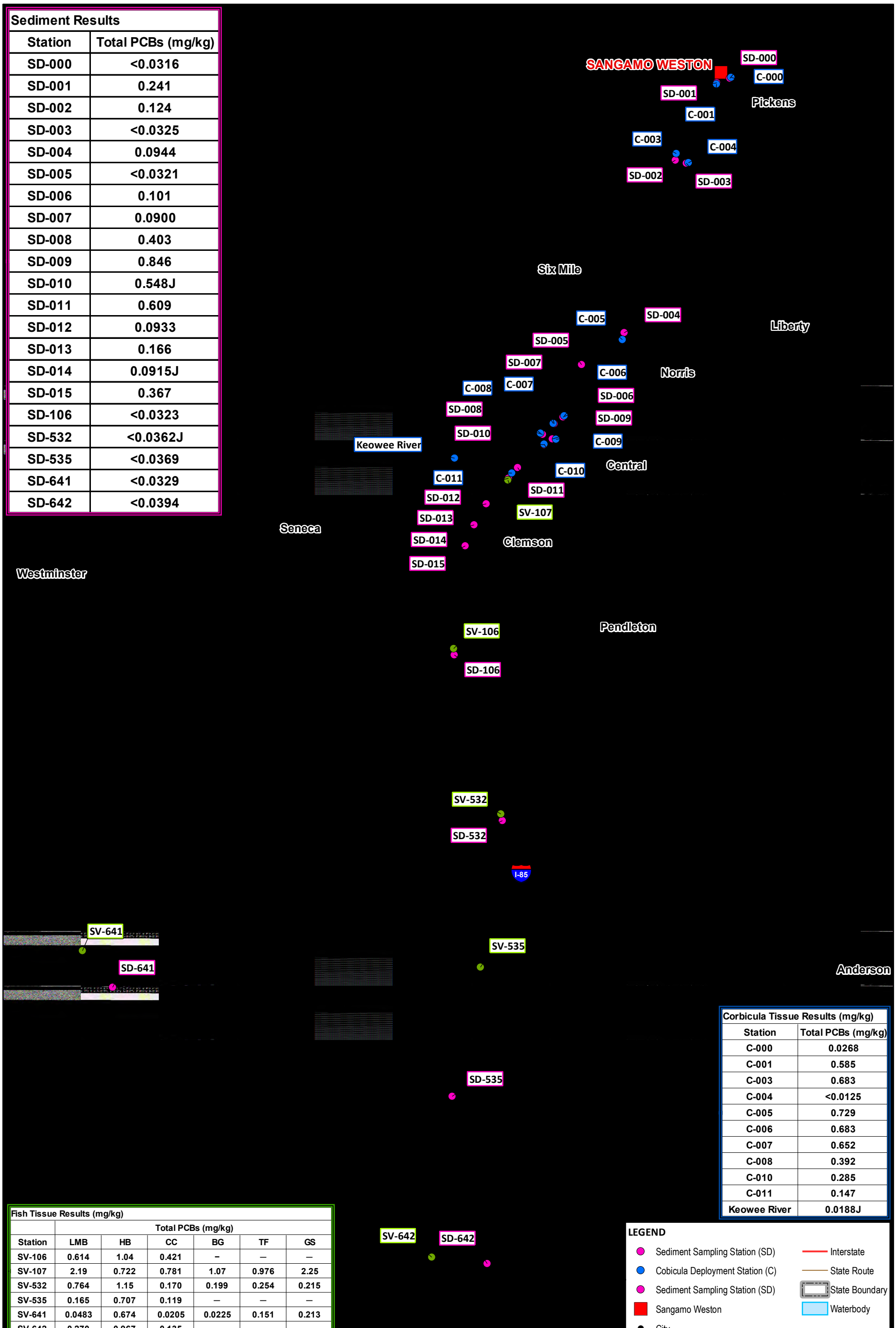
0 1 2
Miles

Figure 17
Operable Unit 2 Site Location Map
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG17_OU2_SITE_LOCATION.MXD AUTHOR: AG 4/17/2019

ch2m

Sediment Results	
Station	Total PCBs (mg/kg)
SD-000	<0.0316
SD-001	0.241
SD-002	0.124
SD-003	<0.0325
SD-004	0.0944
SD-005	<0.0321
SD-006	0.101
SD-007	0.0900
SD-008	0.403
SD-009	0.846
SD-010	0.548J
SD-011	0.609
SD-012	0.0933
SD-013	0.166
SD-014	0.0915J
SD-015	0.367
SD-106	<0.0323
SD-532	<0.0362J
SD-535	<0.0369
SD-641	<0.0329
SD-642	<0.0394



Corbicula Tissue Results (mg/kg)	
Station	Total PCBs (mg/kg)
C-000	0.0268
C-001	0.585
C-003	0.683
C-004	<0.0125
C-005	0.729
C-006	0.683
C-007	0.652
C-008	0.392
C-010	0.285
C-011	0.147
Keowee River	0.0188J

Fish Tissue Results (mg/kg)						
	Total PCBs (mg/kg)					
Station	LMB	HB	CC	BG	TF	GS
SV-106	0.614	1.04	0.421	–	–	–
SV-107	2.19	0.722	0.781	1.07	0.976	2.25
SV-532	0.764	1.15	0.170	0.199	0.254	0.215
SV-535	0.165	0.707	0.119	–	–	–
SV-641	0.0483	0.674	0.0205	0.0225	0.151	0.213
SV-642	0.270	0.967	0.135	–	–	–

Notes:
1. x = less than
2. J = estimated

Acronyms:
PCBs – polychlorinated biphenyls
mg/kg – milligrams per kilogram
LMB - Largemouth Bass
HB - Hybrid Bass
CC - Channel Catfish
BG - Bluegill
TF - Threadfin Shad
GS - Gizzard Shad

Data Sources:
Base Layers: Esri World Reference Layers, 2016
Hydrography: USGS National Hydrography Dataset (NHD), 1999

0 1.5 3
Approximate scale in Miles

Figure 18
2018 Results by Sampling Location
Fourth Five-Year Review Report
Sangamo Weston Site, Pickens, South Carolina

EN0518161147MKE \\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\S\SCHLUMBERGER\SANGAMO_SITE\MAPS\FOURTH_FIVE_YR_REVIEW\FIG18_LAKEHARTWELL_SAMPLINGRESULTS_2018.MXD AG017958 4/15/2019

Appendix C - Site Chronology

Table C-1. Chronology of Site Events for Operable Unit 1

Date	Event
September 1985	Discovery and Site Inspection
March 1986	Preliminary Assessment
January 1987	Proposed Listing on NPL
June 1987	Administrative Order on Consent with STC for Performance of RI/FS
January 1988	RI/FS Work Plan Approved
February 1990	Final Listing on NPL
December 1990	RI/FS Completed and ROD Signed
September 1991	First ESD
April 1992	Initiated RD for Soil
June 1992	Initiated RD for Groundwater
December 1992	Consent Decree with STC Lodged with Court
June 1993	Second ESD
November 1993	Completed RD and Initiated RA
November 1993 – July 1994	Excavation of Soil at Satellite Disposal Sites
June 1995	Completed RD/RA for Soil
July 1995 – May 1997	Excavation of Soil at Plant Site
December 1995 – May 1997	Thermal Desorption of Soil at Plant Site
January 1996	Completed RD for Groundwater at Breazeale Site
January 1997	RD for Groundwater at Plant Site Completed
March 1997	RD Complete
June 1997	Began Groundwater Recovery at Breazeale Site
November 1998	Began Groundwater Recovery at Plant Site
September 1998	Delisted Nix, Welborn, and Trotter Sites from NPL
May 1999	Interim RA Report
August 1999	Construction Completion/Preliminary Closeout Report Signed
January 2002	Delisted Dodgens Site from NPL
June 2004	Additional Source Characterization at Plant Site near Town Creek
November 2004	Additional Soil and Capacitor Debris Removal at Plant Site
March 2005	Supplemental Groundwater Assessment at Plant Site
August/September 2005	Supplemental Groundwater Remediation Activities at Plant Site

Table C-1. Chronology of Site Events for Operable Unit 1

Date	Event
September 2005	First FYR Report Approved
March 2007	Phase 1 Residual Source Investigations at Plant Site
June 2007	Phase 2 Residual Source Investigations at Plant Site
2007	ISCO Pilot Studies at Breazeale Site
2007	Three dimensional Seismic Surveys of Area H and FMB Area at Plant Site
December 2007	EPA Approved Modification of Surface Water Sampling Program for Plant Site
September 2008	Soil Vapor Extraction Pilot Study at Plant Site
2008	Additional Soil and Capacitor Debris Removal at Plant Site
January 2009	Shutdown of Wells in Well Field 2 at Breazeale Site to Prepare for Chemical Oxidation Program
April 2009	Additional Soil and Capacitor Debris Removal at Plant Site
September 2009	Initial ISCO Injections at Breazeale Site
February 2010	Second FYR Report Approved
September 2010	Shutdown of Recovery Wells at Area 3 with EPA Approval
September 2010	Installation of Area 2 Sump Groundwater Seep Collection System
October 2010 to March 2011	Construction of Groundwater Seep Collection System at Area 3
March 2011	Began Operation of Area 3 Seep Collection System and Relocated Outfall of the GWTS
April 2012	Installed Storm Water Control Structure and Sump at Area 5
April 2012	Storm Water Control Improvements on Sangamo Road at Plant Site
July - August 2012	Source Area Evaluation at Breazeale Site with Soil Screening for VOCs using Membrane-interface Probe
July – December 2012	Optimization Improvements to GWTS at Plant Site
September 2012	Updated CSM for Plant Site
November 2012	Excavation of Hot Spot Soil and Installation of Infiltration Gallery for Further ISCO Treatments at Breazeale Site
December 2012	ISCO Injection at Breazeale Site Infiltration Gallery
2011	Shutdown of Recovery Well at Area D
February 2013	Rescinded NPDES Permit for Breazeale Site
March 2013	HydraSleeve Comparison Study
May 2013	Completed Modification to GWTS with New Controls System and Building at Area 5
May 2013	SCDHEC Approved Decommissioning Plan for Breazeale Site GWTS
June 2013	Removal of Effluent Discharge Pipe and Diffuser at Wolf Creek and Cap

Table C-1. Chronology of Site Events for Operable Unit 1

Date	Event
March-June 2013	Supplemental Site Characterization at Areas B, D, H, and FMB Area of Plant Site
October 2013	Developed and Cleaned Well SDMW-4 and Area 2 Recovery Wells and Performed Capacity Tests
September 2013 – February 2014	Soil Excavation at Area B and Area H of Plant Site
February 2014	Geophysical Survey of Area 5 at Plant Site
June 2013 – March 2014	Well Abandonment and Final GWTS Decommissioning at Breazeale Site
March 2014	Vapor Intrusion Screening Study
July 2014	Third ESD to Include ICs as Part of the Remedy
August 2014 – December 2014	Vapor Intrusion Testing near Former Secure Landfill
September 2014 – December 2014	Groundwater Investigation and ISCO Injection at Breazeale Site
November 2014	ISCO Injection at Area H
March 2015	Third FYR Report Approved
March 2015	Well Rehabilitation at Plant Site
March 2015	Additional Environmental Investigation at the Plant Site (multiple areas)
June 2015	EPA Approved Modification of Groundwater Monitoring Frequency from Annual to Biennial at Breazeal Site
August 2015	ISCO Injection at Area D
August 2015	Abandonment of Seven Monitoring Wells at Plant Site
September 2015	ISCO Injection at Area H
December 2015	Predesign Investigation Began at the Plant Site (multiple areas)
January 2016	Abandonment of Six Monitoring Wells at Plant Site
March 2016	Updated CSM for Plant Site
March 2016	ISCO Injections at Area H
April 2016	ISCO Injections at Area D
May 2016	Completed Aquifer Testing in Area 2 and Area 3
June 2016	Completed Column Studies at the Plant Site in Area 2, 3, and 5
July 2016	Changed LTM Groundwater Monitoring Network at Plant Site
August 2016	ISCO Injection at Area D
October 2016	Abandonment of Two Monitoring Wells at Plant Site
October 2016	Installed AS Wells at Area 2 during Phase 1 Pilot Study
November 2016	ISCO Injections at Area D and Area H
November 2016	Phase I AS System in Mid-Plume Transect Startup and Tracer Test at Area 2
December 2016	Abandonment of Eight Monitoring Wells at Area D
January 2017	Soil Removal at Area D

Table C-1. Chronology of Site Events for Operable Unit 1

Date	Event
May 2017	ISCO Injection at Area H and Replacement Monitoring Well Installation at Area D
May 2017	Initiated Area 5 Stormwater Sampling Program
June 2017 – July 2017	ISCO Injections at Area D and Area H
June 2017	Repaired Area 5 Stormwater Structure
June 2017	Installed Monitoring Wells at Area 2 at the Property Boundary
July 2017	EPA Approved Modification of LTM Groundwater Monitoring Frequency from Annual to Biennial at the Plant Site (First Event in 2018)
July 2017	Shutdown of Groundwater Recovery System at Area 2
July 2017 – September 2017	Groundwater Study at Area 2
August 2017	Installed AS Wells at Area 2 along Property Boundary Transect
September 2017	EPA Approved Continued Shutdown of Area 2 Groundwater Recovery System during AS Pilot Study
November 2017	Began Operation of Select Property Boundary AS Wells at Area 2 and Installed Additional AS Wells at Mid-Plume and along Property Boundary Transect
November 2017	Installed Additional Injection Wells at Area H
December 2017	Area 3 SBGR Work Plan Submitted to EPA and SCDHEC
December 2017 – March 2018	Area 2 AS Pilot Study System Upgrade and Installation
March 2018	Area 2 AS Pilot Study Phase II Full System Start Up
April 2018 – June 2018	ISCO Injections at Area D and Area H
June 2018	Installed SBGR at Area 3 and Began Optimization Testing
October 2018	Began SBGR Pilot Study at Area 3

Table C-2. Chronology of Site Events for Operable Unit 2

Date	Event
September 1985	Discovery and Site Inspection
March 1986	Preliminary Assessment
January 1987	Proposed to NPL
February 1990	Final Listing on NPL
April 1990	RI/FS Special Notice to STC
September 1990 to April 1994	Fund-Lead RI/FS
June 1994	OU2 ROD Issued
June 1994	Installed Trash-rack Rakes at Woodside 1/Woodside 2 Impoundments to Facilitate Downstream Passage of Sediments
April/May since 1995	Annual Monitoring of Aquatic Biota and Sediments
September 1997	Trash-rack Rakes Not Performing as Expected
September 1997 to March 1998	Initial Sediment Management Alternative Evaluation for Twelvemile Creek Impoundments
July 1998	Initiated Public Education Program and Issued a Joint, Risk-based Fish Consumption Advisory by States of South Carolina and Georgia
October 1998	Initial Sediment Dredging at Woodside 1 and Woodside 2 Impoundments
October 1998	Completed RD and Began RA
July 1999	Second Sediment Dredging at Woodside 1 and Woodside 2 Impoundments
August 1999	Preliminary Close-Out Report
December 1999	Data Collection for Sediment Transport Modeling
January 2000	High-flow Sluice Gate Installation Evaluation
April 2000	Conducted Sediment Transport Modeling and Completed Second Sediment Management Alternative Evaluation for Twelvemile Creek Impoundments
July 2000	Completed Public Education Telephone Interviews
January 2001	Third Sediment Dredging at Woodside 1 and Woodside 2 Impoundments
September 2001	Phase 1 Monitored Natural Recovery Investigation Report Completed by EPA
February 2002	Fourth (and last to date) Sediment Dredging at Woodside 1 and Woodside 2 Impoundments
June 2002	Phase 2 Monitored Natural Remediation Investigation Report Completed by EPA
September 2002	Interim RA Report
November 2002	Second Data Collection for Sediment Transport Modeling
April 2003	Sediment Transport Modeling and Morphology Evaluation to Evaluate In-stream Impacts from Dam Removal
April 2003	Phase 3 Monitored Natural Remediation Investigation Report Completed by EPA
July 2004	Health Consultation Regarding Lake Hartwell Fish Consumption

Table C-2. Chronology of Site Events for Operable Unit 2

Date	Event
September 2004	First FYR Report Approved
2004	NRT and STC Negotiations and Settlement concerning NRDA
April 2009	Installed Fish Advisory Signs
2009	Expedited Order for Dam Removal
September 2009	ESD issued by EPA
February 2010	Second FYR Report Approved
February 2011	Sediment Dredging within Reach above Woodside 1 Impoundment Completed and Woodside 1 Dam Demolished
August 2011	Completed Sediment Dredging within Reach above Woodside 2 Impoundment and Demolished Woodside 2 Dam
January 2012	Installed Monuments at Woodside 1 and Woodside 2 Locations
April 2012	Improved Stormwater Control on Sangamo Road at Plant Site to Reduce Sediment Erosion and Promote Vegetative Restoration with Live Stakes
October 2011 – May 2012	Completed Supplemental Remedial Investigation to Evaluate Residual PCB Concentrations in Twelvemile Creek
September 2012	Completed Human Health Risk Assessment for Twelvemile Creek
November 2012	Stream Restoration Including Structural Stabilization and Vegetative Restoration
January 2013	Visual Assessment Following Near-Bankfull Flows
March 2013	Second Quarter Bank Stabilization Structural Monitoring Assessment
April 2013	First Semiannual Vegetation Assessment
June 2013	Third Quarter Bank Stabilization Structural Monitoring Assessment
August 2013	Final Bank Stabilization Structural Monitoring Assessment
August 2013	Visual Assessment Following Bankfull Flows
November 2013	Second Semiannual Vegetation Assessment
March 2014	Supplemental Planting and Camp Creek Repair
May 2014	Third Semiannual Vegetation Assessment
March 2015	Third 5YR Approved
January 2016	SCDHEC Approved Modifications of Post-Closure Groundwater Sampling and Reporting Frequency from Semiannual to Annual, SMU Inspection from Quarterly to Annual, and Documentation of Groundwater Monitoring and SMU Inspection Activities in One Combined Annual Report
April 2016	Lake Hartwell Fish and Sediment Study
September 2017	SCDHEC Approved Modification of Groundwater Monitoring Frequency at Twelvemile Creek SMU from Annual to Every 5 Years
April 2018	Lake Hartwell Fish and Sediment Study
October 2018	Post-Closure Groundwater Sampling

Appendix D - Public Notification for Availability of Draft Final Fourth Five-Year Review Report

The United States Environmental Protection Agency (EPA) Region 4 and the South Carolina Department of Health and Environmental Control (SCDHEC) have initiated the Fourth Five-Year Review for Operable Unit One (OU1) and Operable Unit Two (OU2) of the Sangamo Weston/Twelve Mile Creek/Lake Hartwell Polychlorinated Biphenyl (PCB) Contamination Superfund Site in Pickens County, South Carolina. Five Year Reviews are conducted to evaluate the protectiveness of cleanup actions taken at Superfund sites.

OU1 of the Sangamo site addressed the land-based PCB source areas, including the former Plant site and six satellite disposal areas. Soils impacted by PCBs were excavated from the disposal areas and stockpiled at the Plant Site for treatment. From December 1995 through May 1997, approximately 60,000 tons of soil were treated via thermal desorption and backfilled on the Plant Site. Active groundwater recovery and treatment was initiated at the Plant Site in November 1998. The Plant Site groundwater recovery system has recovered more than 400 million gallons of groundwater and removed an estimated 2,180 pounds of chlorinated solvents and 34 pounds of PCBs. The treatment system was completely refurbished in 2013 with various upgrades and maintenance occurring as needed. In early 2017, approximately 16,700 tons of soil containing residual source material was excavated and transported off-site for proper disposal. This supplemental work resulted in the removal of approximately 6,541 pounds of PCB mass. Additional technologies have been implemented at the site to facilitate groundwater remediation. The Breazeale Site water treatment system recovered an estimated 116 million gallons prior to shut-down in 2009 and decommissioning in 2014.

OU2 of the Sangamo site addressed the sediment, surface water, and biological migration pathways down stream from the land-based source areas. A fish consumption advisory on Lake Hartwell was first issued in 1976 and has been modified many times since to provide meal advice to anglers based on PCB trends in fish tissue. Impacted surface sediments in the Twelve Mile Creek Arm of Lake Hartwell are being addressed by natural burial processes referred to as Monitored Natural Recovery.

EPA and SCDHEC anticipate that the Fourth Five Year Review for the Sangamo site will be completed in September 2019. Public comments and questions on the Five Year Review process are encouraged. For more information on the Sangamo site, please visit the EPA web page at https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0403252 or contact the EPA/SCDHEC project managers below:

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Bureau of Land & Waste Management
2600 Bull Street
Columbia, SC 29201
803.898.0910
padgetjp@dhec.sc.gov

LEGALS

property conveyed to James Jackson by the following conveyances: by Deed of Roslynn Williams, dated September 4, 2003 and recorded February 17, 2004 in Book 793 at Page 268; by Deed of Arbutis Davis, Odena Rosemond, Jeanette Williams, and Thelma Briggs, dated July 30, 2003 and recorded February 17, 2004 in Book 793 at Page 271; and by Deed of Etta Mae Lee and James Owens dated August 30, 2003, and recorded February 17, 2004, in Book 793 at Page 274, all Deeds recorded in the Office of the Register of Deeds for Pickens County. Property Address: 519 West Front Street, Liberty, SC 29657; TMS: 4087-08-88-9175; LESS: All that certain piece, parcel, or lot of land lying and being situate in the State of South Carolina, County of Pickens, and being more fully described as follows, to-wit: BEGINNING at a point on edge of West Front Street and running along the street N82-24-27E 90.45 feet to a point; thence leaving the street and running S05-09-32E 145.71 feet to a point; thence N83-16-39W 97.07 feet to a point; thence N3-04-09W 120.87 feet to the point of Beginning. This being the same property conveyed to James Jackson by the following conveyances: by Deed of Arbutis Davis, Odena Rosemond, Jeanette Williams, and Thelma Briggs dated January 1, 2008 and recorded March 31, 2009 in Book 1245 at Page 159; by Deed of Etta Mae Lee, dated January 31, 2009, and recorded March 31, 2009 in Book 1245 at Page 162; by Deed of James C. Owens, dated February 27, 2009, and recorded March 31, 2009 in Book 1245 at Page 165, in the Office of the Register of Deeds for Pickens County. Property Address: 515 West Front Street, Pickens, SC TMS: 4087-88-98-0161; All of the proceeding is the description of the subject property, as described herein, which is the 0.41 acre parcel bearing the following: Property Address: 517 West Front Street, Liberty City, SC 29657; TMS: 4087-08-88-9083; MH: 4087-08-88-9083; This conveyance also includes a continual right of way for purposes of ingress and egress as shown in the conveyance from Mary Etta J. Anderson dated December 20, 1976, and recorded in Book 13-D at Page 612 in the Office of the Clerk of Court of Pickens County. ORDER OF JOINDER WHEREAS, Rosslyn Williams may claim an interest in the real property which is the subject matter of this action; and WHEREAS, joinder will not deprive the Court of jurisdiction over the subject matter of this action; and unless Rosslyn Williams is joined as a party, complete relief as to the Plaintiff's causes of action cannot be accorded among those already parties hereto; THEREFORE, pursuant to Rules 19 and 53 of the South Carolina Rules of Civil Procedure, for good cause indicated, IT IS HEREBY ORDERED

LEGALS

THAT: (1) Rosslyn Williams shall be joined as a party defendant in the above captioned action and her name be added to the caption; and (2) The caption be amended ab initio, so that no re-service of the Summons and Complaint upon the other named defendants shall be necessary or required; and (3) The Defendant shall be served with this Order attached to the Summons and Complaint, and shall thereafter have 15 days to serve Plaintiff with an Answer. IT IS SO ORDERED. The Honorable R. Murray Hughes, Special Referee for Pickens County, SC

Cox & Cole, LLC
ATTORNEY FOR PLAINTIFF
Westley P. Cox
(S.C. Bar #101704)
32 E. Main St.,
Williamston, SC 29697
(864) 847-9289

5/11, 5/15, 5/22

Legal Notices / Notices To Creditors

NOTICE TO CREDITORS OF ESTATES

All persons having claims against the following estates **MUST** file their claims on Form #371ES with the Probate Court of **Pickens** County, the address of which is **222 McDaniel Ave., B-16, Pickens, SC 29671,** within eight (8) months after the date of the first publication of this Notice to Creditors or within one (1) year from date of death, whichever is earlier (SCPC 62-3-801, *et seq.*), or such persons shall be forever barred as to their claims. All claims are required to be presented in written statements, on the prescribed form (FORM #371ES) indicating the name and address of the claimant, the basis of the claim, the amount claimed, the date when the claim will become due, the nature of any uncertainty as to the claim, and a description of any security as to the claim.

Estate: Minnie Jane Brown Baker
Date of Death: 04/01/2019
Case #2019ES3900301
Personal Representative:
Leonard S. Baker, Sr.
747 Hester Store Road
Easley, SC 29640
Attorney: N/A

5/8, 5/15, 5/22

Estate: William Edward Bright
Date of Death: 04/03/2019
Case #2019ES3900336
Personal Representative:
Susan D. Bright
114 Gladiola Lane
Pickens, SC 29671
Attorney: N/A

5/15, 5/22, 5/29

Estate: Marie White Davis
Date of Death: 04/09/2019
Case #2019ES3900295
Personal Representative:
Ellis Davis, Jr.
282 Old Dacusville Rd.
Easley, SC 29640
Attorney: N/A

5/15, 5/22, 5/29

Estate: Lucy Alice K. Dubuc
Date of Death: 03/29/2019
Case #2019ES3900265
Personal Representative:
Gerald J. Dubuc
133 Upper Springs Rd.
Pickens, SC 29671
Attorney: N/A

5/1, 5/8, 5/15

Estate: Julius Lenere Harris
Date of Death: 04/03/2019
Case #2019ES3900334
Personal Representative:
Wanda Harris
101 Forest Park Drive
Easley, SC 29642
Attorney: N/A

5/15, 5/22, 5/29

Legal Notices / Notices To Creditors

Estate: Wade Hampton Law, Jr.
Date of Death: 03/14/2019
Case #2019ES3900298
Personal Representative:
Elizabeth H. Law
416 Fond Du Lac Drive
Central, SC 29630
Attorney: N/A

5/8, 5/15, 5/22

Estate: Frances Elizabeth Duncan Mahaffey
Date of Death: 04/15/2019
Case #2019ES3900310
Personal Representative:
Billy Vernon Mahaffey
475 Singing Pines Road
Seneca, SC 29678
Attorney: N/A

5/15, 5/22, 5/29

Estate: Frances Lou Ellen Manley
Date of Death: 03/18/2019
Case #2019ES3900268
Personal Representative:
Janice Baxter
192 Grove Road
Pickens, SC 29671
Attorney: N/A

5/1, 5/8, 5/15

Estate: Patricia Whitfield Morrison
Date of Death: 03/06/2019
Case #2019ES3900307
Personal Representative:
Clint Morrison
3 Ardmore Drive
Taylors, SC 29687
Attorney: N/A

5/1, 5/8, 5/15

Estate: Lois Virginia Nicholson Smith
Date of Death: 03/18/2019
Case #2019ES3900288
Personal Representative:
Minnie Lee Hunter
186 Sunny Lane
Pickens, SC 29671
Attorney: N/A

5/8, 5/15, 5/22

Estate: Ruby Evatt Smith AKA Ruby Lee Evette Smith
Date of Death: 10/29/2018
Case #2018ES3900811-2
Personal Representative:
Gayla S. Smith
204 Yates Road
Liberty, SC 29657
Attorney: N/A

5/1, 5/8, 5/15

Estate: Keith David Stewart
Date of Death: 04/01/2019
Case #2019ES3900287
Personal Representative:
Paula S. Welborn
120 Bentwood Lane
Pickens, SC 29671
Attorney: N/A

5/1, 5/8, 5/15

Estate: Susan Carol Waldrop
Date of Death: 01/10/2019
Case #2019ES3900195
Personal Representative:
Steven M. Merck
400 Mills Ave., #228
Greenville, SC 29605
Attorney: N/A

5/1, 5/8, 5/15

Estate: Raymond Ray Williams
Date of Death: 11/29/2018
Case #2019ES3900319
Personal Representative:
Barbara L. Williams
Address: 1846 Brannen Rd., SE
Atlanta, GA 30316
Attorney: M. Ed McLaurin
Address: 10 Commons Blvd.
Seneca, SC 29678

5/8, 5/15, 5/22

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Maintenance Worker at Clemson University's Youth Learning Institute in Pickens. 40 hours/week. $12/hour. To apply, send resume to **ceharpe@clemson.edu**

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LARGE ESTATE SALE: Fri. & Sat., May 17 & 18 @ 163 Jewel St., Pickens below Pickens Middle School. 8 am Until. Rain or Shine.

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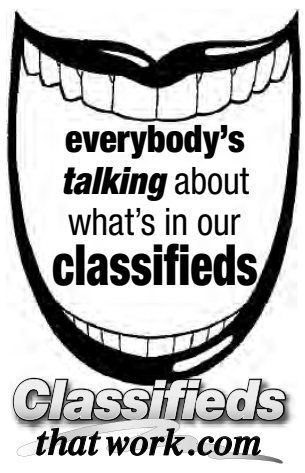

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The U.S. Environmental Protection Agency, Region 4 Announces a Five-Year Review for the Sangamo Weston/Twelve Mile Creek/ Lake Hartwell PCB Contamination Superfund Site Pickens County, South Carolina

Purpose/Objective: The U.S. Environmental Protection Agency (EPA) and South Carolina Department of Health and Environmental Control (SCDHEC) are conducting a Five-Year Review of the remedy for the Sangamo Weston/Twelvemile Creek/Lake Hartwell PCB Contamination (Site) in Pickens County, South Carolina. The purpose of the Five-Year Review is to make sure the selected cleanup actions effectively protect human health and the environment.

Site Background: Sangamo Weston owned and operated the 220-acre capacitor manufacturing plant (Plant Site) in Pickens County, South Carolina from 1955 to 1987. A variety of dielectric fluids containing PCBs were used for manufacturing capacitors until 1977. Chlorinated solvents, primarily tetrachloroethene (PCE) and trichloroethene (TCE), were used as degreasing agents during the operation. Off-specification capacitors and wastewater treatment sludge were disposed of at several locations onthe Plant Site and at six remote sites located off the property (Nix, Dodgens, Welborn, Cross Roads, Trotter, and Breazeale Sites).

Cleanup Actions: To expedite the investigation and response activities, the overall site was divided into two separate Operable Units (OUs). OU1 of the Sangamo site addressed the land-based PCB source areas, including the former Plant site and six satellite disposal areas. Soils impacted by PCBs were excavated from the disposal areas and stockpiled at the Plant Site for treatment. From December 1995 through May 1997, approximately 60,000 tons of soil were treated via thermal desorption and backfilled on the Plant Site. Active groundwater recovery and treatment was initiated at the Plant Site in November 1998. The Plant Site groundwater recovery system has recovered more than 400 million gallons of groundwater and removed an estimated 2,180 pounds of chlorinated solvents and 34 pounds of PCBs. The treatment system was completely refurbished in 2013 with various upgrades and maintenance occurring as needed. In early 2017, approximately 16,700 tons of soil containing residual source material was excavated and transported off-site for proper disposal. This supplemental work resulted in the removal of approximately 6,541 pounds of PCB mass. Additional technologies have been implemented at the Site to facilitate groundwater remediation. The Breazeale Site water treatment system recovered an estimated 116 million gallons prior to shut-down in 2009 and decommissioning in 2014.

OU2 of the Sangamo site addressed the sediment, surface water, and biological migration pathways downstream from the land-based source areas. A fish consumption advisory on Lake Hartwell was first issued in 1976 and has been modified many times since to provide meal advice to anglers based on PCB trends in fish tissue. Impacted surface sediments in the Twelve Mile Creek Arm of Lake Hartwell are being addressed by natural burial processes referred to as Monitored Natural Recovery.

Five-Year Review Schedule: The National Contingency Plan requires review of remedial actions that result in any hazardous substances, pollutants or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure every five years to ensure the protection of human health and the environment. EPA and SCDHEC anticipate that the fourth Five-Year Review for the Sangamo site will be completed in September 2019.

EPA Invites Community Participation in the Five-Year Review Process: EPA is conducting this Five-Year Review to evaluate the effectiveness of the Site's remedy and to make sure the remedy remains protective of human health and the environment. As part of the Five-Year Review process, EPA and SCDHEC staff are available to answer any questions about the Site. Community members who have questions about the Site or the Five-Year Review process, or who would like to participate in a community interview, are asked to contact:

Craig Zeller, P.E.
EPA Region 4
Superfund Division
61 Forsyth Street
Atlanta, GA 30303
Phone: (404) 562-8827
Email: zeller.craig@epa.gov

Joel Padgett, P.G.
SCDHEC
Bureau of Land & Waste Management
2600 Bull Street
Columbia, SC 29201
Phone: (803) 898-0910
Email: padgetjp@dhec.sc.gov

Additional site information is available at the Site's local document repository, located at Pickens County Public Library, 304 Biltmore Road, Easley, SC 29640, (864) 850-7077 and RM Cooper Library, Clemson University, Clemson, SC 29634, (864) 656-3027 and online at https://www.epa.gov/superfund/sangamo-twelve-mile-creek

NOTICE OF PUBLIC HEARING
STATE OF SOUTH CAROLINA
COUNTY OF PICKENS
BEFORE THE PICKENS COUNTY COUNCIL

Notice is hereby given that, pursuant to law, the following Public Hearings will be held in the Auditorium, Pickens County Administration Facility, 222 McDaniel Avenue, Pickens, South Carolina, commencing at 6:30P.M.on **Monday June 3rd, 2019** on the following matters:

- TO PROVIDE FOR ADOPTION OF A BUDGET AMENDMENT CONTAINING ESTIMATES OF REVENUE AND EXPENDITURE CHANGES FOR PICKENS COUNTY FOR THE FISCAL YEAR BEGINNING JULY 1, 2018 AND ENDING JUNE 30, 2019.
- FY 2019-2020 BUDGET ORDINANCE NO. 569 FOR THE COUNTY OF PICKENS, SOUTH CAROLINA. THE FOLLOWING BUDGET IS PROPOSED:

Notice is hereby given that, pursuant to law, a hearing will be held in the Auditorium, Pickens County Administration Facility, 222 McDaniel Avenue, Pickens, SC, commencing at 6:30 p.m. on Monday, June 3rd, 2019 on the following matter:
FY 2019-2020 Budget Ordinance No. 569 for the County of Pickens, South Carolina. The following budget is proposed:

	Current Year 2018-2019		Proposed Year 2019-2020		%
	Expenditures	Revenues	Expenditures	Revenues	Change
General Fund	$43,066,050	$43,066,050	$46,805,229	$46,805,229	8.7
Debt Service Fund	3,995,775	3,995,775	2,907,457	2,907,457	(27.2)
Tri-County Tech	1,585,100	1,585,100	1,579,900	1,579,900	(0.3)
Fixed Nuclear Fund	110,516	110,516	109,320	109,320	(1.1)
Library	3,416,131	3,416,131	3,616,856	3,616,856	5.9
Victim Advocate	105,234	105,234	107,219	107,219	1.9
Emergency Phone	920,714	920,714	829,686	829,686	(9.9)
Fire Districts	5,715,628	5,715,628	7,551,332	7,551,332	32.1
State Accommodation Tax	61,750	61,750	152,000	152,000	146.2
Tourism Fund	113,597	113,597	-0-	-0-	(100.0)
Local Accommodation Tax	200,000	200,000	220,102	220,102	10.1
Vehicle Road Fee	2,100,000	2,100,000	2,150,000	2,150,000	2.4
Recreation	300,000	300,000	419,261	419,261	39.8
Prison Fund	2,400	2,400	2,400	2,400	0.0
Pickens Alliance	513,405	13,405	465,116	465,116	(9.4)
Public Service Commission	1,769,220	1,769,220	1,755,562	1,755,562	(0.8)
Airport	673,349	673,349	1,520,094	1,520,094	125.8
Totals	**$ 64,648,869**	**$ 64,648,869**	**$ 70,191,534**	**$70,191,534**	**8.6**

Millage

	Current Year:	Proposed Year	Value:
General Fund	55.8 Mils	55.8 Mils	$514,432
Tri-County Tech	2.6	2.6	522,891
Bonds	3.5	3.4	514,432
Library	6.3	6.3	522,891
County Sewer	2.0	1.5	302,094
Vineyards Fire District	51.1	50.4	16,982
Shady Grove Fire District	15.6	15.6	39,360
Springs Fire District	53.4	41.4	15,608

Members of the general public are invited to attend the public hearing. It is requested that those desiring to be heard concerning these matters advise the Clerk to Council in writing at 222 McDaniel Ave. B-1, Pickens SC 29671. Such requests should be received by the Clerk to Council on or before June 3rd, 2019.

Roy Costner, Chairman

Appendix E - Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	Operable Unit One (OU1)

Photo No.	Date
1	9-20-2018

Description
Plant Site
Wastewater Treatment Plant (WWTP) Building

Photo No.	Date
2	9-20-2018

Description
Plant Site
WWTP Interior

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU1

Photo No.	Date
3	9-20-2018

Description
Plant Site
WWTP Equalization Basin and Aeration System

Photo No.	Date
4	9-20-2018

Description
Plant Site
Area 5 Pumphouse and Sump

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU1

Photo No.	Date
5	9-20-2018

Description
Plant Site
Area 2 – Mid-plume Air Sparge System

Photo No.	Date
6	9-20-2018

Description
Plant Site
Area 2 – Mid-plume Air Sparge System Manifold

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU1

Photo No.	Date
7	9-20-2018

Description
Plant Site
Area 2 - Property boundary
Air Sparge System

Photo No.	Date
8	9-20-2018

Description
Plant Site
Area 2 – Air Sparge Well Surface Completions

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU1

Photo No.	Date
9	9-20-2018

Description
Plant Site
Area 3 – Solar Array for Subgrade Biogeochemical Reactor (SBGR) System

Photo No.	Date
10	9-20-2018

Description
Plant Site
Area 3 – SBGR Reactor Vessel Inspection Ports

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU1

Photo No.	Date
11	9-20-2018

Description
Plant Site
Area 2 – Compressor Building (Former Surge Tank Building)

Photo No.	Date
12	9-20-2018

Description
Plant Site
Area H – Current Condition

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU1

Photo No.	Date
13	9-20-2018

Description
Plant Site
Area D – Post Excavation, Looking North

Photo No.	Date
14	9-20-2018

Description
Breazeale Site
Exterior of Decommissioned WWTP Building

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU1

Photo No.	Date
15	9-20-2018

Crossroads Site
Site Entrance

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	Operable Unit Two (OU2)

Photo No.	Date
1	9-20-2018

Description
Twelve Mile Creek (OU2) Sediment Management Unit (SMU) View of east side of the SMU looking north

Photo No.	Date
2	9-20-2018

Description
Twelve Mile Creek (OU2) SMU View of the upper section of the SMU looking southwest

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU2

Photo No.	Date
3	9-20-2018

Description
Twelve Mile Creek (OU2) SMU
View of the SMU looking north

Photo No.	Date
4	9-20-2018

Description
Twelve Mile Recreational Area Boat Launch/Ramp, Lake Hartwell (OU2)
Posted health advisory sign for fish consumption

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU2

Photo No.	Date
5	9-20-2018

Description
Twelve Mile Creek (OU2)
From the Whitfield's property looking upstream across Twelve Mile Creek

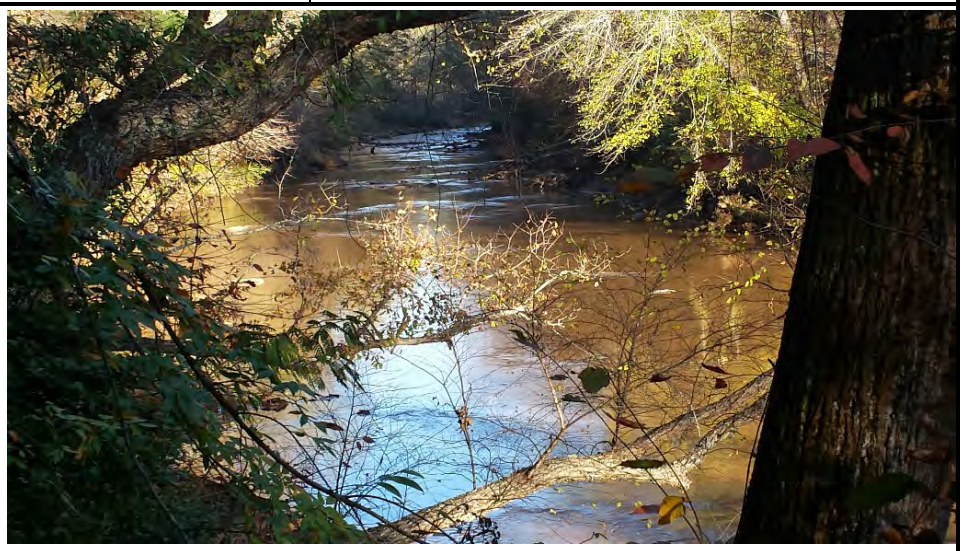
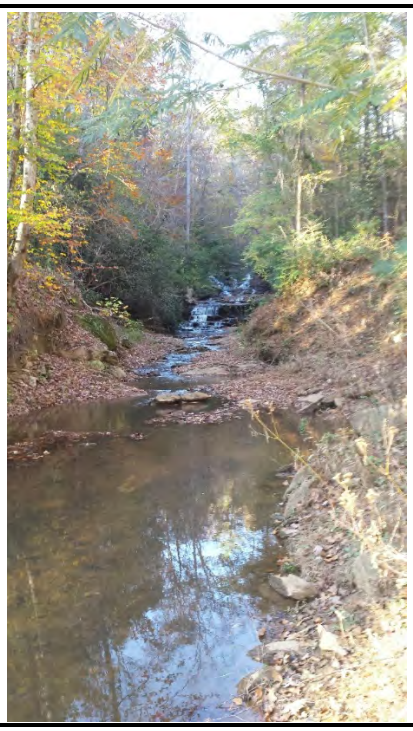


Photo No.	Date
6	9-20-2018

Description
Twelve Mile Creek (OU2)
Camp Creek – Side wall revegetation (1)



Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU2

Photo No.	Date
7	9-20-2018

Description
Twelve Mile Creek (OU2)
Camp Creek – Side wall revegetation (2)

Photo No.	Date
8	9-20-2018

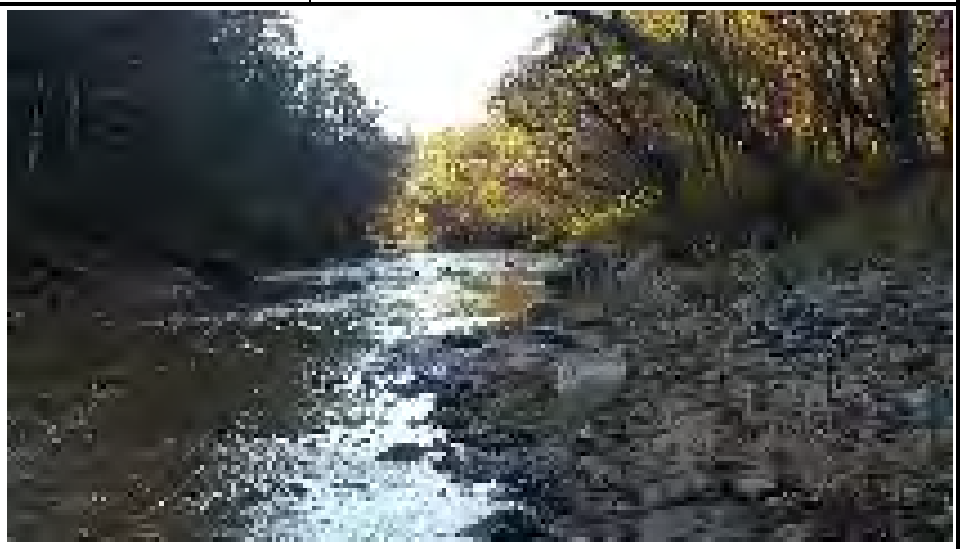
Description
Twelve Mile Creek (OU2)
Balls Beach – From Ball's Beach looking upstream

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU2

Photo No.	Date
9	9-20-2018

Description
Twelve Mile Creek (OU2)
Balls Beach – From Ball's Beach looking down stream



Client Name:	Site Location:
Schlumberger Technology Corporation	OU2

Photo No.	Date
10	9-20-2018

Description
Historic location of Woodside I Dam

Photographic Log

Client Name:	Site Location:
Schlumberger Technology Corporation	OU2

Photo No.	Date
11	9-20-2018

Description
Historic location of Woodside II Dam