401356
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From: Brookshire, Mary Ann <maryann.brookshire@wsp.com>
Sent: Tuesday, November 14, 2023 11:06 AM
To: Kuhn, Kimberly M. <kuhnkm@dhec.sc.gov>
Cc: Northern, Carol <carol.northern@wsp.com>; LaRosa, Rob <Rob.LaRosa@Lennoxintl.com>; Berresford, James <berresjl@dhec.sc.gov>
Subject: Former Ducane Company Site, Blackville, SC - Revised Feasibility Study and Response to Comments

Hi Kim,

The responses to DHEC comments and the revised Feasibility Study for the Former Ducane Company Site in Blackville, SC are attached.

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

Thanks,
Mary Ann

Mary Ann Brookshire
Senior Lead Consultant, Environmental Science
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November 14, 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: Revised **Feasibility Study Report**
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 *Revised Feasibility Study Report* for the former Ducane Company Site located in Blackville, Barnwell County, South Carolina (BLWM File # 401356). The *Revised Feasibility Study Report*, which incorporates comments received from South Carolina Department of Health and Environmental Control on August 28, 2023, is being submitted in accordance with the requirements of Voluntary Cleanup Contract 16-5848-RP executed on November 17, 2016.

After reviewing the remedial alternatives with considerations for the remedial action objectives (RAOs) and other regulatory criteria, in-situ chemical reduction (ISCR) with enhanced biodegradation (EB) and monitored natural attenuation (MNA) was determined to be the most likely alternative to achieve RAOs for the Site. The introduction of ISCR with EB will have the best opportunity for long-term effectiveness while also immediately addressing the chemicals of concern after the initial treatment.

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 Northern

Carol D. Northern
Project Principal

Steve Diamond

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

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 23810 STEVE S. DIAMOND

cc: Mr. Rob LaRosa, Director of EH&S, Lennox International, Inc.

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Feasibility Study Report
Revision 1.0

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
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WSP Project No. EC02.20160378.23

November 2023

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EXECUTIVE SUMMARY

This Feasibility Study (FS) report has been prepared on behalf on Lennox International, Inc. (Lennox) to propose remedial alternatives for the former Ducane Company Site (the Site) in Blackville, Barnwell County, South Carolina. The FS is based on environmental assessments conducted at the Site from 1999 to 2023 and a Plume Analytics® evaluation of the historical groundwater data. The purpose of remedial action at the Site is to reduce concentrations of volatile organic compounds (VOCs) to facilitate natural attenuation of the groundwater.

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. Aromatic hydrocarbons are below all threshold limits for groundwater, therefore only CVOCs are retained as contaminants of concern (COCs) for the feasibility study.

For the feasibility study, six different options were assessed for possible use as a remedial action. The options included no action, institutional controls, monitored natural attenuation, in-situ chemical oxidation, in-situ chemical reduction, and enhanced bioremediation. Five of the six options were retained for further consideration based on Site subsurface conditions and historical treatment attempts. The five options were then grouped into four separate remedial alternatives and analyzed for implementation based on criteria set forth in the US Environmental Protection Agency (EPA) guidance for feasibility studies.

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1.0 INTRODUCTION

This Feasibility Study (FS) report has been prepared on behalf on Lennox International, Inc. (Lennox) to propose remedial alternatives for the former Ducane Company Site (the Site) in Blackville, Barnwell County, South Carolina. The FS is based on environmental assessments conducted at the Site from 1999 to 2023 and a Plume Analytics® evaluation of the historical groundwater data. The purpose of the selected remedial alternative is to reduce concentrations of volatile organic compounds (VOCs) at the Site to facilitate natural attenuation of the groundwater.

1.1 SITE LOCATION

The Site, which is located at 118 West Main Street in Blackville, South Carolina (Figure 1), consists of approximately 105 acres with roughly 19 acres originally developed as a production building and a research and development building. In 1968, Ducane began operations at the Site manufacturing gas grills, furnaces, and air conditioners. Ducane stopped operating at the Site in 1999. Currently, 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 wooden storage building production and warehouse storage. Figure 2 is a depiction of the historical production building with process references (e.g., Former Paint System) at the time Ducane occupied the Site buildings.

1.2 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 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, semi-annual groundwater sampling for a period of two years (four total sampling events) 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 was proposed. DHEC approved the Assessment report in letters dated May 8 and June 1, 2017.

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The four semi-annual groundwater sampling events were conducted in October 2017, March 2018, October 2018, and March 2019 as proposed 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, respectively. 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 with DHEC was held on August 28, 2019, to discuss future Site activities. As a result of that meeting, Lennox proposed to install one additional monitoring well (MW-17), conduct one additional year of semi-annual groundwater sampling and update the Plume Analytics® study. The *Updated Assessment Report* and the additional Site activities were approved by DHEC in a letter dated August 29, 2019.

The additional semi-annual groundwater sampling events were conducted in October 2019 and April 2020. Additional assessment activities were conducted in June 2021 to delineate contaminants in groundwater near monitoring well MW-3, assess potential sources of contamination, and to gain additional subsurface information to better inform on potential remediation strategies. The results of the additional activities conducted in 2021 were presented to DHEC during a December 15, 2021, meeting.

Additional groundwater sampling and well evaluation activities were conducted in 2022. The most recent *Updated Assessment Report* (WSP, 2022) for the Site was submitted to DHEC on September 28, 2022. This report presented the results of the 2022 additional assessment activities and provided an updated Plume Analytics® study. Additional activities were recommended in a November 15, 2022 meeting with DHEC. Recommendations included preparation of an FS Work Plan (WSP 2023), which was submitted on February 16, 2023, and approved by DHEC on March 10, 2023.

1.3 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)

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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:

Area No.	Location	Comments	Constituents of Concern
1	Material Receiving Area	The purported 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 Area No. 3 and north of the production building 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 this FS report.

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

			Source Area Monitoring Wells						
			Area 1		Area 2		Area 3	Area 4	Area 5
Event	Date	Injectant	MW-1/MW-1D	MW-7	MW-2/MW-2D	MW-10	MW-3/MW-3D	MW-5	No wells
Pilot Test	May-June 2001	Fenton's Reagent	X	X	X	X	X	X	
Injection 1	February 2002	K-Permanganate	X	X	X	X		X	
Injection 2	May – June 2002	K-Permanganate	X	X					
Injection 3	October 2002	K-Permanganate		X					X
Injection 4	December 2002	K-Permanganate		X				X	
Injection 5A	July 2003	K-Permanganate		X					
Injection 5B	July 2003	Sodium lactate and ethyl lactate			X	X			
Injection 6	April 2004	ABC	X	X				X	
Injection 7	November 2006	ABC Plus		X					
Injection 8	April 2008	ABC Plus		X			X		
Injection 9	April 2008	ABC						X	

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

Chemical oxidation using Fenton's reagent and potassium permanganate are appropriate technologies to address CVOCs in groundwater. However, implementation of these technologies was apparently not effective in reducing CVOC concentrations during the first two years of ground water remediation efforts, based upon the observation that CVOC concentrations rebounded

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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. During that event, ABC® and ABC® + (ABC with ZVI) were injected (Allied Air, 2013).

2.0 NATURE AND EXTENT OF CONTAMINATION

Site groundwater is monitored annually for VOCs and 1,4-dioxane at most of the well locations shown on Figure 2. 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).

For the purposes of this Feasibility Study, the descriptions on the nature and extent of contamination are based on the April 2022 groundwater sampling event. There was another sampling event that was conducted at the Site in April 2023. Those results, which were provided to DHEC in the Semi-Annual Progress Report dated September 1, 2023, are still being evaluated and have not yet been incorporated into the Groundwater Plume Analytics® evaluation. The April 2022 groundwater analytical results indicated the presence of aromatic hydrocarbons, CVOCs, acetone, chloroform, methylene chloride, and 1,4-dioxane. A summary of the VOC analytical results is provided in Table 1 and the MNA parameter results are summarized in Table 2. The April 2022 groundwater data was used to update the Groundwater Plume Analytics® evaluation, as discussed in Section 2.4. 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. Cross-sections for the Site are provided in Appendix A.

2.1 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 those detected at MW-3. Results of the

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groundwater samples from boring DP-15 and well MW-5 indicate that aromatic hydrocarbons are not present at groundwater monitoring points within the building. Current concentrations of aromatic hydrocarbons are below EPA Maximum Contaminant Levels (MCLs) or Tapwater RSLs as indicated on Table 1. Therefore, aromatic hydrocarbons are not considered chemicals of concern (COCs) for this FS.

2.2 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-TCA) and 1,1,2-trichloroethane (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-DCA), 1,1-dichloroethane (1,1-DCA), and vinyl chloride. These daughter products can be formed by both natural and enhanced reductive dechlorination processes. Plume concentration maps for the COCs are provided in Appendix B.

<u>Treatment Area 1 - East of the Production Building (MW-3)</u>

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 (µg/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 below ground surface (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.

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Treatment Area 2 -North of the Production Building (MW-18 and MW-4/4D)

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 is much lower than that observed in monitoring well MW-3. Although monitoring well MW-18 is downgradient of MW-3, another source (possibly the Old Maintenance Area) is suspected because primarily daughter products are observed in MW-3 and primarily parent products are observed in MW-18, and 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, a camera survey conducted on April 22, 2020, indicated that there are breaches in the well casing of MW-4D at approximately 20 and 30 feet below the top of the casing. In June 2021, an attempt was made to lower a passive diffusion sampler (PDS) to a depth of 80 feet bgs. The PDS could not be lowered to the deeper interval (80 feet) in MW-4D 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.

Treatment Area 3 - South of the Production Building (MW-7 and MW-1/1D)

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.

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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 concentrations that are either non-detect or below MCLs 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.

<u>Beneath the Production Building (MW-5)</u>
CVOCs were detected in groundwater samples collected from monitoring well MW-5 and boring DP-15 as shown on Figure 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). at concentrations above the applicable MCL and/or EPA RSL. However, these concentrations are orders of magnitude less than those detected in groundwater samples collected from well MW-3 located east of the production building.

<u>West Loading Dock (MW-2 and MW-2D)</u>

The west loading dock was identified by others as a CVOC source area in the in the Former Ducane Monitoring Report (ERM 2007). This area is located downgradient of the contaminant plume west of the production building. CVOCs were not detected in the most recent groundwater samples collected from monitoring wells MW-2, MW-2D, MW-10, MW-11, and MW-14; therefore, treatment is not required for this area, and it will not be further evaluated in this FS.

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2.3 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. Since 1,4-dioxane is co-located with the CVOCs it will not be addressed separately in this FS; however, it will continue to be monitored.

Methylene chloride was also detected at concentrations above the EPA MCL while chloroform and acetone were detected at concentrations 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.

2.4 GROUNDWATER PLUME ANALYTICS® EVALUATION

A Groundwater Plume Analytics® evaluation was conducted for the Upper Shallow aquifer at the Site using groundwater analytical data collected through April 2022. Relative changes in plume characteristics between sampling events were observed 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

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Based on the Groundwater Plume Analytics® analysis 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, a decrease in total chloroethenes and total chloroethanes has been observed since the last several sampling events. Additionally, in the case of the total chloroethene molar fractions, a noticeable decrease in cis-1,2-DCE and increase in vinyl chloride was observed, which indicates a progression through the reductive dechlorination sequence suggesting the Site is beginning the transition from stability (i.e., attenuation rate = soil desorption rate) to reduction.

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 likely serving as a carbon source for reducing bacteria and contributing to the reductive dechlorination processes.

2.5 SUMMARY

Based on the results of assessment and remediation activities conducted at the Site since 1999, only CVOCs are retained as chemicals of concern (COCs) for the FS. A list of COCs is provided in Table 4.

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3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents the basis for identification, evaluation, and selection of remedial technologies and process options that were considered in the development of the remedial alternatives presented in Section 4.0.

3.1 REMEDIAL ACTION OBJECTIVES

The remedial action objective (RAO) describes what the proposed site remediation is expected to accomplish. The following RAOs have been identified for the Site:

- Prevent ingestion of groundwater with concentrations of COCs above applicable drinking water standards.
- Restore groundwater concentrations to applicable remediation goals.
- Protect unimpacted nearby environments.

3.1.1 Chemicals and Media of Concern

As described in Section 2.0 and the DHEC-approved FS Work Plan, the COCs for the Site are CVOCs in groundwater. The FS Work Plan identified the following COCs for the Site:

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

1,1,1-TCA was included in the approved FS Work Plan. However, upon further review, this constituent has not been detected above the MCL since 2014 and has thus been removed as a COC for the Site. Nevertheless, should 1,1,1-TCA still be present in the subsurface, it will be treated along with the COCs identified above.

3.1.2 Identification of the Regulatory Criteria

- Chemical-specific—requirements that set protective remediation goals for the COCs. These are set as the RAO.

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- Location-specific—requirements that restrict remedial actions based on the characteristics of the Site [natural subsurface conditions such as pH or oxidation reduction potential (ORP)] or its immediate surroundings.
- Action-specific—requirements that set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants. Potential for spread of contamination off-site is seen as an action-specific regulatory requirement.

3.1.3 Preliminary Remediation Goals

Preliminary remediation goals (PRGs) are cleanup goals for concentrations of contaminants in environmental media that, when attained, should achieve RAOs. PRGs were established based on compliance with chemical-specific regulatory criteria and protection of human health from exposure to contaminated groundwater. PRGs were set to EPA Maximum Concentration Levels (MCLs) or Tapwater Regional Screening Levels (RSLs). The FS Work Plan identified the following quantitative remediation goals for attainment of the RAOs:

COC	Preliminary Remediation Goals (µg/L)
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
1,2-DCA	5
1,1-DCA	2.8

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The cleanup goals for the Site are based on achieving conditions that would be protective for commercial/industrial land use.

3.1.4 Estimated Volumes of Contaminated Media

Based on communication with DHEC during a meeting on November 15, 2022, historical remedial action performed at the Site, and current groundwater conditions, remedial treatment is recommended for the following areas in an effort to reduce COCs to acceptable levels.

Treatment Area 1 - East of the Production Building (MW-3)

Residual COC concentrations in groundwater above the regulatory limits exist in the vicinity of MW-3 between the former drum storage area and the solvent storage area. Based on the results of the limited groundwater assessment performed in the vicinity of the former drum storage and solvent storage areas, the plume appears to be isolated to an area between the two former storage areas to a depth of approximately 20 feet bgs. A treatment area of approximately 5,625 ft^2 and an injection zone of 20 ft is estimated for Treatment Area 1.

Treatment Area 2 - North of the Production Building (MW-18 and MW-4/4D)

COCs in groundwater above the regulatory limits appear to be concentrated in the vicinity of well MW-18 (boring DP-12), which is directly northwest of the old maintenance area and downgradient of well MW-3. Based on CVOC concentrations in wells MW-4 and MW-4D located downgradient of well MW-18, the groundwater plume appears to attenuate approximately 200 feet from MW-18. CVOCs detected in monitoring well MW-4D are suspected to have originated from the shallow groundwater zone. As previously described, the down-hole camera survey identified potential breaches in the casing of well MW-4D which would allow groundwater from the shallow zone to infiltrate the deeper groundwater zone. A treatment area of approximately 7,500 ft^2 and an injection zone of 20 ft is estimated for Treatment Area 2.

Additionally, MW-4D will serve as an injection point to facilitate spot treatment of the deeper aquifer. After treatment, monitoring well MW-4D will be abandoned and replaced for monitoring purposes.

Treatment Area 3 - South of the Production Building (MW-1/1D and MW-7)

Residual COCs in groundwater above the regulatory limits exist in the vicinity of MW-1 and MW-7, which are located in the vicinity of the former Material Loading Area. The plume appears

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isolated in this area. Based on groundwater data, TCE and PCE observed in deeper well MW-1D (approximately 50 ft bgs) is assumed to be residual contamination that may have migrated from the shallow groundwater zone. A treatment area of 7,500 ft^2 and an injection zone of 20 ft is estimated for Treatment Area 3. Additionally, MW-1D will serve as an injection point to facilitate spot treatment of the deeper aquifer. After treatment, monitoring well MW-1D will be abandoned and replaced for monitoring purposes.

Beneath the Production Building (MW-5)

Residual COCs in groundwater above the regulatory limits exist beneath the building in the vicinity of DP-15 and further downgradient in MW-5. These locations are downgradient of the former drum storage and solvent storage areas (vicinity of MW-3) located outside the building. Additionally, it is anticipated that groundwater quality in the proximal area of MW-5 and DP-15 will benefit from groundwater treatment in the general area of MW-3. Therefore, treatment will not be conducted in this area.

The area of groundwater contamination requiring remediation at the Site is estimated and may require adjustment as new groundwater data is obtained. To evaluate the probable cost of various remedial alternatives, a volume of the treatment area was assumed for each location described above. Modifications to the probable cost estimate will be required based on performance of the actual remedial technologies implemented, as new groundwater data is obtained.

3.2 GENERAL RESPONSE ACTIONS

A general response action (GRA) is defined in the CERCLA guidance as a media-specific generic action for addressing contamination and achieving RAOs. The GRAs provide the framework for identifying remedial technologies or methods for the Site. Based on the RAO for the Site, the media of concern is groundwater. In review of remediation guidance documents (USEPA 1988) and media of concern, the GRAs may include one or more of the following actions summarized below.

General Response Action	Description
No Action	No action is taken to remediate the media and contamination remains in place.

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General Response Action	Description
Institutional Controls	Administrative methods or institutional controls that limit land use and access to prevent receptor exposure to contaminated media.
Monitoring	Measurement of contaminant concentrations over time to determine changes and trends in contaminant nature and extent and assess effectiveness of active remedial technologies.
Treatment	Use of in-situ treatment technologies to physically bind, chemically degrade or enhance microbial degradation of COCs.

3.2.1 No Action

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

3.2.2 Institutional Controls

Institutional controls are administrative methods that limit land use or access to prevent receptor exposure to contaminated media left in place at the Site. Institutional controls can be used as the primary component of a remedial alternative or in combination with other remediation technologies and process options (RTPOs) 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 institutional controls, such as land-use restrictions, are meant to supplement RTPOs during all phases of remediation and may be a necessary component of the final remedy.

3.2.3 Monitoring

Monitoring is a response action that is commonly combined with other active remedial alternatives to provide the data necessary to determine if the remedial action successfully achieved RAOs and cleanup standards. Monitoring involves media sampling and analysis of contaminant concentrations and other ancillary variables to track the progress and overall effectiveness of a remedial action.

3.2.4 Treatment

Treatment involves the addition of any 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.

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Treatment can be achieved in-situ by a variety of methods including chemical oxidation, chemical reduction, or enhanced bioremediation.

3.3 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

One or more remediation technologies and process options (RPTOs) may exist for each GRA (except no action). Remediation technologies refer to general categories of technology types, and process options refer to specific methods or equipment types within each technology type. Based on the RAOs, PRGs, the media of concern and site conditions, applicable RTPOs for the GRAs were identified for the Site and are summarized below.

General Response Action	Remedial Technology	Process Options
Treatment	In-Situ Treatment	In-Situ Chemical Oxidation In-Situ Chemical Reduction Enhanced Bioremediation

In addition to treatment, institutional controls and monitoring were identified for further screening since both may supplement and support other RTPOs as part of a complete remedial strategy or design.

3.3.1 Criteria for Preliminary Screening of Remedial Technologies and Process Options

The RTPOs identified for groundwater were evaluated to identify those that are most viable to the site-specific conditions and RAOs. Each RTPO was screened against the criteria described below.

- <u>Effectiveness</u>—The effectiveness of an RTPO refers to the likelihood that the technology will be effective at reducing the toxicity, mobility, and/or volume of, or exposure to the COCs at the Site given the specific conditions. Each RTPO was evaluated for effectiveness based on demonstrated success at similar sites/conditions and historical applications at the Site.

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- Implementability—This criterion considers the relative ease of implementing the RTPO and considers factors such as availability of the materials and services to implement the RTPO.
- Relative Cost—This criterion considers the capital and O&M costs to implement the RTPO.

3.3.2 Identification, Screening, and Evaluation of Technologies

The results of the RTPO screening process are described for each GRA below.

Institutional Controls

Although institutional controls alone do not reduce the toxicity, mobility, or volume of contamination at a site, they can be conditionally effective at preventing exposure of human receptors to contaminated groundwater. Some common options of institutional controls are as follows:

1 Government Controls—Zoning restrictions or local ordinances

2 Property Controls—Deed restrictions, easements, covenants

3 Information Tools—Public notices, signage.

These institutional controls would most likely be used in combination with other RTPOs to achieve a remedy that is protective of human health and the environment. A common institutional control is a land use or deed restriction that specifies groundwater usage restrictions and procedures following completion of the remedial action. Institutional controls are implementable and are low-cost relative to other RTPOs. Institutional controls are retained as an RTPO to be included as a component of the active remedial alternatives.

Monitoring

Monitoring involves collection of groundwater samples to evaluate the extent of contamination and the progress of remedial actions, and to demonstrate that the remedial action has achieved the RAO and cleanup goals. Monitoring is retained as an RTPO to be included as a component of the active remedial alternatives.

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Treatment

Three in-situ treatment RTPOs were identified as potentially viable for the Site groundwater. The screening of these RTPOs is discussed below.

In-Situ Chemical Oxidation (ISCO) - ISCO involves the addition of specific reagents to chemically oxidize the COCs thereby reducing the toxicity, mobility, or volume of the contaminants. Chemical oxidants can be effective for treatment of CVOCs.

In-Situ Chemical Reduction (ISCR) - ISCR involves the addition of specific reagents to chemically reduce the COCs thereby reducing the toxicity, mobility, or volume of the contaminants. Chemical reduction can be effective for treatment of CVOCs.

Enhanced Bioremediation (EB) – In general terms, EB involves the addition of specific amendments to the subsurface to stimulate the naturally occurring subsurface microbial processes to degrade the target constituents. Bioremediation can be effective for treatment of CVOCs.

3.4 DESCRIPTION OF REMEDIAL OPTIONS

The EPA guidance for feasibility studies, references the NCP requirements for 5-year reviews over a 30-year period. Each option listed below is assumed to meet this requirement of the EPA guidance.

3.4.1 Option 1 – No Action

The no action option is required under the NCP to provide a baseline scenario against which all other alternatives are compared. Under the no action option, no funds are expended for remediation and no remedial actions are taken making it easily implementable There is no long-term or short-term effectiveness with the no action option. This option does not reduce the toxicity, mobility or volume through any means and is not expected to be accepted by regulatory authorities.

3.4.2 Option 2 – Institutional Controls (ICs)

Institutional controls (ICs) consist of non-engineered instruments such as land use restrictions, zoning and building permits, and other administrative and legal controls that limit exposure. Under

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this option, no funds are expended for remediation. The possibility of achieving RAOs by ICs alone is low. Long-term effectiveness is low because although ICs may reduce the likelihood of exposure, they do not directly address the COCs. There is no reduction of toxicity, mobility, or volume with ICs other than natural degradation which has been slow at the Site. Property owner acceptance is required for implementation of ICs. ICs can be combined with other options.

3.4.3 Option 3 – Monitored Natural Attenuation (MNA)

MNA consists of allowing naturally occurring subsurface microbial processes to degrade the COCs and monitoring the progress via a groundwater sampling regimen. MNA requires the monitoring of COCs as well as other site-specific groundwater parameters, to assess the effectiveness of subsurface microbes at reducing the parent compounds (PCE, TCE) to daughter products (e.g., cis/trans DCE, 1,1-DCE, VC) and benign end products (e.g., ethene/ethane). Based on the Plume Analytics® analysis and evaluation of groundwater data, there is strong evidence that reductive dechlorination is occurring at the Site. Therefore, evidence suggests MNA would be an appropriate approach for the Site. However, the current concentrations of the COCs preclude MNA from being an appropriate remedy at this time due to the likely long timescale that would be required to achieve PRGs. In other words, short-term effectiveness is not expected with MNA alone. MNA uses well established protocols and generally does not require specialized equipment or services. Additionally, MNA may follow other RTPOs.

3.4.4 Option 4 - In-Situ Chemical Oxidation (ISCO)

ISCO involves the addition of specific chemical reagents to oxidize COCs thereby reducing the toxicity, mobility, or volume of the contaminants. Oxidants can be effective for treatment of a wide range of contaminants, such as CVOCs, given proper subsurface conditions. Depending on the injectate, ISCO has a low to moderate degree of long-term effectiveness as the chemical oxidant is depleted by the degradation of the COCs but also can be depleted by natural subsurface conditions, such as naturally occurring metals and/or organic materials. ISCO has a high degree of short-term effectiveness as an immediate reduction in some constituents is expected, but historical applications at the Site have shown little long-term effectiveness and rebound to pretreatment concentrations. However, ISCO success is dependent on a variety of factors that need to be considered such as injection location, rate/pressure, formulations, volumes, target

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concentration levels, geochemical conditions, etc. The technology is implementable, and the cost can be relatively low to moderate depending on the extent of the COC plume(s).

3.4.5 Option 5 – In-situ Chemical Reduction (ISCR)

ISCR involves the addition of specific reagents to abiotically destroy COCs through chemical reduction thereby reducing the toxicity, mobility, or volume of the contaminants. A by-product of ISCR is the potential creation of reducing conditions conducive to biological reductive dechlorination of COCs as a result of low ORP. Therefore, a concern that should be considered is the potential accumulation of daughter products should the aquifer return to more aerobic conditions post ISCR. Chemical reduction can be effective for treatment of organic contaminants, such as CVOCs. ISCR has a moderate degree of long-term effectiveness as the chemical reductant is depleted by the degradation of the COCs but can also be depleted by naturally occurring subsurface conditions. ISCR has a high degree of short-term effectiveness as an immediate reduction in some COCs is expected and historical applications at the Site have shown effectiveness at reducing the toxicity, mobility, and/or volume of COCs. The technology is implementable, and the cost can be relatively low to moderate depending on the extent of the COC plume(s). ISCR can be combined with other options.

3.4.6 Option 6 – Enhanced Bioremediation (EB)

EB consists of the introduction of oxygen or hydrogen amendments to create aerobic or anaerobic conditions, respectively. In the case of the site COCs, a hydrogen-release amendment would be added to the subsurface to stimulate anaerobic biological reductive dechlorination processes. Additional amendments may also be added to adjust specific parameters such as pH and/or ORP potentially making the subsurface conditions more favorable for microbial activities. EB would be expected to reduce the toxicity, mobility, and/or volume of COCs by reduction of the volume of the COCs available; however, daughter breakdown products may be more toxic than the original parent contaminant, potentially causing an increase in potential toxicity initially until the daughter products degrade into innocuous end products. EB has an expected moderate to high degree of long-term effectiveness. There are factors which could inhibit long-term effectiveness, such as microbial die off, change in subsurface conditions, overload of contaminants, etc., but these may be able to be addressed with additional treatments. The short-term effectiveness is low to moderate as it would not be expected to see significant immediate reductions. In general, EB

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uses well established techniques, technologies, and equipment for implementation. EB can be combined with other options.

3.5 SUMMARY OF OPTIONS

The Groundwater Plume Analytics® evaluation demonstrated evidence that reductive dechlorination is occurring at the Site. Additionally, groundwater monitoring will be required for any treatment method implemented to observe effectiveness of the treatment approach and to monitor attenuation of the COCs. Therefore, MNA will be retained for further consideration as a remedial alternative.

ISCO is a proven technology to address CVOCs at many sites. However, past implementation of ISCO at the Site appears not to have been effective based on groundwater concentration observations. The relative lack of success may be related to a variety of factors such as injection location, rate/pressure, formulations, volumes, target concentration levels, geochemical conditions, etc. Despite the lack of large-scale success in historical applications of ISCO at the Site, ISCO is being considered for spot treatment in wells MW-1D and MW-4D due to the relatively low concentrations and innovative approach to use the existing deep wells as injection points.

ISCR would be expected to abiotically reduce the COCs and historically appears to have been effective at the Site. ICSR will be retained for further consideration as a remedial alternative.

Due to the relatively high initial contaminant levels, EB would likely not be an appropriate stand-alone approach. However, because ISCR typically generates negative ORP conditions that drive reductive dechlorination, EB in conjunction (i.e., concurrent or after) with ISCR would be an advantageous approach. Therefore, EB will be retained for further consideration.

ICs alone do not meet the RAOs. ICs may need to be in place while treatment is underway to reduce exposure to potential receptors. As such, ICs will be incorporated in each remedial alternative, as needed.

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4.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

Four remedial alternatives were developed from the RTPOs retained during the screening process described in Section 3.0. Each remedial alternative includes a combination of RTPOs and was developed to provide a range of options for achieving the RAO and meeting regulatory criteria. The remedial alternatives for further consideration include:

1) No Action
2) MNA
3) ISCR and MNA
4) ISCR, EB, and MNA

Alternatives 2, 3 and 4 may also include implementation of ICs. The four remedial alternatives were evaluated for implementation based on criteria set forth in the EPA guidance for feasibility studies.

4.1 DESCRIPTION OF REMEDIAL ALTERNATIVES

4.1.1 Alternative 1 – No Action

The no action alternative provides a baseline scenario against which all other alternatives are compared. Under the no action alternative, no funds are expended for remediation.

4.1.2 Alternative 2 – MNA

MNA requires monitoring of COCs as well as other site-specific groundwater parameters, to assess the effectiveness of subsurface microbial processes at converting the parent compounds (PCE, TCE) to the daughter products (e.g., cis/trans DCE, 1,1-DCE, VC) and innocuous end products. Due to the relatively high concentrations of COCs, MNA without the implementation of other active treatments could extend for decades before achieving RAOs or may stall before RAOs are achieved. No funds are expended for remediation; however, a groundwater management plan including periodic sampling will be required.

4.1.3 Alternative 3 – ISCR and MNA

Alternative 3 consists of injection of specific reducing reagents to abiotically destroy CVOCs. ISCR will also likely create strong reducing conditions conducive to reductive dechlorination. However, there is a potential that the initial strong reducing conditions may generate daughter

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products that accumulate prior to complete attenuation. Therefore, longer monitoring times (MNA) may be required for natural attenuation of the daughter products. This alternative consists of injecting a reducing agent in select locations where concentrations are above RSLs and/or /MCLs. The groundwater will require monitoring to confirm the effectiveness of the process Confirmation sampling and analyses will be performed for 5-years post treatment to demonstrate that cleanup goals have been achieved. The concentrations in groundwater will be evaluated at the end of the 5-year MNA period to determine the next steps (i.e., additional treatment, continuing MNA, or Site closure). ISCR when combined with MNA allows for assessment of effectiveness and determination if additional treatment is required. Less restrictive ICs with the possibility of eliminating ICs after RAOs have been achieved is also available with this alternative.

4.1.4 Alternative 4 – ISCR, EB, and MNA

Alternative 4 consists of ISCR treatment initially to reduce the mass of parent compounds via chemical reduction, which will abiotically destroy the target compounds at the injection site. A by-product of this is a graduated lowering of ORP (halo effect) from the injection point which is conducive to biological reductive dechlorination. ISCR may be a short-term treatment as once the reductant is spent, groundwater ORP may rise to background levels and stall the reductive dechlorination process. Introduction of hydrogen releasing amendments will prolong the lower ORP in the groundwater and drive further reductive dechlorination of the daughter products to innocuous end products over the long term. The introduction of hydrogen releasing amendments is proposed as the EB treatment. Implementing EB following ISCR, or in conjunction with ISCR, is a prudent approach. MNA allows for the assessment of effectiveness and determination if additional treatment is required. Less restrictive ICs with the possibility of eliminating ICs after RAOs have been achieved is also possible with this alternative. Confirmation sampling and analyses will be performed for 5-years post treatment to demonstrate that cleanup goals have been achieved. The concentrations in groundwater will be evaluated at the end of the 5-year MNA period to determine the next steps (i.e., additional treatment, continuing MNA, or Site closure).

4.2 EVALUATION CRITERIA

EPA guidance defines nine criteria for evaluation of remedial action alternatives. The nine criteria defined under CERCLA for evaluation of remedial alternatives fall into three categories – threshold criteria, primary balancing criteria, and modifying criteria.

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Each alternative must be capable of meeting the following two threshold criteria:

- *Overall Protection of Human Health and the Environment* - Protectiveness of human health and the environment is based on an evaluation of each alternative's ability to meet the RAO.
- *Compliance with Regulatory Criteria* - Each alternative is evaluated to determine how it complies with or can be modified to comply with state regulatory criteria.

The comparative analysis of alternatives is then based on the following five primary balancing criteria:

- *Long-Term Effectiveness and Permanence -* This criterion requires an evaluation of the potential long-term risks remaining after implementation of the remedy. Issues addressed for each alternative include the magnitude of long-term risks and the long-term reliability of the management controls.

- *Short-Term Effectiveness -* The evaluation of short-term effectiveness is based on the protectiveness of human health achieved during the construction and implementation phase of the remedial action. Key factors to be considered by this evaluation include risk to residents, risk to site workers and the community, and the time required to complete onsite construction work.

- *Reduction of Toxicity, Mobility, or Volume through Treatment -* This criterion addresses the preference under CERCLA for remedial alternatives that permanently and significantly reduce the mobility, toxicity, or volume of hazardous substances through treatment.

- *Implementability -* The implementability of each alternative is evaluated based on its technical and administrative feasibility and the availability of services and materials. Technical feasibility takes into consideration difficulties that may be encountered during construction and operation. Administrative feasibility factors include coordination with other offices and agencies, such as obtaining permits or approvals for various onsite activities.

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- *Cost* - Evaluation of the cost of each alternative includes estimation of capital costs, operation, and maintenance (O&M) costs, and the net present value (NPV) based on a 5-year O&M period. The NPV cost provides a means of comparing the total costs of different alternatives with different O&M requirements and duration. The costs are presented in a format consistent with *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (USACE and USEPA 2000).

After DHEC reviews this FS report, the following two modifying criteria will be considered in the Record of Decision (ROD):

- *Regulatory Acceptance* - State acceptance will be determined based on review of this FS report.

- *Community Acceptance*—Formal evaluation of the community responses and/or concerns regarding the alternatives will be considered based on written comments to the proposed plan and, if requested by the public, input during public meetings. Additionally, the FS informally addresses community acceptance of each alternative based on anticipated feedback and concerns from the community.

4.3 EVALUATION OF REMEDIAL ALTERNATIVES

4.3.1 Alternative 1 – No Action

The following table presents an evaluation of the no action alternative relative to the CERCLA evaluation criteria.

Criteria	Analysis
Overall Protection of Human Health and the Environment	The no action alternative is not protective of human health or the environment. This alternative does not eliminate any exposure pathways or reduce the level of risk of the existing media contamination.
Compliance with RAOs	This alternative does not achieve the RAO established for the Site. Location and action-specific regulatory criteria do not apply to this alternative since remedial actions will not be conducted.

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Criteria	Analysis
Long-Term Effectiveness and Permanence	Long-term effectiveness is poor as the current level of contamination and associated risk is not projected to change substantially with time. Because contaminants remain under this scenario, a review/reassessment of the Site would be performed at 5-year intervals.
Reduction of Toxicity, Mobility, or Volume through Treatment	This alternative will minimally reduce the toxicity, mobility, or volume of COCs. The COCs can be expected to degrade naturally over time; however, an extended time frame (decades) may be required before notable changes in concentrations occur.
Short-Term Effectiveness	This remedy is not expected to have any significant short-term effectiveness.
Implementability	The no action alternative is easily implemented.
Order of Magnitude Cost	$0 Total Cost

4.3.2 Alternative 2 – MNA

The following table presents an evaluation of the Alternative 2 relative to the CERCLA evaluation criteria.

Criteria	Analysis
Overall Protection of Human Health and the Environment	The alternative is protective of human health and the environment by preventing receptor exposure to contaminated media if ICs are also implemented. This alternative does not eliminate any exposure pathways or reduce the level of risk of the existing media contamination.
Compliance with RAOs	This alternative may achieve the RAO established for the Site over an extended period. Location- and action-specific regulatory criteria do not apply to this alternative.
Long-Term Effectiveness and Permanence	Long-term effectiveness is poor as the current level of contamination and associated risk is not projected to change substantially with time. Because contaminants remain under this scenario, a review/reassessment of the Site would be performed at 5-year intervals.
Reduction of Toxicity, Mobility, or Volume through Treatment	This alternative will slightly reduce the toxicity and volume of COCs as they degrade over time; however, an extended time frame (decades) may be required before notable changes in concentrations occur, and attenuation may stall depending on subsurface conditions. The plume is currently stable.

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Criteria	Analysis
Short-Term Effectiveness	This remedy is not expected to have any significant short-term effectiveness.
Implementability	This alternative is easily implemented. Because the alternative relies on monitoring, there are potential administrative and schedule/logistical challenges to implementation of this alternative.
Order of Magnitude Cost	$280,000 Total NPV (-30% to +50%)

4.3.3 Alternative 3 – ISCR and MNA

The following table presents an evaluation of Alternative 3 relative to the CERCLA evaluation criteria.

Criteria	Analysis
Overall Protection of Human Health and the Environment	This alternative would be protective of human health and the environment by treatment of the source area, monitoring migration and breakdown of COCs by both chemical treatment and subsurface microbial processes to eventually comply with RSL/MCLs.
Compliance with RAOs	This alternative would achieve the RAO. Location and action specific regulatory criteria are achieved by this alternative.
Long-Term Effectiveness and Permanence	This alternative would have a moderate degree of long-term effectiveness as the groundwater that contain COCs at concentrations that exceed RAO goals would be treated chemically; however, the chemical reduction agent may be depleted by naturally occurring materials and processes before complete destruction occurs thus creating unwanted daughter products and requiring additional dosages. Site subsurface conditions could be monitored to maintain effectiveness and as well as the breakdown of COCs. Monitoring results will be used to assess effectiveness and determine if additional treatments are necessary. ICs would be implemented until RAOs are achieved.
Reduction of Toxicity, Mobility, or Volume through Treatment	This alternative will reduce the toxicity and volume of COCs. In addition to being degraded chemically, the COCs can be expected to degrade naturally over time. Intermediate degradation products may be more toxic than the original contaminant, causing an increase in toxicity initially in the treatment regimen. Monitoring of the Site subsurface conditions will also allow assessment of effectiveness and if additional treatments are necessary. The plume is currently stable.

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Criteria	Analysis
Short-Term Effectiveness	This alternative would be effective immediately upon completion of the treatment; however, there is the potential for short-term impacts to workers (e.g., treatment chemical exposure) and for nuisance issues during the active remediation injection period. Further, depending on the subsurface conditions and groundwater migration, the concentrations of COCs and/or more toxic daughter products could rebound or be produced after the initial treatment. These potential issues can be managed through well-established engineering controls and monitoring.
Implementability	This alternative uses well-established techniques and technologies and does not require specialized services or equipment. There are no known challenges to completing this alternative that cannot be addressed through proper engineering design and construction.
Order of Magnitude Cost	$1,500,000 Total NPV (-30% to +50%)

4.3.4 Alternative 4 – ISCR, EB, and MNA

The following table presents an evaluation of Alternative 4 relative to the CERCLA evaluation criteria.

Criteria	Analysis
Overall Protection of Human Health and the Environment	This alternative would be protective of human health and the environment by treating groundwater that contains COCs at concentrations that exceed RSL/MCLs with chemical agents and amendments to enhance subsurface dechlorination.
Compliance with RAOs	This alternative would achieve the RAO. Location and action specific regulatory criteria are achieved by this alternative.
Long-Term Effectiveness and Permanence	This alternative would have a high degree of long-term effectiveness as the groundwater that contains COCs at concentrations that exceed RSL/MCLs would be treated initially by chemical reduction then undergo long-term treatment via microbial degradation. The microbial degradation will be optimized by adding amendments to promote favorable subsurface conditions for biodegradation. However, the chemical reductant may be depleted by other naturally occurring substances and processes requiring additional dosages. Furthermore, additional amendments to support EB may be needed. Thus, ICs, monitoring, and maintenance may be required into the foreseeable future.

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Criteria	Analysis
Reduction of Toxicity, Mobility, or Volume through Treatment	Treatment with this alternative would reduce/eliminate the volume of contamination in groundwater and thereby substantially reduce/eliminate the COC toxicity. Intermediate degradation products may be more toxic than the original contaminant, causing an increase in toxicity initially in the treatment regimen; however, this would be reduced by the enhanced bioremediation. Monitoring of the Site subsurface conditions will also allow assessment of effectiveness of the remedy and if additional treatments are necessary. The plume is currently stable.
Short-Term Effectiveness	This alternative would be effective immediately upon completion of the treatment; however, there is the potential for short-term impacts to workers (e.g., treatment chemical exposure) and for nuisance issues during the active remediation injection period. Further, depending on the subsurface conditions and groundwater migration, the concentrations of COCs could rebound after initial treatment. These potential issues can be readily and effectively managed through well-established engineering controls and monitoring.
Implementability	This alternative uses well-established techniques and technologies and does not require specialized services or equipment. There are no known challenges to completing this alternative that cannot be addressed through proper engineering design and construction. Because the alternative relies on monitoring and potentially multiple treatments, there are potential administrative and schedule/logistical challenges to implementation of this alternative.
Order of Magnitude Cost	$1,700,000 Total NPV (-30% to +50%)

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5.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

In this section, the four remedial alternatives that were evaluated in Section 4.0 are compared to each other. The basis of the comparison is the nine CERCLA evaluation criteria previously described. Through this comparative analysis, it is possible to establish rankings between the alternatives for the various criteria. The results of these comparisons are tabulated and ranked to highlight the remedial technologies that represent the most suitable alternative for achieving Site RAOs.

5.1 Basis for Comparative Analysis

The purpose of the comparative analysis is to compare and contrast the various strengths, weaknesses, and overall performance of each remedial alternative while also providing a rational basis for selecting a treatment remedy. A brief summary of the comparisons between Remedial Alternatives 1 through 4 is presented in the table below.

Comparison of Remedial Alternatives

	Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Threshold Criteria	**Description**	**No Action (5 year time frame)**	**Monitored Natural Attenuation (5 year time frame)**	**ISCR and MNA (5 year time frame)**	**ISCR, EB, and MNA (5 year time frame)**
	Overall Protection of Human Health and Environment	Does not reduce potential exposure to COCs or potential migration in an acceptable time frame.	Does not reduce potential exposure to COCs or potential migration in an acceptable time frame.	Reduces potential exposure to COCs and controls potential migration by treating with chemically reducing agent.	Reduces potential exposure to COCs and controls potential migration by treating with chemically reducing agent and enhances biological degradation.
Balancing Criteria	**Compliance with RAOs**	Does not comply with RAOs.	May potentially comply with RAOs over a long time frame.	High possibility of achieving RAOs.	High possibility of achieving RAOs.
	Long-term Effectiveness and Permeance	Low effectiveness for mitigating exposure and preventing migration off-site.	Low effectiveness for mitigating exposure and preventing migration off-site.	Moderatley effectiveness for exposure and potential migration due to potential exhaustion of chemically reducing agents.	High effectiveness for exposure and potential migration from EB treatments supplementing breakdown once chemically reducing agents expended.
	Short Term Effectiveness	No short term effectiveness.	No short term effectiveness.	High short term effectiveness due to the treatment with chemically reducing agents.	High short term effectiveness due to the treatment with chemically reducing agents.
	Reduction of Toxicity, Mobility, or Volume	No reduction in toxicity, mobility, or volume.	Slow and limited reduction of volume by MNA.	Alternative 3's ISCR treatment would have a high reduction in toxicity, mobility and volume by the chemical agents destroying COCs during intial treatment.	Alternative 4's reduction in toxicity, mobility, and volume would be high due to the initial reduction in volume by the ISCR treatment and the long term microbial degradation from EB.

Balancing Criteria	Implemenetability	Not applicable.	Low implementability as there are limited MNA mechanisms and extended time frames before achieving RAOs.	Alternative 3's implementability is moderate due to the technology used to implement this alternative being widely used and safe practices are well established. Any issues with implementability can be adddressed in the planning and design phases.	Alternative 4's implementability is moderate due to the technology used to implement this alternative being widely used and safe practices are well established. Any issues with implementability can be adddressed in the planning and design phases.
	Estimated Costs	Capital costs: $0 Annual OM&M: $0 Net Present Worth: $0	Capital Costs: $0 Annual OM&M: $56,000 Net Present Worth: $280,000	Capital Costs: $1,200,000 Annual OM&M: $56,000 Net Present Worth: $1,500,000	Capital Costs: $1,400,000 Annual OM&M: $56,000 Net Present Worth: $1,700,000
Modifying Criteria	Regulatory Acceptance	Not anticipated to be acceptable by regulatory agencies due to COCs not being addressed.	Not anticipated to be acceptable by regulatory agencies due to extended time frames required.	Anticipated to be acceptable by regulatory agencies due to chemical treatment reducing COCs and shortening treatment time frames.	Anticipated to be acceptable by regulatory agencies due to chemical treatment reducing COCs and shortening treatment time frames.
	Community Acceptance	Not anticipated to be acceptable by the community due to COCs not being addressed.	Not anticipated to be acceptable by the community due to extended time frames required.	Anticipated to be acceptable by the community due to chemical treatment reducing COCs and shortening treatment time frames.	Anticipated to be acceptable by the community due to chemical treatment reducing COCs and shortening treatment time frames.

5.2 THRESHOLD CRITERIA

Alternative 1 (no action) does not meet the threshold criteria of overall protection of human health and the environment and compliance with regulatory criteria. The current conditions of the Site represent an unacceptable, potential hazard, and would not meet the RAO. Without active remediation or engineering and/or institutional controls, there is a potential risk of exposure to groundwater by potential receptors. Alternative 2 may meet the threshold criteria as exposure to groundwater would be managed and the RAO could be achieved; however, the time frame (potentially decades) is restrictive. The two active remedial alternatives (Alternatives 3 and 4) would potentially meet the threshold criteria.

5.3 BALANCING CRITERIA

The following paragraphs discuss each of the remedial alternatives with respect to the balancing criteria.

5.3.1 Long-Term Effectiveness and Permanence

Alternative 1 does not attain long-term effectiveness and permanence as no remedial action is taken at the Site. Alternative 2 has the possibility of having long-term effectiveness and permanence but the potential of natural attenuation stalling is present.

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Both Alternative 3 and Alternative 4 will initially reduce the concentration of contaminants to allow for natural attenuation of the COCs over time to attain the criteria of long-term effectiveness and permanence. Under Alternative 3, groundwater would be treated with chemically reducing agents designed to abiotically destroy COCs to attain RAOs. However, the chemical agents may be depleted quickly causing incomplete destruction of COCs and creation of more toxic daughter products; therefore, reapplication of chemical agents and long term MNA may be needed to achieve long term effectiveness.

Alternative 4 would be identical to Alternative 3 with the exception that EB would provide favorable long-term conditions for microbial degradation of COCs (including daughter products) and potentially reduce the MNA period.

5.3.2 Short-Term Effectiveness

Alternative 1 and Alternative 2 would not meet the short-term effectiveness objective as there is no active remediation in these alternatives. Alternative 3 and Alternative 4 are similar with respect to the short-term effectiveness and should be immediately effective upon completion of the remedial action. The two active remedial alternatives involve the use of chemical agents introduced via well-established practices. Potential short-term impacts to workers can be readily addressed though proper design and execution of the remedial action, including use of well-established best management practices. Many of the potential short-term impacts associated with the active remedies are related to the noise, chemical agent exposure, and mobilization of COCs. Some of the key factors related to these activities include, but are not limited to:

- Inherent hazards associated with the use of heavy machinery.
- Potential for exposure to chemicals that, without proper controls, can represent a hazard or at least a nuisance to workers and the adjacent community.
- Potential for mobilization of contaminants through the pressure generated during the injection process.

5.3.3 Reduction of Toxicity, Mobility, or Volume

Alternative 1 and Alternative 2 have the possibility of reducing the toxicity, mobility, or volume of the COCs through attenuation over long time frames. Alternative 3 and Alternative 4 should

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substantially reduce the toxicity and volume of contaminated groundwater. The addition of EB in Alternative 4 would improve the long-term reduction of toxicity, mobility, or volume of contaminants.

5.3.4 Implementability

Each of the remedial alternatives are relatively easy to implement with Alternative 1 and Alternative 2 having minimal implementation obstacles and relying on routine tasks already conducted at the Site. Alternative 3 and Alternative 4, are relatively easy to implement and involve readily available and reliable technologies. Additionally, the effectiveness of the alternatives can be readily evaluated through groundwater monitoring. Implementation of these alternatives does not hinder the use of any other treatment in the future.

5.3.5 Costs

For each remedial alternative a projected cost analysis was performed and itemized. The details for each remedial alternative are included in Appendix C and summarized below.

Alternative 1 would not have any costs associated with implementation as no remedial action would be taken.

Alternative 2 is estimated to cost $280,000 and would include five years of semi-annual groundwater monitoring for COCs and natural attenuation parameters at a cost of $56,000 annually.

Alternative 3 is estimated to cost approximately $1,500,000 and would include installation of 132 injection wells to cover the approximately 22,500 ft^2 area of treatment, purchase of the ZVI injectant for approximately 5,500 yd^3 of pore volume, an initial treatment implementation of 45 days of injections for 100% of the area and a second treatment implementation the next year of 21 days of injections for 50% of the area. Sampling costs associated with the injection monitoring, and semi-annual MNA monitoring for 5 years are as described above in the Alternative 2 discussion.

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Alternative 4 is estimated to cost approximately $1,700,000 and would include the costs included in the Alternative 3 discussion with an increased cost for the injectant per cubic yard of treatment to add injectants to enhance biodegradation.

It should be noted that these costs are based on various assumptions. For example, injectant costs may vary based on subsurface conditions and 5 years of groundwater monitoring costs would be subject to inflationary pressures. Modifications to the estimated costs may be required based on actual effectiveness of remedial alternatives, regulatory requirements, or other unforeseen conditions. A detailed cost estimate for Alternative 3 and Alternative 4 is provided as Appendix C.

5.4 MODIFYING CRITERIA

Alternative 1 (No action) would not be acceptable to meet the modifying criteria of regulatory and community acceptance because the contaminants would not be addressed. Alternative 2 (MNA) is not anticipated to be acceptable to the regulatory agency or community due to the length of time for RAOs to be achieved given the current concentrations of COCs. Alternative 3 (ISCR and MNA) could be acceptable to both regulatory agencies and the community as chemical treatment would reduce concentrations to shorten the remedial timeframe for MNA. Alternative 4 (ISCR, EB, and MNA) could also be acceptable to both the regulatory agency and the community as chemical treatment and EB would reduce concentrations to shorten the remedial timeframe for MNA.

5.5 RESULTS OF COMPARATIVE ANALYSIS

A points-based system was developed as a tool to provide useful evaluation and tabulation of the results of the comparative analyses presented Section 5.1. For each analysis criteria, a ranking number has been assigned to represent relative strengths and weaknesses of the four treatment alternatives. Ranking points were assigned by applying a sliding-scale that applied the following rational:

Low – 1 point

Low to Moderate – 2 points

Moderate – 3 points

Moderate to High – 4 points

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High – 5 points

The ranking criteria associated with the relative cost for each treatment were assigned by applying the following rationale:

Zero to low cost – 5 points

Moderate cost – 3 points

High cost – 1 point

Based on this points-based ranking system, the treatment remedies that most appropriately reflect and achieve the ranking criteria will have the highest cumulative point totals. The result of this points-based comparative analysis is provided in the table below:

Summary of Comparative Analysis Results

	ALTERNATIVES			
	No Action	MNA	ISCR & MNA	ISCR, EB, & MNA
Overall Protection of Human Health and the Environment	1	1	5	5
Compliance with RAOs	1	2	5	5
Long-Term Effectiveness and Permanence	1	2	3	5
Short-Term Effectiveness	1	1	5	5
Reduction of Toxicity, Mobility, and Volume	1	2	4	5
Implementability	3	3	5	5
Net Present Worth Cost	5	3	2	1
Regulatory Acceptance	1	2	5	5
Community Acceptance	1	1	5	5
Total Points	**15**	**17**	**39**	**41**

Alternative 1 and Alternative 2 fail to meet the threshold criteria of addressing Site RAOs in a reasonable time frame.

Alternative 3 and Alternative 4 have higher overall rankings. Both active remedial alternatives are anticipated to comply with RAOs, achieve short-term effectiveness, and manifest long-term

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effectiveness and permanence with Alternative 4 having a higher likelihood of achieving long-term permanence. The only other effective difference between the two active alternatives is that the cost of Alternative 4 is higher than Alternative 3. However, the addition of the EB treatment for long term effectiveness in Alternative 4 outweighs the lower cost of Alternative 3, which has the potential for the chemical reduction agent to be depleted before complete destruction occurs thus creating unwanted daughter products and requiring additional dosages.

6.0 REFERENCES

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TABLES

TABLE 1. SUMMARY OF DETECTED GROUNDWATER ANALYTICAL RESULTS - ORGANICS
Former Ducane Company Site
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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	**1400**	**5.0 J**	**100**	<10	**7.2 J**	<10	<10	<10	<10	<10	**55**	**570**	<1.0
MW-1D	48 - 53	4/19/22	<20	<1.0	<1.0	<1.0	<1.0	<1.0	**1.1**	<1.0	<1.0	<1.0	<1.0	**86**	<1.0	<1.0	<1.0	**14**	<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	**10 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
MW-3	5 - 15	4/20/22	<4000	<200	<200	**960**	<200	**400**	**16000**	**130 J**	**330**	<200	<200	<200	**120 J**	<200	<200	<200	**1300 J**	**1300**	**240**
MW-3D	20 - 25	4/20/22	<20	<1.0	**0.94 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
MW-4	8 - 18	4/20/22	<20	<1.0	<1.0	<1.0	<1.0	<1.0	**5.5**	<1.0	<1.0	<1.0	<1.0	**2.5**	<1.0	<1.0	**0.51 J**	**4.9**	<1.0	<1.0	<1.0
MW-4D	72 - 82	4/20/22	<20	<1.0	<1.0	<1.0	<1.0	**1.0**	**0.74 J**	<1.0	<1.0	<1.0	<1.0	**32**	<1.0	<1.0	<1.0	**1.4**	<1.0	<1.0	<1.0
MW-5	15 - 20	4/21/22	<20	<1.0	<1.0	**2.6**	**0.64 J**	**1.4**	**330**	**2.8**	<1.0	<1.0	<1.0	**150**	<1.0	<1.0	**0.61 J**	**220**	**6.1**	<1.0	**9.0**
MW-7	2 - 12	4/20/22	<20	<1.0	<1.0	<1.0	<1.0	**1.2**	**710**	**5.9**	**240**	**2.3**	<1.0	<1.0	**6.4**	<1.0	<1.0	**0.66 J**	**1400**	**660**	**1.5 J**
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	**1.6**	<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	**0.81 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
MW-18	15 - 25	4/20/22	<20	**1.1**	**0.48 J**	**0.49 J**	<1.0	**13**	**9.2**	<1.0	<1.0	<1.0	<1.0	**390 J**	**1.4**	**0.89 J**	**17**	**550 J**	**0.81 J**	**8.8**	<1.0
DP-15	15	4/19/22	<100	<5.0	<5.0	**22**	**6.4**	**17**	**420**	**12**	<5.0	<5.0	**5.5**	**60**	<5.0	<5.0	**30**	**97**	**11**	<5.0	**51**
DP-15	22	4/19/22	<100	<5.0	<5.0	**24**	**6.7**	**22**	**430**	**13**	<5.0	<5.0	**7.4**	**73**	<5.0	<5.0	**31**	**120**	**14**	<5.0	**52**

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	**16**	<0.1 J	**3.3**	<1.0	**1.3**	<10	**13**	**470**	<15
MW-1D	48 - 53	4/19/22	<20	**1.8**	<0.1 J	**0.39 J**	<1.0	<1.0	<10	<10	**3.6 J**	<15
MW-2	5 - 15	4/19/22	<20	**6.1**	**1.2**	**3.7**	<1.0	<1.0	<10	<10	<10	<15
MW-2D	39 - 44	4/19/22	<20	**2.9**	**0.16 J**	**0.92 J**	< 1.0	<1.0	<10	<10	<10	<15
MW-3	5 - 15	4/20/22	<20	**39**	<0.02	<1.0	**2.5**	**12**	**33**	**110**	**7900**	<15
MW-3D	20 - 25	4/20/22	<20	**12**	**3.5**	**0.41 J**	< 1.0	<1.0	<10	<10	<10	<15
MW-4	8 - 18	4/20/22	<20	**8.9**	**0.013 J**	**2.2**	<1.0	**1.2**	<10	<10	**2.9 J**	<15
MW-4D	72 - 82	4/20/22	<20	**1.8**	**0.069**	**1.0**	<1.0	<1.0	<10	<10	<10	<15
MW-5	15 - 20	4/21/22	<20	**16**	**0.35**	**0.68 J**	**2.9**	**0.42 J**	<10	<10	**1200**	<15
MW-7	2 - 12	4/20/22	**24**	**18**	<0.02	**0.52 J**	<1.0	**6.0**	**30**	**150**	**1600**	<15
MW-10	2 - 12	4/20/22	<20	**11**	<0.02	**6.1**	<1.0	**2.1**	<10	<10	**62**	<15
MW-11	2 - 12	4/20/22	**44**	**3.4**	<0.02	**5.6**	<1.0	**2.1**	<10	<10	**200**	<15
MW-14	2 - 12	4/20/22	<20	**3.3**	<0.02	**4.8**	<1.0	**1.3**	<10	<10	**96**	<15
MW-15	9 - 19	4/19/22	<20	**3.3**	**0.042 J**	**9.5**	<1.0	**0.54 J**	<10	<10	**8.0 J**	<15
MW-16	10 - 20	4/20/22	<20	**12**	**5.3**	**0.41 J**	<1.0	<1.0	<10	<10	**2.8 J**	<15
MW-17	20 - 30	4/19/22	<20	**7.4**	**1.75 J**	**12**	<1.0	<1.0	<10	<10	<10	<15
MW-18	15-25	4/20/22	**38**	**7.5**	**1.5**	**2.3**	<1.0	**0.71 J**	<10	**8.3 J**	**44**	<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	Bottom of Screened Interval feet, NAVD	Top of Screened Interval feet, NAVD	April 18, 2022	
				Depth to Water feet below TOC	Groundwater Elevation feet
MW-1	282.05	259.09	274.09	5.60	276.45
MW-1D	282.08	226.08	231.08	8.27	273.81
MW-2	277.71	259.76	269.76	2.37	275.34
MW-2D	277.61	230.72	235.72	4.19	273.42
MW-3	279.68	262.09	272.09	3.99	275.69
MW-3D	279.94	247.11	252.11	4.39	275.55
MW-4	279.74	258.89	268.89	5.22	274.52
MW-4D	279.91	195.05	205.05	9.29	270.62
MW-5	279.85	260.23	265.23	5.18	274.67
MW-7	280.76	265.65	275.65	4.06	276.70
MW-10	278.12	274.70	264.70	8.27	269.85
MW-11	280.64	267.56	277.56	5.82	274.82
MW-14	280.81	266.98	276.98	5.95	274.86
MW-15	282.82	259.98	269.98	5.97	276.85
MW-16	278.48	255.74	265.38	3.69	274.79
MW-17	285.28	252.34	261.98	8.91	276.37

Notes

NAVD - North American Vertical Datum of 1988 — Prepared by: JDD 10/3/23

TOC - top-of-casing — Checked by: CDN 10/3/23

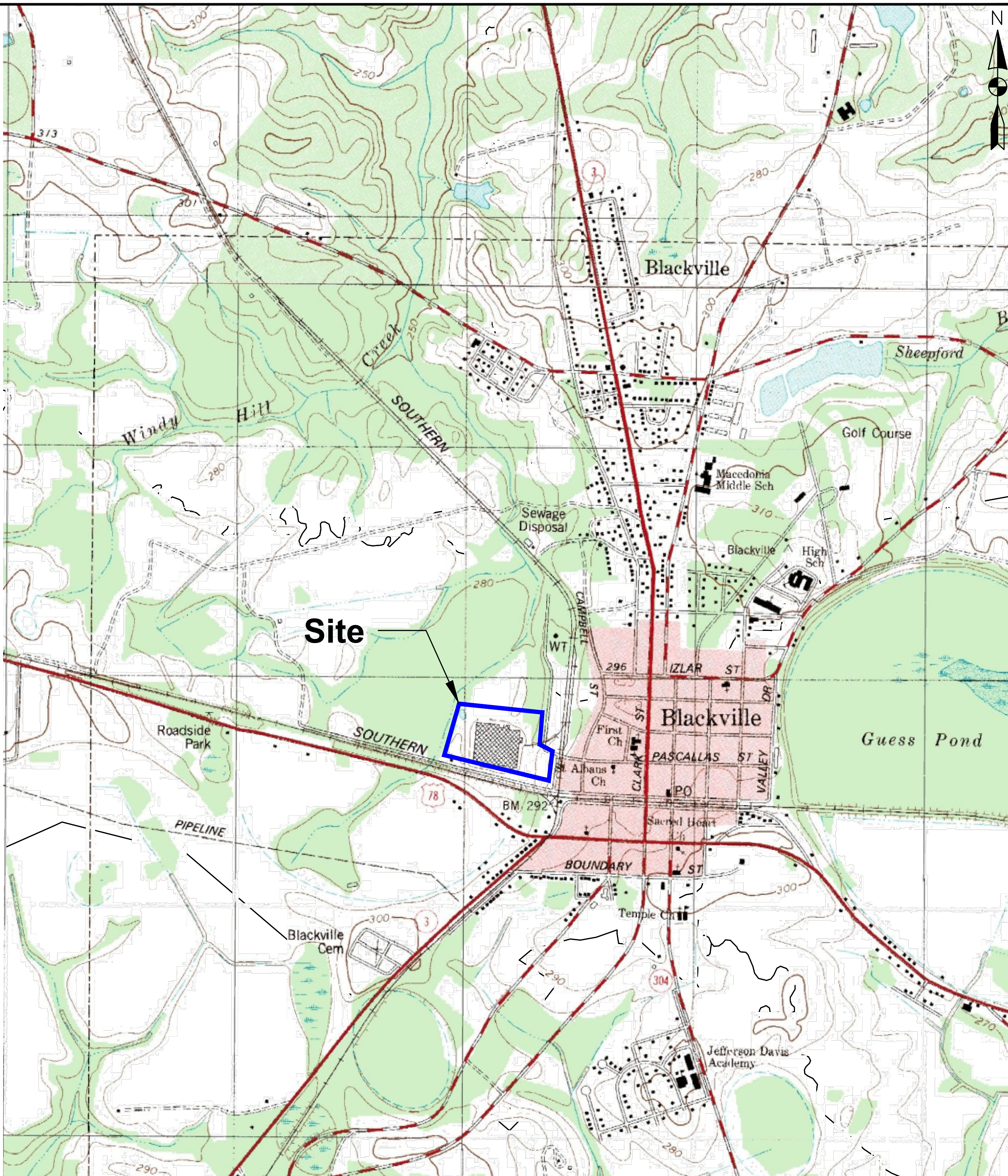
*Screened intervals of each of the wells, except for wells MW-16, MW-17, and MW-18, were based on reports by others.

Table 4. Summary of Chemicals of Concern
Former Ducane Company Site
Blackville, Barnwell County, South Carolina
BLWM File #401356

Area	Chemical of Concern
Eastern Area (MW-3)	**CVOC** 1,1-Dichloroethane 1,1-Dichloroethene cis-1,2-Dichloroethene trans-1,2-Dichloroethene Vinyl Chloride
Northern Area (MW-18, MW-4, MW-4D)	**CVOC** Tetrachloroethane Trichloroethene 1,1,2-Trichloroethane 1,1-Dichloroethene
Southern Area (MW-1, MW-1D, MW-7)	**CVOC** Tetrachloroethane Trichloroethene cis-1,2-Dichloroethene Vinyl Chloride

Prepared by: JDD 5/17/23
Checked by: MAB 7/6/23

FIGURES



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

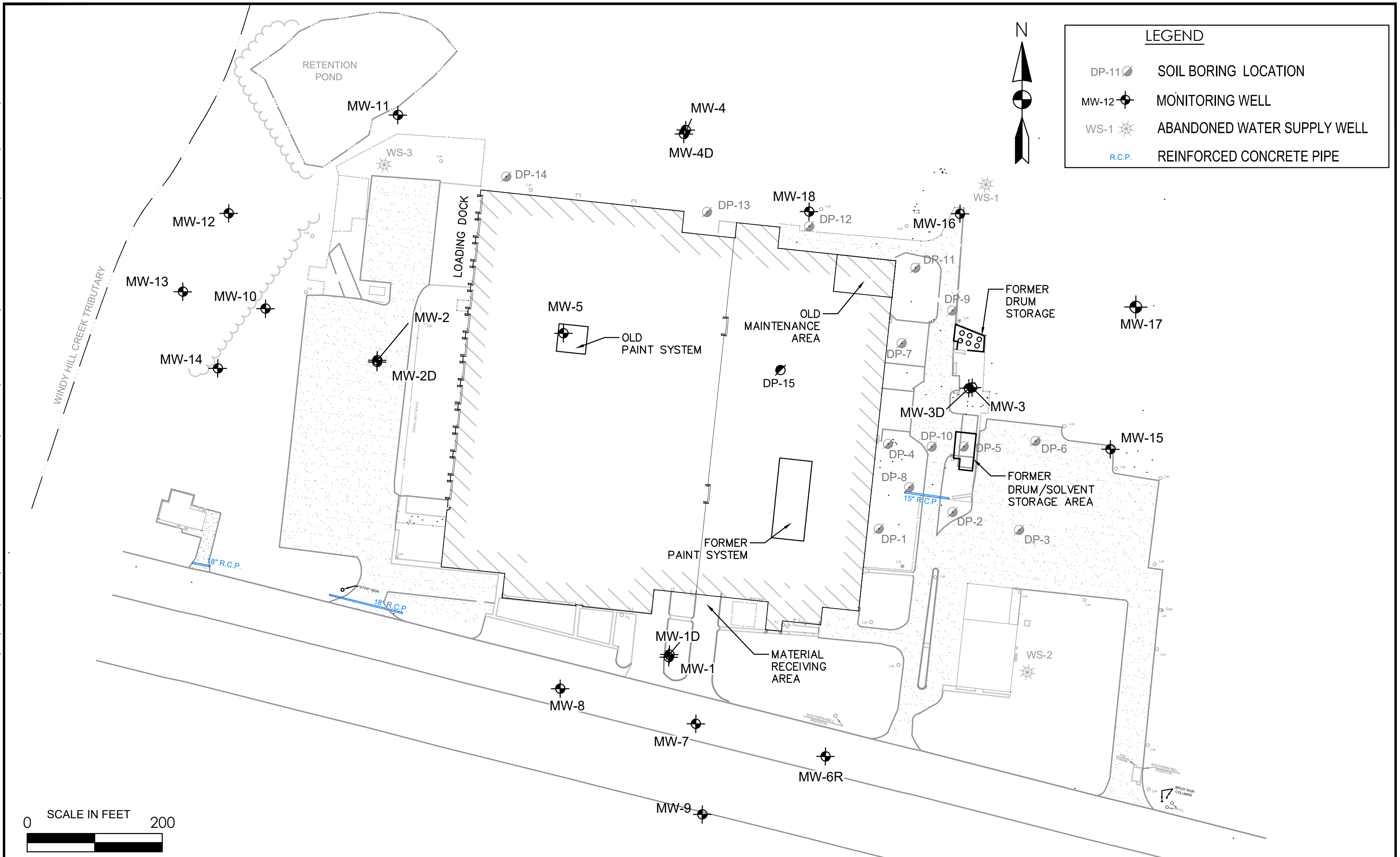
PROJECT NO. EC02.20160378.21

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

SITE LOCATION MAP

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

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox_Main_2017.dwg (Site Location) 03/11/22 10:25 – hpham



FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA

BLWM FILE # 401356

PROJECT NO. EC02.20160378.21

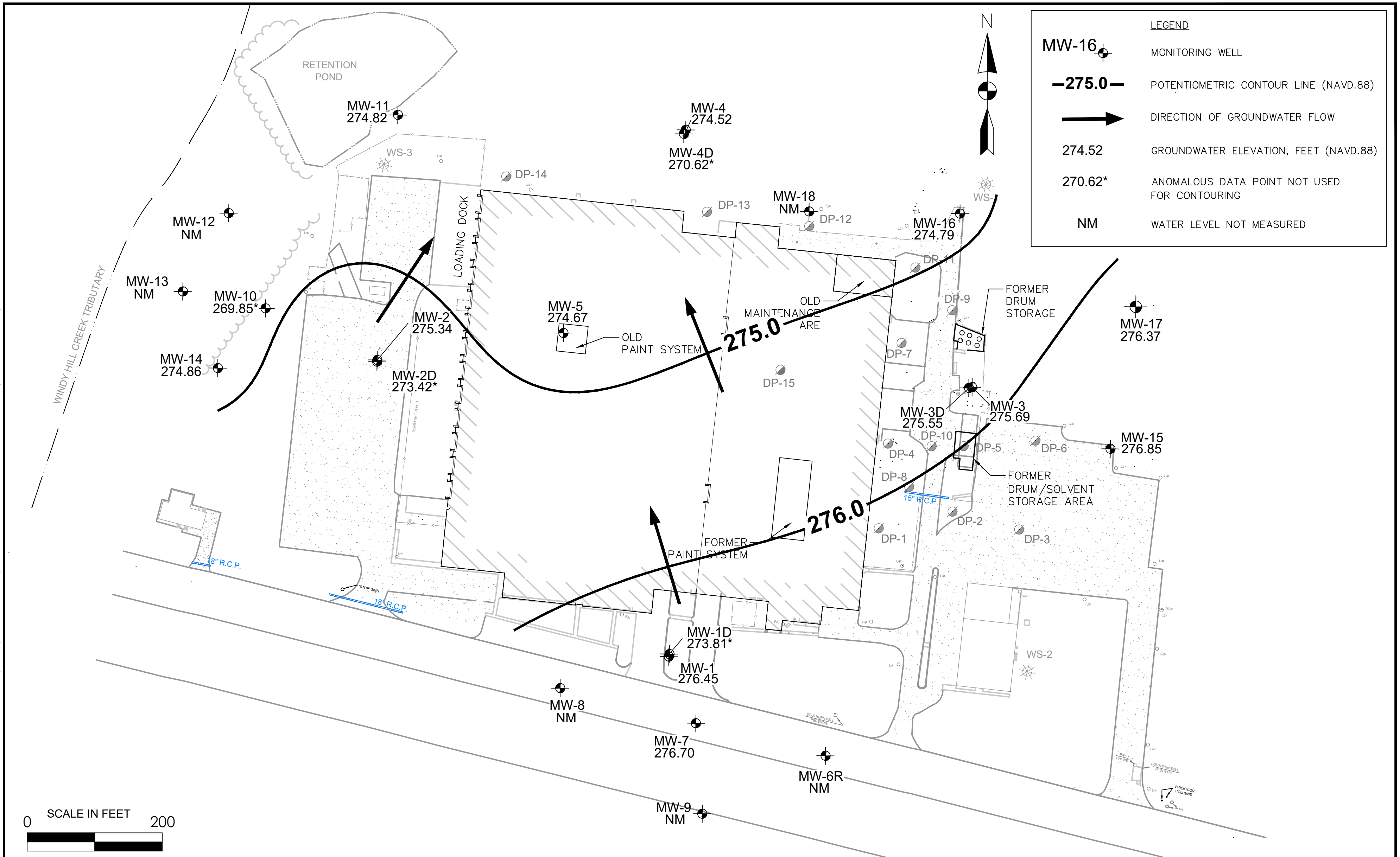
WSP USA

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

MONITORING WELL and SOIL BORING LOCATIONS

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

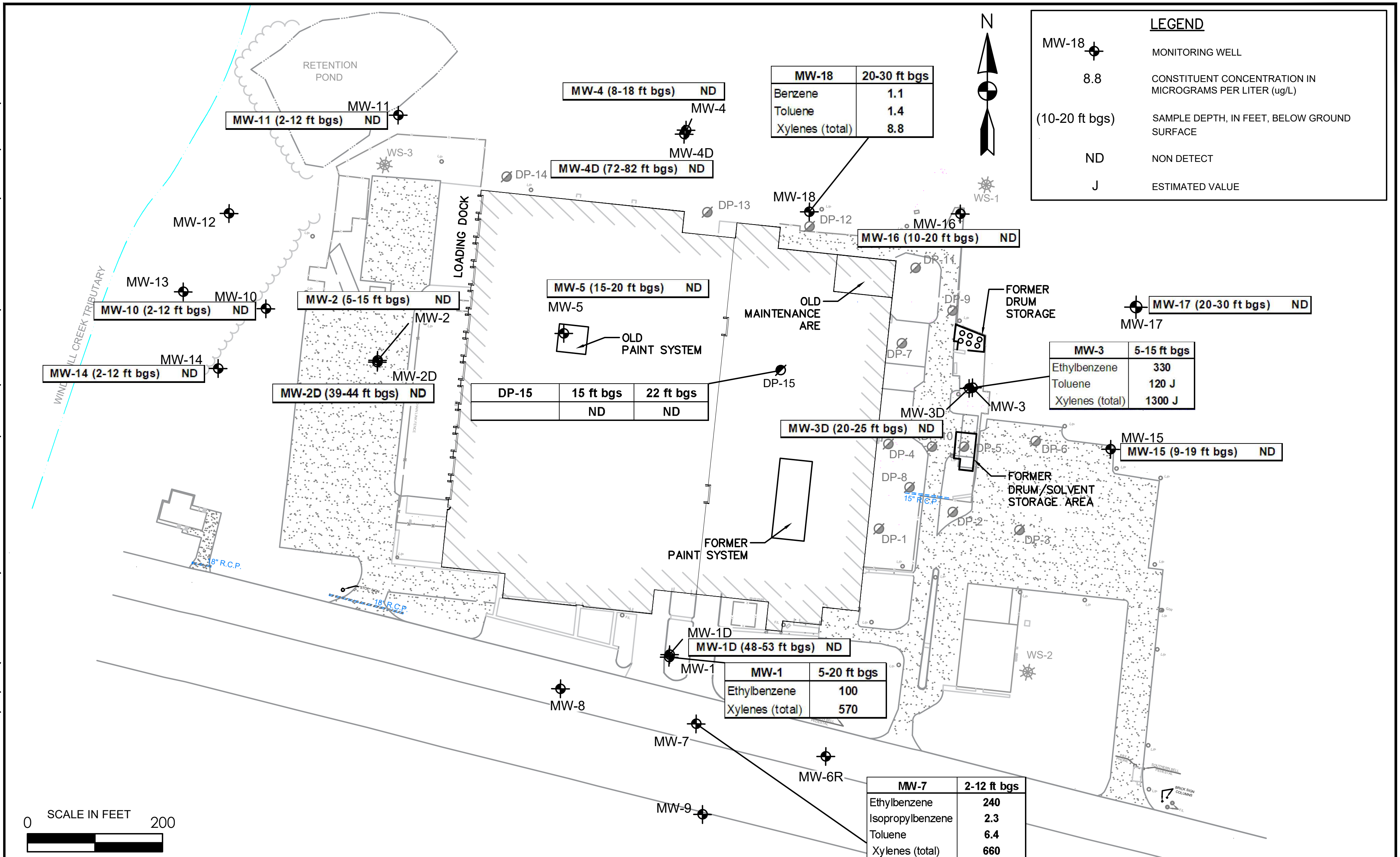
BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA
BLWM FILE # 401356

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



FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA

BLWM FILE # 401356

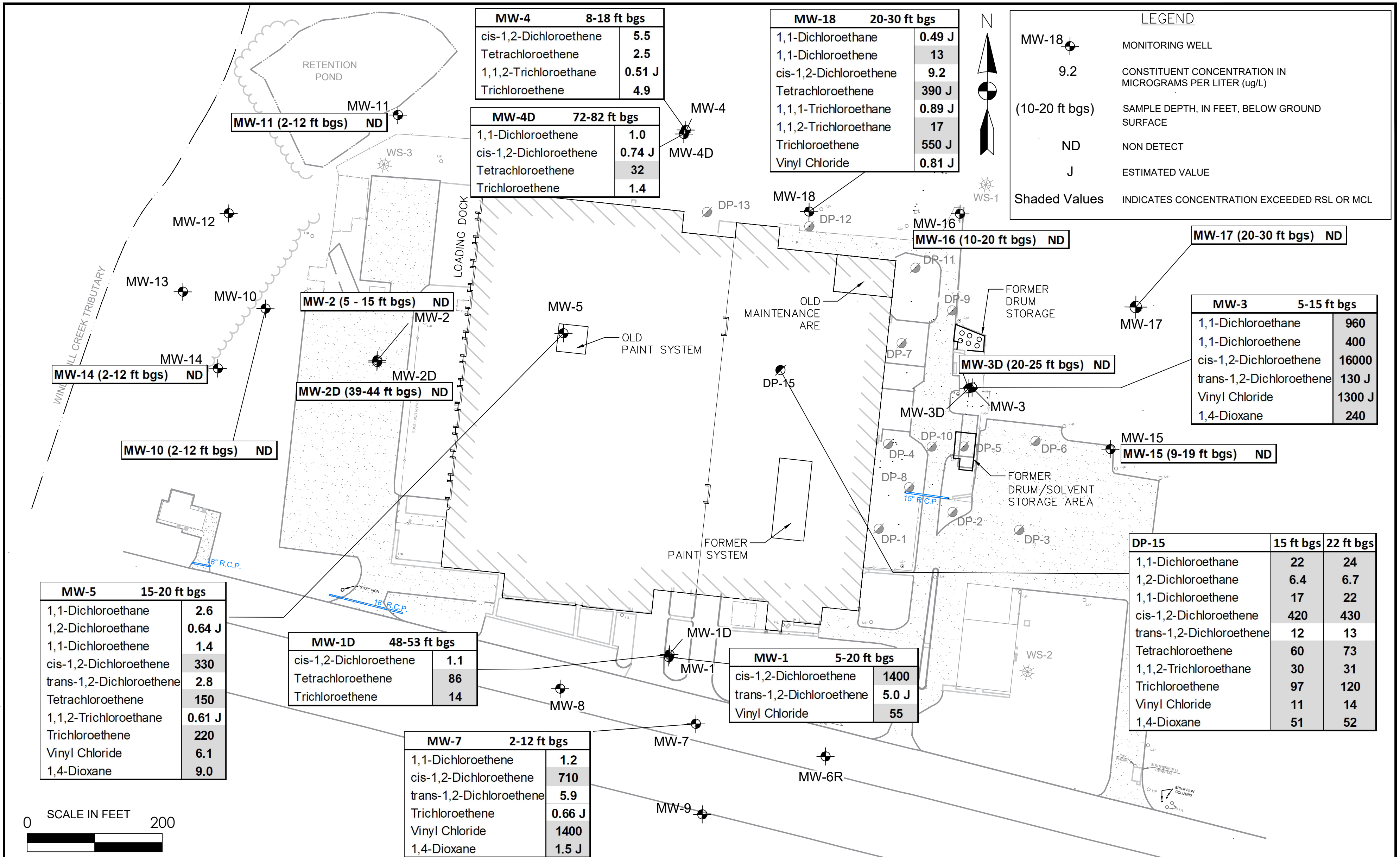
PROJECT NO. EC02.20160378.21

WSP USA

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

GROUNDWATER ANALYTICAL RESULTS
AROMATIC HYDROCARBONS
APRIL 2022

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



LEGEND

MW-18	MONITORING WELL
9.2	CONSTITUENT CONCENTRATION IN MICROGRAMS PER LITER (ug/L)
(10-20 ft bgs)	SAMPLE DEPTH, IN FEET, BELOW GROUND SURFACE
ND	NON DETECT
J	ESTIMATED VALUE
Shaded Values	INDICATES CONCENTRATION EXCEEDED RSL OR MCL

MW-11 (2-12 ft bgs) ND

MW-14 (2-12 ft bgs) ND

MW-10 (2-12 ft bgs) ND

MW-2 (5 - 15 ft bgs) ND

MW-2D (39-44 ft bgs) ND

MW-16 (10-20 ft bgs) ND

MW-17 (20-30 ft bgs) ND

MW-3D (20-25 ft bgs) ND

MW-15 (9-19 ft bgs) ND

MW-4	8-18 ft bgs
cis-1,2-Dichloroethene	5.5
Tetrachloroethene	2.5
1,1,2-Trichloroethane	0.51 J
Trichloroethene	4.9

MW-4D	72-82 ft bgs
1,1-Dichloroethene	1.0
cis-1,2-Dichloroethene	0.74 J
Tetrachloroethene	32
Trichloroethene	1.4

MW-18	20-30 ft bgs
1,1-Dichloroethane	0.49 J
1,1-Dichloroethene	13
cis-1,2-Dichloroethene	9.2
Tetrachloroethene	390 J
1,1,1-Trichloroethane	0.89 J
1,1,2-Trichloroethane	17
Trichloroethene	550 J
Vinyl Chloride	0.81 J

MW-3	5-15 ft bgs
1,1-Dichloroethane	960
1,1-Dichloroethene	400
cis-1,2-Dichloroethene	16000
trans-1,2-Dichloroethene	130 J
Vinyl Chloride	1300 J
1,4-Dioxane	240

DP-15	15 ft bgs	22 ft bgs
1,1-Dichloroethane	22	24
1,2-Dichloroethane	6.4	6.7
1,1-Dichloroethene	17	22
cis-1,2-Dichloroethene	420	430
trans-1,2-Dichloroethene	12	13
Tetrachloroethene	60	73
1,1,2-Trichloroethane	30	31
Trichloroethene	97	120
Vinyl Chloride	11	14
1,4-Dioxane	51	52

MW-5	15-20 ft bgs
1,1-Dichloroethane	2.6
1,2-Dichloroethane	0.64 J
1,1-Dichloroethene	1.4
cis-1,2-Dichloroethene	330
trans-1,2-Dichloroethene	2.8
Tetrachloroethene	150
1,1,2-Trichloroethane	0.61 J
Trichloroethene	220
Vinyl Chloride	6.1
1,4-Dioxane	9.0

MW-1D	48-53 ft bgs
cis-1,2-Dichloroethene	1.1
Tetrachloroethene	86
Trichloroethene	14

MW-1	5-20 ft bgs
cis-1,2-Dichloroethene	1400
trans-1,2-Dichloroethene	5.0 J
Vinyl Chloride	55

MW-7	2-12 ft bgs
1,1-Dichloroethene	1.2
cis-1,2-Dichloroethene	710
trans-1,2-Dichloroethene	5.9
Trichloroethene	0.66 J
Vinyl Chloride	1400
1,4-Dioxane	1.5 J

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox_Main_2022.dwg (Chlorinated VOC) 08/10/22 11:13 – 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

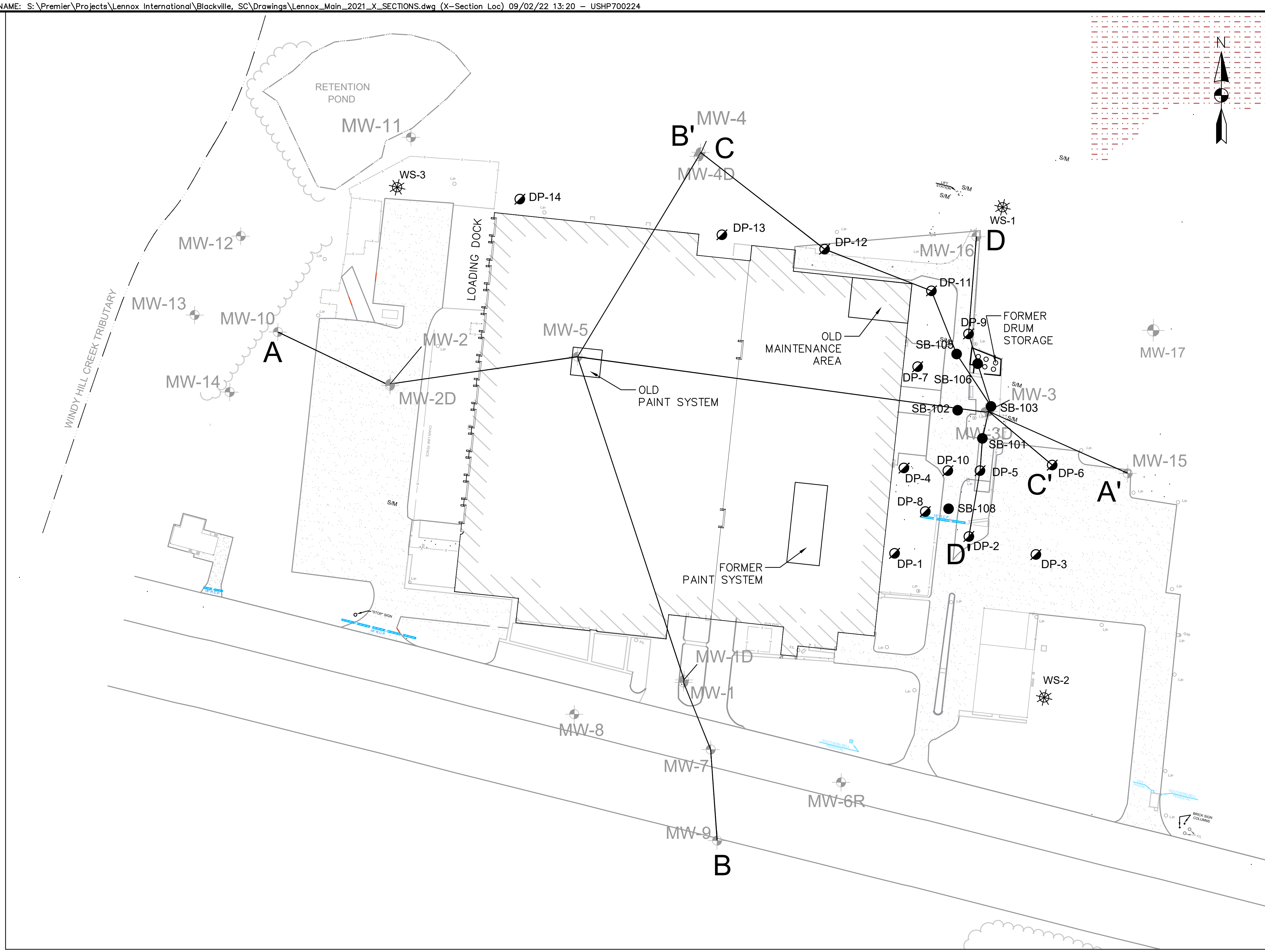
GROUNDWATER ANALYTICAL RESULTS CHLORINATED VOCs and 1,4-DIOXANE APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
HVP	MAB	08/10/2022	5

APPENDIX A

CROSS SECTIONS

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox_Main_2021_X_SECTIONS.dwg (X-Section Loc) 09/02/22 13:20 – USHP700224



LEGEND

MW-12 MONITORING WELL

WS-1 ABANDONED WATER SUPPLY WELL

FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA

BLWM FILE # 401356

PROJECT NO. 02.20160378.23

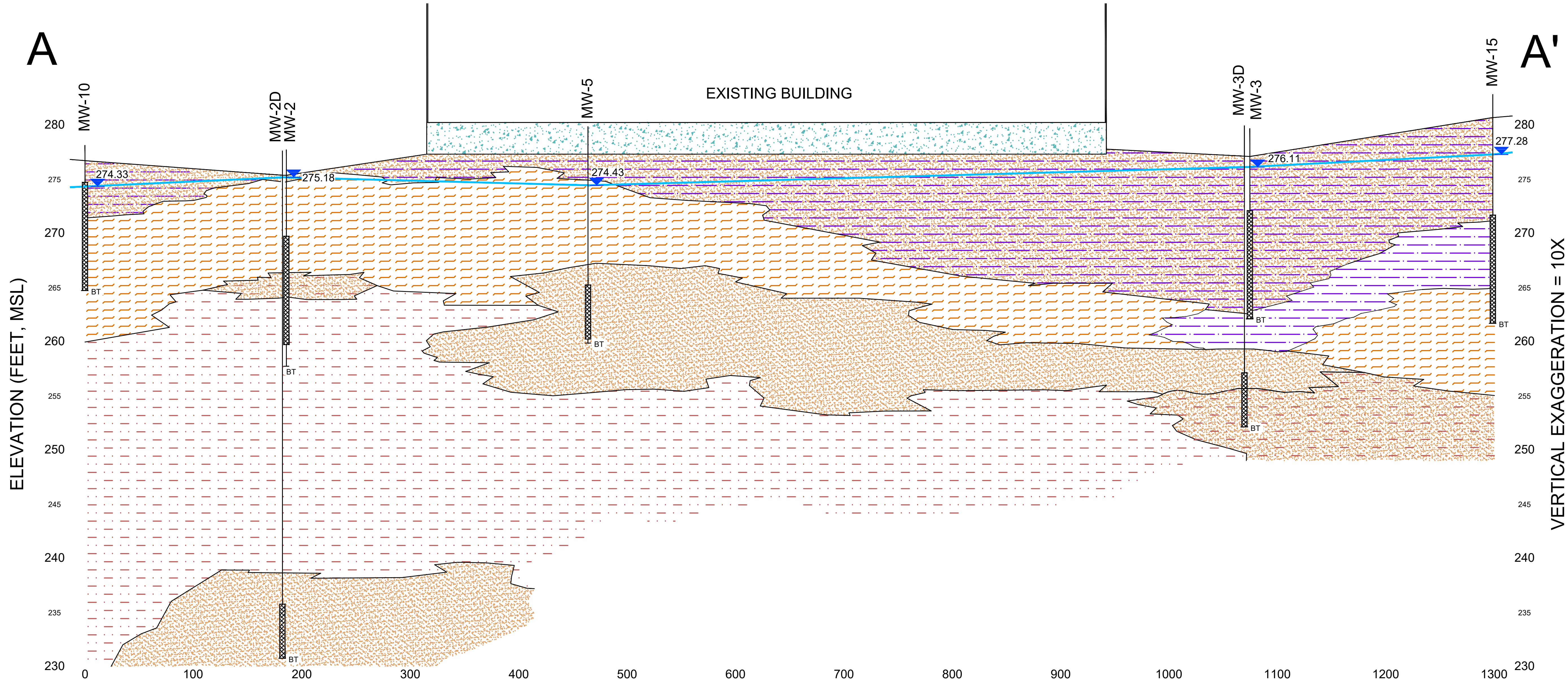
wsp

1880 WEST OAK PKWY, BLDG 100, STE 106,
MARIETTA, GA, 30062
770-973-2100

CROSS SECTION LOCATION MAP

DRAWN: HVP	CHECKED: AGL	DATE: 10/18/2021	FIGURE: A-1

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox_Main_2021_X_SECTIONS.dwg (X-Section A-A') 09/02/22 13:22 – USHP700224



LEGEND

	EXISTING BUILDING		SANDY SILT
	CLAYEY SAND		CLAY
	SILT / CLAYEY SILT		SILTY SAND
	SAND		GROUNDWATER ELEVATION (FEET, NAVD.88) APRIL 20, 2020
	SANDY CLAY		WELL SCREEN INTERVAL
		BT	BORING TERMINATED

FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA

BLWM FILE # 401356

PROJECT NO. 02.20160378.23

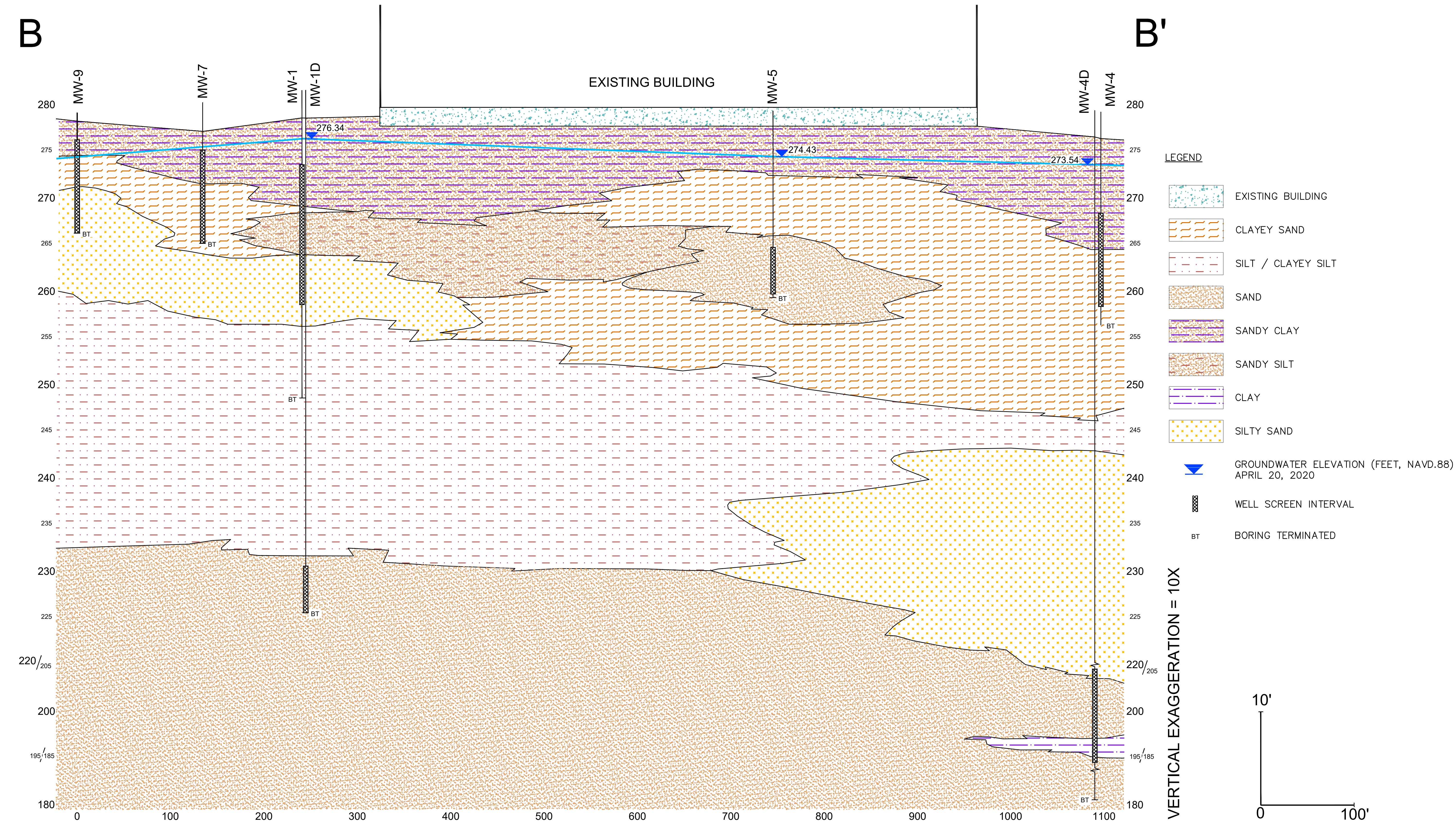
wsp

1880 WEST OAK PKWY, BLDG 100, STE 106,
MARIETTA, GA, 30062
770-973-2100

CROSS SECTION A-A'

DRAWN:	CHECKED:	DATE:	FIGURE:
HVP	AGL	10/25/2021	A-2

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox_Main_2021_X_SECTIONS.dwg (X-Section B-B') 09/02/22 13:24 - USHP700224



FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA

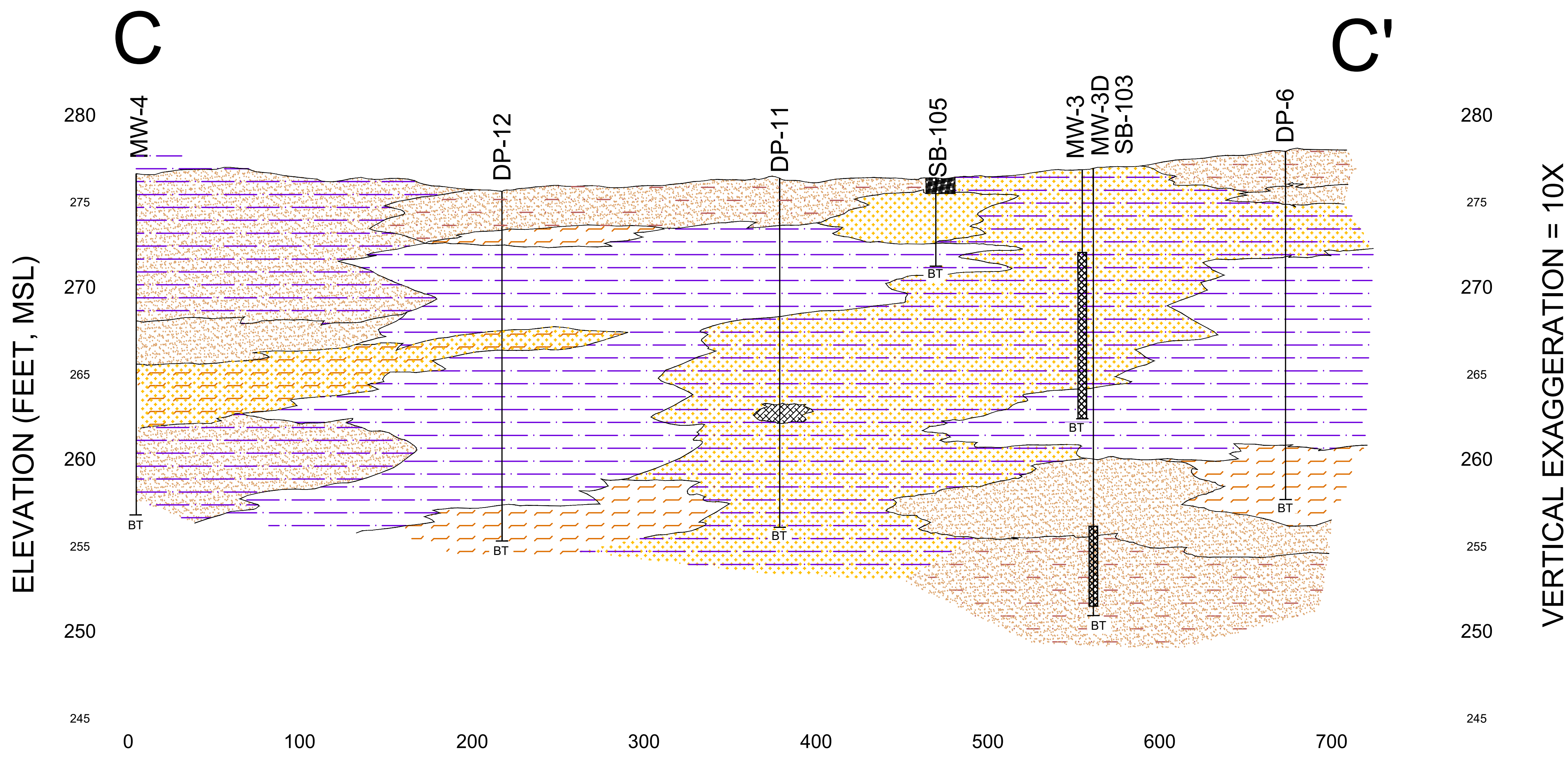
BLWM FILE # 401356

PROJECT NO. 02.20160378.23

1880 WEST OAK PKWY, BLDG 100, STE 106,
MARIETTA, GA, 30062
770-973-2100

CROSS SECTION B-B'

DRAWN: HVP	CHECKED: AGL	DATE: 9/3/2020	FIGURE: A-3



LEGEND

	SANDY CLAY		SANDY SILT		ASPHALT
	CLAYEY SAND		CLAY		DEGRADED WOOD
	SILT / CLAYEY SILT		SILTY SAND		SILTY CLAYEY SAND
	SAND		WELL SCREEN INTERVAL		
BT	BORING TERMINATED				

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

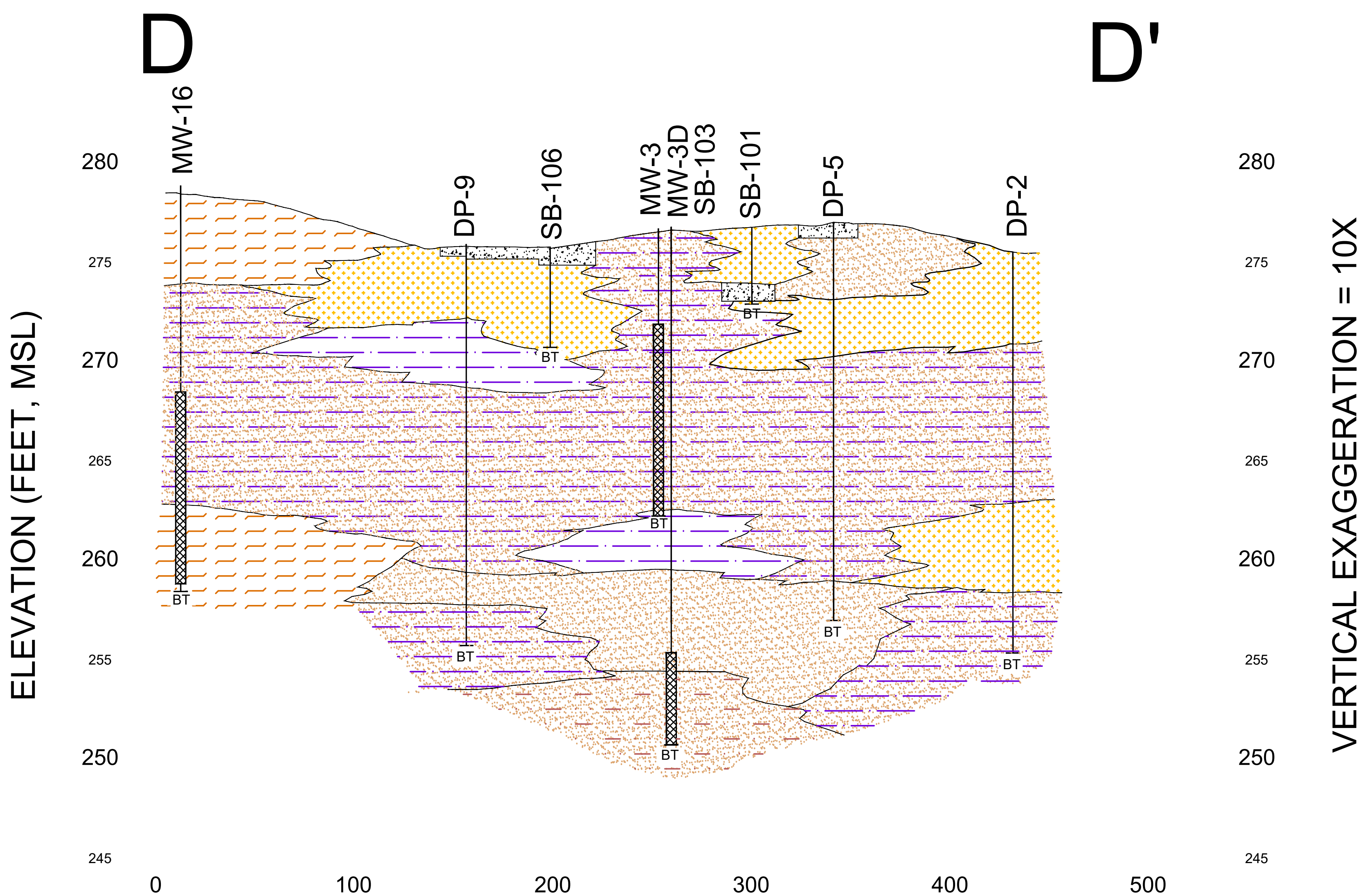
PROJECT NO. 02.20160378.23

wsp
1880 WEST OAK PKWY, BLDG 100, STE 106,
MARIETTA, GA, 30062
770-973-2100

CROSS SECTION C-C'

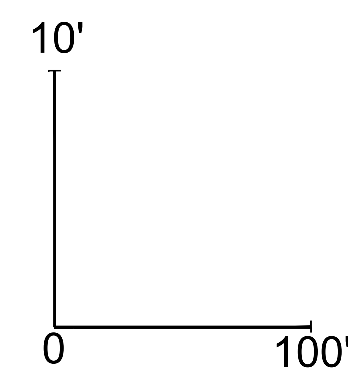
DRAWN:	CHECKED:	DATE:	FIGURE:
HVP	AGL	10/25/2021	A-4

FILE NAME: S:\Premier\Projects\Lennox International\Blackville, SC\Drawings\Lennox_Main_2021_X_SECTIONS.dwg (X-Section D-D) 09/02/22 13:18 - USHP700224



LEGEND

- CLAYEY SAND
- SANDY SILT
- SILT / CLAYEY SILT
- CLAY
- CONCRETE
- SAND
- SILTY SAND
- SILTY CLAYEY SAND
- SANDY CLAY
- WELL SCREEN INTERVAL
- BT BORING TERMINATED



FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA

BLWM FILE # 401356

PROJECT NO. 02.20160378.23

1880 WEST OAK PKWY, BLDG 100, STE 106,
MARIETTA, GA, 30062
770-973-2100

CROSS SECTION D-D'

DRAWN:	CHECKED:	DATE:	FIGURE:
HVP	AGL	10/19/2021	A-5

APPENDIX B

PLUME CONCENTRATION MAPS

LEGEND

Monitoring Well

Hanging Well

17 Concentration (µg/L)

NS (0.69) Well Not Sampled (Assigned Value Shown)

Plume Center of Mass

Control Point

FORMER DUCANE COMPANY SITE

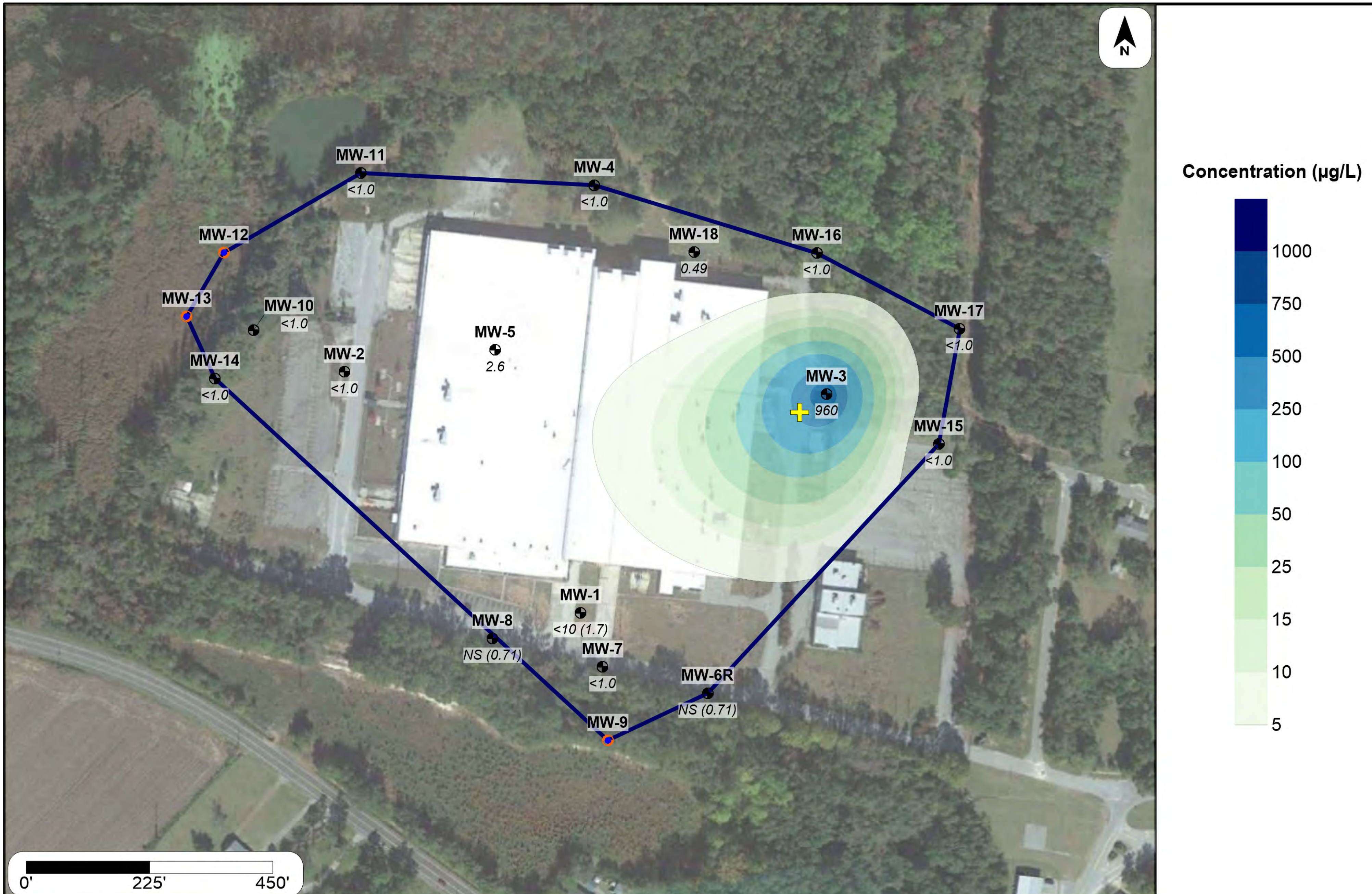
BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA
BLMW FILE # 401356

wsp

1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100

1,1,2-TCA CONCENTRATION MAP
UPPER SHALLOW
APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---



LEGEND

Monitoring Well

Hanging Well

960 Concentration (µg/L)

NS (0.71) Well Not Sampled (Assigned Value Shown)

Plume Center of Mass

Control Point

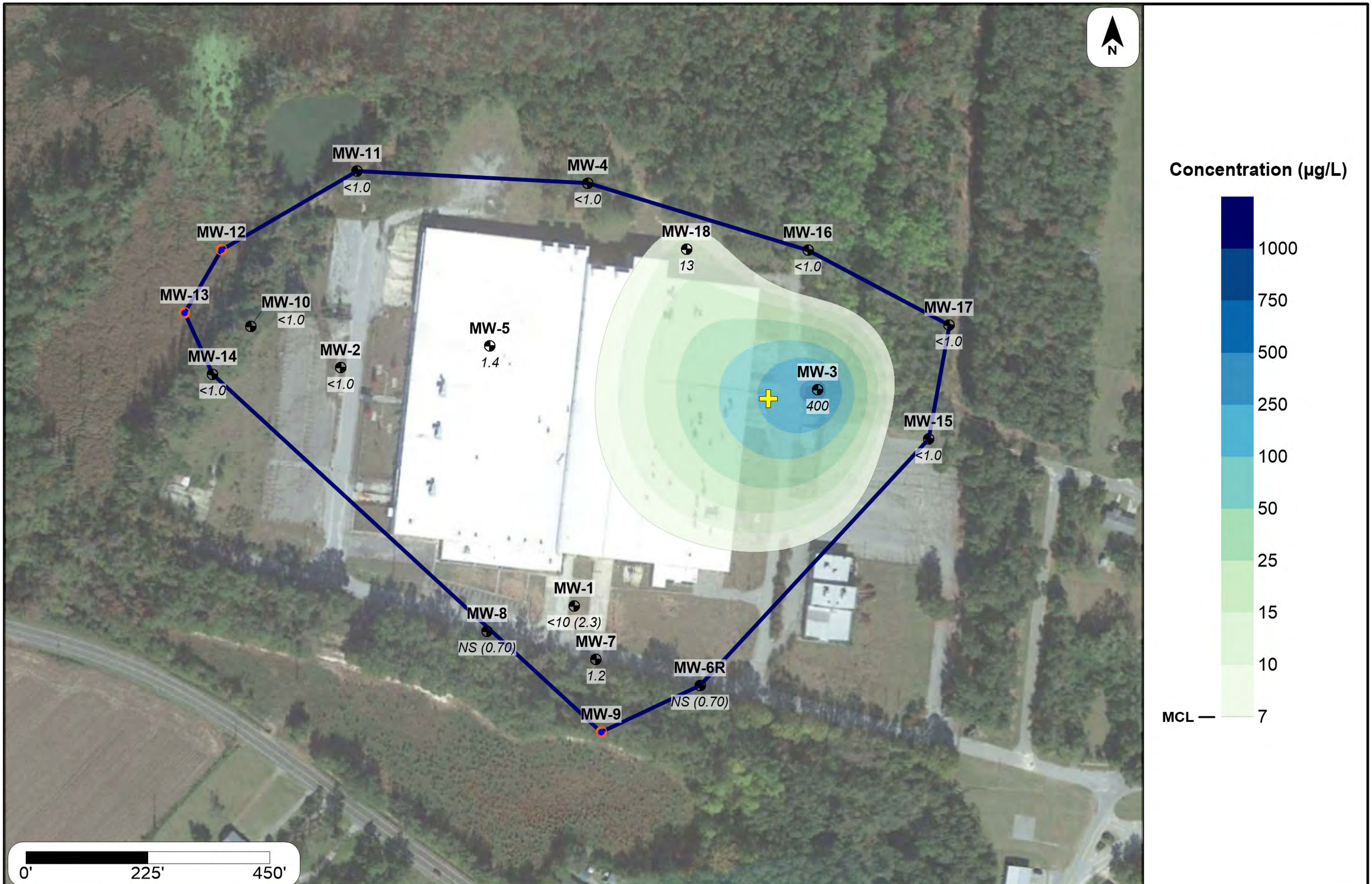
FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA
BLMW FILE # 401356

1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100

1,1-DCA CONCENTRATION MAP
UPPER SHALLOW
APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---



LEGEND

- Monitoring Well
- Hanging Well
- 400 Concentration (µg/L)
- NS (0.70) Well Not Sampled (Assigned Value Shown)
- Plume Center of Mass
- Control Point

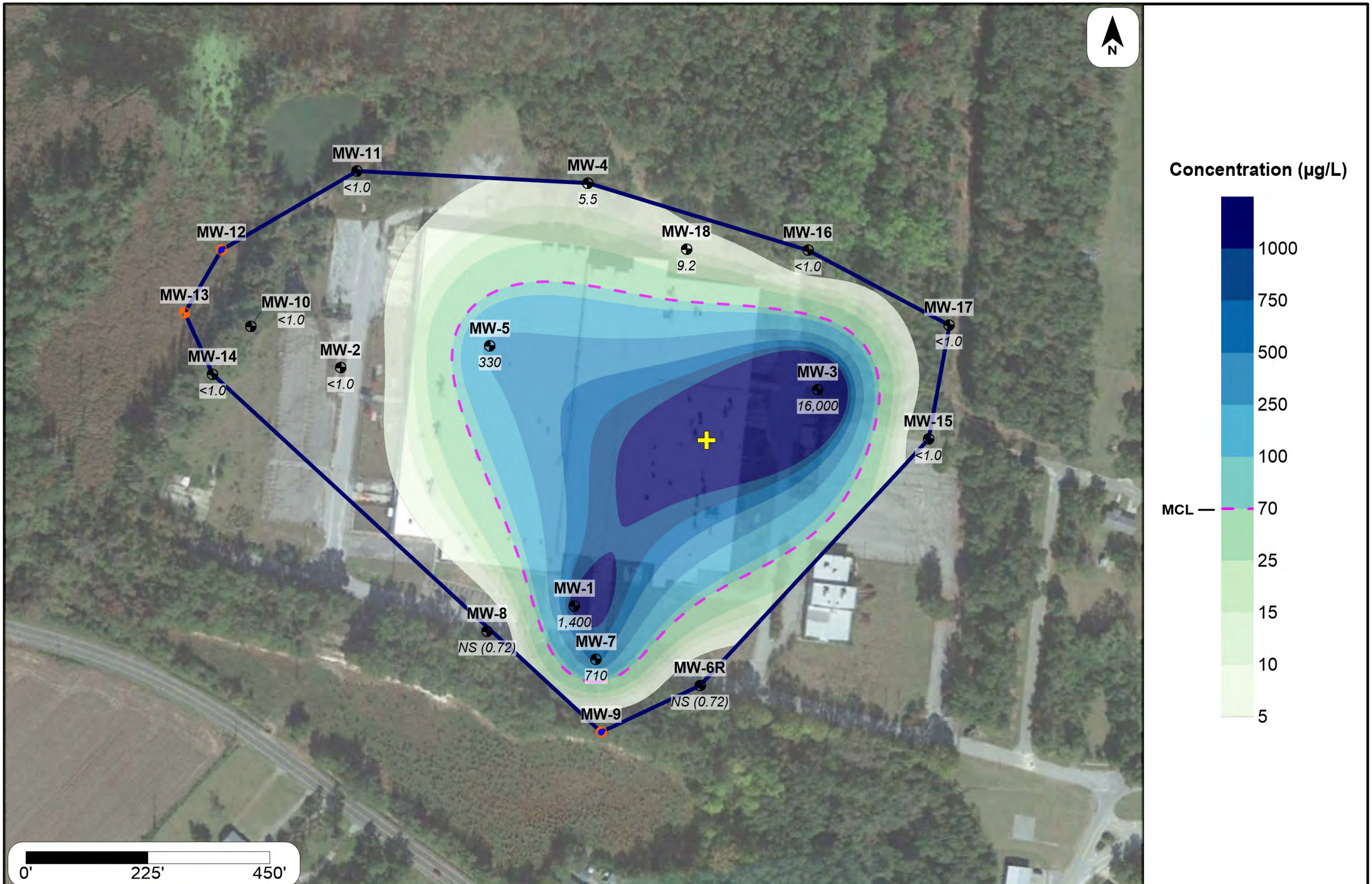
FORMER DUCANE COMPANY SITE

**BLACKVILLE, BARNWELL COUNTY,
SOUTH CAROLINA
BLMW FILE # 401356**

**1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100**

**1,1-DCE CONCENTRATION MAP
UPPER SHALLOW
APRIL 2022**

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---



LEGEND

- Monitoring Well
- Hanging Well
- 330 Concentration (µg/L)
- NS (0.72) Well Not Sampled (Assigned Value Shown)
- Plume Center of Mass
- Control Point

FORMER DUCANE COMPANY SITE

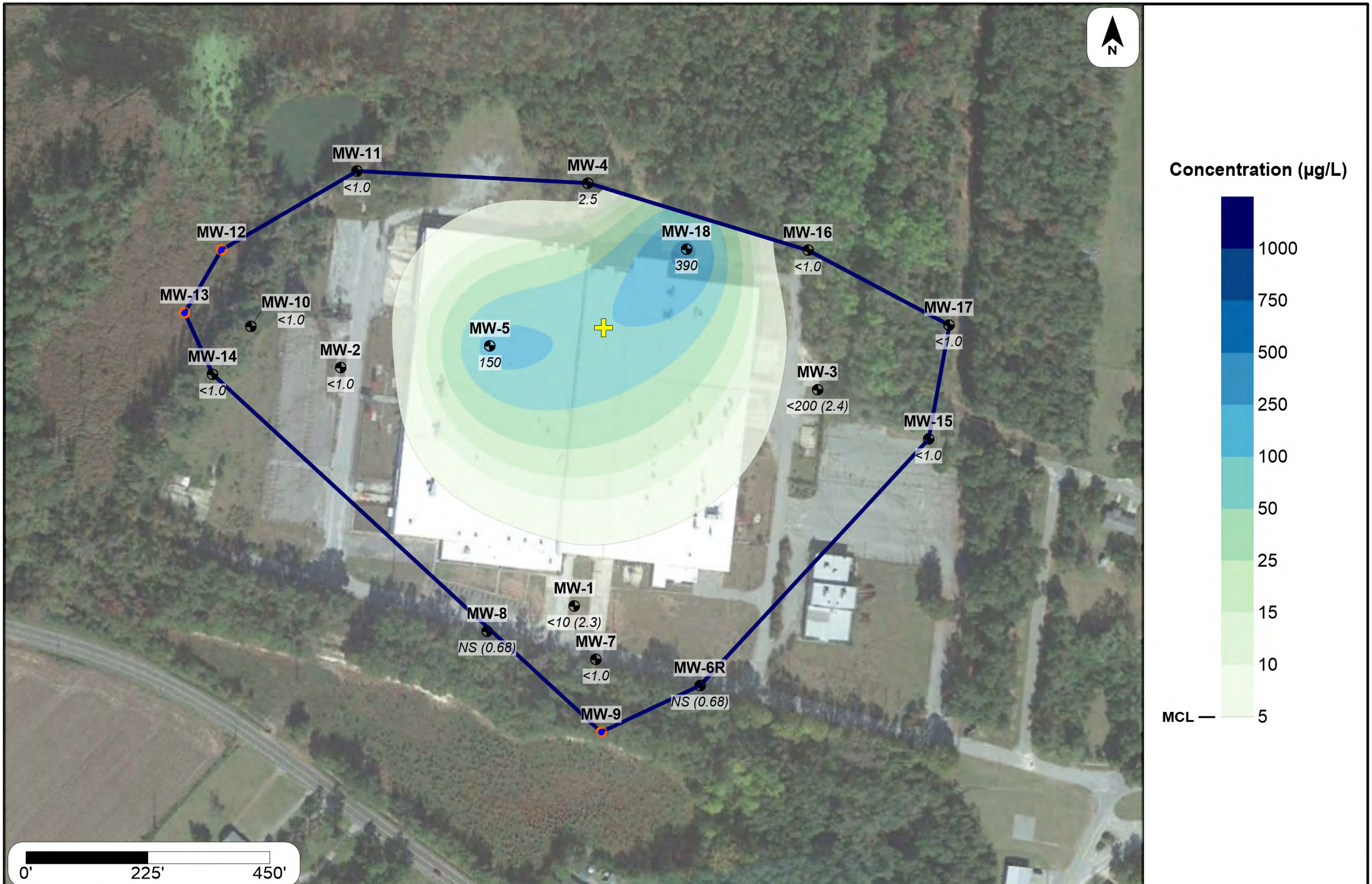
BLACKVILLE, BARNWELL COUNTY,
SOUTH CAROLINA
BLMW FILE # 401356

wsp

1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100

CIS-1,2-DCE CONCENTRATION MAP UPPER SHALLOW APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---



LEGEND

Monitoring Well

Hanging Well

390 Concentration (µg/L)

NS (0.68) Well Not Sampled (Assigned Value Shown)

Plume Center of Mass

Control Point

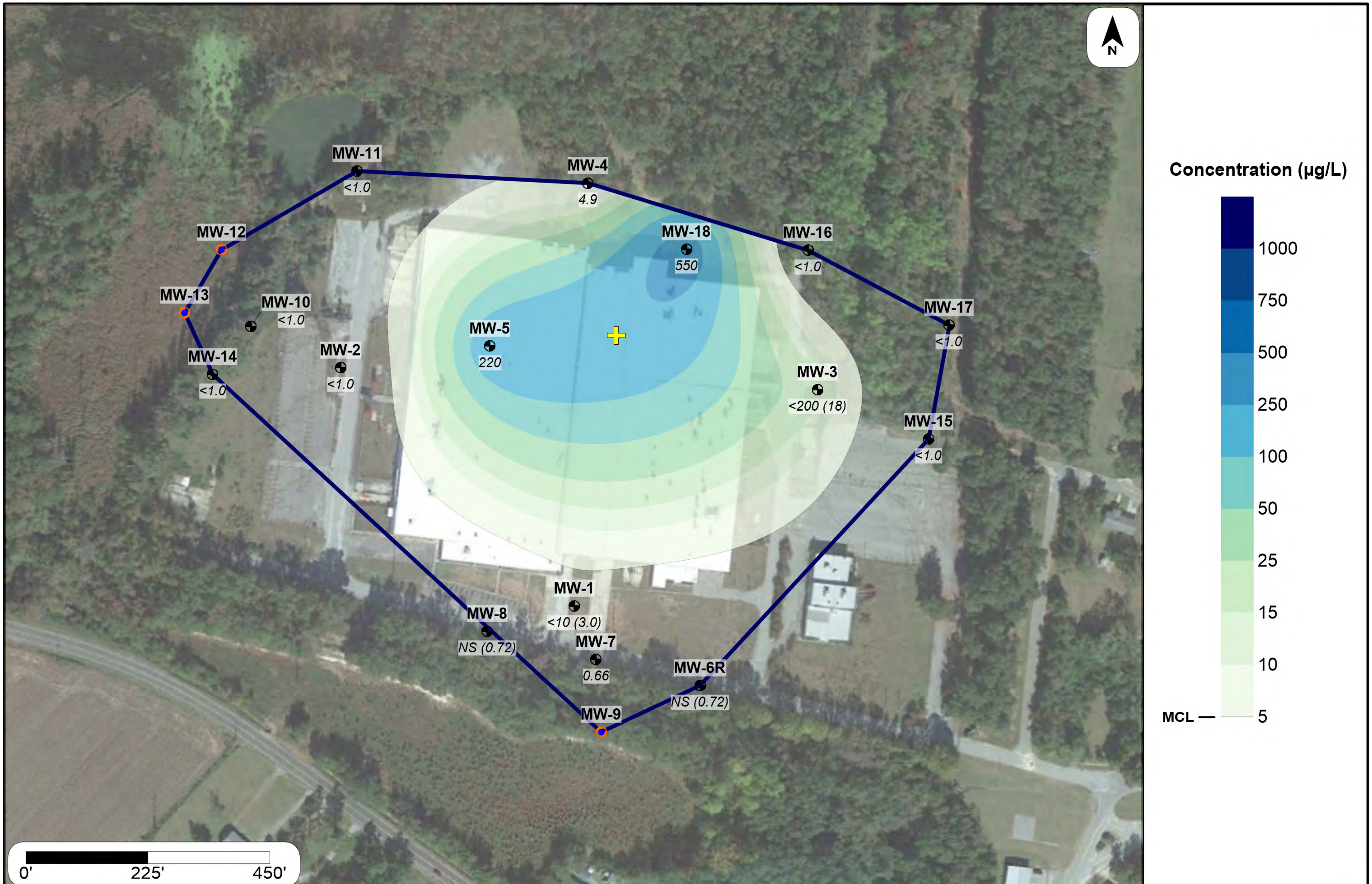
FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA
BLMW FILE # 401356

1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100

PCE CONCENTRATION MAP
UPPER SHALLOW
APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---



LEGEND

- Monitoring Well
- Hanging Well
- 220 Concentration (µg/L)
- NS (0.72) Well Not Sampled (Assigned Value Shown)
- Plume Center of Mass
- Control Point

FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA
BLMW FILE # 401356

wsp

1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100

TCE CONCENTRATION MAP UPPER SHALLOW APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---

LEGEND

- Monitoring Well
- Hanging Well
- 130 Concentration (µg/L)
- NS (0.73) Well Not Sampled (Assigned Value Shown)
- Plume Center of Mass
- Control Point

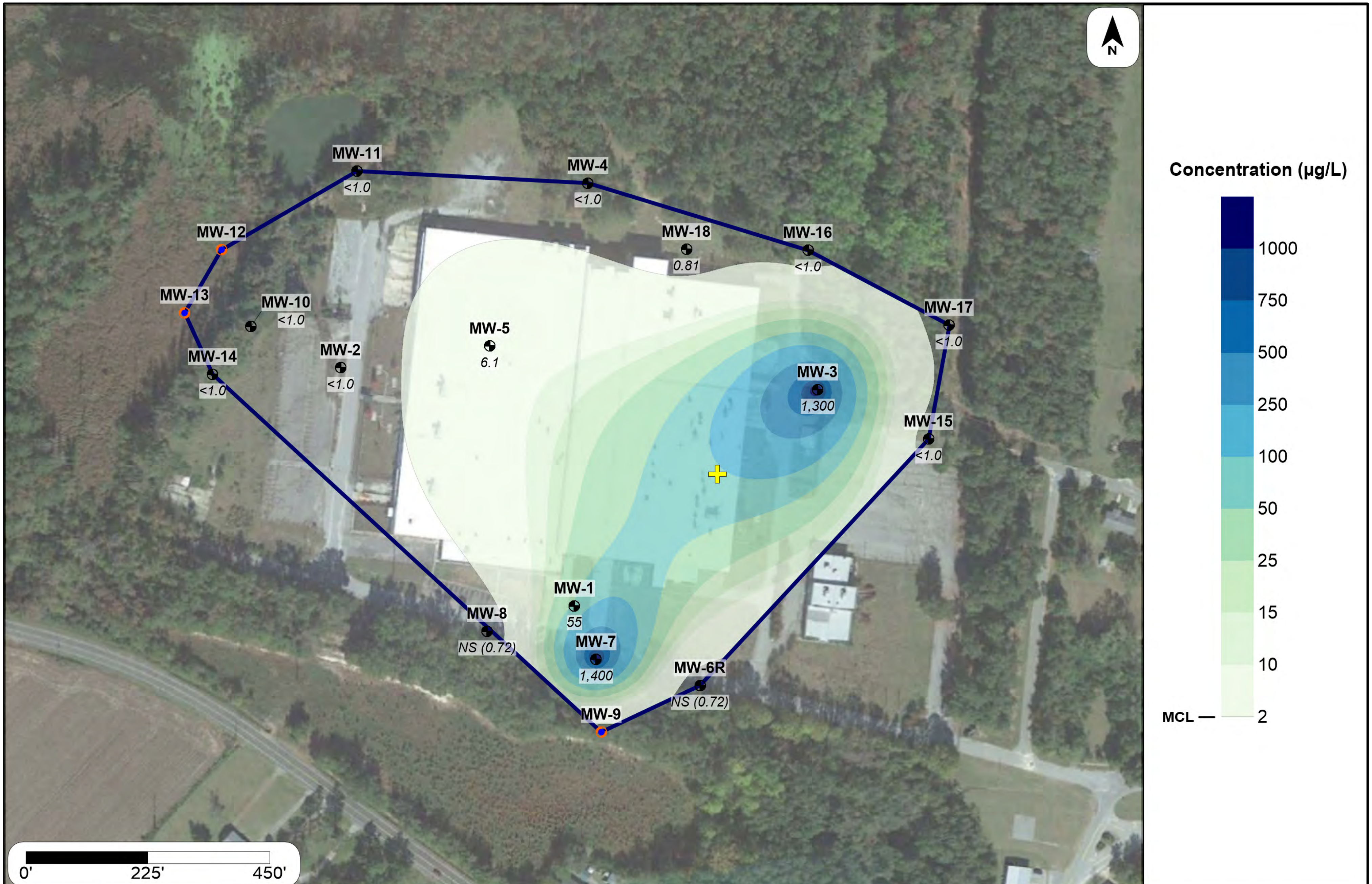
FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA
BLMW FILE # 401356

wsp
1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100

TRANS-1,2-DCE CONCENTRATION MAP UPPER SHALLOW APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---



LEGEND

- Monitoring Well
- Hanging Well
- 55 Concentration (µg/L)
- NS (0.72) Well Not Sampled (Assigned Value Shown)
- Plume Center of Mass
- Control Point

FORMER DUCANE COMPANY SITE

BLACKVILLE, BARNWELL COUNTY, SOUTH CAROLINA
BLMW FILE # 401356

wsp

1880 West Oak Pkwy. Building 100, Suite 106
Marietta, GA 30062
(700) 973-2100

VINYL CHLORIDE CONCENTRATION MAP UPPER SHALLOW APRIL 2022

DRAWN:	CHECKED:	DATE:	FIGURE:
LLT	---	08/29/2023	---

APPENDIX C

COST ANALYSIS

Order of Magnitude Cost - Alternative 3

SCOPE:

The remedial objective is to reduce elevated VOC concentrations in the vicinity of Treatment Area 1 (MW-3), Treatment Area 2 (MW-18), Treatment Area 3 (MW-7), and spot treatment (MW-4/4D and MW-1/1D). Spot treatment of these areas is proposed for the rough order of magnitude cost. The remedial action is limited and approximated based on the proposed technology, geology, treatment areas and assumptions shown below and will be adjusted based on actual design.

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	MNA Monitoring (5 years)	1	LS	$ 280,000	$ 280,000
2	ISCR Injection - 1st Round (22,500 SF)	1	LS	$ 856,829	$ 860,000
3	ISCR Injection - 2nd Round (22,500 SF)	1	LS	$ 193,216	$ 190,000
4	Final Summary Report	1	LS	$ 28,396	$ 30,000
				SUBTOTAL	**$ 1,360,000**
				CONTINGENCY (10%)	**$ 136,000**
				TOTAL	**$ 1,500,000**
				+25% Opinion of Probable Cost TOTAL	$ 1,875,000
				-25% Opinion of Probable Cost TOTAL	$ 1,125,000

Notes/Assumptions:

1 Assume CVOCs are COCs.
2 Three different areas for specific localized treatment of the plume. Assumes plumes are delineated.
3 Remedial treatment and design using in situ chemical reduction technology.
4 Baseline sampling on 5 monitoring wells , CVOC analysis.
5 Alternative 3 is assumed to be performed over two injection events (see below).
6 Application of treatment technology assumed to be performed using two well point clusters due to lithology (installed during 1st Round).
7 Assume permitting for Underground Injection Control (UIC) Permit
8 Assumes remedial objective is to reduce elevated concentrations.
9 Injection time is dependant on actual site conditions and operation times are assumed for OPC.
10 Utility is available (power and water)
11 Treatment Area 1- dimensions 75 ft length x 75 ft width x 20 ft in thickness
Treatment Area 2- dimensions 100 ft length x 75 ft width x 20 ft in thickness
Treatment Area 3- dimensions 100 ft length x 75 ft width x 20 ft in thickness
Deep Well Spot Treatment (MW-4D and MW-1D) - assume ~1,000 gals per location
12 Assumed % application of technology for treated area.

Assumed % application of technology for treated area.	1st Round	2nd Round
Treatment Area 1 (VOCs = 28,130ppb)	100%	50%
Treatment Area 2 (VOCs = 8,431ppb)	100%	25%
Treatment Area 3 (VOCs = 2,119 ppb)	100%	25%
Deep Well Spot Treatment (MW-4D and MW-1D)	100%	100%

* deep well treatment is limited to each well rather than an area.

13 Groundwater samples to be collected 30 days after injections.
14 Low flow-sampling assume 20 feet depth of bottom.
15 Analysis: VOCs by 8260 Volatile (ug/ml) for $70.00/sample
16 Analyses VOC at 5-day turnaround time (TAT)
17 Assumed to be performed over 1 year.
18 Assumed one report will be prepared for remedial efforts.
19 Assumed final sampling event performed in Task 4.
20 Does not include well abandoment activities.
21 Replacement Wells for MW-1D and MW-4D

Order of Magnitude Cost - Alternative 4

SCOPE:

The remedial objective is to reduce elevated VOC concentrations in the vicinity of Treatment Area 1 (MW-3), Treatment Area 2 (MW-18), Treatment Area 3 (MW-7), and spot treatment (MW-4/4D and MW-1/1D). Spot treatment of these areas is proposed for the rough order of magnitude cost. The remedial action is limited and approximated based on the proposed technology, geology, treatment areas and assumptions shown below and will be adjusted based on actual design.

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	MNA Monitoring (5 years)	1	LS	$ 280,000	$ 280,000
2	ISCR Injection - 1st Round (22,500 SF)	1	LS	$ 856,800	$ 860,000
3	Enhanced Bio and ISCR - 2nd Round (22,500 SF)	1	LS	$ 366,900	$ 370,000
4	Final Summary Report	1	LS	$ 28,400	$ 30,000
				SUBTOTAL	**$ 1,540,000**
				CONTINGENCY (10%)	**$ 154,000**
				TOTAL	**$ 1,700,000**
				+25% Opinion of Probable Cost TOTAL	$ 2,125,000
				-25% Opinion of Probable Cost TOTAL	$ 1,275,000

Notes/Assumptions:

1 Assume CVOCs are COCs.
2 Three different areas for specific localized treatment of the plume. Assumes plumes are delineated.
3 Remedial treatment and design using in situ chemical reduction technology.
4 Baseline sampling on 5 monitoring wells, CVOC analysis.
5 Alternative 4 is assumed to be performed over two injection events (see below).
6 Application of treatment technology assumed to be performed using two well point clusters due to lithology (installed during 1st Round).
7 Assume permitting for Underground Injection Control (UIC) Permit.
8 Assumes remedial objective is to reduce elevated concentrations.
9 Injection time is dependant on actual site conditions and operation times are assumed for OPC.
10 Utility is available (power and water)
11 Treatment Area 1- dimensions 75 ft length x 75 ft width x 20 ft in thickness
Treatment Area 2- dimensions 100 ft length x 75 ft width x 20 ft in thickness
Treatment Area 3- dimensions 100 ft length x 75 ft width x 20 ft in thickness
Deep Well Spot Treatment (MW-4D and MW-1D) - assume ~1,000 gals per location
12 Assumed % application of technology for treated area.

	1st Round	2nd Round
Treatment Area 1 (VOCs = 28,130ppb)	100%	100%
Treatment Area 2 (VOCs = 8,431ppb)	100%	100%
Treatment Area 3 (VOCs = 2,119 ppb)	100%	100%
Deep Well Spot Treatment (MW-4D and MW-1D)	100%	100%

* deep well treatment is limited to each well rather than an area.

13 1st Round ZVI only and 2nd Round Enhanced Bio with ZVI
14 Groundwater samples to be collected 30 days after injections.
15 Low flow-sampling assume 20 feet depth of bottom.
16 Analysis: VOCs by 8260 Volatile (ug/ml) for $70.00/sample
17 Analyses VOC at 5-day turnaround time (TAT)
18 Assumed to be performed over 1 year.
19 Assumed one report will be prepared for remedial efforts.
20 Assumed final sampling event performed in Task 4.
21 Does not include well abandonment activities.
22 Replacement Wells for MW-1D and MW-4D