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Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit

April 2018 through April 2019 (U)

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LIST OF ABBREVIATIONS AND ACRONYMS

~	approximate, approximately
ac	acre
ARP	A-Area Miscellaneous Rubble Pile
ASVE	active soil vapor extraction
CMI/RAIP	Corrective Measures Implementation/Remedial Action Implementation Plan
ft	feet, foot
ha	hectare
IC	institutional controls
kg	kilogram
lb.	pound
µg/L	microgram per liter
m	meter
mg/kg	milligram per kilogram
OOS	Out of Service
OU	operable unit
PCB/PAH	polychlorinated biphenyl/polycyclic aromatic hydrocarbon
PCE	tetrachloroethylene
PCR	Post-Construction Report
PER	Performance Evaluation Report
ppmv	parts per million by volume
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RG	remedial goal
SCDHEC	South Carolina Department of Health and Environmental Control
scfm	standard cubic feet per minute
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SVE	soil vapor extraction
SVEU	soil vapor extraction unit
TCE	Trichloroethylene
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VEW	vapor extraction well
VMW	vapor monitoring well
VOC	volatile organic compound
WSRC	Westinghouse Savannah River Company LLC

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1.0 INTRODUCTION

The A-Area Miscellaneous Rubble Pile (ARP) (731-6A) Operable Unit (OU) is listed as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit/Comprehensive Environmental Response, Compensation, and Liability Act Unit in Appendix C of the Federal Facility Agreement for the Savannah River Site (SRS).

The ARP OU is located in the northwest part of the SRS within A Area and immediately east of M Area. It is approximately (~) 1.8 kilometers (1.1 miles) from the nearest site boundary (Figure A1). The unit covers ~1.35 hectares (ha [5.8 acres {ac}]) and is bounded on the southwest and southeast by outfall drainages that coalesce on the south side of the unit (Figure A2).

The ARP OU has been divided into three subunits: the Piles Area, the Ash Area, and the Trenches Area (Figure A2). The Piles Area (~0.93 ha [2.3 ac]) contains many small mounds (0.61- to 1.52-meter (m [2- to 5-feet {ft}] high) of construction debris that were disposed of directly on the ground surface. The Ash Area (~0.73 ha [1.8 ac]) contains buried construction debris and an ash layer of ~1.22 m (4 ft). The Trenches Area (~0.65 ha [1.6 ac]) contains construction debris in a 2.44- to 3.66-m (8- to 12-ft) deep T-shaped trench. A detailed facility description is provided in the *Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation Report Work Plan Addendum for the A-Area Miscellaneous Rubble Pile (731-6A)* (WSRC 1998).

The purpose of this Performance Evaluation Report (PER) is to provide formal evaluation of collected operating data for the passive soil vapor extraction (SVE) system at the Trenches Area of the ARP OU through April 30, 2019. This report includes a summary of the operational data collected for the reporting period April 2018 through April 2019. An evaluation of other components of the ARP OU remedy is discussed in Section 2.0.

2.0 REMEDIAL ACTIONS

The Remedial Action Objectives (RAOs) for each of the three ARP OU subunits as documented in the *Record of Decision Remedial Alternative Selection for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit* (WSRC 2003a) are listed below:

RAOs for the Piles Area:

- to protect the future industrial worker from exposure to arsenic and lead in the lead hot spot above their respective remedial goals (RGs) of 4.4 mg/kg and 400 mg/kg; and
- to protect the future industrial worker or resident from exposure to aroclor-1254 and benzo(a)pyrene in the polychlorinated biphenyl/polycyclic aromatic hydrocarbon (PCB/PAH) waste pile above their respective RGs of 1 mg/kg and 0.052 mg/kg.

RAO for the Ash Area:

- to protect the future industrial worker from exposure to elevated levels of arsenic in the surface soil above the RG of 4.4 mg/kg.

RAOs for the Trenches Area:

- to protect the future industrial worker from exposure to arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene and dibenzo(a,h)anthracene in the soil above their respective RGs of 4.4 mg/kg, 2.56 mg/kg, 0.256 mg/kg, 2.56 mg/kg, and 0.256 mg/kg; and
- to prevent leaching of trichloroethylene (TCE) and tetrachloroethylene (PCE) to groundwater above their respective maximum contaminant level of 5 µg/L (soil RGs for TCE and PCE are 0.0877 and 0.656 mg/kg, respectively).

The remedial actions (RA) taken for each of the three ARP OU subunits are described below:

- Piles Area – The hot spot removal final action has been successfully completed. Confirmatory sampling of the PCB/PAH and the lead hot spots conducted in accordance with the Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP) (WSRC 2003b) verified removal of contaminants and demonstrated that the RGs had been achieved. Confirmatory sampling results are provided in the Post-Construction Report (PCR) (WSRC 2004). Refer to Section 4.1 and Table B-5 and Table B-6 of the PCR.
- Ash Area – The RA for the Ash Area, as detailed in the CMI/RAIP (WSRC 2003b) and PCR (WSRC 2004), is institutional controls (ICs). The ICs final action is ongoing. ICs were

implemented at the Ash Area and include the installation of access control warning signs around the contaminated area.

- Trenches Area – The final action consists of three components: the 0.3-m (1-ft) soil cover, an active SVE (ASVE) system, and ICs. The soil cover was installed between October and December 2003. Operation of the ASVE system commenced on April 26, 2004. The ASVE system transitioned to passive SVE on March 14, 2017. This report evaluates the effectiveness of the SVE RA at this subunit, found in Section 3.0 of this report.

Annual inspections are conducted at the ARP OU to verify that ICs are in place and to ensure that no deficiencies exist with the integrity of the soil cover at the Trenches Area subunit. The evaluation of the ICs and the soil cover are recorded on a Field Inspection Checklist, documented in the Five-Year Remedy Review Reports, and summarized below.

The ARP OU was inspected on January 16, 2019 (SRNS 2019). The ARP OU inspection confirmed that ICs were in place. However, active ant mounds were observed on the Trenches Area soil cover. Pesticide was applied to the active ant mounds on the day of the inspection. Standing dead pine trees and trail vegetation were noted on the day of inspection. The dead pine trees and the trail vegetation were removed on January 29, 2019. One waste unit sign had been damaged by a fallen tree. The waste unit sign was replaced on February 8, 2019.

2.1 ARP OU Trenches Area

Seven (7) ASVE wells (AMP001 vapor extraction well [VEW] through AMP007VEW) and twelve (12) vapor monitoring wells (VMW [AMP001VMW through AMP012VMW]) were installed in the ARP OU Trenches Area in February 2004. Full-scale operations began on April 26, 2004.

The 782-3M soil vapor extraction unit (SVEU) provided vacuum for the ARP SVE wells and for several other wells at the A-014 Outfall (RCRA remediation). The air flow from the ARP header was typically around 100 standard cubic feet per minute (scfm).

In June 2014, the United States Environmental Protection Agency (USEPA), South Carolina Department of Health and Environmental Control (SCDHEC), and United States Department of Energy agreed to transition to passive SVE due to a lack of a downward trend in volatile organic compound (VOC) concentrations, diffusion limitations observed in the data for ~8 years, slow mass removal, and the cost and maintenance required to operate an ASVE system with limited benefit.

SRS transitioned from ASVE to passive SVE by disconnecting the seven (7) SVE wells from the 782-3M SVEU on March 14, 2017. MicroBlowers™ with BaroBalls™ were placed on these wells. Furthermore, the twelve (12) VMWs (previously used to measure vacuum) were also converted to a less energy intensive passive system with MicroBlowers™ and BaroBalls™ (Figure A3). The use of all nineteen (19) existing wells for passive extraction ensures the effectiveness of a passive remedy with respect to vacuum coverage and monitoring. The nineteen (19) passive SVE wells began operating on June 14, 2017. The nineteen (19) passive SVE wells are sampled annually and reported in the annual ARP OU PER. A typical passive SVE well is shown in Figure A4.

The data collected for the reporting period April 2018 through April 2019 includes the pressure, flow rate, and concentration from the nineteen (19) VEWs. These data are sufficient to estimate the VOC mass removed. This report includes a summary of the operational data collected from April 2018 through April 2019.

2.2 Operational Sampling Results

2.2.1 Compliance Monitoring

In accordance with South Carolina Regulation 61-612.70.7(e)(5), a permitted facility is authorized to make changes within their facility without requiring a permit revision if the changes do not exceed the emissions allowable under the permit. In January 2017, the SRS submitted an operational flexibility request to SCDHEC to add the (19) passive VEWs to the Insignificant Activities list for the Title V Air Permit. Insignificant Activity generally means any air emissions or air emissions unit that has the potential to emit less than five tons per year of any criteria

pollutant. Emission data obtained from the nineteen (19) VEWs will continue to be reported to document compliance with the air discharge permit conditions contained in the Title V Air Permit (SCDHEC 2007).

2.2.2 Performance Monitoring

Performance monitoring samples are scheduled annually in accordance with sampling of SRS passive SVE systems. The performance monitoring objective is to measure system performance with respect to the rate of TCE and PCE reduction in the vadose zone. Performance monitoring is being used to establish total system capability, track the ARP OU emissions, and determine the overall effectiveness of the system. Data (PCE and TCE concentrations and flow rates) are collected (as listed in Table B1) at the nineteen (19) VEWs.

Performance monitoring data are tabulated in Table B2 and Table B3.

This data set was used to estimate the mass removed and the cumulative mass removed as depicted in Figures A5 and A6, respectively. These data points are estimations of removal since monitoring is performed annually, and with respect to data, are variable.

The mass removal calculations were conducted in a manner similar to that used in a study of SVE and air sparging (Holbrook et al. 1998) in which soil gas concentrations were converted to mass removal rates using the volumetric flow rate and the Ideal Gas Law. The generalized equation used for mass removal is as follows:

(Equation 1)

$$\mathbf{M = Q \times C \times MW \times T}$$

where:

M	=	cumulative mass removed (lb.)	MW	=	molecular weight (grams/mole)
Q	=	extraction flow rate (cfm)	T	=	operational period (hr)
C	=	vapor concentration (ppmv)			

$$M = Q \cdot \left(C \cdot \frac{1\,ft^3}{10^6 \cdot ft^3} \right) \cdot MW \cdot \left(\frac{mole}{24.466 \cdot liter} \cdot \frac{28.3 \cdot liter}{ft^3} \cdot \frac{lb}{453.592 \cdot gm} \cdot \frac{60 \cdot min}{hr} \right) \cdot T$$

As indicated in Figures A5 and A6, from April 2004 through April 2017, the active SVEU removed an estimated mass of ~64.3 kg (142 lbs) of VOCs. From April 2018 through April 2019, the passive SVE systems removed an estimated mass of ~2.1 kg (4.6 lbs) of VOCs. The passive SVE systems have removed an estimated mass of ~3.7 kg (8.2 lbs) of VOCs since beginning operations in June 2017.

The performance monitoring data indicates that the passive SVE system functioned adequately for the conditions and met air compliance objectives.

2.2.3 Process Monitoring

Process monitoring is performed to allow an understanding of the response behavior of the system and to evaluate the system's operational performance. Process monitoring is performed to determine if settings are appropriate or if modifications should be made to allow more efficient operation. The process monitoring at the ARP OU Trenches Area during this reporting period included pressure and flow rate.

The process data (Tables B2 and B3) indicate that the zone of influence reached the target area under the operational scheme. This is evidenced by the vacuum distribution (Table B2) in the extraction wells, which covered the entire trench. The vacuum distribution across the entire treatment area remained fairly uniform. VOC emissions were variable but contributed to source removal in the area.

2.2.4 Updated Contaminant Migration Model

In accordance with the approved *Sampling and Analysis Plan for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)* (SRNS 2015), additional characterization of the ash layer and vadose zone soils located beneath the Trenches Area soil cover was conducted in July 2018 to evaluate if the VOCs are partitioned in the hydraulic/cutting oils and to provide information on the remaining VOC concentration in soil and ash. A PCR Addendum was submitted in October 2018 to document the change in the power source from active to passive SVE and included the July 2018 soil and ash characterization data (SRNS 2018a).

In 2019, the nearly 20-year old fate and transport model for the ARP OU was updated using the 2018 characterization data. Refinement of the fate and transport model included the consideration of three primary factors. First, active and passive SVE have removed VOC mass and reduced PCE and TCE concentrations in the vadose zone. Second, the updated fate and transport modeling includes a greater level of discretization (five layers instead of two) based on lithology characterization and incorporates site specific data that account for thin layers of low hydraulic conductivity material. The increased numerical detail and stratigraphy result in longer travel times and increased attenuation of constituents. Third, a lower water table elevation is appropriate based on more recent water table data, creating a greater vadose zone transport distance resulting in longer travel times and increased attenuation of contaminants.

These factors were considered in the updated fate and transport model and documented in the *Contaminant Migration Model for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)* (SRNS 2018b). The results of the fate and transport model indicate that residual PCE and TCE contamination beneath the Trenches Area soil cover no longer pose a contaminant migration concern.

3.0 CONCLUSIONS/RECOMMENDATIONS

The ARP OU passive SVE system removed ~2.1 kilograms (kg [4.6 pounds {lbs}]) of contaminant VOC mass during this reporting period (April 2018 to April 2019). Vacuum levels at the monitoring wells indicate that the subunit was adequately influenced by the extraction well network. The SVE concentrations are very low and have been steady for years, indicative of diffusion limitations in the contaminated soil/subsurface media.

The fate and transport model for the ARP OU was updated in 2019 and the results reported in the *Contaminant Migration Model for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)* (SRNS 2018b). The updated model indicates that TCE and PCE at the ARP OU Trenches Area no longer pose a threat to human health and the environment. Three primary factors have changed since the original modeling was performed nearly 20 years ago that lead to this result. First, active and passive SVE have removed mass and reduced concentrations in the vadose zone.

Second, the modeling performed includes a greater level of discretization (five layers instead of two) and incorporates site specific data that account for thin layers of low hydraulic conductivity material. The greater level of numerical detail and stratigraphic consideration results in longer travel times and increase attenuation of constituents. Third, recent site data indicate that the water table occurs at a greater depth of approximately 123.5 ft, which results in a larger thickness and longer travel times within the unsaturated zone. This provides additional protection for groundwater because of the increased time for natural attenuation of COCs to occur prior to reaching the water table. The updated contaminant migration model is submitted concurrently with this PER.

Based on the reported results of this PER, the revised conceptual model, and the 2019 fate and transport model conclusions, SRNS recommends that the RGs for TCE and PCE can be revised to reflect current conditions and recent vadose zone fate and transport modeling. A Core Team meeting is recommended for the Fall 2019 timeframe to discuss the information in this PER, the revised fate and transport model, and the updated RGs. Upon agreement from the USEPA and SCDHEC, a path forward on the appropriate administrative vehicle to document these changes, and if appropriate, discontinued operation of the passive SVE system will be enacted.

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WSRC, 2004. *Post-Construction Report (PCR) for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)*, WSRC-RP-2004-4088, Revision 1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

APPENDIX A

FIGURES

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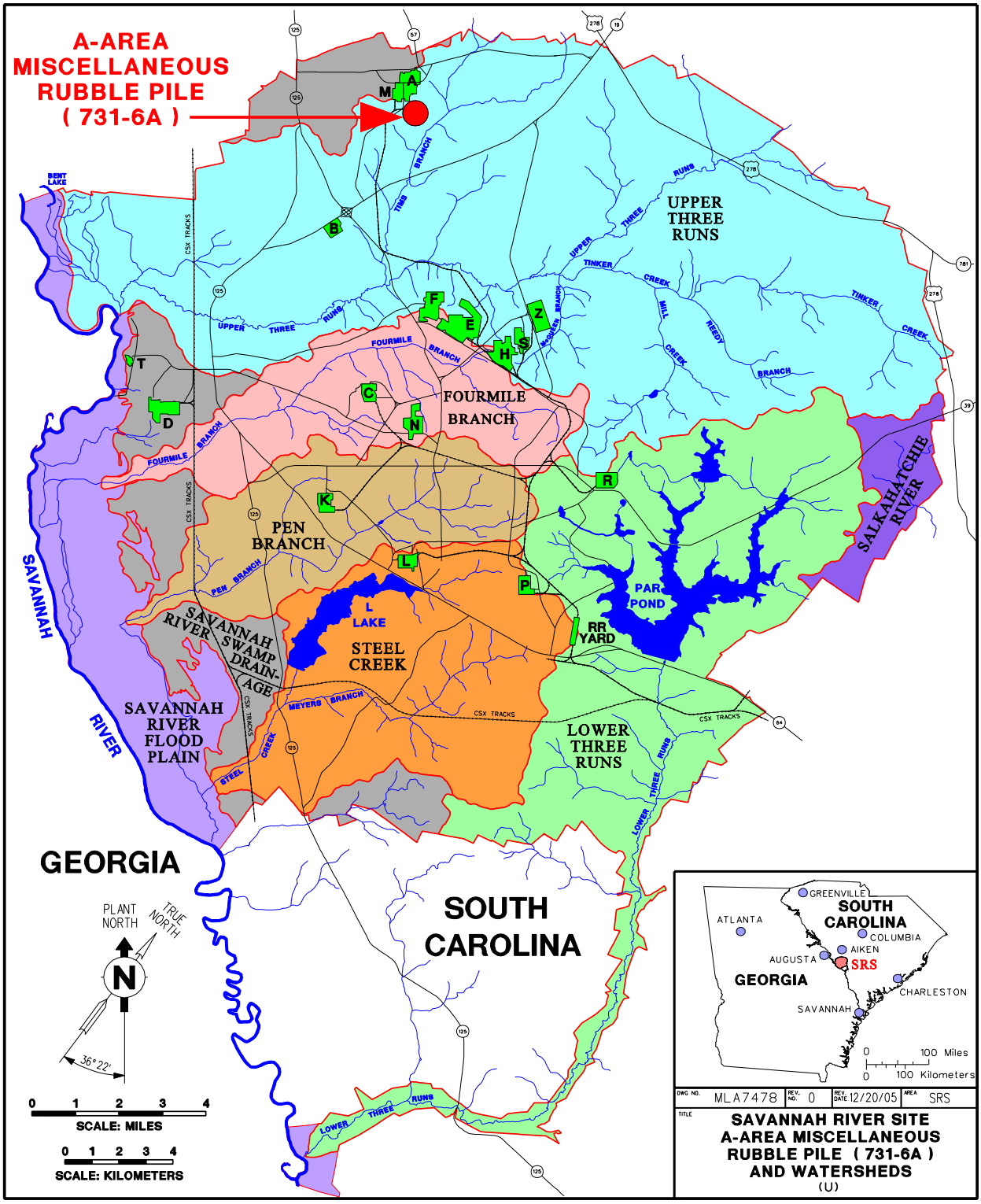

Figure A1. Location of the ARP OU at SRS

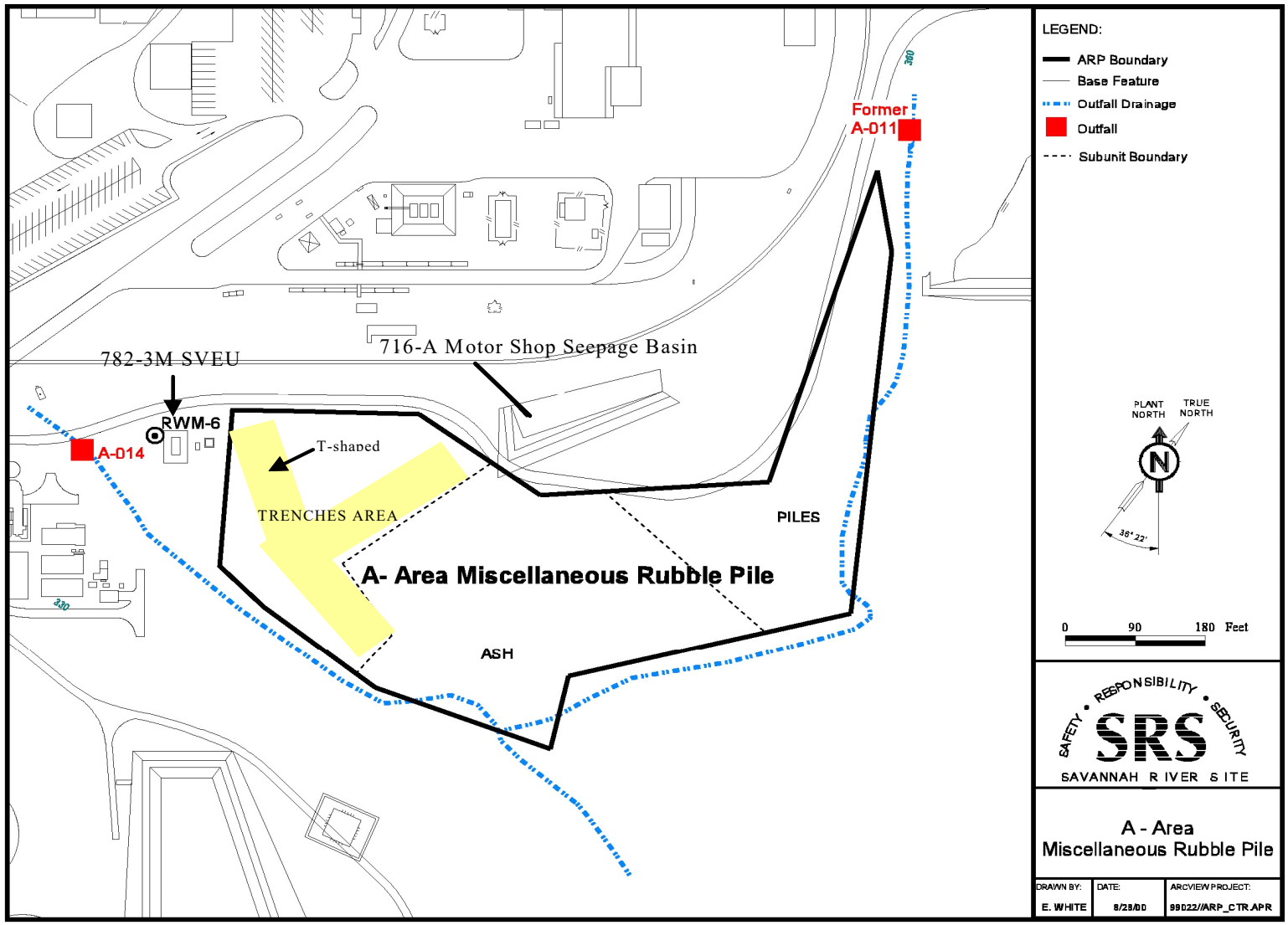

Figure A2. ARP OU (731-6A)

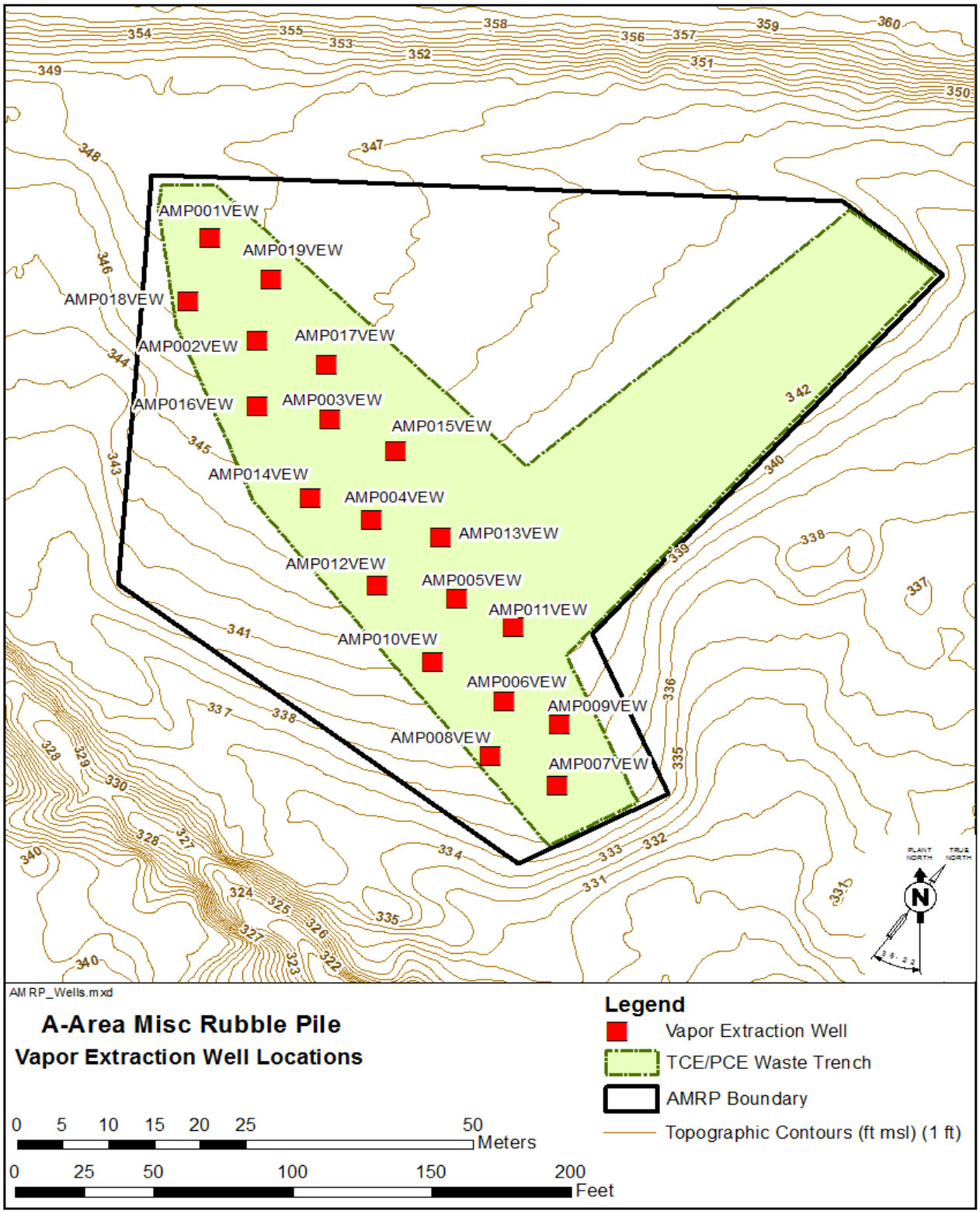

Figure A3. ARP OU Extraction Well Locations

Figure A4. Typical Passive SVE Well

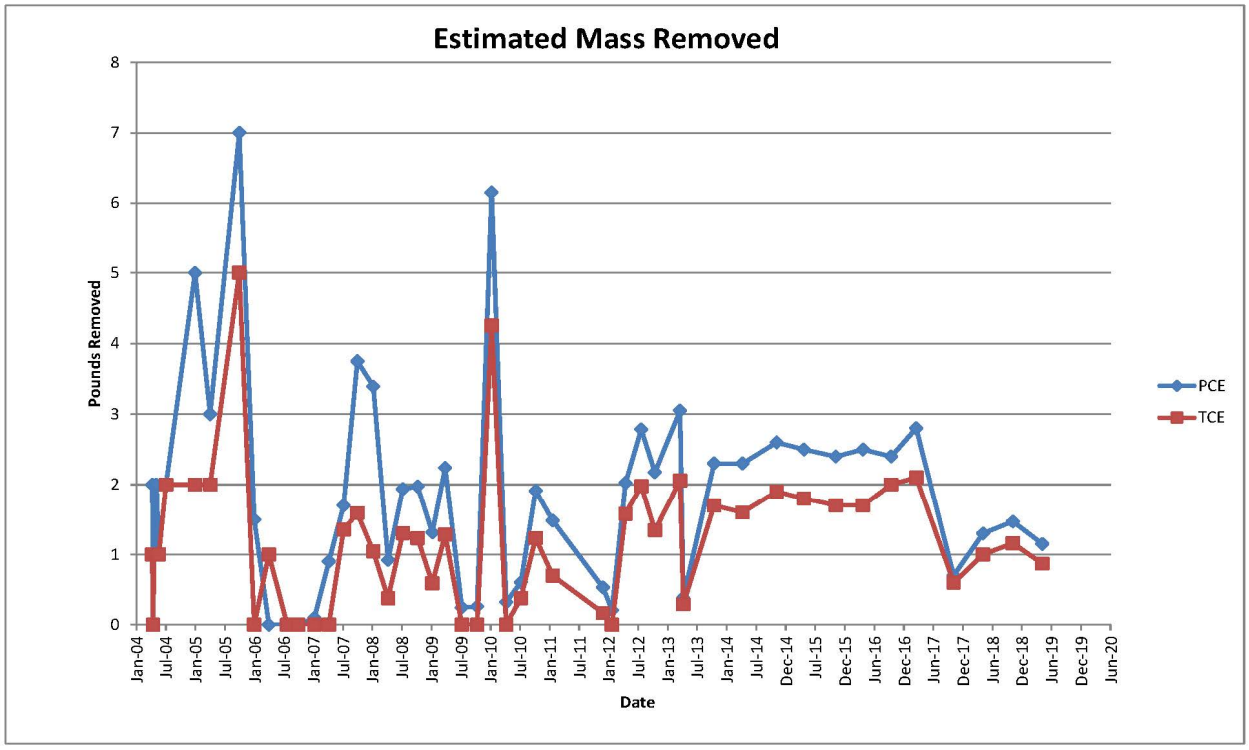

Figure A5. ARP SVE Wells Performance Monitoring – Estimated Mass Removed

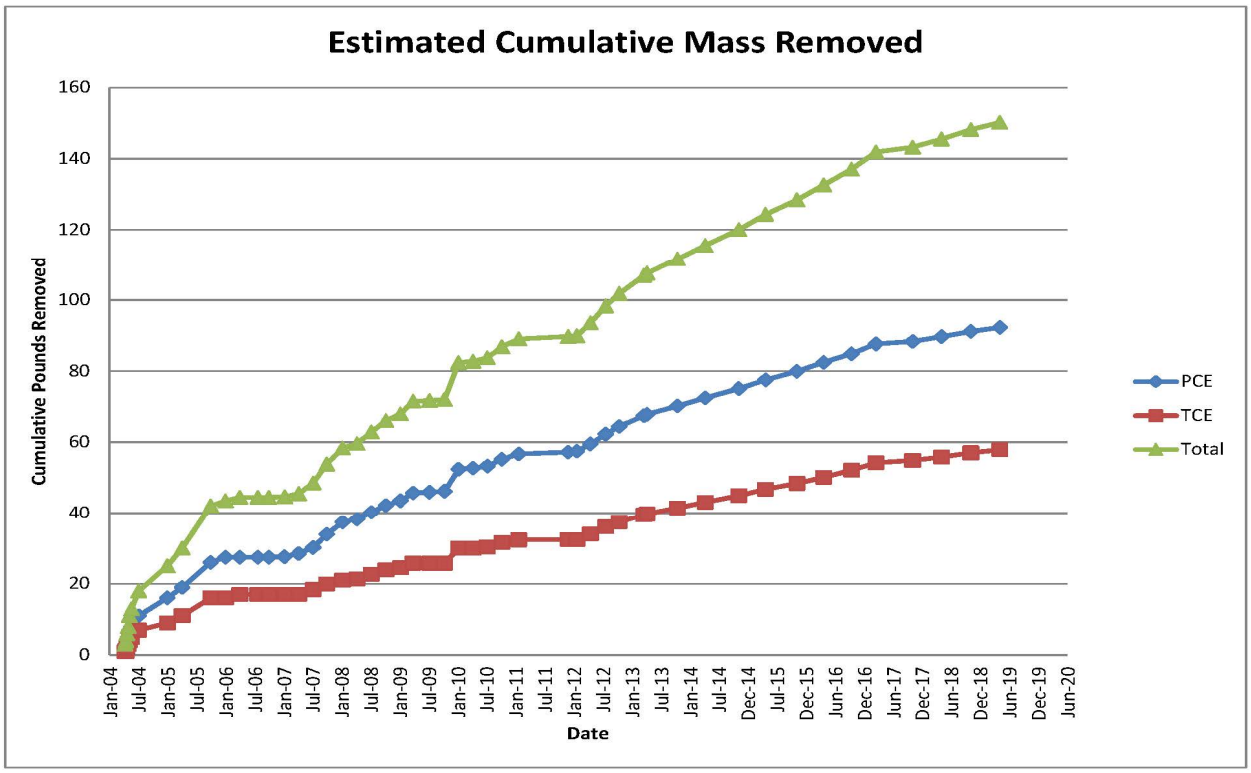

Figure A6. ARP SVE Wells Performance Monitoring – Estimated Cumulative Mass Removed

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APPENDIX B

TABLES

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Table B1. Passive SVE Wells – Monitoring Data

Sample Location	Laboratory GC *(ppmv)*		
	11/27/2018		
	PCE	TCE	Flow *(scfm)*
AMP001VEW	0.158	0.072	7
AMP002VEW	0.041 (J)	0.057	2
AMP003VEW	0.479	0.455	3
AMP004VEW	0.168	0.197	5
AMP005VEW	0.097	0.079	3
AMP006VEW	0.055 (J)	0.050 (J)	2
AMP007VEW	0.108	0.051 (J)	3
AMP008VEW	0.052 (J)	0.042 (J)	4
AMP009VEW	0.028 (U)	0.036 (J)	1
AMP010VEW	0.339	0.225	7
AMP011VEW	0.028 (U)	0.039 (J)	3
AMP012VEW	0.467	0.333	6
AMP013VEW	0.123	0.092	4
AMP014VEW	0.489	0.563	8
AMP015VEW	0.034 (J)	0.053 (J)	6
AMP016VEW	0.294	0.395	6
AMP017VEW	0.384	0.443	3
AMP018VEW	0.066	0.088	9
AMP019VEW	0.028 (U)	0.049 (J)	5

Notes:
GC = Gas Chromatography
J = estimated value
ppmv = part per million by volume
scfm = standard cubic feet per minute
U = non-detect

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Table B2. Passive SVE Wells – Process Monitoring Data – Vacuum

Date	Vacuum *(inches water)*																		
	AMP001VEW	AMP002VEW	AMP003VEW	AMP004VEW	AMP005VEW	AMP006VEW	AMP007VEW	AMP008VEW	AMP009VEW	AMP010VEW	AMP011VEW	AMP012VEW	AMP013VEW	AMP014VEW	AMP015VEW	AMP016VEW	AMP017VEW	AMP018VEW	AMP019VEW
04/16/18	7.5	2.0	6.0	11.0	10.5	12.5	1.0	6.5	2.0	2.5	14.0	3.0	7.5	1.5	9.0	3.0	3.0	4.5	2.0
05/16/18	8.0	1.5	4.5	8.5	4.5	12.0	1.0	5.5	1.0	3.0	14.5	2.5	7.0	2.0	9.0	3.0	2.0	4.0	1.5
06/13/18	6.5	2.0	5.8	8.5	8.5	11.0	1.0	5.5	1.5	3.5	13.0	2.5	6.5	2.0	8.0	2.5	2.0	5.5	1.5
07/09/18	7.0	2.0	6.2	10.0	9.2	12.0	1.0	5.0	1.3	3.8	14.5	2.5	6.5	2.0	8.0	3.0	2.0	5.5	1.5
08/08/18	8.0	1.5	6.0	10.5	8.5	11.5	1.5	6.0	2.0	3.0	14.0	2.5	7.0	OOS	8.5	2.5	1.5	6.0	1.0
09/13/18	7.0	1.5	6.5	10.0	9.5	13.5	1.0	5.0	1.0	3.0	14.0	2.0	6.5	2.0	8.0	2.5	1.5	5.5	1.5
10/23/18	8.5	2.6	6.0	12.7	9.5	12.5	1.0	3.5	1.0	3.5	15.0	3.0	5.5	2.0	7.9	2.6	2.0	5.5	1.0
11/27/18	7.0	4.0	6.5	12.0	10.0	15.0	4.0	5.0	1.5	3.2	15.0	3.0	7.0	3.0	8.5	2.5	3.0	3.5	3.5
12/17/18	OOS	1.5	9.0	11.5	11.0	13.6	6.0	OOS	3.0	3.5	13.5	3.2	9.5	1.8	11.5	2.6	2.2	OOS	1.0
01/23/19	3.0	1.5	6.5	10.5	10.0	12.5	6.5	6.3	2.5	3.0	12.5	2.5	6.5	2.0	6.0	2.5	1.5	4.0	2.5
02/06/19	3.0	3.0	7.5	OOS	11.0	14.5	6.0	6.5	2.0	3.0	15.0	2.5	6.5	3.0	6.5	OOS	2.5	4.5	3.0
03/12/19	3.5	2.5	7.0	14.0	11.5	14.5	1.5	5.5	2.5	3.5	15.0	3.0	7.0	1.5	OOS	2.5	2.0	5.0	2.0
04/24/19	2.5	2.0	2.5	11.0	6.0	13.5	1.0	6.5	1.0	3.0	14.5	2.5	6.5	2.0	5.0	2.5	2.0	2.5	2.0

OOS = Out of Service

Table B3. Passive SVE Wells – Process Monitoring Data – Flow

Date	Flow *(scfm)*																		
	AMP001VEW	AMP002VEW	AMP003VEW	AMP004VEW	AMP005VEW	AMP006VEW	AMP007VEW	AMP008VEW	AMP009VEW	AMP010VEW	AMP011VEW	AMP012VEW	AMP013VEW	AMP014VEW	AMP015VEW	AMP016VEW	AMP017VEW	AMP018VEW	AMP019VEW
04/16/18	5	3	8	9	12	6	4	3	2	6	4	6	10	7	5	8	6	7	6
05/16/18	8	1	7	7	11	6	5	8	1	13	2	13	8	14	9	13	6	11	7
06/13/18	7	2	9	12	6	6	6	10	1	6	7	8	5	8	13	11	3	6	4
07/09/18	7	2	4	12	8	9	5	7	1	8	14	9	10	10	11	9	3	9	4
08/08/18	9	2	10	13	14	11	4	11	1	9	13	13	10	OOS	7	9	3	12	6
09/13/18	5	2	6	9	10	11	2	8	1	7	14	12	8	7	5	8	4	9	6
10/23/18	3	1	4	2	4	3	2	6	1	7	2	8	5	8	6	8	3	7	2
11/27/18	7	2	3	1	3	2	3	4	2	7	3	6	4	8	6	6	3	9	5
12/17/18	OOS	1	4	3	4	2	5	OOS	1	7	2	9	6	9	3	8	2	OOS	5
01/23/19	2	1	4	12	8	13	16	8	1	6	11	6	8	5	6	5	3	7	2
02/06/19	4	1	4	OOS	11	2	6	9	1	6	13	7	11	6	5	OOS	2	9	2
03/12/19	2	2	6	13	12	8	4	9	1	6	5	6	11	9	OOS	7	3	11	3
04/24/19	4	1	4	13	11	8	2	5	1	7	4	10	6	7	6	9	3	2	2

OOS = Out of Service
scfm = standard cubic feet per minute