

**From:** Brookshire, Mary Ann <maryann.brookshire@wsp.com>

**Sent:** Thursday, February 16, 2023 10:42 AM

**To:** Kuhn, Kimberly M. <kuhnkm@dhec.sc.gov>

**Cc:** Berresford, James <berresjl@dhec.sc.gov>; Northern, Carol <carol.northern@wsp.com>; Yeh, Ariel <ariel.yeh@lennoxintl.com>

**Subject:** Former Ducane Company Site; Voluntary Cleanup Contract 16-5848-RP; File #401356; Feasibility Study Work Plan

**\*\*\* Caution. This is an EXTERNAL email. DO NOT open attachments or click links from unknown senders or unexpected email. \*\*\***

Hi Kim,

The Feasibility Study Work Plan for the Former Ducane Company Site in Blackville, SC is attached for your review.

Please let me know if you have any questions regarding the work plan or the project in general.

Thanks,  
Mary Ann



**Mary Ann Brookshire**

Senior Lead Consultant, Environmental Science  
CHMM

T+ 1 678-569-2880

F+ 1 770-973-7395

M+ 1 404-317-7748

WSP USA (formerly EarthCon Consultants, Inc.)  
1880 West Oak Pkwy  
Suite 100, Building 106  
Marietta, GA 30062



February 16, 2023

Ms. Kimberly Kuhn  
South Carolina Department of Health and Environmental Control  
Bureau of Land and Waste Management  
2600 Bull Street  
Columbia, South Carolina 29201

Subject: **Feasibility Study Work Plan**  
Former Ducane Company Site  
Blackville, Barnwell County, South Carolina  
BLWM File # 401356  
WSP Project No. EC02.20160378.21

Dear Ms. Kuhn:

On behalf of our client Lennox International Inc. (Lennox), WSP USA Inc. (WSP) is submitting the enclosed *Feasibility Study Work Plan* for the former Ducane Company Site located in Blackville, Barnwell County, South Carolina (BLWM File # 401356). This plan is being submitted in accordance with the requirements of Voluntary Cleanup Contract 16-5848-RP executed on November 17, 2016.

Please free to call us at (770) 973-2100 if you have any questions or if we can provide any additional information.

Respectfully submitted,  
**WSP USA INC.**

Carol D. Northern  
Project Principal

Steve Diamond, P.E. (SC #23810)  
Senior Engineer

cc: Ms. Ariel Yeh, Senior Manager for Environmental Sustainability, Lennox International, Inc.

WSP USA  
1880 West Oak Parkway  
Building 100, Suite 106  
Marietta, GA 30062

Tel: +1-770-973-2100  
wsp.com



## **FEASIBILITY STUDY WORK PLAN**

**FORMER DUCANE COMPANY SITE  
118 WEST MAIN STREET  
BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA  
BLWM FILE #401356**

**PREPARED FOR:**

**LENNOX INTERNATIONAL, INC.  
2140 Lake Park Boulevard  
Richardson, Texas 75080**

**PREPARED BY:**

**WSP USA INC  
1880 West Oak Parkway  
Building 100, Suite 106  
Marietta, Georgia 30062  
770-973-2100**

**WSP Project No. EC02.20160378.21**

**February 2023**



## CONTENTS

<b>1.0</b>	<b>INTRODUCTION</b> .....	<b>1</b>
1.1	Scope and Objectives .....	1
1.2	Site Location .....	1
1.3	Regulatory Background .....	1
<b>2.0</b>	<b>SITE BACKGROUND</b> .....	<b>2</b>
<b>3.0</b>	<b>GROUNDWATER MONITORING</b> .....	<b>5</b>
3.1	Aromatic Hydrocarbons .....	5
3.2	Chlorinated VOCs .....	6
3.3	Other Constituents .....	8
<b>4.0</b>	<b>GROUNDWATER PLUME ANALYTICS® EVALUATION</b> .....	<b>9</b>
4.1	Groundwater Plume Analytics® Results .....	9
4.2	MNA Parameters .....	10
4.3	Lower Shallow Aquifer Wells (i.e., “D” wells).....	11
4.4	Summary .....	11
4.5	Recommendations from the 2022 Updated Assessment Report .....	12
<b>5.0</b>	<b>FEASIBILITY STUDY APPROACH</b> .....	<b>12</b>
5.1	Constituents of Concern.....	13
5.2	Remedial Action Objectives .....	13
5.3	Remediation Goals .....	13
5.4	Evaluation Criteria.....	14
<b>6.0</b>	<b>IDENTIFICATION OF POTENTIAL REMEDIAL ALTERNATIVES</b> .....	<b>15</b>
6.1	No Action .....	15
6.2	Institutional Controls .....	15
6.3	Monitored Natural Attenuation .....	15
6.4	Treatment .....	16
<b>7.0</b>	<b>REFERENCES</b> .....	<b>16</b>



## **TABLES**

Table 1	Summary of Detected Groundwater Analytical Results - Organics
Table 2	Groundwater MNA Results
Table 3	Groundwater Level Measurements

## **FIGURES**

Figure 1	Site Location Map
Figure 2	Monitoring Well and Soil Boring Locations
Figure 3	Potentiometric Surface Map – April 18, 2022
Figure 4	Groundwater Analytical Results Aromatic Hydrocarbons – April 2022
Figure 5	Groundwater Analytical Results Chlorinated VOCs and 1,4-Dioxane – April 2022

## **APPENDICES**

Appendix A	Groundwater Historical Data Summary
------------	-------------------------------------

## 1.0 INTRODUCTION

### 1.1 Scope and Objectives

The Feasibility Study (FS) Work Plan has been prepared on behalf on Lennox International, Inc. (Lennox) to propose remedial alternatives to be evaluated as part of an FS. The *FS Work Plan* is based on environmental assessments conducted at the Site from 1999 to 2022 and a Plume Analytics® evaluation of the historical groundwater data. The FS is being conducted to reduce concentrations of volatile organic compounds (VOCs) at the Site to allow natural attenuation of the groundwater.

### 1.2 Site Location

The former Ducane Company Site (the Site) is located at 118 West Main Street in Blackville, South Carolina (Figure 1). The Site consists of approximately 105 acres with about 19 acres developed with a production building and a research and development building. The Site is identified by Barnwell County as consisting of three parcels owned by the Barnwell County Economic Development Corporation. Two of the parcels are leased to PineView Buildings for the production of wooden storage buildings and Pegasus for warehouse storage (Figure 2).

### 1.3 Regulatory Background

On November 17, 2016, Lennox entered into Voluntary Cleanup Contract 16-5848-RP (the Contract) with the South Carolina Department of Health and Environmental Control (DHEC). In accordance with the Contract requirements, comprehensive groundwater sampling of Site wells was conducted from January 30 to February 2, 2017. The groundwater samples were analyzed for VOCs to update the status of the known plume and select wells were also analyzed for Target Analyte List (TAL) metals. The results of the comprehensive groundwater sampling event were presented in an Assessment Report dated March 24, 2017. Based on the sampling event results and the subsequent Plume Analytics® study, the Assessment Report proposed conducting semi-annual groundwater sampling for a period of two years (four total sampling events). The Assessment Report also recommended minor repairs to monitoring wells and the installation of one additional monitoring well (MW-16) north of MW-3 to address a data gap identified during the Plume Analytics® study. DHEC approved the Assessment report in letters dated May 8 and June 1, 2017.

The four semi-annual groundwater sampling events were conducted at the Site in October 2017, March 2018, October 2018 and March 2019. Groundwater sampling was conducted as described in the March 2017 *Assessment Report* and the *Work Plan for Monitoring Well Installation* dated June 29, 2017 and approved by DHEC on July 17, 2017. The results for the first three semi-annual groundwater sampling events were provided to DHEC in Semi-Annual Monitoring Reports dated January 30, 2018, July 23, 2018, and January 24, 2019. The results of the fourth semi-annual groundwater sampling event conducted in March 2019 along with the updated Plume Analytics® study were provided to DHEC in the *Updated Assessment Report* dated July 26, 2019.

A meeting was held on August 28, 2019 to discuss future Site activities. As a result of that meeting, Lennox agreed to install one additional monitoring well (MW-17), redevelop monitoring well MW-4D, conduct one additional year of semi-annual groundwater sampling and update the Plume Analytics® study with the additional groundwater analytical results. The *Updated Assessment Report* and the additional Site activities were approved by DHEC in a letter dated August 29, 2019.

Additional groundwater sampling events were conducted in October 2019, April 2020, June 2021, and April 2022. Updates to the reports were provided in July 2019, September 2020, October 2021, and September 2022. Additional assessment activities were conducted in June 2021 to delineate contaminants in groundwater near monitoring well MW-3 and assess potential sources of contamination. The results of the additional activities conducted in 2021 were presented to DHEC during a December 15, 2021, meeting.

The most recent *Updated Assessment Report* for the Former Ducane Company Site (BLWM File #401356) was submitted on September 28, 2022. This report presented the results of the 2022 additional assessment activities and provides an updated Plume Analytics® study. Additional activities were recommended in a November 15, 2022 meeting with DHEC. Recommendations included preparation of this *FS Work Plan*.

## 2.0 SITE BACKGROUND

Assessment and remediation activities have been ongoing at the Site since 1999. Constituents detected in Site soils and groundwater included chlorinated volatile organic compounds (CVOCs) and aromatic hydrocarbons. The five source areas originally identified at the site in the Former Ducane Monitoring Report (ERM 2007) are shown on Figure 2 and include:

	Location	Comments	Constituents of Concern
1	Material Receiving Area	The source area is at a drainage ditch at the southern central portion of the property boundary extending to the south-central portion of the production building.	CVOCs and aromatic hydrocarbons
2	West Loading Dock	Downgradient portion of the contaminant plume located west of the facility.	CVOCs
3	Drum Storage Area	Source area located east of the building, where a former solvent storage area and hazardous waste drum storage area were located. A documented release of naphtha occurred in 1999.	CVOCs and aromatic hydrocarbons
4	Old Paint System	Located under the production building in the west-central portion of the building	CVOCs
5	Former Paint System	Located under the production building in the southeastern portion of the building	CVOCs

A soil assessment was conducted in June 2021 to provide additional delineation of soils at the Site. Aromatic hydrocarbons were detected in soil borings in the vicinity of the Drum Storage Area; however, concentrations of the aromatic hydrocarbons were below United States Environmental Protection Agency (EPA) Industrial Soil Regional Screening Levels (RSLs) (EarthCon 2021). CVOCs were observed at the northeast corner of the building in the vicinity of a former maintenance shop (i.e., Old Maintenance Area) and a soil boring located in the vicinity of the Drum Storage Area. The concentrations of CVOCs in these areas were also below EPA Industrial Soil RSLs. Because concentrations of constituents detected in soil were below the RSLs, soil will not be considered further in the FS.

Approximately nine in-situ chemical oxidation/bio-remediation injection events were performed at the Site from July 2003 to April 2008 (Allied 2011). A summary of the remediation events is provided in the table below:



Event	Date	Injectant	Source Area Monitoring Wells							
			Area 1		Area 2		Area 3	Area 4	Area 5	
			MW-1/MW-1D	MW-7	MW-2/MW-2D	MW-10	MW-3/MW-3D	MW-5	No wells	
Pilot Test	5/11-6/16/2001	Fenton's Reagent								
Injection 1	2/20-2/25/2002	K-Permanganate								
Injection 2	5/17-6/4/2002	K-Permanganate								
Injection 3	10/16-10/18/2002	K-Permanganate								
Injection 4	12/26-12/30/2002	K-Permanganate								
Injection 5A	7/9/2003	K-Permanganate								
Injection 5B	7/10-7/12/2003	Sodium lactate and ethyl lactate								
Injection 6	4/28-4/29/2004	ABC								
Injection 7	11/27-11/30/2006	ABC Plus								
Injection 8	4/14-4/22/2008	ABC Plus								
Injection 9	4/14-4/22/2008	ABC								

ABC - Anaerobic BioChem – Sodium lactate, ethyl lactate, linoleic acid, dipotassium phosphate and vitamin B12  
 ABC Plus - Anaerobic BioChem Plus – ABC compounds plus zero valent iron  
 K-Permanganate – Potassium Permanganate  
 Fenton's Reagent – Hydrogen Peroxide and Iron Catalyst

Chemical oxidation using Fenton's reagent and potassium permanganate were not found to be effective in reducing CVOC concentrations during the first two years of ground water remediation efforts. In general, CVOC concentrations rebounded following the potassium permanganate injections. In-situ bioremediation began in July 2003. The most recent bioremediation event was

conducted in April 2008 in the areas of MW-7, MW-3/3D, and MW-5 to promote additional mass reduction. Anaerobic BioChem (ABC), a bioremediation product, and ZVI were injected (Allied 2013).

### 3.0 GROUNDWATER MONITORING

Site groundwater is monitored annually for VOCs using EPA Method 8260D and 1,4-dioxane using EPA Method 8260D Selective Ion Monitoring (SIM). The groundwater samples are also analyzed for the monitored natural attenuation (MNA) parameters nitrate, sulfate, sulfide, chloride, alkalinity, total organic carbon (TOC) and dissolved gases (ethane, ethene, methane and propane). A summary of the most recent VOC analytical results is provided in Table 1 and the MNA parameter results are summarized in Table 2. Monitoring well locations are shown on Figure 2. The laboratory analytical reports and data validation summary were provided in the Updated Assessment Report dated September 28, 2022. A summary of historical groundwater analytical results is provided in Appendix A.

The water level measurements collected on April 18, 2022 (Table 3) were used to develop a potentiometric surface map for the Site, which is included as Figure 3. As shown on Figure 3, groundwater elevation data indicate groundwater flow is to the north-northwest which is consistent with groundwater flow measured in previous sampling events.

The April 2022 groundwater analytical results indicate the presence of acetone, chloroform, aromatic hydrocarbons, CVOCs, methylene chloride and 1,4-dioxane as discussed below. Additionally, the April 2022 groundwater data was the subject of another Groundwater Plume Analytics® analysis, as discussed in Section 4.1 of this report. .

#### 3.1 Aromatic Hydrocarbons

Aromatic hydrocarbons (benzene, ethylbenzene, toluene, isopropyl benzene, and/or xylenes) were detected east of the building proximal to monitoring well MW-3, northeast of the building at monitoring well MW-18, and south of the building at monitoring wells MW-1 and MW-7 as shown on Figure 4. The highest concentrations were observed in monitoring well MW-3, which is the location of a release of Naphtha-100 in 1999 (ERM,1999). Concentrations detected at MW-18 were approximately two orders of magnitude lower that what was detected at MW-3. Results of the groundwater samples from boring DP-15 and well MW-5 indicate that aromatic hydrocarbons are not present in groundwater under the building. Current concentrations of aromatic

hydrocarbons are below EPA Maximum Contaminant Levels (MCLs) or Tapwater RSLs as indicated on Table 4.

### 3.2 Chlorinated VOCs

CVOCs were detected at the highest concentrations east of the building proximal to monitoring well MW-3 and south of the building proximal to monitoring well MW-7, with lower concentrations observed beneath the building at MW-5 and DP-15 as shown on Figure 5. The CVOCs detected include chlorinated solvents commonly used in industry such as tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCE) and 1,1,2-tetrachloroethane (1,1,2-TCA). Daughter products of these solvents were also observed including cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethane (1,2-DCE), 1,1-dichloroethane (1,1-DCA), and vinyl chloride. These daughter products can be formed by both natural attenuation processes and bioremediation.

#### East of the Production Building

The CVOCs detected in the groundwater sample from monitoring well MW-3 are primarily daughter products such as cis-1,2-DCE, trans-1,2-DCE, 1,1-DCA, 1,1-DCE, and vinyl chloride. However, the reporting limits of the possible parent CVOCs (TCE and PCE) were elevated [200 micrograms per liter ( $\mu\text{g/L}$ )] due to dilutions required for other compounds. The presence of daughter products is likely due to previous bioremediation in the area and natural attenuation processes. Concentrations of each of the CVOCs detected in monitoring well MW-3 exceeded the applicable EPA MCL or RSL.

Monitoring well MW-3 is screened from 5 to 15 feet bgs in a sandy clay underlain by a five-foot clay layer. Monitoring well MW-3D is screened in a saturated sand/sandy silt layer beneath the 5-foot clay layer. VOCs were not detected in deeper well MW-3D indicating that the presence of CVOCs is limited to groundwater above the clay at this location.

#### North of the Production Building

Monitoring well MW-18 is located downgradient of monitoring well MW-3 and the Old Maintenance Area. Monitoring well MW-18 was installed to confirm previous detections of CVOCs in soil boring DP-12 and to provide a location to monitor CVOC concentrations in the area north of the production building. Parent compounds (TCE, PCE, and 1,1,2-TCA) and the daughter product

1,1-DCE were detected in monitoring well MW-18 at concentrations similar to those previously detected in boring DP-12.

The total CVOC concentration detected in MW-18 (981.4 µg/L) is much lower than that observed in monitoring well MW-3 (18,790 µg/L). Although monitoring well MW-18 is downgradient of MW-3, another source (possibly the Old Maintenance Area) is suspected because 1) primarily daughter products are observed in MW-3 and primarily parent products are observed in MW-18 and 2) results of the 2021 investigation suggest localized impacts in both areas (EarthCon, 2021). The presence of parent compounds in monitoring well MW-18 may also be attributed to the fact that remediation has not been performed in this part of the Site.

Monitoring wells MW-4 and MW-4D are located downgradient of monitoring well MW-18. Concentrations of CVOCs in monitoring well MW-4 are less than applicable RSLs and much lower than the concentrations in monitoring well MW-18. CVOCs are also detected in monitoring well MW-4D; however, results of previous investigations suggest that the integrity of this well may be compromised.

A camera survey conducted on April 22, 2020, indicated that there were potential breaches in the well casing of MW-4D at approximately 20 and 30 feet below the top of the casing. In June 2021, EarthCon attempted to lower a passive diffusion sampler (PDS) to a depth of 80 feet below ground surface (bgs). The PDS could not be lowered to the deeper interval (80 feet) in MW-4D as originally planned due to refusal, which also indicates a problem with well integrity. It is suspected that the CVOCs detected in monitoring well MW-4D may be associated with shallow-impacted groundwater entering MW-4D from the breaches identified at 20 and 30 feet bgs.

#### South of the Production Building

CVOCs were observed in the groundwater sample from monitoring well MW-7, which is screened from 2 to 12 feet bgs. Both parent (TCE) and daughter products were detected in the groundwater sample from MW-7. The presence of daughter products is likely due to previous bioremediation in the area and natural attenuation processes.

The presence of daughter products extends to monitoring well MW-1 located downgradient of monitoring well MW-7. Well MW-1 is screened from 5 to 20 feet bgs. The impacted area is localized based on historical non-detect CVOC results from monitoring wells MW-6R and either non-detect or low (below the MCL) concentrations in monitoring well MW-8. Monitoring well MW-

6R is located approximately 200 feet east of MW-7, and MW-8 is located approximately 200 feet west of MW-7.

PCE, TCE, and cis-1,2-DCE were also detected in the groundwater sample from monitoring well MW-1D screened from 48 to 53 feet. Parent products (TCE and PCE) were observed in the deeper well that were not in the associated shallow well (MW-1). The source of the constituents in MW-1D may be deeper residual contamination in the vicinity of monitoring well MW-7 that migrated to MW-1D and migrated deeper through breaches in the casing of monitoring well MW-1D.

### Beneath the Production Building

CVOCs were detected in groundwater samples collected from monitoring well MW-15 and boring DP-15 as shown on Figure 5. The purpose of groundwater location DP-15 was to assess whether another source may be under the building and confirm concentrations between monitoring wells MW-3 and MW-5. The analytes detected in the groundwater samples from DP-15 are consistent with those detected in groundwater from monitoring well MW-5 and do not indicate an additional source of groundwater contamination. The groundwater samples from monitoring well MW-5 and boring DP-15 contained both parent compounds (TCE and PCE) and daughter products (cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and vinyl chloride). As shown on Table 4, concentrations of TCE, PCE, 1,1-DCE, 1,2-DCA, 1,1-DCA, cis-1,2-DCE, 1,1,2-TCA, and vinyl chloride in the samples from DP-15 were above the applicable MCL and/or EPA RSL. Concentrations of TCE, PCE, cis-1,2-DCE, and vinyl chloride in the sample from monitoring well MW-5 also exceeded the MCL.

### **3.3 Other Constituents**

In addition to the aromatic hydrocarbons and CVOCs, 1,4-dioxane was detected in groundwater samples from wells MW-3, MW-5, and MW-7 and boring DP-15 at concentrations that are above the EPA RSL. 1,4-Dioxane was not detected in the samples collected north and downgradient of the production building.

Methylene chloride was also detected in samples MW-1 and DP-15 at concentrations above the EPA MCL. Chloroform was detected in samples MW-3D, MW-16, MW-17, and MW-18 at concentrations below the EPA MCL. Acetone was detected in sample MW-2D at a concentration below the EPA RSL. Methylene chloride, chloroform, and acetone are common laboratory and/or

field contaminants and will not be considered further in the FS. However, they will continue to be monitored.

#### 4.0 GROUNDWATER PLUME ANALYTICS® EVALUATION

A Groundwater Plume Analytics® evaluation, including a Ricker Method® Plume Stability Analysis, was conducted for the Upper Shallow aquifer at the Site using groundwater analytical data provided by Environmental Resources Management (ERM) through 2014, analytical data collected by EarthCon through June 2021, and analytical data collected by WSP in April 2022. Relative changes in plume characteristics between sampling events were observed during the Groundwater Plume Analytics® evaluation, and trends were evaluated to indicate whether the plume was stable, increasing, or decreasing. The evaluation was conducted for the following constituents:

##### **Chloroethenes**

- PCE
- TCE
- cis-1,2-DCE
- trans-1,2-DCE
- 1,1-DCE
- Vinyl Chloride
- Total chloroethenes (molar basis)

##### **Chloroethanes**

- 1,1,2-TCA
- 1,1,1-TCA
- 1,2-DCA
- 1,1-DCA
- Total chloroethanes (molar basis)

##### **Aromatic Hydrocarbons**

- Toluene
- Ethylbenzene
- Xylenes

This Groundwater Plume Analytics® evaluation included the following elements:

- Ricker Method® Plume Stability Analysis
- Total molar trend and molar fraction analysis for chloroethenes and chloroethanes
- Ricker Method® Spatial Change Indicator™
- Geochemical MNA isopleths
- Groundwater elevation trend evaluation

The methodologies of the aforementioned elements of the Groundwater Plume Analytics® services are provided in the *Updated Assessment Report* dated September 22, 2022.

#### 4.1 Groundwater Plume Analytics® Results

A Ricker Method® Plume Stability Analysis was conducted for the Site using groundwater data for each of the constituents from 1999 to 2022.

The following table summarizes the plume stability trends for plume area, average concentration, and mass indicator from February 2017 through April 2022.

**Ricker Method® Plume Stability Results (February 2017– April 2022)**

<b><u>Constituent</u></b>	<b><u>Area</u></b>	<b><u>Average Concentration</u></b>	<b><u>Mass Indicator</u></b>
PCE***	Stable*	Stable	Stable*
TCE***	Stable	Stable	Stable
cis-1,2-DCE	Stable**	Stable	Stable
trans-1,2-DCE	Stable	Stable	Stable
1,1-DCE	Stable	Stable	Stable
Vinyl Chloride	Stable	Stable	Stable
<b>Total Chloroethenes</b>	Stable	Stable	Stable
1,1,2-TCA	NA	NA	NA
1,1,1-TCA	NA	NA	NA
1,2-DCA	Stable	Increasing	Increasing
1,1-DCA	Decreasing	Stable	Stable
<b>Total Chloroethanes</b>	Decreasing	Stable	Stable
<b>Toluene</b>	Stable	Stable	Stable
<b>Ethylbenzene</b>	Stable	Increasing	Increasing
<b>Xylenes</b>	Stable*	Increasing	Increasing

Notes:

- \*Indicates Mann-Kendall trend is increasing
- \*\*Indicates Mann-Kendall trend is decreasing
- \*\*\*MW-18 excluded from trends

The results summarized above indicate that the 1,2-DCA, ethylbenzene, and xylenes plumes are increasing since February 2017. The other constituent plumes are stable (i.e., no trend).

**4.2 MNA Parameters**

Isopleth maps were produced for each of the MNA parameters analyzed (DO, ORP, ferrous iron, methane, ethane, ethene, and total organic carbon). The MNA isopleths show strong correlation and patterns that provide evidence that biological degradation is occurring. For example, there is evidence of biodegradation through the observation of the metabolic byproducts methane, ethane, and ethene. It is known that reductive dechlorination mechanisms are most favorable under strongly reducing redox conditions (methanogenesis), which is evident at the Site by the presence of dissolved methane in most wells. The location of the metabolic byproducts and reducing conditions correspond to the highest concentration portion of the CVOC plumes, indicating that an MNA solution for the plumes could be a viable remedial approach. Additionally, the co-location of the aromatic hydrocarbon plumes with the CVOC plumes may prove beneficial

from the standpoint that the aromatic hydrocarbons are providing a carbon-source and thus enhancing the anaerobic degradation of the CVOCs, which the evidence supports.

#### **4.3 Lower Shallow Aquifer Wells (i.e., “D” wells)**

A Groundwater Plume Analytics® plume analysis could not be conducted for the four deeper wells (MW-1D, MW-2D, MW-3D, and MW-4D). In instances where this occurs due to lack of a “plume” over the well network, a well-by-well depiction of data can be presented.

The data show that wells MW-2D and MW-3D did not have detectable concentrations of CVOCs in the most recent sampling event (except for J-value acetone and chloroform detected in each well, respectively).

MW-1D had detectable concentrations of PCE, TCE, and cis-1,2-DCE with the PCE and TCE concentrations exceeding the MCL. Additionally, the CVOC concentrations in water samples obtained from MW-1D have continued a steady increase since the recent routine sampling program began in 2017. During this period, the molar fraction of the CVOCs has stayed relatively consistent with PCE approximately 80% and TCE approximately 15-20% of the overall plume.

MW-4D had a detectable level of PCE above the MCL, detectable levels of TCE and 1,1-DCE below the MCL, and an estimated J-value detection of cis-1,2-DCE. As described in Section 3.2, there are integrity concerns regarding the casing for well MW-4D which may potentially be allowing shallow-impacted groundwater to discharge into the well. Therefore, the concern is that CVOC concentrations in MW-4D may be attributed to apparent breach(es) in the well casing.

#### **4.4 Summary**

Based on the Groundwater Plume Analytics® analysis conducted on the Upper Shallow aquifer wells, it appears that both the chloroethene and chloroethane plumes are stable and show evidence of attenuation through natural processes, primarily through reductive dechlorination. Based on the results of the April 2022 sampling event, we have observed a decrease in total chloroethenes and total chloroethanes since the last several sampling events. Additionally, in the case of the total chloroethene molar fractions, we observed a noticeable decrease in cis-1,2-DCE and increase in vinyl chloride, which indicates a progression through the reductive dechlorination sequence. Perhaps the site is beginning the transition from stability (i.e., attenuation rate = soil desorption rate) to reduction.



The aromatic hydrocarbon plumes of ethylbenzene and xylene are statistically increasing while the toluene plume appears to be stable. Additionally, the aromatic hydrocarbon plumes are co-located with the areas of highest total chloroethene and total chloroethanes concentrations. This co-location of plumes may prove beneficial as the aromatic hydrocarbons are probably serving as a carbon source for reducing bacteria and contributing to the reductive dechlorination processes.

#### **4.5 Recommendations from the 2022 Updated Assessment Report**

The data presented in the *2022 Updated Assessment Report* (WSP, 2022) strongly support that a MNA remedy would be appropriate and worth pursuing as a future Site remedy for the Upper Shallow aquifer, once CVOC concentrations in the area proximal to MW-3 are further reduced. To move in that direction, the report recommended proceeding to the feasibility study stage of this project per the Contract for the Site to address the current plumes and move toward an MNA remedy. The first deliverable is this FS Workplan. The following additional recommendations were also included:

- Monitoring well MW-1D– implement a downhole camera survey similar to the process that discovered the well integrity issues in MW-4D.
- Monitoring well MW-4D – abandon well in place due to potential breaches in the well casing at 20 and 30 feet. Prior to well abandonment, temporarily convert this well into a deep injection remediation well using a sodium or potassium permanganate product. The intent would be to allow the permanganate material to penetrate the deeper aquifer and areas of the breached casing, thus treating areas along preferential groundwater flow pathways. After successful completion of the injection activities, the well would then be abandoned.
- Replacement well MW-4DR - Concurrent to the conversion of MW-4D into a temporary injection well, a replacement monitoring well should be installed downgradient of the MW-4D location to monitor the deep groundwater and effectiveness of the remediation attempt.

### **5.0 FEASIBILITY STUDY APPROACH**

Upon approval of this FS Work Plan, a FS will be performed in general accordance with EPA guidance (EPA, 1988; EPA, 1989). The guidance provides a step-wise approach for assessing

remedial alternatives including identifying remedial action objectives and remediation goals, the development and screening of remedial technologies, and evaluating these alternatives.

### 5.1 Constituents of Concern

CVOCs and aromatic hydrocarbons are the predominant compounds identified in groundwater at the Site. The CVOCs are considered the constituents of concern (COCs) at the Site; therefore, the FS will focus on remediation of the CVOCs in groundwater including:

- PCE
- TCE
- cis-1,2-DCE
- trans-1,2-DCE
- 1,1-DCE
- Vinyl chloride
- 1,1,2-TCA
- 1,1,1-TCA
- 1,2-DCA
- 1,1-DCA

Aromatic hydrocarbons will not be the focus of the FS as concentrations of these constituents are below health-based regulatory criteria (MCLs or EPA RSLs).

### 5.2 Remedial Action Objectives

Remedial action objectives (RAOs) are the end points which, when obtained, will result in appropriate protection of human health and the environment. A list of proposed RAOs for the Site is provided below:

**RAO 1:** Prevent ingestion of groundwater containing COCs in excess of applicable drinking water standards.

**RAO 2:** Restore groundwater concentrations to applicable remediation goals.

### 5.3 Remediation Goals

Remediation goals are components of RAOs that are media and constituent specific numerical values meant to provide an objective metric for when the RAO has been attained. The following remediation goals are proposed:

<b>COC</b>	<b>Remediation Goal (µg/L)</b>
PCE	5
TCE	5
cis-1,2-DCE	70
trans-1,2-DCE	100
1,1-DCE	7
Vinyl Chloride	2
1,1,2-TCA	5
1,1,1-TCA	200
1,2-DCA	5
1,1-DCA	2.8

#### 5.4 Evaluation Criteria

The remedial technologies will be evaluated to identify those that are most viable to the site-specific conditions and RAO. Each technology will be screened against the criteria described below.

- **Effectiveness**—The effectiveness of a technology refers to the likelihood that the technology will be effective at reducing the toxicity, mobility, and/or volume of, or exposure to, the COCs given the specific conditions at the Site. Each technology will be evaluated for effectiveness based on demonstrated success at similar sites/conditions.
- **Implementability**—This criterion considers the relative ease of implementing the technology and considers factors such as availability of the materials and services to implement the RTPPO and the depth of contamination.
- **Relative Cost**—This criterion considers the capital and O&M costs to implement the technology.

## 6.0 IDENTIFICATION OF POTENTIAL REMEDIAL ALTERNATIVES

The following remedial alternatives will be assessed in the FS.

Remedial Alternatives	Description
No Action	No action is taken to remediate groundwater and contamination remains in place.
Institutional Controls	Administrative methods that limit land use and access to limit or prevent receptor exposure to contaminated groundwater
Monitored Natural Attenuation (MNA)	Continued monitoring of environmental media to observe contaminant concentration changes over time and assess effectiveness of remedial technology
Treatment	Use of in situ treatment technologies to chemically degrade COCs or enhance biodegradation.

### 6.1 No Action

No action is a baseline scenario used for comparing and evaluating against alternative technologies. No remedial action or monitoring would be performed under the no action alternative, which provides an “as is” baseline assessment of the impact on potential receptors.

### 6.2 Institutional Controls

Institutional controls (ICs) are administrative methods that limit land use or access to prevent receptor exposure to contaminated media left in place at a site. ICs can be used as the primary component of a remedial alternative or in combination with other remediation technologies to reduce or prevent exposure from contaminated media kept in place at a given site (USACE and USEPA, 2000). The National Contingency Plan (NCP) emphasizes that ICs, such as land-use restrictions, are meant to supplement remedial alternatives and may be a necessary component of the final remedy.

### 6.3 Monitored Natural Attenuation

MNA is a technology that may be combined with other technologies to provide the data necessary to determine if the remedial action and/or existing natural processes have achieved or continue

to move the Site towards RAOs and cleanup goals. MNA involves groundwater sampling and analysis of contaminant concentrations and other MNA parameters to track the progress and overall effectiveness of a remedial action.

#### **6.4 Treatment**

Treatment may involve the use of chemical, biological, and/or physical process to cause the destruction or alteration of the contamination to a form that is less toxic and/or less mobile. For example, in situ chemical amendments involve the addition of specific chemical reagents to degrade/destroy COCs and thereby reduce the toxicity, mobility, and volume of the contaminants. In situ chemical oxidation, in situ chemical reduction, and enhanced biodegradation can be effective for treatment of organic contaminants, such as CVOCs. However, some in situ technologies have limitations or create adverse effects such as causing leaching of inorganics to groundwater. Some technologies are implementable; however, the cost can be unreasonably high depending on the extent of groundwater requiring remediation. Furthermore, technologies may pose an increased health and safety risk due to the chemical reagents used or the way the technology is implemented. The treatment technologies to be evaluated in the FS will be focused on in-situ technologies that have been previously used at the Site including in-situ chemical oxidation, in-situ chemical reduction, and bioremediation. The selection process will consider criteria such as the long- and short- term effectiveness, implementability, and cost.

### **7.0 REFERENCES**

Allied Air, 2011. *Site Assessment Work Plan Blackville, South Carolina*, Allied Air Enterprises, February 14, 2011.

Allied Air, 2013. *Groundwater and Soil Assessment Report Site #01356, Former Ducane Facility, Blackville, South Carolina*, Allied Air Enterprises, January 2013.

EarthCon, 2021. *Updated Assessment Report, Former Ducane Facility, Blackville, South Carolina*, EarthCon Consultants, Inc., October 2021.

ERM, 1999. *Phase III Environmental Site Assessment, The Ducane Company, Blackville, SC*, Environmental Resources Management, September 1999.

Ricker, J.A. 2008. A Practical Method to Evaluate Ground Water Contaminant Plume Stability. *Groundwater Monitoring & Remediation* 28, no. 4: 85–94

WSP. 2022. *Updated Assessment Report, Former Ducane Facility, Blackville, South Carolina,*  
WSP USA Inc, September 2022.

# **TABLES**

**TABLE 1. SUMMARY OF DETECTED GROUNDWATER ANALYTICAL RESULTS - ORGANICS**

Former Ducane Company Site  
 Blackville, Barnwell County, South Carolina  
 BLWM File # 401356

Constituent (ug/L)			Acetone	Benzene	Chloroform	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Ethylbenzene	Isopropylbenzene	Methylene Chloride	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylenes (total)	1,4-Dioxane*	
MCL (ug/L)			--	5	80**	--	5	7	70	100	700	--	5	5	1000	200	5	5	2	10000	--	
RSL (ug/L)			1400	--	0.22	2.8	--	--	--	--	--	45	--	--	--	--	--	--	--	--	--	0.46
Well	Screened Interval/Sample Depth (bgs)	Date Sampled																				
MW-1	5 - 20	4/19/22	<200	<10	<10	<10	<10	<10	<b>1400</b>	<b>5.0 J</b>	<b>100</b>	<10	<b>7.2 J</b>	<10	<10	<10	<10	<10	<b>55</b>	<b>570</b>	<1.0	
MW-1D	48 - 53	4/19/22	<20	<1.0	<1.0	<1.0	<1.0	<1.0	<b>1.1</b>	<1.0	<1.0	<1.0	<1.0	<b>86</b>	<1.0	<1.0	<1.0	<b>14</b>	<1.0	<1.0	<1.0	
MW-2	5 - 15	4/19/22	<20	<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	
MW-2D	39 - 44	4/19/22	<b>10 J</b>	<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	
MW-3	5 - 15	4/20/22	<4000	<200	<200	<b>960</b>	<200	<b>400</b>	<b>16000</b>	<b>130 J</b>	<b>330</b>	<200	<200	<200	<b>120 J</b>	<200	<200	<200	<b>1300 J</b>	<b>1300</b>	<b>240</b>	
MW-3D	20 - 25	4/20/22	<20	<1.0	<b>0.94 J</b>	<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	
MW-4	8 - 18	4/20/22	<20	<1.0	<1.0	<1.0	<1.0	<1.0	<b>5.5</b>	<1.0	<1.0	<1.0	<1.0	<b>2.5</b>	<1.0	<1.0	<b>0.51 J</b>	<b>4.9</b>	<1.0	<1.0	<1.0	
MW-4D	72 - 82	4/20/22	<20	<1.0	<1.0	<1.0	<1.0	<b>1.0</b>	<b>0.74 J</b>	<1.0	<1.0	<1.0	<1.0	<b>32</b>	<1.0	<1.0	<1.0	<b>1.4</b>	<1.0	<1.0	<1.0	
MW-5	15 - 20	4/21/22	<20	<1.0	<1.0	<b>2.6</b>	<b>0.64 J</b>	<b>1.4</b>	<b>330</b>	<b>2.8</b>	<1.0	<1.0	<1.0	<b>150</b>	<1.0	<1.0	<b>0.61 J</b>	<b>220</b>	<b>6.1</b>	<1.0	<b>9.0</b>	
MW-7	2 - 12	4/20/22	<20	<1.0	<1.0	<1.0	<1.0	<b>1.2</b>	<b>710</b>	<b>5.9</b>	<b>240</b>	<b>2.3</b>	<1.0	<1.0	<b>6.4</b>	<1.0	<1.0	<b>0.66 J</b>	<b>1400</b>	<b>660</b>	<b>1.5 J</b>	
MW-10	2 - 12	4/20/22	<20	<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	
MW-11	2 - 12	4/20/22	<20	<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	
MW-14	2 - 12	4/20/22	<20	<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	
MW-15	9 - 19	4/19/22	<20	<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	
MW-16	10 - 20	4/20/22	<20	<1.0	<b>1.6</b>	<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	
MW-17	20 - 30	4/19/22	<20	<1.0	<b>0.81 J</b>	<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	
MW-18	15 - 25	4/20/22	<20	<b>1.1</b>	<b>0.48 J</b>	<b>0.49 J</b>	<1.0	<b>13</b>	<b>9.2</b>	<1.0	<1.0	<1.0	<1.0	<b>390 J</b>	<b>1.4</b>	<b>0.89 J</b>	<b>17</b>	<b>550 J</b>	<b>0.81 J</b>	<b>8.8</b>	<1.0	
DP-15	15	4/19/22	<100	<5.0	<5.0	<b>22</b>	<b>6.4</b>	<b>17</b>	<b>420</b>	<b>12</b>	<5.0	<5.0	<b>5.5</b>	<b>60</b>	<5.0	<5.0	<b>30</b>	<b>97</b>	<b>11</b>	<5.0	<b>51</b>	
DP-15	22	4/19/22	<100	<5.0	<5.0	<b>24</b>	<b>6.7</b>	<b>22</b>	<b>430</b>	<b>13</b>	<5.0	<5.0	<b>7.4</b>	<b>73</b>	<5.0	<5.0	<b>31</b>	<b>120</b>	<b>14</b>	<5.0	<b>52</b>	

**Notes**

ug/L - micrograms per liter  
 < less than the noted limit of quantitation (LOQ)  
 J - estimated concentration  
 \* - 1,4-dioxane reported to the detection limit (DL)  
 \*\* - MCL for total Trihalomethanes  
 MCL - US EPA Maximum Contaminant Level  
 RSL - US EPA Regional Screening Level for Tap Water  
**Bold** - Constituent detected above LOQ or DL  
**Bold and Shaded** - Constituent detected above the RSL or MCL

Prepared by: MAB 6/3/22  
 Checked by: CDN 6/7/22



**TABLE 2. GROUNDWATER MNA RESULTS**  
Former Ducane Company Site  
Blackville, Barnwell County, South Carolina  
BLWM File # 401356

Monitoring Well/Boring ID	Screened Interval/ Sample Depth (bgs)	Sample Date	Alkalinity mg/L	Chloride mg/L	Nitrate-N mg/L	Sulfate mg/L	Sulfide mg/L	TOC mg/L	Ethane ug/L	Ethene ug/L	Methane ug/L	Propane ug/L
MW-1	5 - 20	4/19/22	<20	<b>16</b>	<0.1 J	<b>3.3</b>	<1.0	<b>1.3</b>	<10	<b>13</b>	<b>470</b>	<15
MW-1D	48 - 53	4/19/22	<20	<b>1.8</b>	<0.1 J	<b>0.39 J</b>	<1.0	<1.0	<10	<10	<b>3.6 J</b>	<15
MW-2	5 - 15	4/19/22	<20	<b>6.1</b>	<b>1.2</b>	<b>3.7</b>	<1.0	<1.0	<10	<10	<10	<15
MW-2D	39 - 44	4/19/22	<20	<b>2.9</b>	<b>0.16 J</b>	<b>0.92 J</b>	< 1.0	<1.0	<10	<10	<10	<15
MW-3	5 - 15	4/20/22	<20	<b>39</b>	<0.02	<1.0	<b>2.5</b>	<b>12</b>	<b>33</b>	<b>110</b>	<b>7900</b>	<15
MW-3D	20 - 25	4/20/22	<20	<b>12</b>	<b>3.5</b>	<b>0.41 J</b>	< 1.0	<1.0	<10	<10	<10	<15
MW-4	8 - 18	4/20/22	<20	<b>8.9</b>	<b>0.013 J</b>	<b>2.2</b>	<1.0	<b>1.2</b>	<10	<10	<b>2.9 J</b>	<15
MW-4D	72 - 82	4/20/22	<20	<b>1.8</b>	<b>0.069</b>	<b>1.0</b>	<1.0	<1.0	<10	<10	<10	<15
MW-5	15 - 20	4/21/22	<20	<b>16</b>	<b>0.35</b>	<b>0.68 J</b>	<b>2.9</b>	<b>0.42 J</b>	<10	<10	<b>1200</b>	<15
MW-7	2 - 12	4/20/22	<b>24</b>	<b>18</b>	<0.02	<b>0.52 J</b>	<1.0	<b>6.0</b>	<b>30</b>	<b>150</b>	<b>1600</b>	<15
MW-10	2 - 12	4/20/22	<20	<b>11</b>	<0.02	<b>6.1</b>	<1.0	<b>2.1</b>	<10	<10	<b>62</b>	<15
MW-11	2 - 12	4/20/22	<b>44</b>	<b>3.4</b>	<0.02	<b>5.6</b>	<1.0	<b>2.1</b>	<10	<10	<b>200</b>	<15
MW-14	2 - 12	4/20/22	<20	<b>3.3</b>	<0.02	<b>4.8</b>	<1.0	<b>1.3</b>	<10	<10	<b>96</b>	<15
MW-15	9 - 19	4/19/22	<20	<b>3.3</b>	<b>0.042 J</b>	<b>9.5</b>	<1.0	<b>0.54 J</b>	<10	<10	<b>8.0 J</b>	<15
MW-16	10 - 20	4/20/22	<20	<b>12</b>	<b>5.3</b>	<b>0.41 J</b>	<1.0	<1.0	<10	<10	<b>2.8 J</b>	<15
MW-17	20 - 30	4/19/22	<20	<b>7.4</b>	<b>1.75 J</b>	<b>12</b>	<1.0	<1.0	<10	<10	<10	<15
MW-18	15-25	4/20/22	<b>38</b>	<b>7.5</b>	<b>1.5</b>	<b>2.3</b>	<1.0	<b>0.71 J</b>	<10	<b>8.3 J</b>	<b>44</b>	<15

mg/L - milligrams per liter

ug/L - micrograms per liter

bgs - below ground surface

TOC - total organic carbon

< less than the noted limit of quantitation (LOQ)

J - estimated concentration above the detection limit (DL)

**Bold** - Constituent detected above LOQ or DL

Prepared by: TJM 5/19/22

Checked by: MAB 6/3/22

**TABLE 3. GROUNDWATER LEVEL MEASUREMENTS**

Former Ducane Company Site  
Blackville, Barnwell County, South Carolina  
BLWM File # 401356

Monitoring Well	Top of Casing (TOC) Elevation feet, NAVD	April 18, 2022	
		Depth to Water feet below TOC	Groundwater Elevation feet
MW-1	282.05	5.60	276.45
MW-1D	282.08	8.27	273.81
MW-2	277.71	2.37	275.34
MW-2D	277.61	4.19	273.42
MW-3	279.68	3.99	275.69
MW-3D	279.94	4.39	275.55
MW-4	279.74	5.22	274.52
MW-4D	279.91	9.29	270.62
MW-5	279.85	5.18	274.67
MW-7	280.76	4.06	276.70
MW-10	278.12	8.27	269.85
MW-11	280.64	5.82	274.82
MW-14	280.81	5.95	274.86
MW-15	282.82	5.97	276.85
MW-16	278.48	3.69	274.79
MW-17	285.28	8.91	276.37

**Notes**

NAVD - North American Vertical Datum of 1988

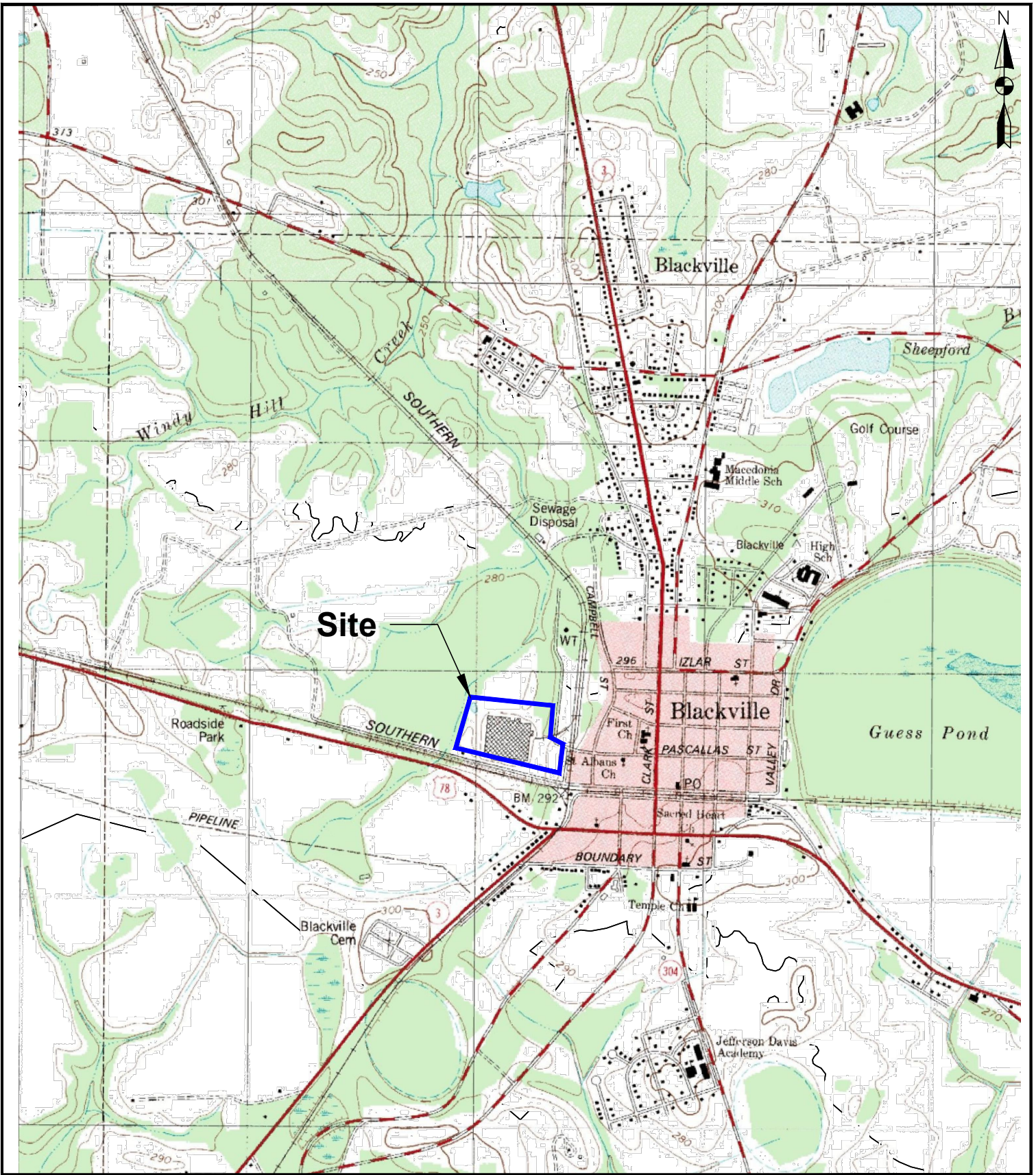
TOC - top-of-casing

Prepared by: MAB 6/7/22

Checked by: CDN 6/7/22

## **FIGURES**

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox\_Main\_2017.dwg (Site Location) 03/11/22 10:25 - hphm



FORMER DUCANE COMPANY SITE  
 BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA  
 BLWM FILE # 401356



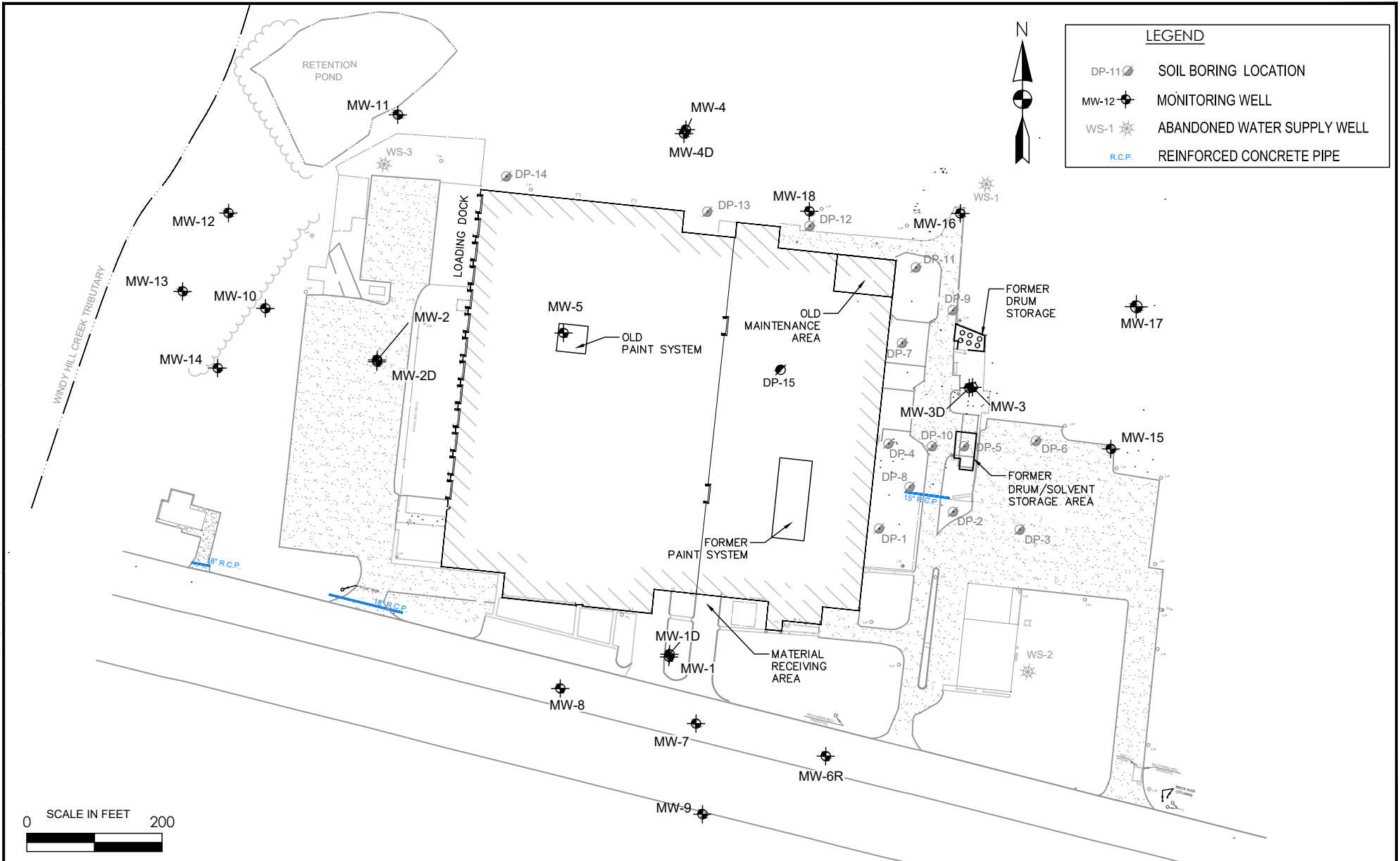
SITE LOCATION MAP

PROJECT NO. EC02.20160378.21

1880 WEST OAK PKWY, BLDG 100, STE 106, MARIETTA, GA, 30062

DRAWN: HVP	CHECKED: MAB	DATE: 03/11/2022	FIGURE: 1
------------	--------------	------------------	-----------





FORMER DUCANE COMPANY SITE  
BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA  
BLWM FILE # 401356

PROJECT NO. EC02.20160378.21



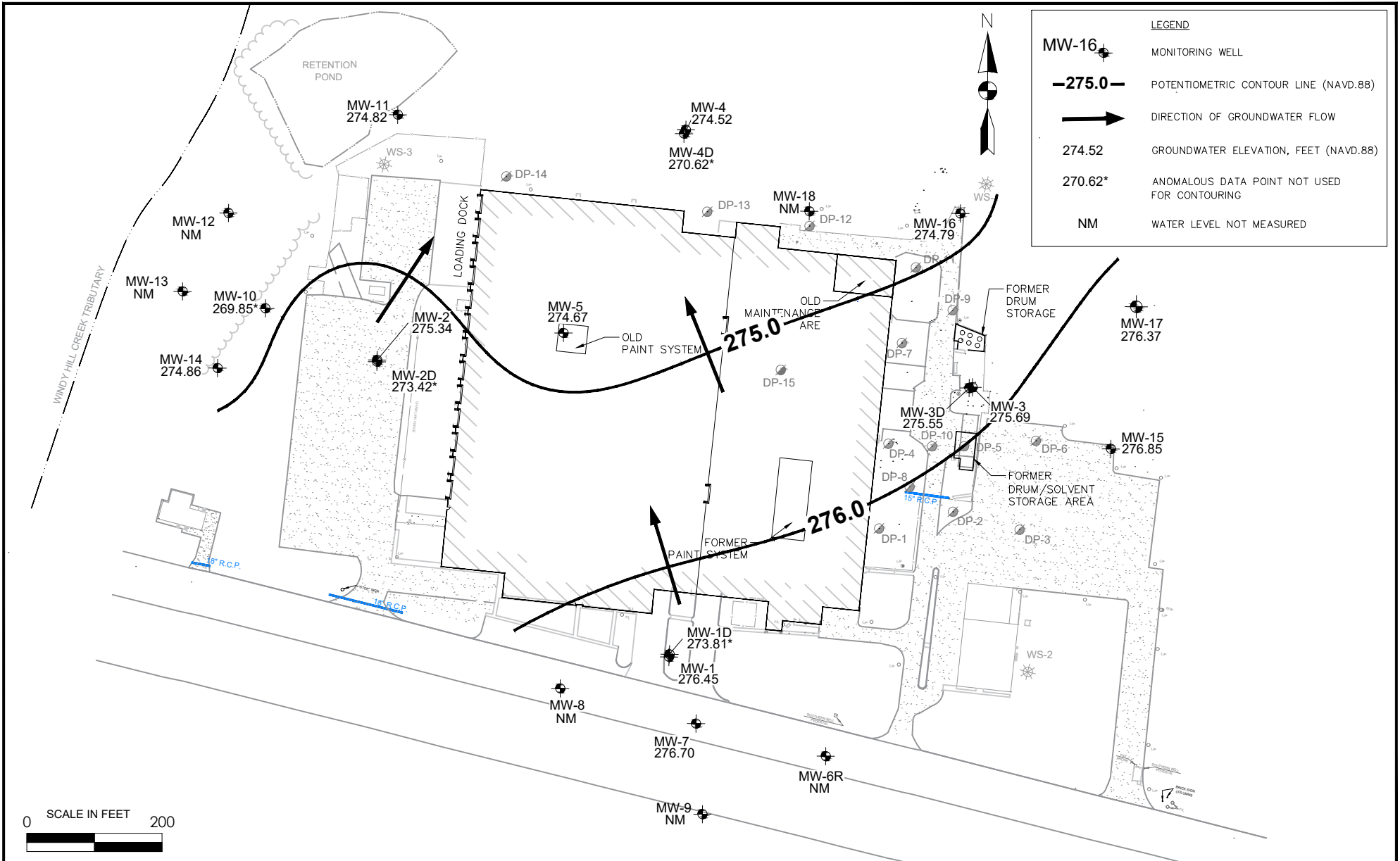
WSP USA

1880 WEST OAK PKWY, BLDG 100, STE 106, MARIETTA, GA, 30062

MONITORING WELL and  
SOIL BORING LOCATIONS

DRAWN: HVP	CHECKED: MAB	DATE: 02/03/2023	FIGURE: 2
------------	--------------	------------------	-----------

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox\_Main\_2022.dwg (POT 18Apr22) 06/13/22 15:52 - USHP700224



FORMER DUCANE COMPANY SITE  
 BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA  
 BLWM FILE # 401356

PROJECT NO. EC02.20160378.21

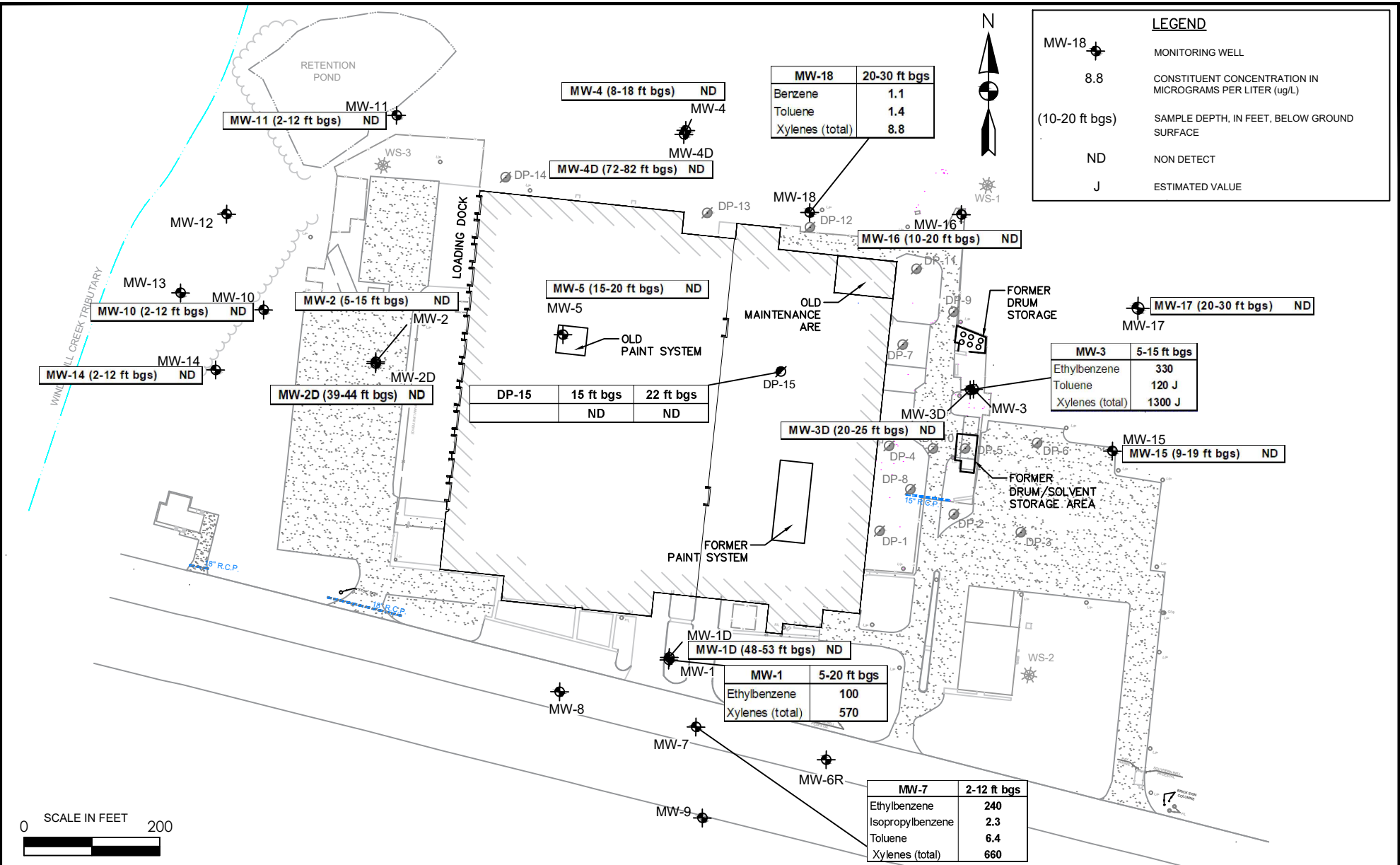


WSP USA

1880 WEST OAK PKWY, BLDG 100, STE 106, MARIETTA, GA, 30062

POTENTIOMETRIC SURFACE MAP  
 APRIL 18, 2022

DRAWN: HVP	CHECKED: MAB	DATE: 06/13/2022	FIGURE: 3
------------	--------------	------------------	-----------



FORMER DUCANE COMPANY SITE  
 BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA  
 BLWM FILE # 401356

PROJECT NO. EC02.20160378.21



WSP USA

1880 WEST OAK PKWY, BLDG 100, STE 106, MARIETTA, GA, 30062

GROUNDWATER ANALYTICAL RESULTS  
 AROMATIC HYDROCARBONS  
 APRIL 2022

DRAWN:	HVP	CHECKED:	MAB	DATE:	08/23/2022	FIGURE:	4
--------	-----	----------	-----	-------	------------	---------	---





## **APPENDIX A**

### **GROUNDWATER HISTORICAL DATA SUMMARY**

Well	Sample Date	Acetone	Benzene	Bromodichloromethane	Bromoform	2-Butanone (MEK)	Carbon disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	Dibromochloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Ethylbenzene	Isopropylbenzene	MTBE	4-Methyl-2-pentanone	Methylene Chloride	Styrene	Tetrachloroethane	Toluene	1,2,4-Trichlorobenzene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylenes	1,1,1,2-Tetrachloroethane	n-Butylbenzene	sec-Butylbenzene	p-Isopropyltoluene	n-Propylbenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Naphthalene	1,4-Dioxane		
MONITORING WELLS	09/01/99	<10	<2	<2	<2	<10	10.6	<2	<2	<2	<2	<2	<2	<2	3.1	22.5	12,000	40.6	1,380	14.1	--	17.3	<10	--	78.5	685	<2	<2	<2	60.2	49.1	5,820	<2	<2	<2	<2	21.7	178	31.2	11.9			
	09/24/99	ND	2.2	ND	ND	ND	9.2	ND	ND	ND	ND	ND	ND	ND	4.2	25.7	18,000	60.1	1,950	18	ND	23.8	ND	--	15.8	1,050	ND	ND	ND	24.6	43.1	8,260	ND	ND	3.8	ND	38.3	215	54.9	22.6			
	05/16/00	ND	15.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	68.4	17,600	361	1,890	ND	27.1	ND	--	ND	979	ND	ND	ND	29.4	ND	7,820	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	04/10/01	ND	1.28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.31	27.4	10,600	46.4	1,050	13.3	ND	ND	ND	--	16.4	436	ND	ND	ND	24.1	105	4,260	ND	ND	ND	ND	24.9	54.3	34.3	14.5			
	06/27/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2	10.1	3,310	78	412	3.6	ND	ND	ND	--	2.6	372	ND	ND	ND	19.7	45	3,360	ND	ND	ND	ND	12.6	41.8	14.2	32.8			
	08/09/01	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.9	ND	8,580	54	854	10.8	ND	ND	ND	--	5.6	396	ND	ND	ND	8.9	76	2,720	ND	ND	ND	ND	ND	ND	ND	118.0	25.4	10.3	
	03/18/02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.5	12.4	6,900	22	635	5.4	ND	ND	ND	--	4.6	317	ND	ND	ND	8.0	ND	2,680	ND	ND	ND	ND	ND	ND	ND	10.7	72.7	74.3	7.3
	06/27/02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11.5	5,090	24	ND	6.0	ND	ND	ND	--	4.5	ND	ND	ND	ND	4.6	29	ND	ND	ND	ND	ND	ND	ND	10.1	71.5	13.4	ND	
	07/15/02	ND	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.9	13.1	6,550	63	813	8.6	ND	ND	ND	--	4.8	344	ND	ND	ND	7.3	65	3,349	ND	ND	1.6	ND	14.8	87.8	18.9	9.4			
	10/16/02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0	647	10	1,900	13.8	ND	ND	ND	--	11.8	89	ND	ND	11.8	14.1	7	9,870	ND	ND	ND	ND	2.8	6.4	2.7	1.8			
	11/01/02	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.6	2,010	12	1,380	7.6	ND	ND	ND	--	17.5	106	ND	ND	ND	13.4	15	7,230	ND	ND	ND	ND	ND	ND	ND	4.5	2.5	ND		
	12/12/02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19.1	3,630	80	613	3.4	ND	ND	ND	--	4.1	201	ND	ND	ND	5.4	18	2,454	ND	ND	1.4	ND	5.3	35.2	8.0	2.1			
	03/11/03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.5	ND	8,820	48	875	8.3	ND	ND	ND	--	4.4	265	ND	ND	ND	5.0	99	3,130	ND	ND	ND	ND	ND	ND	ND	90.5	19.4	8.7	
	06/17/03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0	16.3	6,810	47	938	8.3	ND	ND	ND	--	2.2	239	ND	ND	ND	3.6	110	4,040	ND	ND	1.4	ND	13.8	91.8	18.4	5.8			
	08/14/03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.3	ND	1.3	6,130	14.5	441	ND	ND	ND	--	ND	19	ND	ND	ND	5.77	2,193	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	02/13/04	ND	1.21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	153	1.93	21.3	10,200	153	1040	13.0	ND	ND	--	5.96	355	ND	ND	ND	4.23	92.8	4,970	ND	1.98	1.78	3.30	1.96	136	29.6	11.9			
	06/02/04	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.20	25.1	12,300	127	1,910	15.0	ND	ND	ND	--	1.10	766	ND	ND	ND	1.80	120	9,220	ND	3.20	ND	1.10	24.8	176	34.6	13.9			
	10/07/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	17.5	5,200	49.3	680	ND	ND	ND	--	ND	422	ND	ND	ND	1.50	76.8	3,220	ND	ND	ND	ND	ND	ND	ND	ND	ND	14.2		
	02/18/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16.0	2,580	50.5	764	8.10	ND	ND	ND	--	18.1	238	ND	ND	ND	9.10	85.6	3,530	ND	2.30	1.20	ND	13.8	92.2	19.8	9.00			
	06/02/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15.0	8,200	57.5	820	ND	ND	ND	--	<5	264	ND	ND	ND	<5	75	3,940	ND	ND	ND	ND	ND	ND	ND	ND	ND	<25		
	09/28/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	17.8	12,400	133	1,380	ND	ND	ND	--	ND	524	ND	ND	ND	ND	112	6,580	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11.90	
	12/20/05	ND	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15.6	11,900	28	1,300	ND	ND	ND	--	0.94	394	ND	ND	ND	2.37	97.5	5,830	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.39	
	06/26/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5,280	ND	520	ND	ND	ND	--	ND	110	ND	ND	ND	ND	75	2,430	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	09/27/06	<2	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	17.8	7,530	31.8	922	9.29	<1	<1	--	<1	209	<1	<1	<1	1.49	104	3,910	<1	<1	1.90	2.54	13.9	91.6	19.4	6.95			
	03/29/07	<10	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<10	<10	7.4	<10	13.5	3,120	14.1	159	<10	<10	--	8.6	25.7	<10	<10	<10	13.9	58.9	736	<10	<10	<10	<10	<10	<10	<10	<10			
	09/07/07	<100	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	700	<5	13	<5	<5	<5	--	<5	<5	<5	<5	<5	<5	19	5.2	<5	<5	<5	<5	<5	<5	<5	<5				
	03/10/08	<400	<20	<20	<20	<200	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	4,800	22	460	<20	<20	<20	--	<20	64	<20	<20	<20	<20	86	1,900	<20	<20	<20	<20	<20	<20	<20	<20				
	09/22/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2,200	ND	94	ND	ND	ND	--	ND	28	ND	ND	ND	ND	32	460	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	04/20/09	<200	<10	<10	<10	<120	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	2,800	15	270	<10	<10	<10	--	<10	18	<10	<10	<10	98	1,000	<10	<10	<10	<10	<10	<10	<10	<10					
	06/30/09	<40	<2	<2	<2	<20	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	5.3	2,200	12	220	<2	<2	--	<2	11	<2	<2	<2	84	900	<2	<2	<2	<2	<2	<2	<2	<2	18	3.9	3.1		
	09/09/09	<400	<20	<20	<20	<200	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	6,500	28	550	<20	<20	<20	--	<20	69	<20	<20	<20	150	2,300	<20	<20	<20	<20	<20	<20	<20	<20					
	03/02/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5,300	21	450	ND	ND	ND	--	ND	20	ND	ND	ND	ND	170	1,900	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	10/07/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	1,200	5.6	45	ND	ND	--	ND	2.5	ND	ND	ND	ND	28	160	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.6	ND	ND
	09/27/12	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	1,650	<100	<100	<100	<100	<100	--	<100	<100	<100	<100	<															

















Well	Sample Date	Acetone	Benzene	Bromodichloromethane	Bromoform	2-Butanone (MEK)	Carbon disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	Dibromochloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Ethylbenzene	Isopropylbenzene	MTBE	4-Methyl-2-pentanone	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	1,2,4-Trichlorobenzene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylenes	1,1,1,2-Tetrachloroethane	n-Butylbenzene	sec-Butylbenzene	p-Isopropyltoluene	n-Propylbenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Naphthalene	1,4-Dioxane					
WS-3	03/11/03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	1.19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--		
	06/17/03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--
	08/14/03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--
	02/13/04	ND	ND	ND	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--
	06/02/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--
10/07/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--

Notes:  
Concentrations reported in micrograms per liter  
< - concentration less than the stated reporting limit (RL), practical quantitation limit (PQL) or Limit of Quantitation (LOQ); detection limit for 1,4-dioxane is the detection limit (DL)  
ND - not detected above the RL , PQL or LOQ (limits not provided)  
J - estimated concentration  
-- constituent not analyzed

Prepared by: CDN 5/16/22  
Checked by: MAB 6/6/22