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June 14, 2018

Mr. Jason Wilson, Chief Governmental Hazardous Waste Branch Land Division
c/o Mrs. Brandi Little
Alabama Department of Environmental Management
1400 Coliseum Blvd
Montgomery, Alabama 36110-2059

Subject: *Second Addendum to Corrective Measures Implementation Plan Former Small Weapons Repair Shop, Parcel 66(7) McClellan, Anniston, Alabama*

Dear Mr. Wilson:

On behalf of McClellan Development Authority (MDA), attached for the Alabama Department of Environmental Management's (ADEM) review is the *Second Addendum to Corrective Measures Implementation Plan Former Small Weapons Repair Shop, Parcel 66(7)*. Also, the MDA would request that this letter constitute an Agreement modification request pursuant to Condition II.J of the Cleanup Agreement with respect to the proposed change to the groundwater sampling program as described in Section 5 of this document upon ADEM's concurrence with this document.

Sincerely,

MATRIX ENVIRONMENTAL SERVICES, LLC

Richard L Satkin

Richard Satkin, P.G.
McClellan Program Manager

cc: Mr. Robin Scott, MDA
Mr. Gerald Hardy, MES
Ms. Lisa Holstein, U.S. Army (one paper copy)
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Second Addendum to Corrective Measures Implementation Plan
Former Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

Prepared for:

McClellan Development Authority
Anniston, Alabama

Prepared by:

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June 2018

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TABLE OF CONTENTS

LIST OF TABLES .... **II**

LIST OF FIGURES .... **II**

LIST OF APPENDICES .... **II**

LIST OF ACRONYMS .... **III**

1.0 INTRODUCTION AND SITE HISTORY **1-1**

1.2 CORRECTIVE MEASURE HISTORY 1-1

2.0 GROUNDWATER QUALITY **2-1**

2.1 IDENTIFICATION OF CONSTITUENTS OF CONCERN 2-1
2.3 HISTORICAL DISTRIBUTION OF COCS 2-1
2.4 CURRENT GROUNDWATER QUALITY 2-2
2.4.1 Summary of Groundwater Analytical Results *2-2*
2.4.2 Concentration Trends Over Time *2-2*
2.4.3 Distribution of Corrective Action COCs in Groundwater *2-2*

3.0 CORRECTIVE ACTION OBJECTIVES AND PERFORMANCE STANDARDS **3-1**

4.0 DESIGN BASIS FOR REVISED REMEDY/CORRECTIVE ACTION **4-1**

4.1 GENERAL BASIS 4-1
4.2 IN-SITU CHEMICAL OXIDATION 4-1

5.0 PERFORMANCE, COMPLIANCE, AND MONITORING PLAN **5-1**

6.0 REFERENCES **6-1**

LIST OF TABLES

1 Groundwater Analytical Results for Corrective Action COCs and Degradation Products
2 Performance Monitoring Program

LIST OF FIGURES

1 Site Location Map
2 Parcel Location Map
3 Volatile Concentrations in Residuum Well PPMP-66-MW02/ PPMP-66-MW02RR
4 Volatile Concentrations in Residuum Well PPMP-66-MW06/ PPMP-66-MW06R
5 Volatile Concentrations in Transition Well PPMP-66-MW23/ PPMP-66-MW23R
6 Volatile Concentrations in Transition Well PPMP-66-MW24/ PPMP-66-MW24R
7 Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, September/October 2010 (Baseline)
8 Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, September/October 2010 (Baseline)
9 Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, May 2017
10 Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, May 2017
11 Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, August 2017
12 Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, August 2017
13 Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, November 2017
14 Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, November 2017
15 Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, February 2018
16 Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, February 2018
17 Proposed Injection Points and Monitoring Well Locations

LIST OF APPENDICES

Appendix A: ISCO Technology Loading Calculations

LIST OF ACRONYMS

1,1-DCE	1,1-dichloroethene
ADEM	Alabama Department of Environmental Management
cis-1,2-DCE	cis-1,2-dichloroethene
CMER	Corrective Measures Effectiveness Report
CMIR	Corrective Measures Implementation Report
COC	Chemical of concern
Draft CMIR	*Draft Corrective Measures Implementation Report, Former Small Weapons Repair Shop, Parcel 66(7)*
Final CMIP	*Final Corrective Measures Implementation Plan, Former Small Weapons Repair Shop, Parcel 66(7)*
Final CMIP Addendum	*Tech Memo Addendum* to the *Final CMIP*
LTM	Long-term monitoring
LUC	Land use control
LUCER	Land use control effectiveness report
McClellan	Former Fort McClellan
MDA	McClellan Development Authority
MES	Matrix Environmental Services, LLC
RBTL	Risk-Based Target Level
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial Investigation
SAP	*Installation-Wide Sampling and Analysis Plan*
SI	Site Investigation
Site	Former Small Weapons Repair Shop, Parcel 66(7)
TCE	Trichloroethene
trans-1,2-DCE	trans-1,2-dichloroethene
VC	Vinyl Chloride
VOC	Volatile organic compound

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1.0 INTRODUCTION AND SITE HISTORY

1.1 PURPOSE

The purpose of this Second Addendum to the Corrective Measures Implementation Plan (CMIP) is to modify the approved remedy for the Former Small Weapons Repair Shop, Parcel 66(7) in order to more completely remove residual groundwater contaminants. Figure 1 shows a site map of McClellan and Figure 2 shows a parcel location map of the Site. The specific objectives of this CMIP is to:

- Describe the corrective measures implemented thus far
- Summarize the most recent monitoring results and the current quality of groundwater at the site
- Establish the benefit of additional groundwater corrective action and
- Describe the design and implementation of the proposed corrective action.

1.2 CORRECTIVE MEASURE HISTORY

In March 2007, Matrix Environmental Services, LLC (MES) submitted the *Final Corrective Measures Implementation Plan (Final CMIP) for the Former Small Weapons Repair Shop, Parcel 66(7)* (MES 2007) to the Alabama Department of Environmental Management (ADEM). ADEM acknowledged the approach presented in the *Final CMI Plan* in a letter dated August 29, 2007.

The *Final CMIP* based the site corrective measure goals on Site-Specific Screening Levels (SSSLs) with a 10^{-6} carcinogenic risk and 0.1 non-carcinogenic hazard. Subsequently, Risk-Based Target Levels (RBTLs) were established based on (10^{-5} carcinogenic risk and 1.0 non-carcinogenic hazard) consistent with *Alabama Risk-Based Corrective Action Guidance Manual (ARBCA)*(ADEM, 2017).

The *Final CMIP* proposed in situ soil treatment using anhydrous quicklime and treatment of groundwater via in-situ chemical oxidation (ISCO) by injecting Fenton's reagent. A soil treatment pilot study was successfully performed in the contaminant source area on June 21, 2007. Groundwater monitoring conducted at the site following the soil treatment pilot study demonstrated that the pilot study had a secondary effect resulting in decreases in groundwater contaminant concentrations.

This observed decrease in groundwater contaminant concentrations coupled with the revised cleanup standards (RBTLs) resulted in a reevaluation of the need for ISCO by injection of Fenton's reagent. In March 2009 the MDA submitted a CMIP Addendum that requested a revision in the groundwater specific corrective measure technology. In place of Fenton's reagent injection, MDA proposed the use of potassium permanganate as a chemical oxidant that would achieve the established McClellan RBTLs in groundwater. The revised plan then combined a full-scale soil treatment technology of the plume area with a less aggressive, more appropriate, and less expensive chemical oxidation reagent and reagent delivery system.

From October 2010 to February 2011, the revised corrective measures were implemented at the

Site as outlined in the *Final CMIP* (MES, 2007) and *Final CMIP Addendum* (MES, 2009) to reduce concentrations of VOCs in groundwater at the Site to levels acceptable for industrial use. Details of the corrective measures activities are documented in the *Final Corrective Measures Implementation Report (CMIR), Former Small Weapons Repair Shop, Parcel 66(7)* (*CMIR*) (MES, 2013).

Corrective measures activities included:

- the abandonment of groundwater monitoring wells PPMP-66-MW02, PPMP-66-MW06, PPMP-66-MW12, PPMP-66-MW18, PPMP-66-MW23, and PPMP-66-MW24 located in the target treatment area,
- anhydrous quicklime blending into the soil of the target treatment area to reduce residual COCs concentrations in the soil that may provide a source of contaminants to the groundwater plume,
- direct application of solid potassium permanganate to the exposed bedrock during quicklime mixing activities to promote the chemical oxidation of the COCs in groundwater,
- site restoration and re-vegetation, and
- replacement of the residuum and transition groundwater monitoring wells in the target treatment area, that were previously abandoned, for use in LTM.

2.0 GROUNDWATER QUALITY

2.1 IDENTIFICATION OF CONSTITUENTS OF CONCERN

A summary of the constituents of concern (COCs) identified during the RCRA Facility Investigation (RFI), as well as the maximum detected concentrations (MDCs), incremental lifetime cancer risk (ILCR), and hazard index (HI), are presented in detail in the *Final RFI* (MES, 2006). Because the site and the area immediately surrounding the site are paved with asphalt, therefore, ecological habitat at Parcel 66(7) is very limited for ecological receptors, the RFI concluded that the COCs in the soil at Parcel 66(7) did not pose an unacceptable risk to the ecosystem. As a result, the COCs identified were all related to potential human health risk. Media-specific RFI COCs included:

- Groundwater: Six volatile organic compounds (VOCs) and two metals were identified as human health RFI COCs exceeding SSSLs in groundwater at the Site.
- Surface Soil: Vinyl Chloride exceeded the residential SSSL and was identified as a human health RFI COC in surface and depositional soil.
- Subsurface Soil: No human health RFI COCs were identified in subsurface soil at the Site.

2.2 CORRECTIVE ACTION COCS

Given the land use at the Site is light industrial the Corrective Action COCs and their associated RBTLs are based on the groundskeeper exposure scenario and are:

- cis-1,2-dichloroethene (cis-1,2-DCE) (991 µg/L)
- Trichloroethene (TCE) (205 µg/L)
- Vinyl chloride (VC) (3.86 µg/L)

No Corrective Action COCs were identified for surface or subsurface soil.

2.3 HISTORICAL DISTRIBUTION OF COCS

Initially at the site the greatest concentrations of COCs exceeding RBTLs in the residuum and transition groundwater zones were near the southern and western footprint of former Building 335, proximal to the sanitary sewer system where it was suspected that TCE was disposed during routine operations. Specifically, Corrective Action COC concentrations in the following four groundwater monitoring wells exceeded the groundskeeper RBTLs:

- Residuum groundwater zone: PPMP-66-MW02, PPMP-66-MW06,
- Transition groundwater zone: PPMP-66-MW23, and PPMP-66-MW24

Only groundwater in the residuum and transition zones exceeded RBTLs, and there are no indications that groundwater in bedrock at the site is a concern from a corrective measures perspective. The initial surface extent of the impacted area was restricted to an area of approximately 480 square yards.

2.4 CURRENT GROUNDWATER QUALITY

To meet the recommended actions outlined in the *Final CMIP* (MES, 2007) and the *Final CMIP Addendum* (MES, 2009) and provide data to evaluate the long-term performance of the corrective measures, groundwater at the Site was monitored on a quarterly basis during the seventh year of LTM following the implementation of corrective measures at the Site (MES, 2018). The following activities were performed during the seventh year of LTM:

- Collected groundwater samples and groundwater level measurements from four residuum wells, three transition wells, and one bedrock well during four rounds of sampling conducted from May 2017 to February 2018.
- Analyzed the groundwater samples for the COCs (cis-1,2-DCE, TCE, and vinyl chloride) and their degradation products (1,1-DCE and trans-1,2-DCE) by EPA Method SW8260B.

2.4.1 SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

The analytical results for the groundwater samples collected during the seventh year of LTM are shown in Table 1. The historical analytical results from previous sampling events are also shown in Table 1.

VOC concentrations detected in the groundwater samples were compared to the groundskeeper RBTLs in Table 1. One COC (VC) exceeded the groundskeeper RBTL in three groundwater wells from samples collected during the seventh year of LTM from May 2017 to February 2018.

Samples collected from the LTM wells were used to 1) evaluate the effectiveness of the corrective measures, and 2) evaluate contaminant concentration changes over time that occurred in response to the corrective measures, and 3) assess the long-term performance of the corrective measures in reducing contaminant concentrations.

2.4.2 CONCENTRATION TRENDS OVER TIME

Figures 3 to 6 show the trends in concentrations over time for the COCs. As indicated in the trend figures and Table 1, monitoring wells showed small fluctuations in concentrations during the seventh year of monitoring compared to the prior year.

The COC concentrations in wells PPMP-66-MW08, PPMP-66-MW16, PPMP-66-MW17, PPMP-66-MW18R, and PMP-66-MW24R were less than the groundskeeper RBTLs during this reporting period.

2.4.3 DISTRIBUTION OF CORRECTIVE ACTION COCS IN GROUNDWATER

Figures 7 and 8 present the estimated lateral extent of TCE and VC concentrations exceeding the groundskeeper RBTLs for the residuum and transition groundwater zones at the Site for the baseline September/October 2010 sampling event. Figures 9 to 16 present the estimated lateral extent of TCE and VC concentrations exceeding the groundskeeper RBTLs for the residuum and transition groundwater zones at the Site for the seventh year of LTM. During the seventh year of LTM, the VC plume for both the residuum and transition groundwater zones remained near the estimated source area.

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3.0 CORRECTIVE ACTION OBJECTIVES AND PERFORMANCE STANDARDS

The Corrective Action Objectives initially identified in the CMIP and modified in the first CMIP Addendum for contaminated groundwater at the Site include:

- The selected Corrective Action must be protective of human health and the environment and be consistent with or more protective than required for the planned light industrial reuse of the Site.
- Limit potential exposure to on-Site contaminated groundwater.
- Reduce the concentrations of cis-1,2-DCE, TCE, and VC to achieve an ILCR of less than 10^{-5} and a non-carcinogenic HI less than 1.0 for potential human receptors at the Site under groundskeeper exposure scenario.
- Establish realistic milestones, decision point rules, and performance criteria to achieve the performance standards established for the Corrective Action and to demonstrate the reduction of risk over time.

These objectives remain relevant to this second addendum however the MDA is interested in providing a greater degree of protection whenever feasible.

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4.0 DESIGN BASIS FOR REVISED REMEDY/CORRECTIVE ACTION

4.1 GENERAL BASIS

Groundwater Corrective Action COC concentrations remain above RBTLs for VC. Reducing the VC concentration will limit potential exposure to on-Site contaminated groundwater.

4.2 IN-SITU CHEMICAL OXIDATION

The groundwater remediation program recommended in this Second Addendum to the CMIP uses ISCO technology by applying hydrogen peroxide activated sodium persulfate. ISCO introduces chemical oxidants into the groundwater to oxidize organic contaminants. Complete oxidation to carbon dioxide and water is the desired endpoint of the chemical oxidation process.

Synergistic effects realized from the combination of hydrogen peroxide with sodium persulfate will result in more complete destruction of contaminants including the more recalcitrant compounds as compared to other less aggressive ISCO technologies. The most common oxidant delivery method involves the injection of oxidant solution following on site mixing of reagents immediately prior to injection.

Mass loading for hydrogen peroxide and sodium persulfate was calculated using Groundwater and Environmental Services, Inc (GES) proprietary spreadsheet (Appendix A). Treatment area volume, geologic parameters, and oxidant reaction variables were entered into the spreadsheet. The observed maximum contaminant concentrations were used in the design calculations in order to provide a mass loading of reagent that will drive the ISCO reaction toward complete removal of contaminants. The loading calculations also takes into account the natural soil oxidant demand. Using the values shown in Appendix A, an estimated 8,300 pounds of sodium persulfate which when combined with sufficient hydrogen peroxide solution to achieve an injection volume of 10% of the target area pore volume results in 9,800 gallons of reagent.

All ISCO approaches rely upon contact between the oxidant and the COCs in order to be successful. In order to achieve maximum contact a mixture of persulfate and hydrogen peroxide will be injected into a network of direct push injection points (Figure 17). The activation of the peroxide with persulfate is significantly slower than iron salt- activated peroxide, which allows the reagents to be delivered to the subsurface before the radicals are generated. This delayed activation results in a greater radius-of-influence (ROI) and enhanced destruction of contaminants. By combining hydrogen peroxide with the more stable sodium persulfate, some oxidant (persulfate) may remain in the subsurface for longer periods following the injection event. During this time, groundwater movement will help facilitate additional contact between the oxidant and VOCs.

The proposed injection network (Figure 17) targets the saturated clay/silty clay zone and the weathered shale zone. Injection will occur via 13 direct push technology (DPT) injection points (IPs) with a target injection depth ranging from approximately 3 feet bgs to 30 feet bgs. The depth of the IPs will be no deeper than 30 feet but most likely shallower based on the depth at which competent shale is encountered. The target injection interval includes both vadose and saturated zones depending on the variable depth to water. Target intervals may be adjusted in the field based on observed conditions (e.g., depth to bedrock is shallower/deeper than anticipated).

5.0 PERFORMANCE, COMPLIANCE, AND MONITORING PLAN

Baseline, injection, and performance monitoring of groundwater will be performed over time and analyzed to measure the reduction of target COCs. The results from these tests will be used to evaluate the field implementation of ISCO.

An analytical laboratory certified by the State of Alabama will analyze groundwater samples for VOCs via USEPA Method 8260B, sulfate via USEPA Method 300, and total and dissolved iron via USEPA Method 6010B. A field test kit (CHEMets Kit K-5510 or equivalent) will be used to analyze groundwater samples for hydrogen peroxide and persulfate (CHEMets Kit K-7870 or equivalent). Field parameters (depth to water, temperature, conductivity, pH, dissolved oxygen, and ORP) will be analyzed via standard field probes.

The performance monitoring network will consist of existing wells at the Site, as summarized in Table 2. The analytical suite and proposed sampling frequency are shown in Table 2. The sampling frequency will consist of a pre-injection baseline event, one-month post injection, followed by four quarterly events in Year 1, and two semi-annual sampling events in Year 2. Additional sampling beyond Year 2 will be performed semi-annually and revert back to the eight wells and Corrective Action COCs listed in the Cleanup Agreement.

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6.0 REFERENCES

MES. 2006. *Final Resource Conservation and Recovery Act Facility Investigation for Small Weapons Repair Shop, Parcel 66(7)*. February.

MES. 2007. *Final Corrective Measures Implementation Plan, Former Small Weapons Repair Shop, Parcel 66(7)*. March.

MES. 2009. *Tech Memo Addendum* to the *Final Corrective Measures Implementation Plan, Former Small Weapons Repair Shop, Parcel 66(7)*. March.

MES. 2013. *Final Corrective Measures Implementation Report, Former Small Weapons Repair Shop, Parcel 66(7)*. January.

MES. 2018. *Corrective Measures Effectiveness Report, Seventh Year Long-Term Monitoring, Former Small Weapons Repair Shop, Parcel 66(7)*. April.

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Tables

Table 1: Groundwater Analytical Data for Constituents of Concern and Degradation Products
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

VOCs (µg/L)	GS RBTL	Residuum Well PPMP-66-MW02/PPMP-66-MW02R/PPMP-66-MW02RR *																																	
		3/6/01	4/24/02	5/13/04	11/7/07	5/21/08	10/1/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13	5/8/13	8/26/13	1/2/14	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17	5/18/17	8/7/17	11/20/17	2/8/18
COCs		Historical					Baseline & First Year O&M					2nd Year O&M				3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M				7th Year O & M			
Cis-1,2-Dichloroethene	991	7.5	9.5 (nv)	36	210	130	200	41	29	28	220	300	320	310	530	520	well damaged, could not be sampled	7.9	4.2	2.7	2.9	23	25	34	19	40	31	28	23	18	31	25	39	32	57
Trichloroethene	205	40	29 (nv)	74	480	27	170	34	52	45	87	130	160	140	530	450		3.1	1.0	0.49 J	0.31 J	12	19	35	10	29	27	28	11	6.9	24	21	23	19	31
Vinyl Chloride	3.86	60	67 (nv)	110	100	71	41	10	8.7	17	85	72	65	59	72	73		10	9.3	6.3	5.1	12	11	11	9.1	12	9.1	6.4	9.6	8.0	7.2	5.4	13	7.6	15
Degradation Products																																			
1,1-Dichloroethene	4800	9.2	11 (nv)	28	97	30	37	5	1.8	1.6	8	9.7	10	10	15	15		0.3 J	< 1.0	< 1.0	< 1.0	0.45 J	0.58 J	0.72 J	0.39 J	0.78 J	0.58 J	0.49 J	0.43 J	0.29 J	0.57 J	0.34 J	0.68 J	0.55 J	0.77 J
Trans-1,2-Dichloroethene	1950	6.4	6.7 nv)	10	13	7.2	7.6	12	8.7	15	72	97	110	100	280	220		2.1	1.0	0.57 J	0.71 J	7.1	9.7	15	6.9	18	15	13	8.5	5.1	16	11	19	15	27

VOCs (µg/L)	GS RBTL	PPMP-66-MW02RR			
		5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	25	39	32	57
Trichloroethene	205	21	23	19	31
Vinyl Chloride	3.86	5.4	13	7.6	15
Degradation Products					
1,1-Dichloroethene	4800	0.34 J	0.68 J	0.55 J	0.77 J
Trans-1,2-Dichloroethene	1950	11	19	15	27

VOCs (µg/L)	GS RBTL	Residuum Well PPMP-66-MW06/PPMP-66-MW06R *																													
		3/14/01	4/25/02	5/17/04	11/5/07	5/19/08	9/28/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13	5/8/13	8/26/13	11/19/13	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17
COCs		Historical					Baseline & First Year O&M					2nd Year O&M				3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M			
Cis-1,2-Dichloroethene	991	500	720 (nv)	1600	810	700	580	47	71	46	34	38	56	48	30	25	31	41	29	21	32	33	15	14	17	14	12	11	24	25	11
Trichloroethene	205	9200	14000 (nv)	13000	2900	3900	2100	180	260	380	240	230	310	270	180	150	190	200	150	120	140	180	88	82	69	75	56	48	78	79	37 J
Vinyl Chloride	3.86	< 5	3.5 (nv)	10	26	26	27	2.2	4.8	8.5	5.8	6.1	10	9.9	5.4	4.0	7.9	14	6.9	4.6	7.0	10	3.4	3.1	3.6	1.8	2.0	2.4	7.1	6.5	3.0
Degradation Products																															
1,1-Dichloroethene	4800	310	360 (nv)	300	46	52	44	4.5	7.6	2.8	1.6	1.6	2	1.8	1	0.91 J	1.1	1.3	0.65 J	0.49 J	0.86 J	0.76 J	0.39 J	0.33 J	0.47 J	0.34 J	0.32 J	0.29 J	0.64 J	0.59 J	0.34 J
Trans-1,2-Dichloroethene	1950	17	31 (nv)	130	34	33	30	2.1	4.9	12	7.6	7.9	13	13	8	6.3	8.8	12	7.2	5.9	7.9	9.8	4.9	4.3	4.5	3.8	3.2	2.8	6.0	5.9	2.9

VOCs (µg/L)	GS RBTL	Residuum Well PPMP-66-MW06R			
		5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	13	19	14	16
Trichloroethene	205	55	64	45	49
Vinyl Chloride	3.86	3.8	5.7	3.5	6.1
Degradation Products					
1,1-Dichloroethene	4800	0.29 J	0.66 J	0.45 J	0.49 J
Trans-1,2-Dichloroethene	1950	3.3	5.2	3.3	3.8

VOCs (µg/L)	GS RBTL	Bedrock Well PPMP-66-MW08																										
		3/6/01	5/12/04	5/20/08	10/1/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13	5/8/13	8/26/13	11/19/13	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17
COCs		Historical			Baseline & First Year O&M					2nd Year O&M				3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M			
Cis-1,2-Dichloroethene	991	< 5	< 1.0	< 1.0	0.29 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	205	< 5	< 1.0	0.28 J	0.98 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	3.86	< 5	< 1.0	< 1.0	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products																													
1,1-Dichloroethene	4800	< 5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-Dichloroethene	1950	< 5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

VOCs (µg/L)	GS RBTL	Bedrock Well PPMP-66-MW08			
		5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	< 1	< 1	< 1	< 1
Trichloroethene	205	< 1	< 1	< 1	< 1
Vinyl Chloride	3.86	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products					
1,1-Dichloroethene	4800	< 1	< 1	< 1	< 1
Trans-1,2-Dichloroethene	1950	< 1	< 1	< 1	< 1

Table 1: Groundwater Analytical Data for Constituents of Concern and Degradation Products
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

VOCs (µg/L)	GS RBTL	Residuum Well PPMP-66-MW16																												
		10/17/01	5/13/04	11/7/07	5/20/08	10/1/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13	5/8/13	8/26/13	11/19/13	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17
COCs		Historical				Baseline & First Year O&M					2nd Year O&M				3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M			
Cis-1,2-Dichloroethene	991	< 1.0	< 1.0	0.5 J	< 1.0	0.28 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	0.30 J	< 1.0
Trichloroethene	205	< 1.0	< 1.0	0.77 J	0.6 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	3.86	< 1.0	0.26 J	0.57 J	< 1.0	0.21 J	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products																														
1,1-Dichloroethene	4800	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-Dichloroethene	1950	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

VOCs (µg/L)	GS RBTL	Residuum Well PPMP-66-MW16			
		5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	< 1	< 1	< 1	< 1
Trichloroethene	205	< 1	< 1	< 1	< 1
Vinyl Chloride	3.86	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products					
1,1-Dichloroethene	4800	< 1	< 1	< 1	< 1
Trans-1,2-Dichloroethene	1950	< 1	< 1	< 1	< 1

VOCs (µg/L)	GS RBTL	Transition Well PPMP-66-MW17																										
		5/20/04	5/20/08	9/29/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13	5/8/13	8/26/13	11/19/13	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17
COCs		Historical		Baseline & First Year O&M					2nd Year O&M				3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M			
Cis-1,2-Dichloroethene	991	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	205	< 1.0	0.84 J	0.88 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	3.86	< 1.0	< 1.0	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products																												
1,1-Dichloroethene	4800	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-Dichloroethene	1950	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

VOCs (µg/L)	GS RBTL	Transition Well PPMP-66-MW17			
		5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	< 1	< 1	< 1	< 1
Trichloroethene	205	< 1	< 1	< 1	< 1
Vinyl Chloride	3.86	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products					
1,1-Dichloroethene	4800	< 1	< 1	< 1	< 1
Trans-1,2-Dichloroethene	1950	< 1	< 1	< 1	< 1

VOCs (µg/L)	GS RBTL	Residuum Well PPMP-66-MW18/PPMP-66-MW18R *																										
		5/12/04	5/20/08	9/28/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13	5/8/13	8/26/13	11/19/13	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17
COCs		Historical		Baseline & First Year O&M					2nd Year O&M				3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M			
Cis-1,2-Dichloroethene	991	< 1.0	< 1.0	< 1.0	7.5	14	3.6	1.3	3	7.6	5.2	2.2	2.2	5.2	4.9	1.5	2.1	1.0	2.3	0.26 J	0.67 J	2.3	< 1.0	< 1.0	0.72 J	2.8	1.7	< 1.0
Trichloroethene	205	< 1.0	4.6	< 1.0	21	42	10	3.4	4.5	2.2	0.58 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1 J	1.2	0.68 J	0.6 J	0.31 J	0.48 J	0.44 J	0.57 J	0.76 J
Vinyl Chloride	3.86	< 1.0	< 1.0	< 0.8	0.66 J	6.2	2.4	1	0.96	1.5	1.3	0.64 J	0.76 J	1.8	1.4	0.45 J	0.47 J	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	<0.8	< 0.8	< 0.8	< 0.8
Degradation Products																												
1,1-Dichloroethene	4800	< 1.0	< 1.0	< 1.0	0.25 J	0.32 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-Dichloroethene	1950	< 1.0	< 1.0	< 1.0	0.47 J	2.5	0.36 J	< 1.0	< 1.0	0.38 J	0.29 J	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

VOCs (µg/L)	GS RBTL	Residuum Well PPMP-66-MW18R			
		5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	0.28 J	1.1	0.73 J	0.37 J
Trichloroethene	205	0.74 J	0.76 J	0.34 J	0.28 J
Vinyl Chloride	3.86	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products					
1,1-Dichloroethene	4800	< 1	< 1	< 1	< 1
Trans-1,2-Dichloroethene	1950	< 1	< 1	< 1	< 1

Table 1: Groundwater Analytical Data for Constituents of Concern and Degradation Products
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

Transition Well PPMP-66-MW23/PPMP-66-MW23R *

VOCs (µg/L)	GS RBTL	5/13/04	11/7/07	5/21/08	10/1/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13
COCs		Historical			Baseline & First Year O&M					2nd Year O&M			
Cis-1,2-Dichloroethene	991	1.6	110	75	58	92	550	180	130	93	180	170	150
Trichloroethene	205	1.4	89	290	39	77	940	550	370	200	210	180	130
Vinyl Chloride	3.86	9.2	16	20	6.6	4.5	15	14	20	19	39	33	31
Degradation Products													
1,1-Dichloroethene	4800	2.2	34	57	18	31	96	45	29	16	19	16	11
Trans-1,2-Dichloroethene	1950	< 1.0	0.77 J	2.7	0.47 J	1.2	7.9	5.9	7.2	6.2	22	27	23

VOCs (µg/L)	GS RBTL	5/8/13	8/26/13	11/19/13	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17
COCs		3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M			
Cis-1,2-Dichloroethene	991	130	210	270	170	170	210	220	180	140	91	160	160	80	110	110	170
Trichloroethene	205	75	120	170	120	110	140	210	120	100	62	110	120	66	76	67	120
Vinyl Chloride	3.86	32	48	59	31	41	39	54	33	26	20	28	23	12	19	16	30
Degradation Products																	
1,1-Dichloroethene	4800	8.2	11	14	10	5.4	7.1	6.2	10	7.5	4.1	9.6	9.2	4.0	6.0	5.1	11
Trans-1,2-Dichloroethene	1950	24	43	68	22	52	67	84	39	33	27	35	37	23	31	23	45

VOCs (µg/L)	GS RBTL	Transition Well PPMP-66-MW23R 5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	110	90	130	140
Trichloroethene	205	89	78	120	130
Vinyl Chloride	3.86	16	24	21	24
Degradation Products					
1,1-Dichloroethene	4800	4.9	5.6	7.5	11
Trans-1,2-Dichloroethene	1950	29	37	41	57

Transition Well PPMP-66-MW24/PPMP-66-MW24R *

VOCs (µg/L)	GS RBTL	5/17/04	11/5/07	5/20/08	9/29/10	5/11/11	8/11/11	11/2/11	2/6/12	5/7/12	8/6/12	11/12/12	2/4/13
COCs		Historical			Baseline & First Year O&M					2nd Year O&M			
Cis-1,2-Dichloroethene	991	130	290	260	80	0.47 J	0.47 J	0.39 J	0.46 J	0.39 J	0.64 J	0.55 J	0.32 J
Trichloroethene	205	5000	2500	4000	5.5	2.4	1.1	0.78 J	0.66 J	0.54 J	0.48 J	0.58 J	0.53 J
Vinyl Chloride	3.86	1.2	16	11	20	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products													
1,1-Dichloroethene	4800	180	100	98	4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-Dichloroethene	1950	8.2	7.6	8.5	1.2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

VOCs (µg/L)	GS RBTL	5/8/13	8/26/13	11/19/13	2/5/14	5/7/14	8/11/14	11/3/14	2/3/15	5/18/15	8/3/15	11/12/15	2/9/16	5/3/16	8/4/16	11/1/16	2/14/17
COCs		3rd Year O&M				4th Year O&M				5th Year O&M				6th Year O&M			
Cis-1,2-Dichloroethene	991	0.4 J	0.55 J	0.54 J	0.36 J	0.46 J	0.57 J	0.55 J	0.42 J	0.64 J	0.84 J	0.51 J	0.46 J	0.80 J	1.1	0.95 J	0.74 J
Trichloroethene	205	0.44 J	0.38 J	0.4 J	0.45 J	0.46 J	0.37 J	0.4 J	0.44 J	0.45 J	0.25 J	0.37 J	0.39 J	0.24 J	0.29 J	0.30 J	0.48 J
Vinyl Chloride	3.86	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products																	
1,1-Dichloroethene	4800	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-Dichloroethene	1950	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

VOCs (µg/L)	GS RBTL	Transition Well PPMP-66-MW24R 5/18/17	8/7/17	11/20/17	2/8/18
COCs		7th Year O & M			
Cis-1,2-Dichloroethene	991	0.59 J	0.93 J	0.65 J	0.73 J
Trichloroethene	205	0.32 J	0.38 J	0.46 J	0.49 J
Vinyl Chloride	3.86	< 0.8	< 0.8	< 0.8	< 0.8
Degradation Products					
1,1-Dichloroethene	4800	< 1	< 1	< 1	< 1
Trans-1,2-Dichloroethene	1950	< 1	< 1	< 1	< 1

Notes:
< = Indicates the analyte was not detected at the reported quantitation limit shown.
µg/L = micrograms per liter
COCs = Constituents of concern
GS = Groundskeeper
(nv) = Not validated
LTM = Long-term monitoring
RBTL = Risk-Based Target Level (10^{-5} Risk)
VOCs = Volatile Organic Compounds

* Groundwater samples were collected from the original wells during the historical and baseline rounds (i.e., from March 2001 through October 2010).
Groundwater samples were collected from the replacement wells (noted with a "R" suffix) during the LTM rounds from May 2011 to the present, with the exception of well PPMP-66-MW02R.
Groundwater samples were collected from replacement well PPMP-66-MW02R from May 2011 through May 2013 and from the second replacement well PPMP-66-MW02RR from January 2014 to the present.

Lab Flag:
J = Estimated detection. The analyte is positively identified and the concentration is less than the reporting limit (RL) but greater than the method detection limit (MDL).

Result exceeds GS RBTL

Table 2. PERFORMANCE MONITORING PROGRAM
Small Weapons Repair Shop
McClellan, Anniston, Alabama

		Baseline (pre-injection)				Year 1 (5 Monitoring Events) (1 month post injection, quarterly)				Year 2 2 Monitoring Events (semi-annual)			
Program	Well ID	Field Parameters	VOCs	Iron	Sulfate, Persulfate, H2O2	Field Parameters	VOCs	Iron	Sulfate, Persulfate, H2O2	Field Parameters	VOCs	Iron	Sulfate, Persulfate, H2O2
Focused Performance Monitoring	PPMP-66-MW02RR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW06R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW08	✓	✓		✓	✓	✓		✓	✓	✓		
	PPMP-66-MW14	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW18R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW22	✓	✓		✓	✓	✓		✓	✓	✓		
	PPMP-66-MW23R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW24R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Periphery Monitoring	PPMP-66-MW01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW04	✓	✓		✓	✓	✓		✓	✓	✓		
	PPMP-66-MW07	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	PPMP-66-MW11	✓	✓		✓	✓	✓		✓	✓	✓		
	PPMP-66-MW13	✓	✓		✓	✓	✓		✓	✓	✓		

Notes:

1. Field Parameters include depth to water (DTW), temperature, turbidity, conductivity, pH, oxidation-reduction potential (ORP) and dissolved oxygen.
2. VOCs - volatile organic compounds
3. H2O2 - hydrogen peroxide
4. Sulfate/persulfate and hydrogen peroxide sampling will be suspended once they are no longer detected following the injection.
5. Historical data, if collected within 12 months prior to injection, may be used for baseline data for each location/analyte.
6. Additional sampling/analyses may be performed beyond that presented in the table, if warranted by the performance data.
7. Gray shading indicates wells and analyses overlapping with quarterly monitoring, per Cleanup Agreement (Mod 4, No. AL4 210 020 562).

Figures

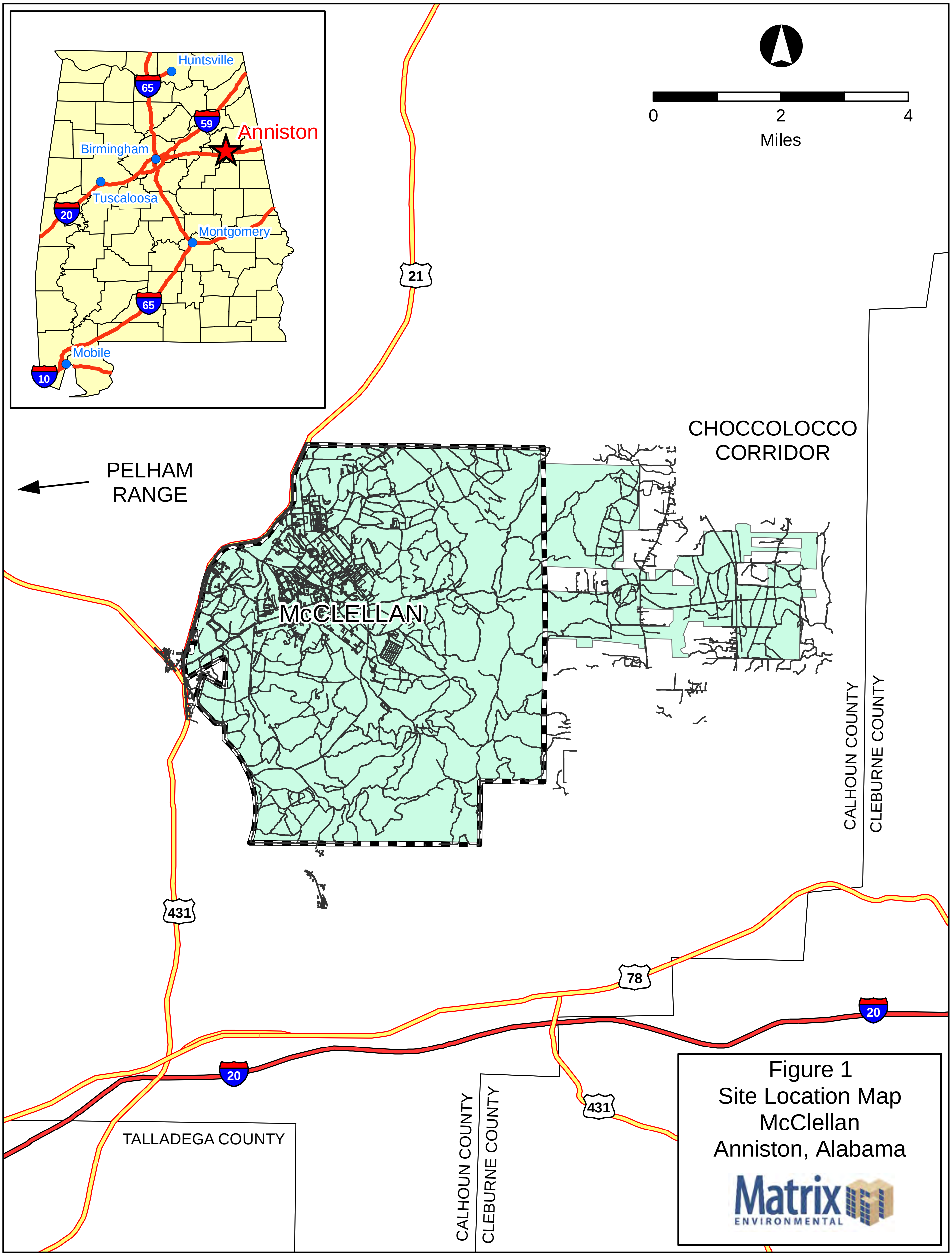

Figure 1
Site Location Map
McClellan
Anniston, Alabama

Matrix ENVIRONMENTAL

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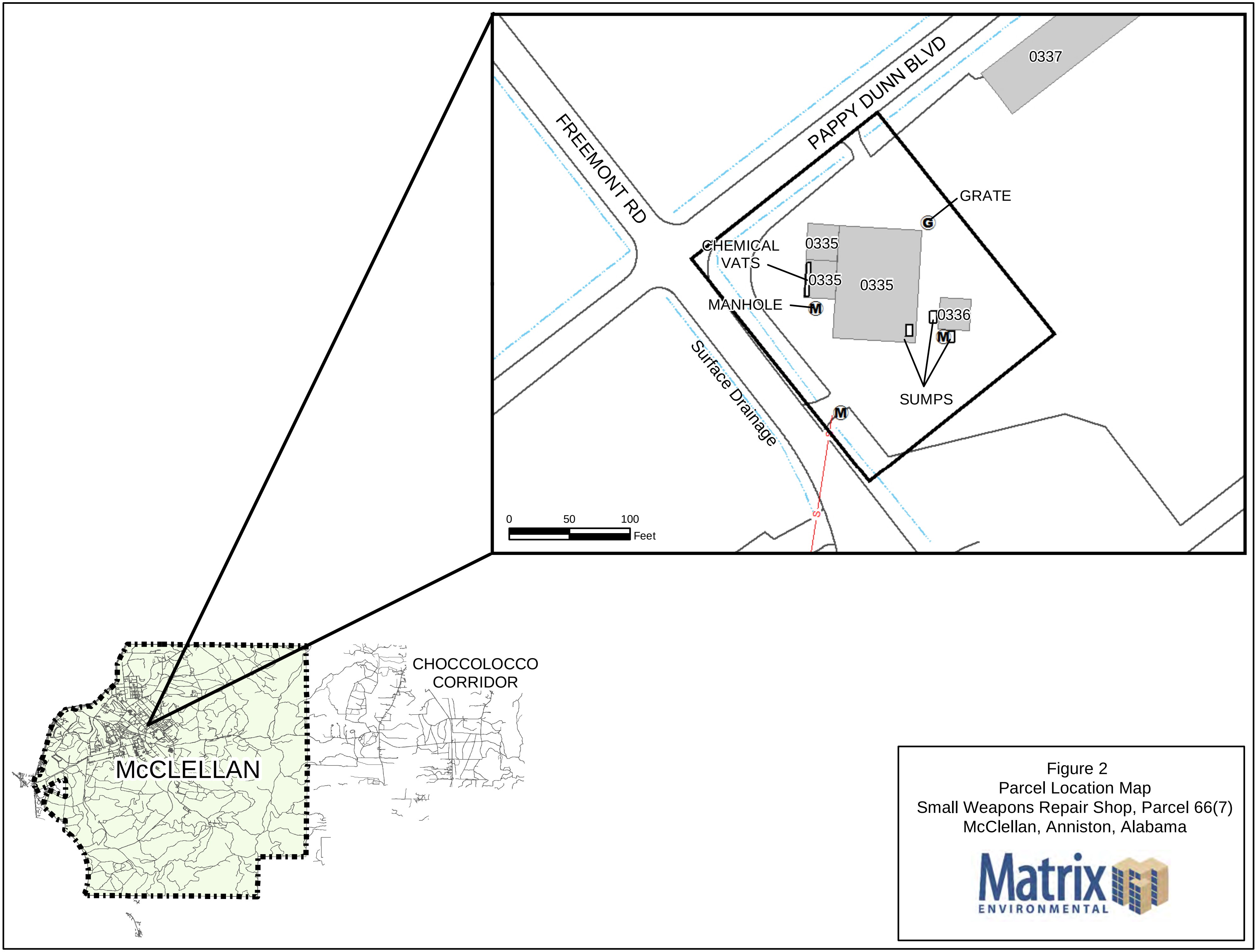
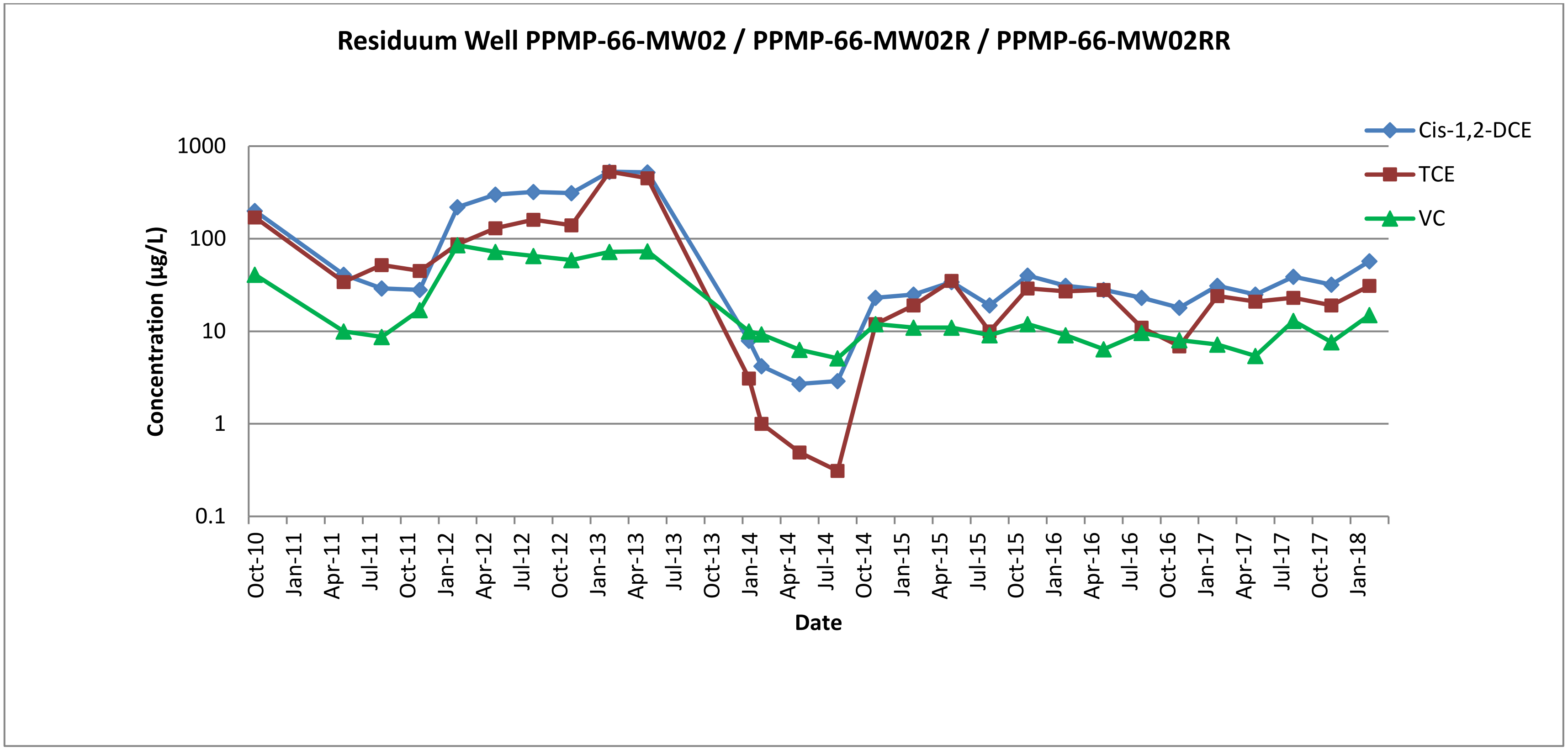


Figure 2
Parcel Location Map
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

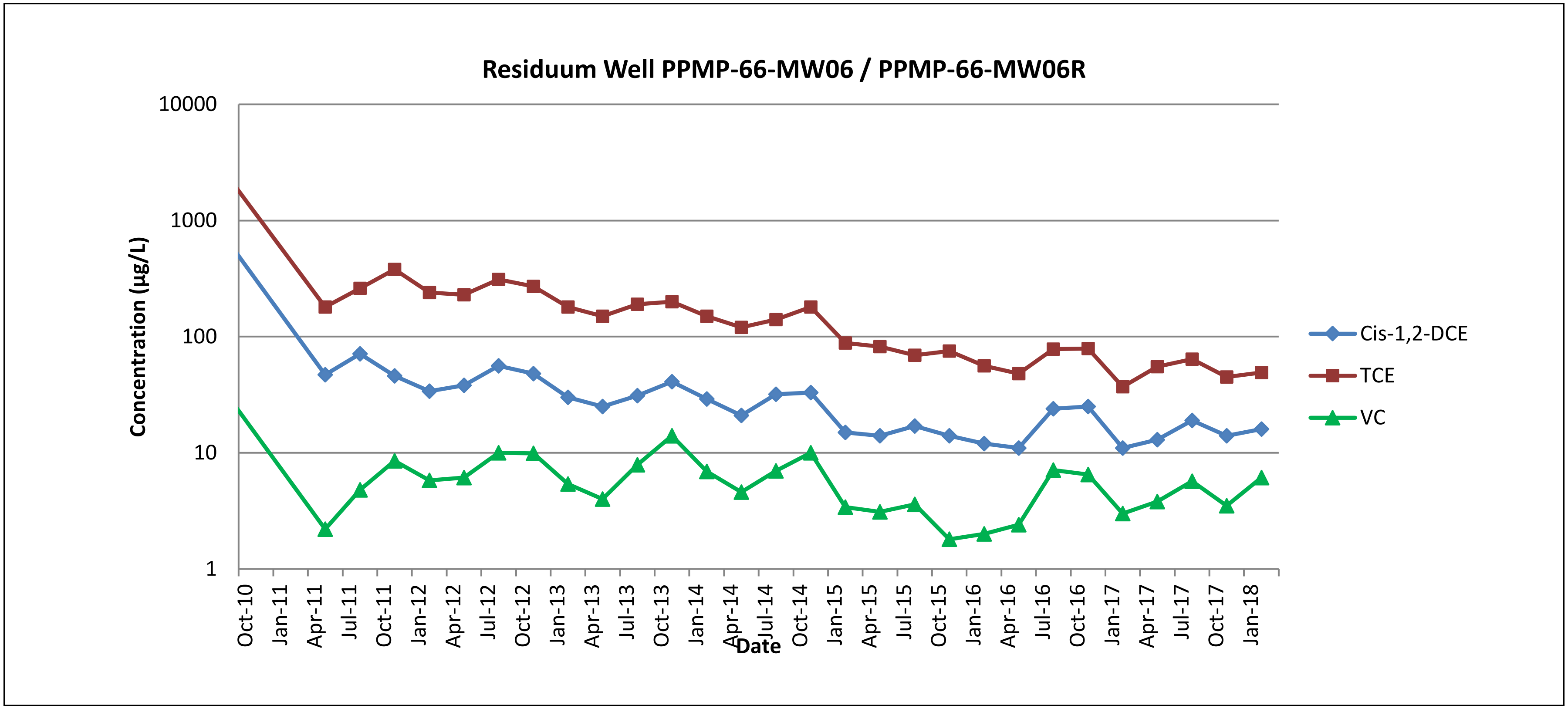
Matrix ENVIRONMENTAL

FILE: G:\gis_projects\Fort_McClellan\03.094.007\active\apps\Small_Weapons-66(7)\CMIR\Figure1-2_Parcel_Location_Map.mxd, 5/7/2012, jeff_clonts



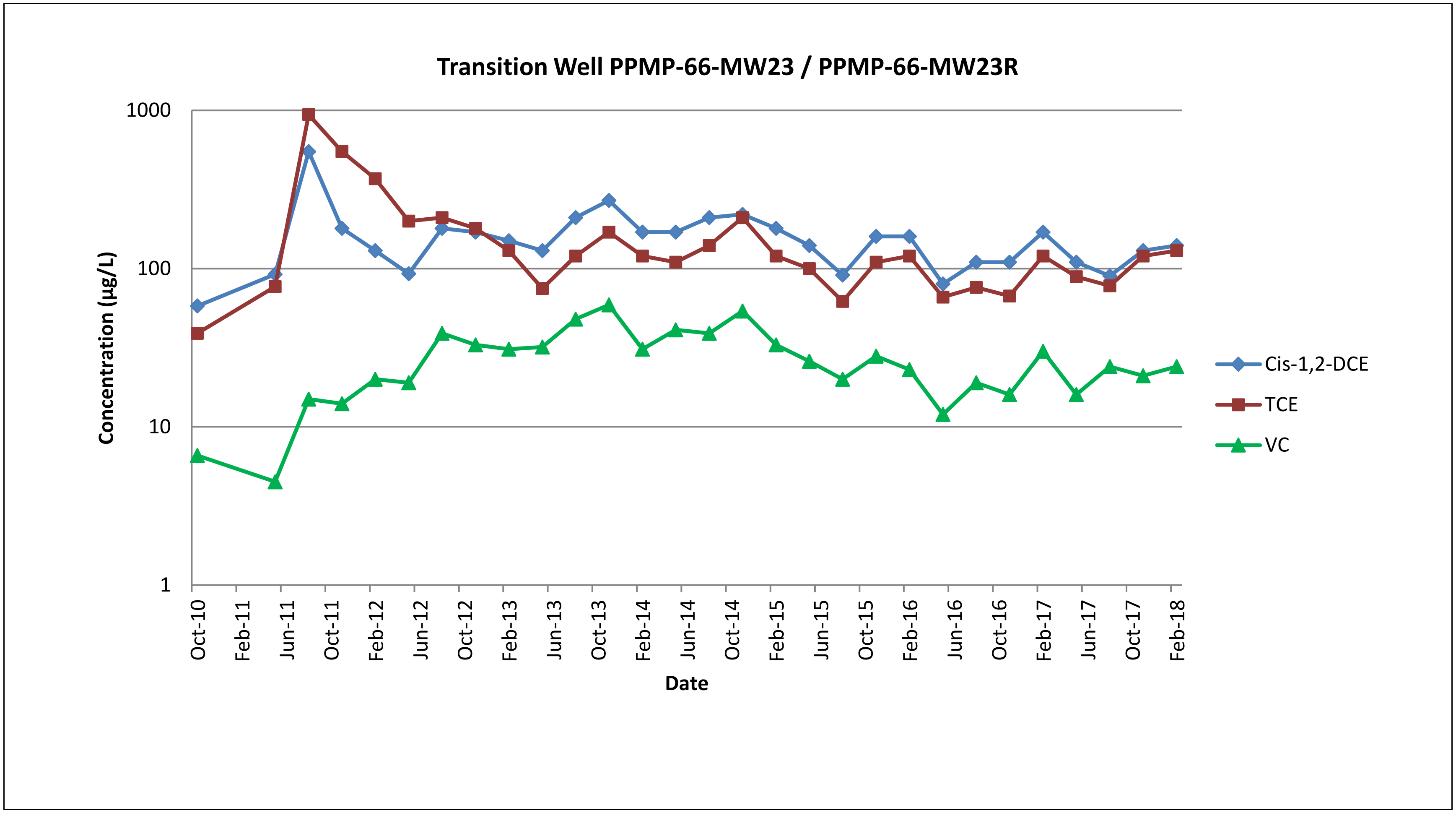
Matrix ENVIRONMENTAL

Figure 3: Volatile Concentrations in Residuum Well
PPMP-66-MW02 / PPMP-66-MW02R/ PPMP-66-MW02RR
Small Weapons, Parcel 66(7)
McClellan, Anniston, Alabama



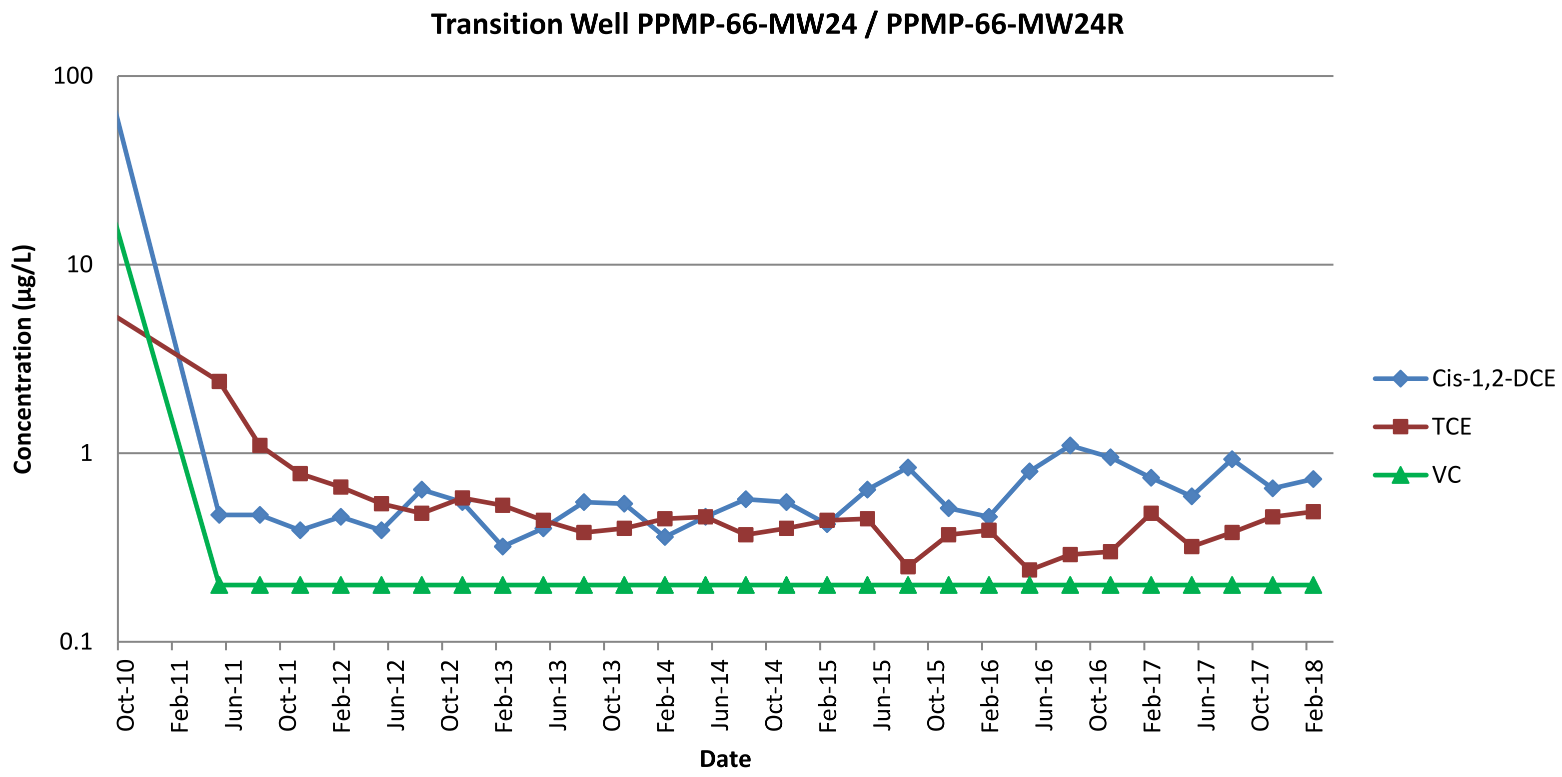
Matrix ENVIRONMENTAL

Figure 4: Volatile Concentrations in Residuum Well
PPMP-66-MW06 / PPMP-66-MW06R
Small Weapons, Parcel 66(7)
McClellan, Anniston, Alabama



MATRIX ENVIRONMENTAL

Figure 5: Volatile Concentrations in Transition Well
PPMP-66-MW23 / PPMP-66-MW23R
Small Weapons, Parcel 66(7)
McClellan, Anniston, Alabama



Matrix ENVIRONMENTAL

Figure 6: Volatile Concentrations in Transition Well
PPMP-66-MW24 / PPMP-66-MW24R
Small Weapons, Parcel 66(7)
McClellan, Anniston, Alabama

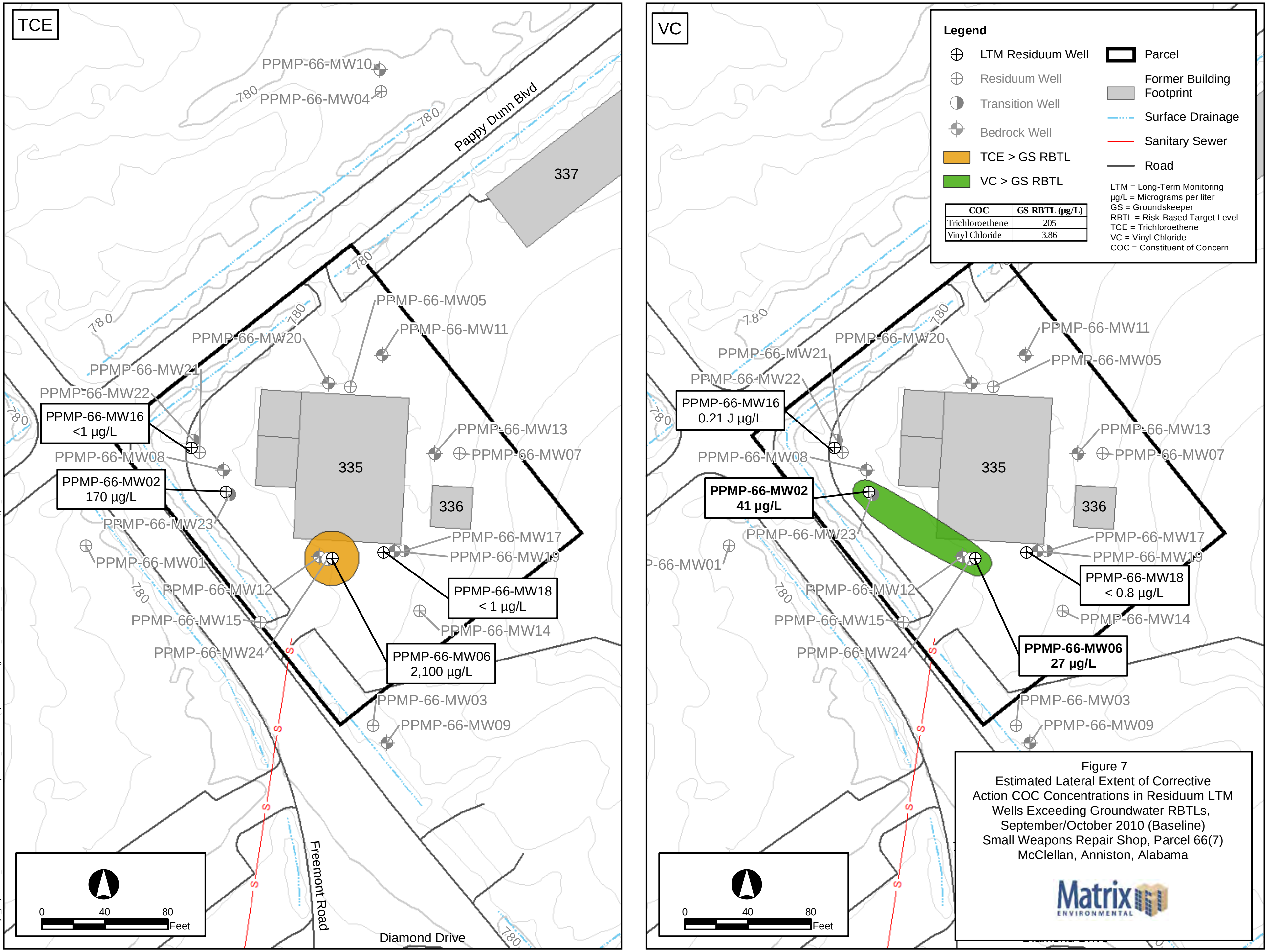


Figure 7
Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, September/October 2010 (Baseline)
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

FILE: G:\gis_projects\Fort_McClellan\03.094.007\active\apps\Small_Weapons-66(7)\CMIR\2014\Figure4-9_Residuum_RBTL_Baseline.mxd, 3/21/2014, jeff_clonts

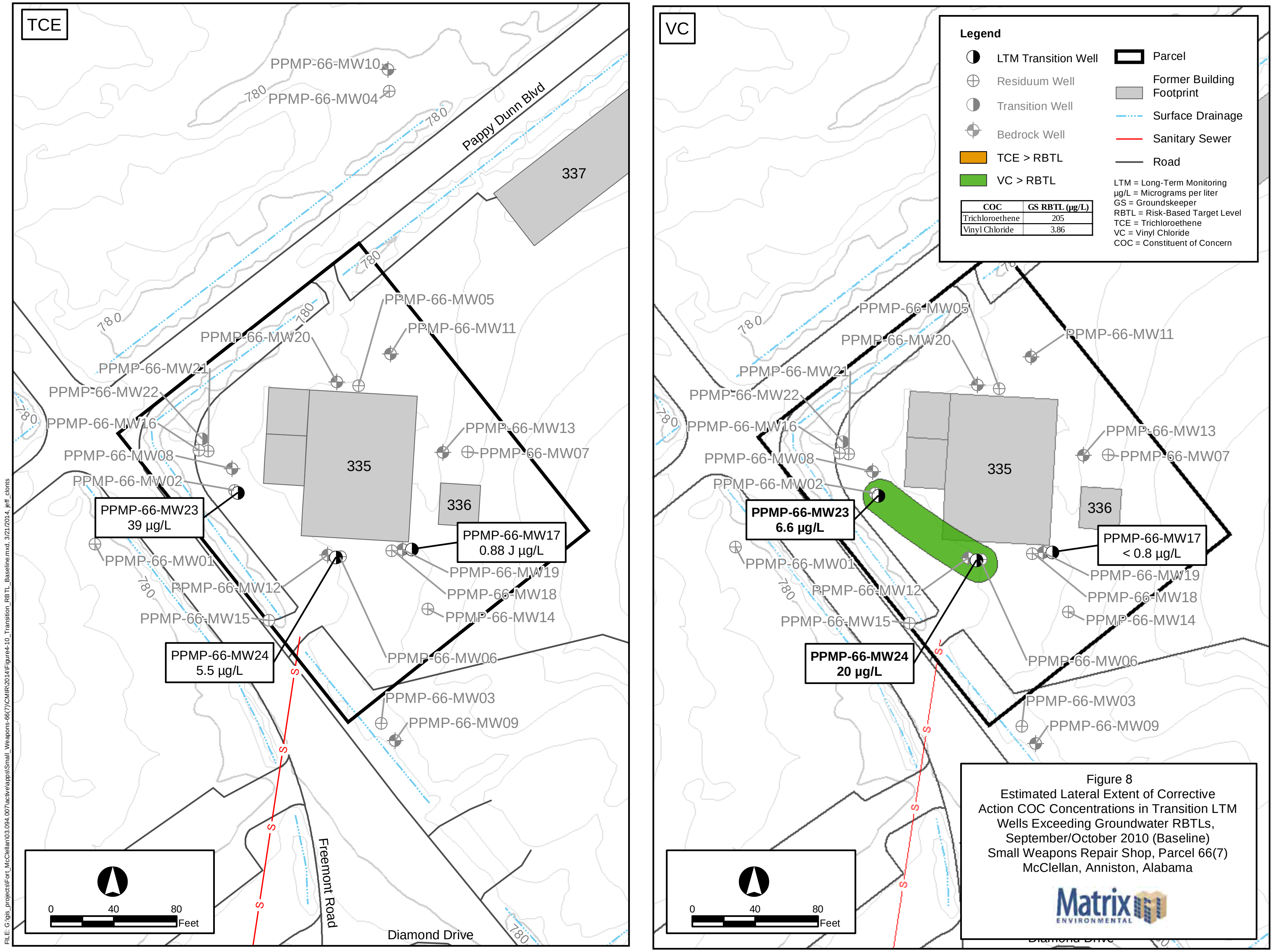


Figure 8
Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, September/October 2010 (Baseline)
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

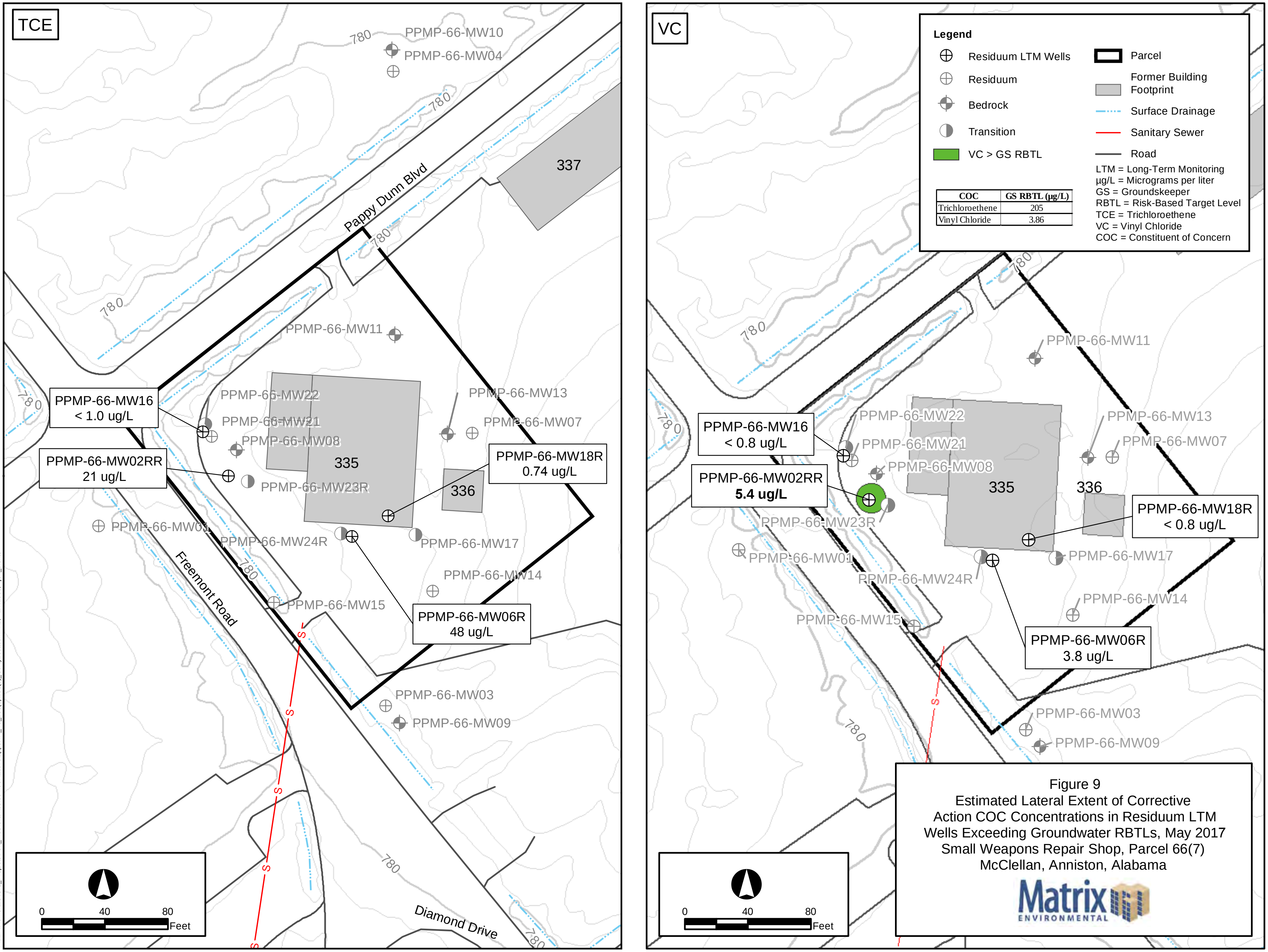
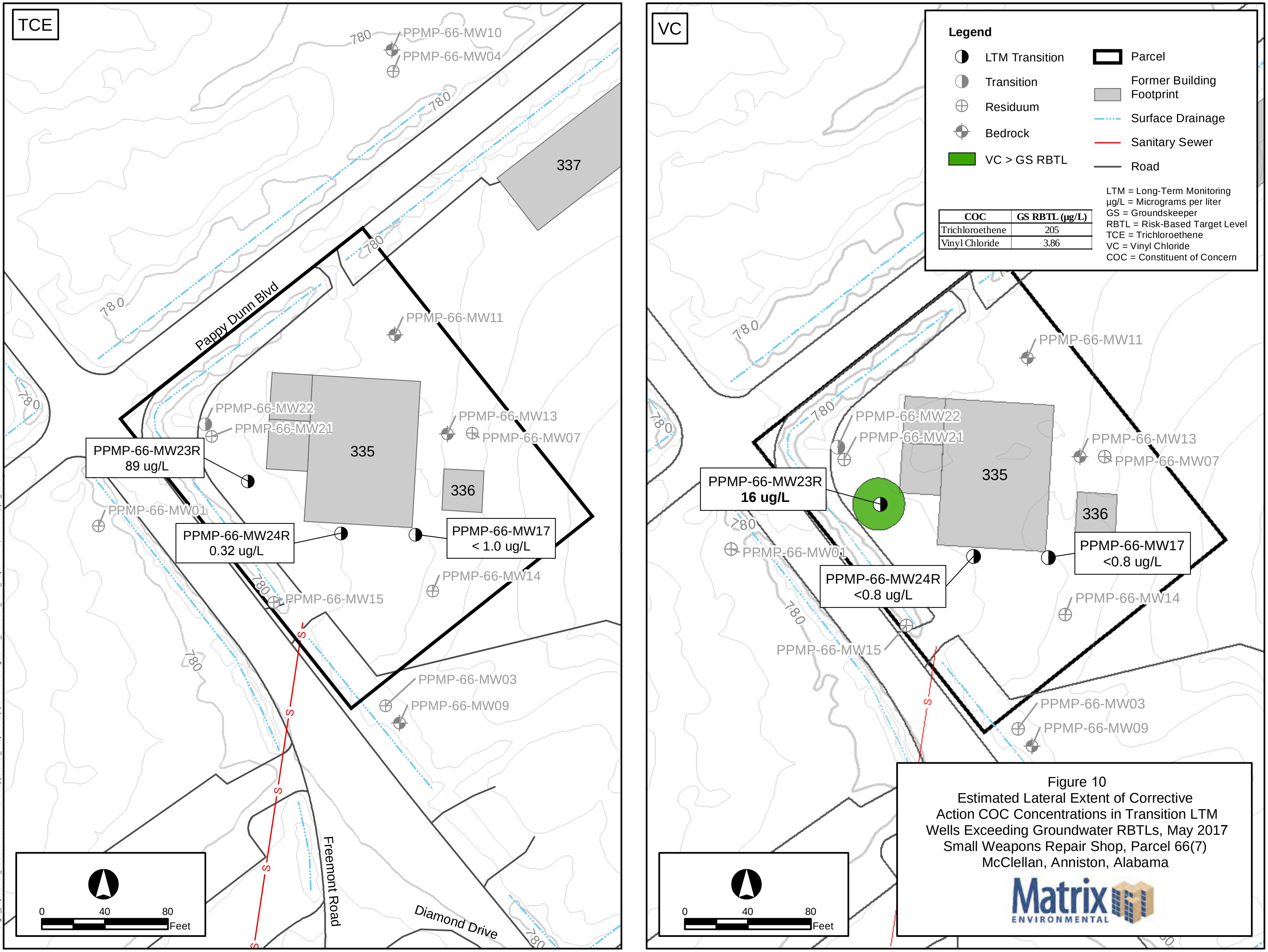


Figure 9
Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, May 2017
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama



COC	GS RBTL (µg/L)
Trichloroethene	205
Vinyl Chloride	3.86

Figure 10
Estimated Lateral Extent of Corrective
Action COC Concentrations in Transition LTM
Wells Exceeding Groundwater RBTLs, May 2017
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

FILE: G:\gis_projects\Fort_McClellan\03.094.007\active\apps\Small_Weapons-66(7)\CMR\2017\Figure4-12_Transition_RBTL_May2016.mxd, 4/11/2017, jeff_clonts

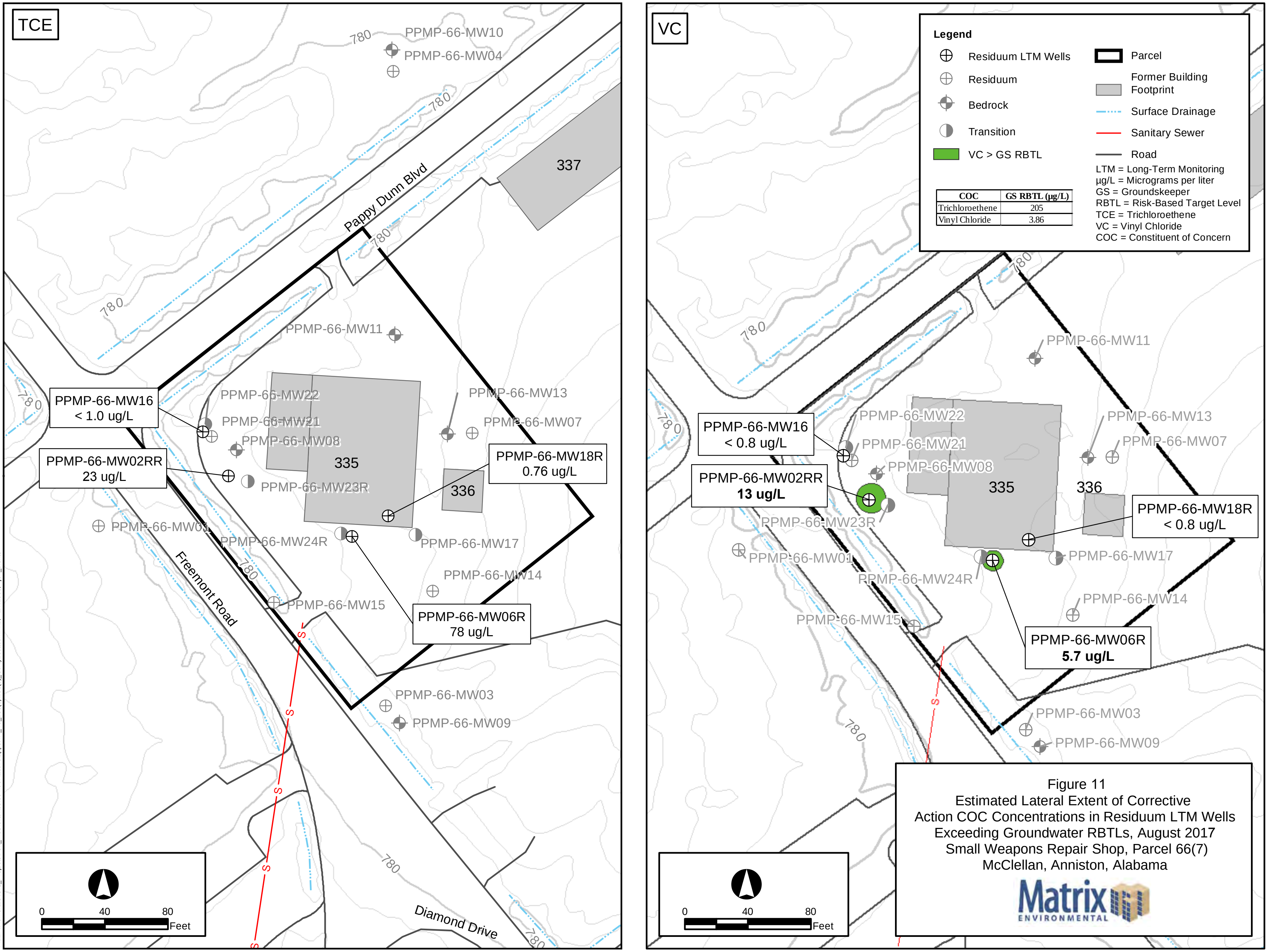


Figure 11
Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, August 2017
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

Matrix ENVIRONMENTAL

FILE: \\Hemera\G\GIS_Projects\Fort_McClellan\03.094.007\active\apps\TA_T6_183(6)\183(6)_UtilityLocation.mxd, 1/7/2008, jeff_clonts

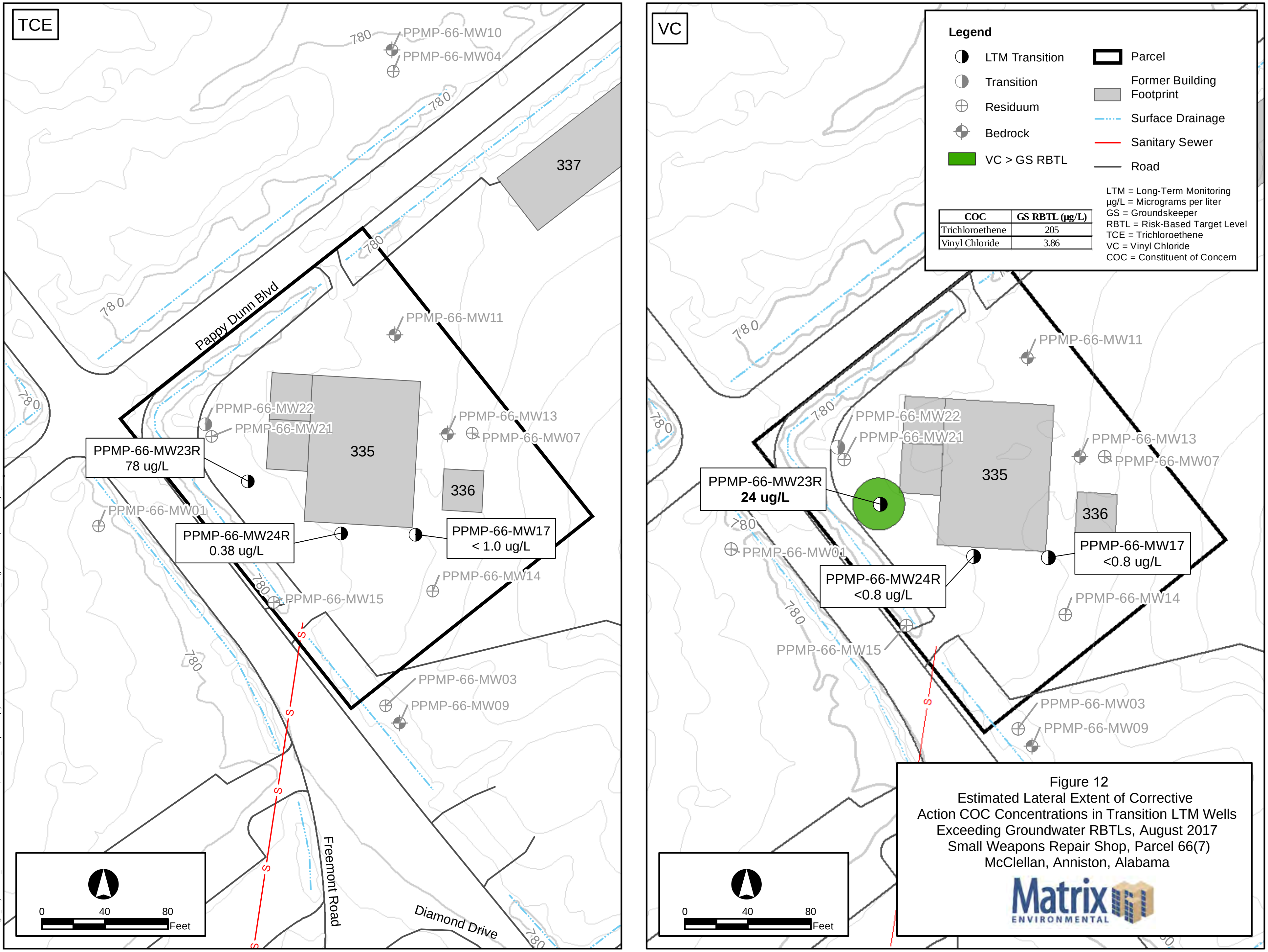


Figure 12
Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, August 2017
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

FILE: G:\gis_projects\Fort_McClellan\03.094.007\active\apps\Small_Weapons-66(7)\CMIR\2017\Figure4-14_Transition_RBTL_August2016.mxd, 4/11/2017, jeff_clonts

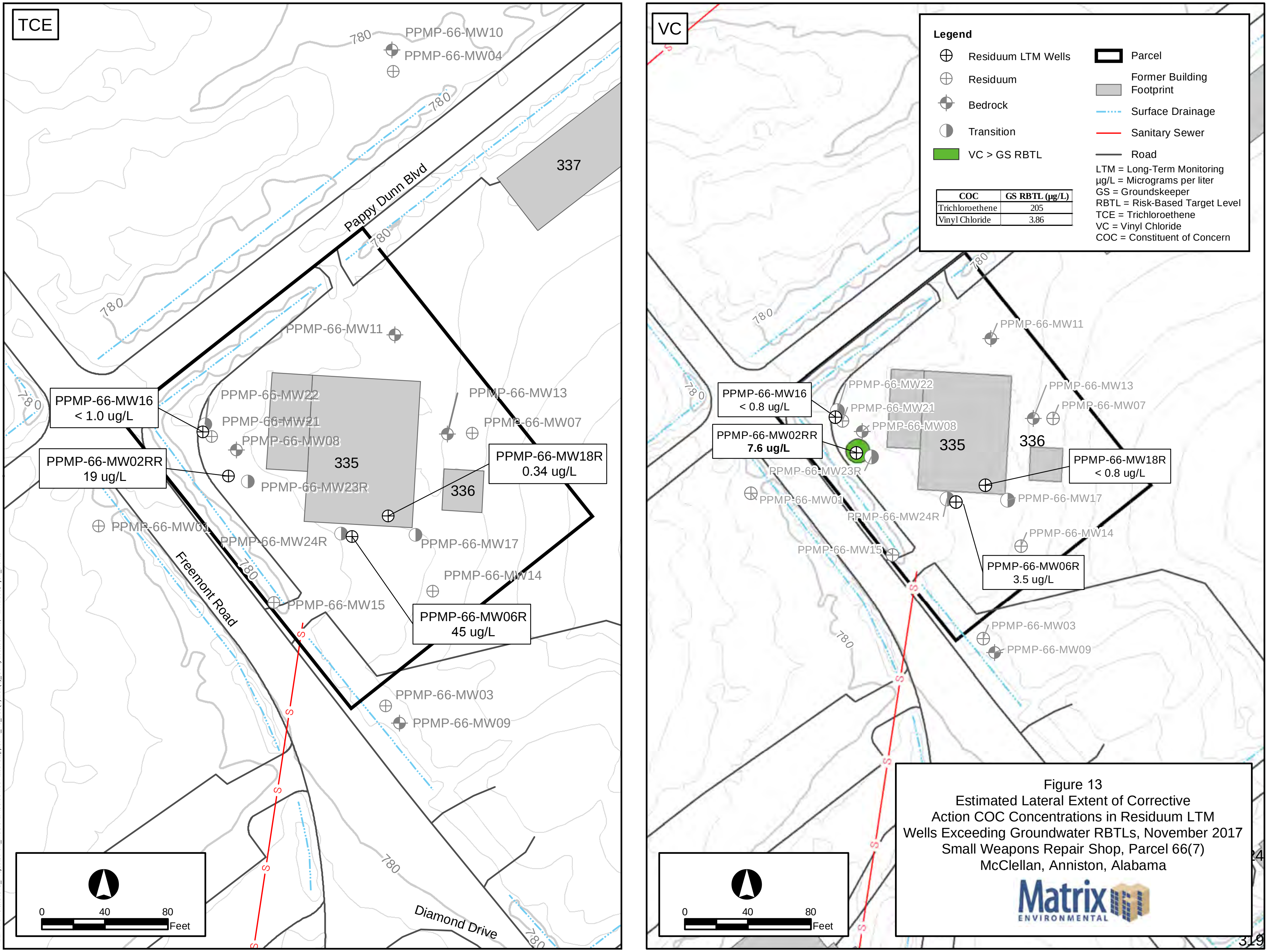


Figure 13
Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, November 2017
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

FILE: \\Hemera\GIS\GIS_Projects\Fort_McClellan\03.094.007\active\apps\TA_T6_183(6)\183(6)_UtilityLocation.mxd, 1/7/2008, jeff_clonts

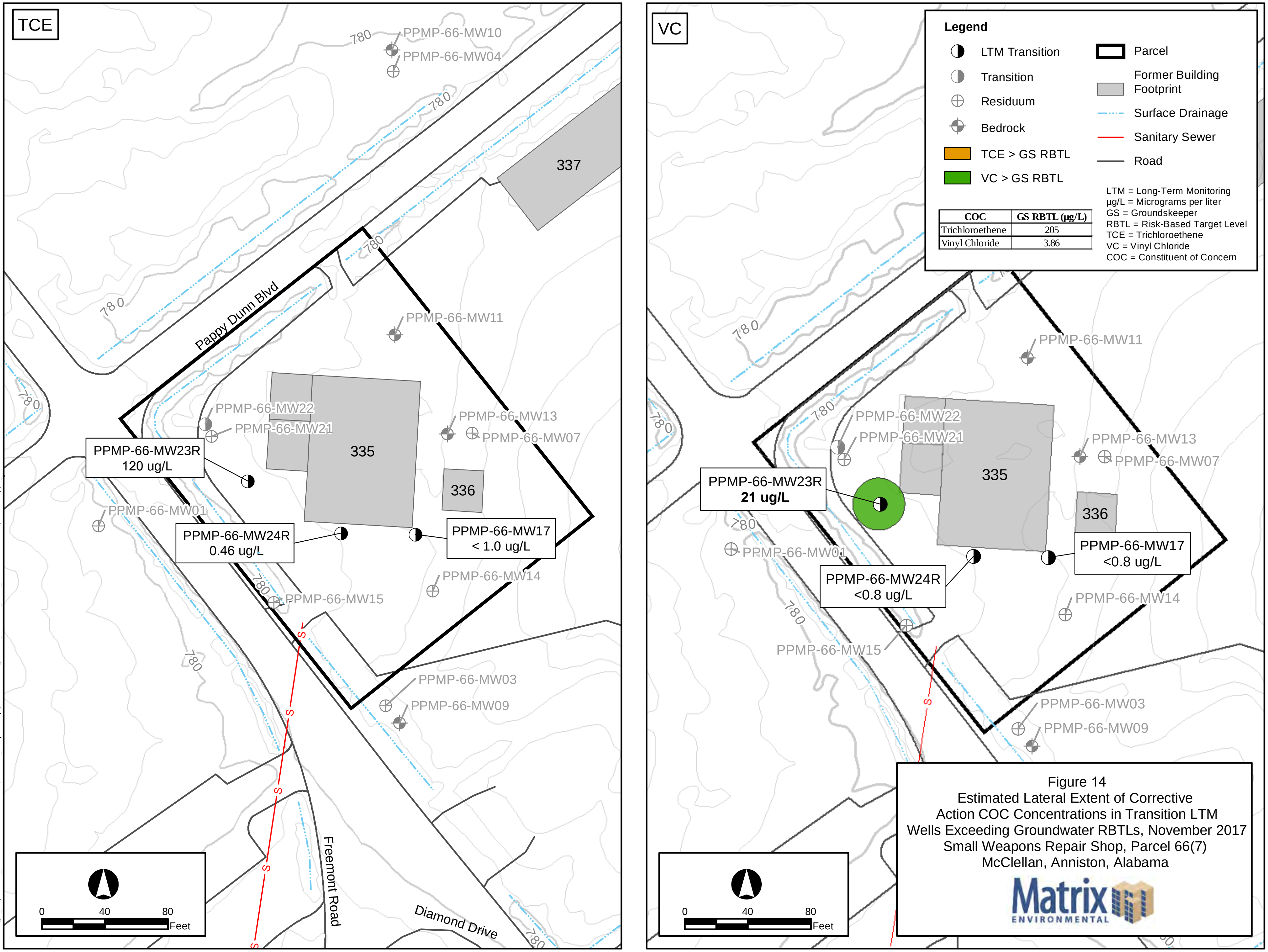


Figure 14
Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, November 2017
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

FILE: G:\gis_projects\Fort_McClellan\03.094.007\active\apps\Small_Weapons-66(7)\CMR\2017\Figure4-16_Transition_RBTL_November2016.mxd, 4/11/2017, jeff_clonts

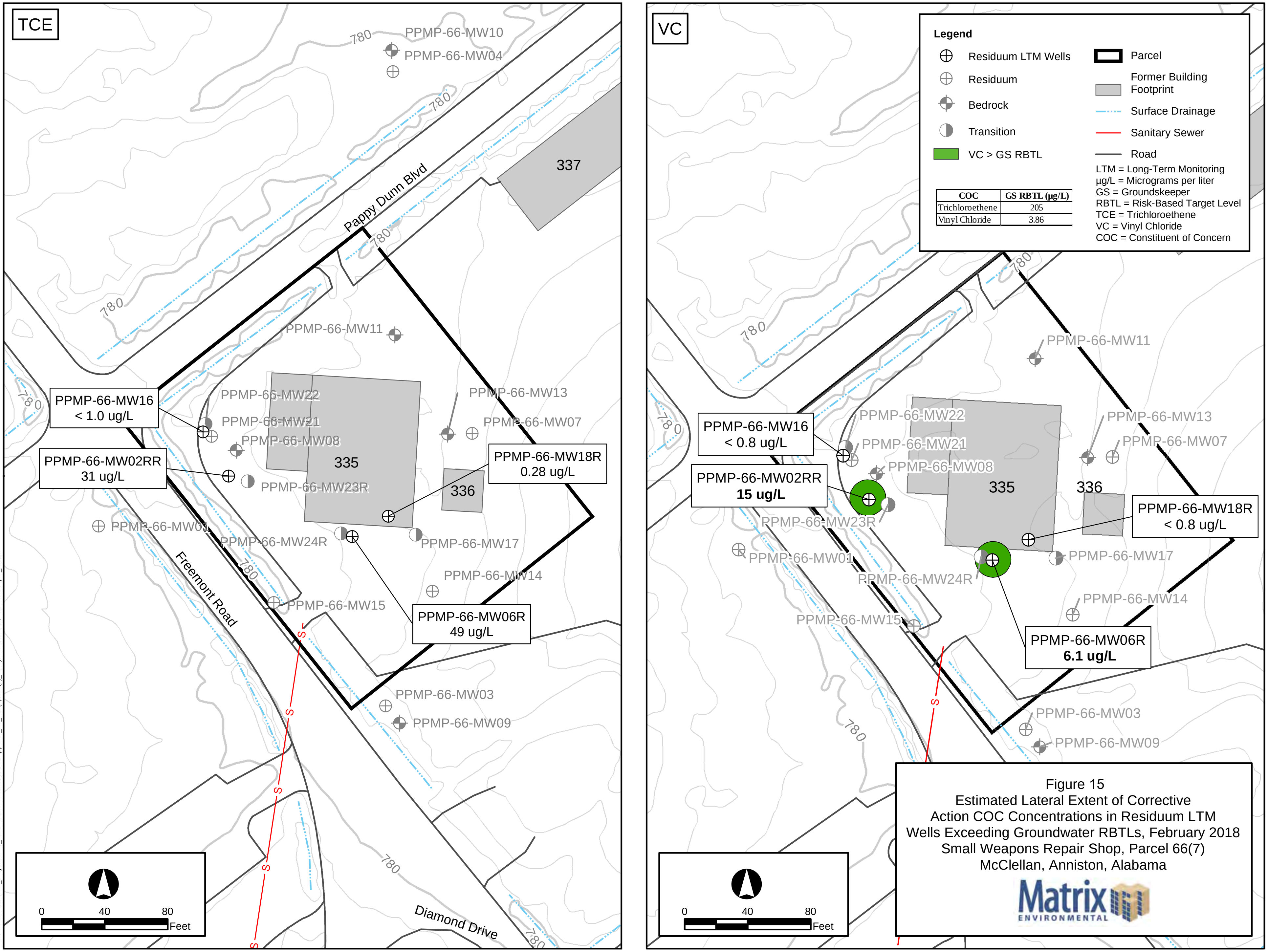
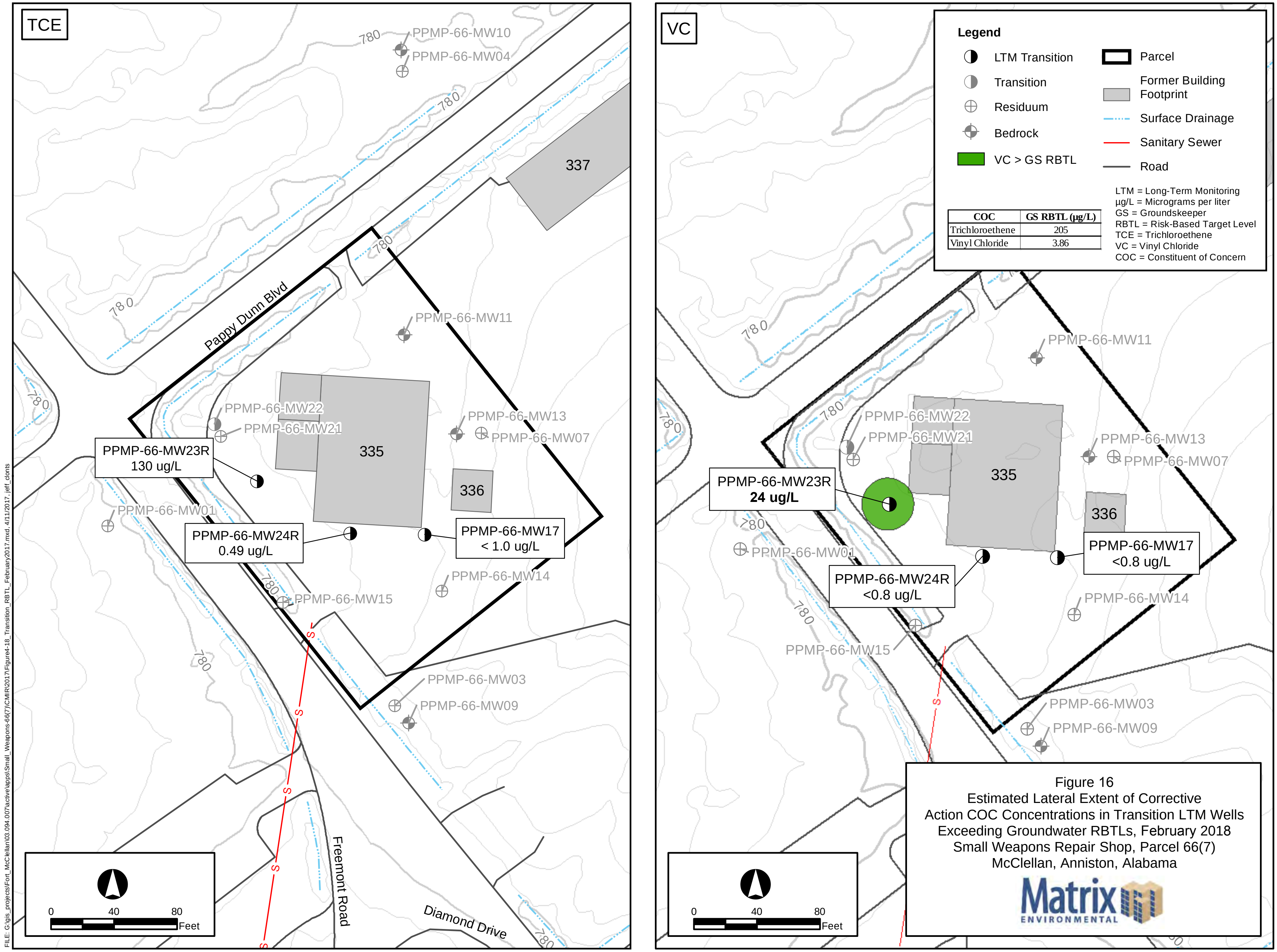


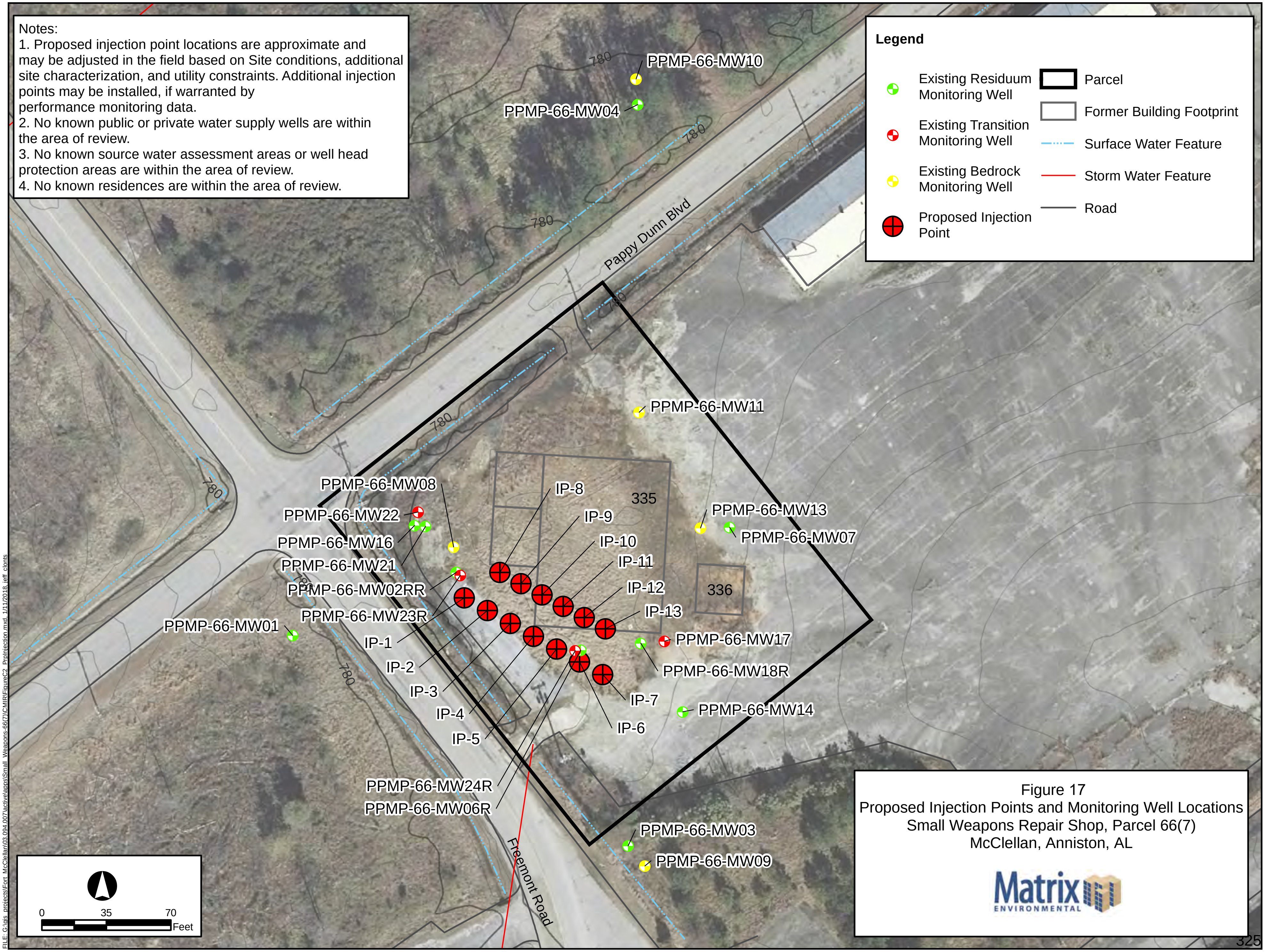
Figure 15
Estimated Lateral Extent of Corrective Action COC Concentrations in Residuum LTM Wells Exceeding Groundwater RBTLs, February 2018
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama

FILE: \\Hemera\G\GIS_Projects\Fort_McClellan\03.094.007\active\apps\TA_T6_183(6)\183(6)_UtilityLocation.mxd, 1/7/2008, jeff_clonts



COC	GS RBTL (µg/L)
Trichloroethene	205
Vinyl Chloride	3.86

Figure 16
Estimated Lateral Extent of Corrective Action COC Concentrations in Transition LTM Wells Exceeding Groundwater RBTLs, February 2018
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, Alabama



Notes:
1. Proposed injection point locations are approximate and may be adjusted in the field based on Site conditions, additional site characterization, and utility constraints. Additional injection points may be installed, if warranted by performance monitoring data.
2. No known public or private water supply wells are within the area of review.
3. No known source water assessment areas or well head protection areas are within the area of review.
4. No known residences are within the area of review.

Legend

- Existing Residuum Monitoring Well
- Existing Transition Monitoring Well
- Existing Bedrock Monitoring Well
- Proposed Injection Point
- Parcel
- Former Building Footprint
- Surface Water Feature
- Storm Water Feature
- Road

0 35 70 Feet

Figure 17
Proposed Injection Points and Monitoring Well Locations
Small Weapons Repair Shop, Parcel 66(7)
McClellan, Anniston, AL

Matrix ENVIRONMENTAL

FILE: G:\gis_projects\Fort_McClellan\03.094.007\active\apps\Small_Weapons-66(7)\CMIR\FigureC2_PrpInjection.mxd, 1/11/2018, jeff_clonts

Appendix A

APPENDIX A

ISCO Technology Loading Calculations

Date:	October 7, 2015
Client:	Matrix Design Group
Site ID:	Small Weapons Repair Shop
Address:	McClellan Anniston, AL
Calc. by:	R Evans

► Instructions:

This is the primary data input sheet for the site information and estimated volume of impacted soil and groundwater. Chemical Oxygen Demand (COD) is also input on this page. These calculations are for saturated zone remediation. This estimate tool is intended to provide estimates of oxidant demand and not to determine the number and location of injection points.

► Total Volume of Estimated Saturated Impact:

Width:	25	ft.
Length:	120	ft.
Thickness of Saturated Impacted Zone:	22	ft.
Total Estimated Volume of Impacted Soil:	66,000	ft^3

► Total Volume of Impacted Groundwater:

Volume of Saturated Zone Impact:	66,000	ft^3
General Soil Type:		
Typical Porosity Range:	10 to 30	%
Porosity of Saturated Zone:	20	%
Estimated Volume of Groundwater:	13,200	ft^3
=	373,782	L
=	98,743	gallons

► Total Mass of Impacted Soil:

Typical Dry Bulk Density Range of Soil:	85 to 138	lb/ft^3
Dry Bulk Density of Soil:	111.5	lb/ft^3
Total Mass of Soil:	7,359,000	lbs
=	3,338,042	kg

► Dissolved-Phase Chemical Oxidation Demand (COD):

Impacted GW Chemical Oxygen Demand:	5.00	mg/L as oxygen
Total Mass of Chemical Oxygen Demand:	4.1	lb as Oxygen
Moles of Chemical Oxygen Demand:	0.1	lb-mol as Oxygen

► Soil Organic Carbon Inputs:

Total Organic Carbon (TOC):	2,000	mg/kg
Fraction Organic Carbon (foc):	0.002	g/g

Appendix A (Continued)

ISCO Technology Loading Calculations

Date:	October 7, 2015
Client:	Matrix Design Group
Site ID:	Small Weapons Repair Shop
Address:	McClellan Anniston, AL
Calc. By:	R Evans

► Instructions

This input sheet is only used when soil data is not available. It is always preferable to calculate oxidant demand from saturated soil data rather than dissolved-phase (groundwater) data. The calculations on this page use the input groundwater concentration, COC properties, and fraction of organic carbon to estimate the mass of each COC in soil. The COCs are grouped below (e.g., VOCs, SVOCs, Chlorinated) and drop down menus are available for common COCs. If COCs not included in the list are needed, the COC name can be typed in column B and the organic carbon partition coefficient (Koc)for that COC must be entered in column F. These calculations may not be applicable if NAPL is present.

► Groundwater Concentration to Soil Equivalent Concentration Estimate

Mass of Impacted Soil: 7,359,000 lb

	Contaminants of Concern	Groundwater Concentration (mg/L)	X	Organic Carbon Partition Coefficient (Koc)	X	Fraction of Organic Carbon (foc)	=	Concentration Adsorbed (mg/kg)	
VOCs				0.0				0.0000	
VOCs				0.0				0.0000	
VOCs				0.0				0.0000	
VOCs				0.0				0.0000	
VOCs				0.0				0.0000	
VOCs				0.0				0.0000	
SVOCs				0.0				0.0000	
SVOCs				0.0				0.0000	
SVOCs				0.0				0.0000	
SVOCs				0.0		0.0020		0.0000	
SVOCs				0.0				0.0000	
SVOCs				0.0				0.0000	
Chlorinated	VC	0.0540		10.0				0.0011	MW-23R, highest concentration
Chlorinated	TCE	0.2100		93.0				0.0391	in last 4 sampling events.
Chlorinated				0.0				0.0000	
Chlorinated				0.0				0.0000	
Chlorinated				0.0				0.0000	
TPH-GRO	TPH-GRO			0.0				0.0000	
TPH-DRO	TPH-DRO			0.0				0.0000	

Appendix A (Continued)

ISCO Technology Loading Calculations

Date:	October 7, 2015
Client:	Matrix Design Group
Site ID:	Small Weapons Repair Shop
Address:	McClellan Anniston, AL
Calc. By:	R Evans

▶ Instructions

Saturated Soil data is the recommended method of oxidant demand calculation. The calculations on this page use the input adsorbed-phase COC concentration and COC properties to calculate the oxidant demand in terms of oxygen required (column L). If laboratory soil data is available, use the "soil data" column for data entry. For petroleum sites, it is recommended that TPH data is used instead of individual COCs (VOCs and SVOCs). If TPH data is entered, the "Mass of COC" and "Mass Oxygen Req." will only use the TPH data and chlorinated data (if applicable). **If the Groundwater COC Inputs tab was used, do not enter information on this tab, move to the HypeAir Oxidant Demand tab.**

▶ Soil Oxygen Demand Calculation

Mass of Soil: 7,359,000 lb

	Contaminants of Concern	Soil Conc. from GW (mg/kg)	Soil Conc. (soil data) (mg/kg)	# Hydrogen	# Carbon	# Chlorine /Bromine/ Nitrogen	# Oxygen	MW	Oxygen Mole Ratio	Oxygen Mass Ratio	Mass of COC (lb)	Mass Oxygen Req. (lb)
VOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
VOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
VOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
VOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
VOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
VOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
SVOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
SVOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
SVOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
SVOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
SVOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
SVOCs		0	0	0	0	0	0	0	0	0.00	0.00	0.00
Chlorinated	VC	0.00108	0	3	2	1	0	62.5	2.75	1.41	0.01	0.01
Chlorinated	TCE	0.03906	0	1	2	3	0	131.5	2.25	0.55	0.29	0.16
Chlorinated		0	0	0	0	0	0	0	0	0.00	0.00	0.00
Chlorinated		0	0	0	0	0	0	0	0	0.00	0.00	0.00
Chlorinated		0	0	0	0	0	0	0	0	0.00	0.00	0.00
TPH-GRO	TPH-GRO	0	0	N/A	N/A	N/A	N/A	N/A	N/A	3.25	0.00	0.00
TPH-DRO	TPH-DRO	0	0	N/A	N/A	N/A	N/A	N/A	N/A	3.25	0.00	0.00
										TOTAL:	0.30	0.17

Date:	October 7, 2015
Client:	Matrix Design Group
Site ID:	Small Weapons Repair Shop
Address:	McClellan Anniston, AL
Calc. By:	R Evans

▶ Total Volume of Estimated Saturated Impact:

Width:	25	ft.
Length:	120	ft.
Thickness of Saturated Impacted Zone:	22	ft.
Total Estimated Volume of Impacted Soil:	66,000	ft^3

▶ Total Volume of Impacted Groundwater:

Volume of Saturated Zone Impact:	66,000	ft^3
Typical Porosity Range:	10	%
Porosity of Saturated Zone:	20	%
Estimated Volume of Groundwater:	98,743	gallons

▶ Total Mass of Impacted Soil:

Dry Bulk Density of Soil:	112	lb/ft^3
Total Mass of Soil:	7,359,000	lbs

▶ Oxidant Demand Calculation

Mass of Oxygen Required to Oxidize Total GW COD:	4.1	lb
Mass of Oxygen Required to Oxidize Soil COCs:	0	lb
Total Oxygen Required (100% efficiency):	4	lb
Moles Oxygen Required (100% efficiency):	0.1	lb-mole

Appendix A (Continued)

ISCO Technology Loading Calculations

Date:	October 7, 2015
Client:	Matrix Design Group
Site ID:	Small Weapons Repair Shop
Address:	McClellan Anniston, AL
Calc. By:	R Evans

▶ Sodium Persulfate ($Na_2S_2O_8$) Volume Calculation

Assumptions

1. *Other oxidizers are not used in conjunction with sodium persulfate.*
2. *COC reacts directly with persulfate.*
3. *Sodium Persulfate transfers 2 electrons per molecule.*
4. *Biodegradation not accounted for on this spreadsheet.*
5. *Not all natural organic and inorganic oxidant demand may be accounted for.*
6. *If assumption 2 is not correct, then provisions for generating sulfate radicals will be necessary.*

Sodium Persulfate Molecular Weight:	238	lb/lb-mole
# of Oxygen Atoms Available per $Na_2S_2O_8$ Molecule:	1	
Mass Percent Sodium Persulfate Available as Oxygen:	6.7%	
Sodium Persulfate Efficiency:	100%	
Mass Sodium Persulfate Required for COCs:	64	lb
Soil Oxidant Demand Estimate:	1	g Sodium Persulfate/kg Soil
Mass Sodium Persulfate Required for SOD:	7,359	lb Sodium Persulfate

▶ Sodium Persulfate Injection Rate

Assumptions

1. *Sodium Persulfate is without an activator.*
2. *Sodium Persulfate can be delivered dry or as a solution.*

Mass Sodium Persulfate Required:	8,300	lb
Sodium Persulfate Concentration (wt/wt):	10%	
Mass Sodium Persulfate Required:	8,300	lb
Bag Size (in pounds):	55	lb
Number of Bags Required:	151	

Increased mass to achieve 10% pore volume of liquid oxidant injection

Sodium Persulfate Delivery Concentration (wt/wt):	10%	
Volume Sodium Persulfate Solution Required for Delivery:	9,825	gal

Number of Simultaneous Sodium Persulfate Injection Wells:	6	
Liquid Flow Rate per Injection Well:	0.75	gal/min
Number of Total Hours of Site Time:	10	hrs/day
Maximum Duration of Injection Well Operation:	7	hrs/day
Injection Concentration:	10%	
Total Liquid Volume:	9,825	gal
Sodium Persulfate Flow Rate per Day:	1,890	gal/day
Total Injection Time Needed:	6.0	days

▶ Sodium Persulfate Activation Methods

See the following section on activation methods considerations for additional information on activation method implementation.

Hydrogen Peroxide

Assumptions

1. *All Hydrogen Peroxide reacts with Sodium Persulfate.*
2. *This calculation does not account for the effects of Hydrogen Peroxide.*

Mass Sodium Persulfate Required:	8,300	lb
Hydrogen Peroxide Molecular Weight:	34	lb/lb-mole
Peroxide to Sodium Persulfate Mole Ratio:	5 1	
Moles of Sodium Persulfate:	34.9	
Moles of Hydrogen Peroxide:	174.4	
Hydrogen Peroxide Demand for Sodium Persulfate Activation:	5,929	lb
Hydrogen Peroxide Concentration (wt/wt):	31.0%	
Injection Density:	9.45	lb/gal
Amount of Solution Needed:	2,023	gal

Considerations for Activation with Hydrogen Peroxide

1. Hydrogen peroxide can be injected after injecting sodium persulfate or can be mixed ex-situ with sodium persulfate and co-injected.
2. It is recommended that if the sodium persulfate and 8 wt% hydrogen peroxide solution are added: -
No more than **5 gallons** of 8% hydrogen peroxide should be added per gallon of 30% sodium persulfate solution. - No
more than **3 gallons** of 8% hydrogen peroxide should be added per gallon of 20% sodium persulfate solution. -
No more than **2 gallons** of 8% hydrogen peroxide should be added per gallon of 10% sodium persulfate solution.
(FMC Corporation Klozur Activation Procedures)

Process of Activating with Hydrogen Peroxide

This calculation does not account for the hydroxyl radicals generated from the hydrogen peroxide that will also react with contaminant mass and other organic matter. *Hydroxyl radicals can initiate persulfate radical formation, and persulfate radicals can stimulate formation of hydroxyl radicals. Hydrogen peroxide may react directly with contaminants in addition to the persulfate, yielding either a higher efficiency in destroying reactive and recalcitrant contaminants. (Novel Activation Technologies for Sodium Persulfate In Situ Chemical Oxidation, FMC and ERM, 2004.)*